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A comparison of seeking-finding behaviours across the contexts of environmental space, paper documents, and on-screen

Doctor of Philosophy

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Abstract

This thesis compares behaviour across three contrasting contexts: environmental space, paper documents, and on-screen. The behaviours examined are defined as *seeking-finding behaviours*: these comprise continuous, recursive sequences of choices made by an individual purposefully seeking and progressing towards a defined objective; these processes are constructive, dynamic, responsive, and interactive. Such behaviours may be more readily known as wayfinding, information-seeking, or navigating. The lack of a single term encompassing this group of behaviours is indicative of the paucity of previous research using this frame of reference. While there is discussion of seeking-finding in individual contexts, there is little comparing this behaviour between contexts, and none examining it across all three contexts. Comparing behaviours across contexts is facilitated here by the formulation of a taxonomy that creates categories of behaviour equally applicable to all three contexts. This taxonomy differentiates behaviours according to characteristics of the information driving them. In doing this, the taxonomy facilitates comparisons hitherto unrealised, and allows connections to be drawn across multiple disciplines. Behaviours in the three contexts are compared by using the taxonomy in the analysis of data from three studies of human behaviour. This analysis finds that interactions between categories of behaviour, and with the factors of individual, context, and task are complex and multi-dimensional. The conclusion is drawn that, when viewed through the lens of information source, seeking-finding behaviours *are* comparable across the contexts of environmental space, paper documents, and on-screen. Such comparisons can be revealing about behaviour in ways productive for both information design practice and research across several disciplines, affording new insights and connections. Furthermore, the questions that drive the taxonomy offer an approach for information designers to interrogate their choices when designing.

Declaration:

I confirm that this is my own work and the use of all material from other sources has been properly and fully acknowledged.

ANDREW BARKER

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1 / Introduction

This section states the agenda for the thesis. It starts with the principal and secondary research questions. This is followed by definitions of key terms, and a discussion of frames of reference. The latter begins with an explanation as to why I have chosen to undertake this research, and then outlines the issues that shape the approach to the research questions. This section proceeds with a brief overview of relevant research and practice literature, indicating aspects that suggest answers to the research questions. Finally, I outline how the rest of this thesis approaches the research questions.

If you are the kind of person who wants to know the 'why' of this research before knowing the 'what', then please see section 1.3.1.

1.1 / Research questions

The principal question that this research aims to examine is:

In what ways are seeking-finding[1] behaviours[2] comparable across the contexts[3] of environmental space, documents printed on paper, and on-screen?

The research also aims to answer the secondary question:

What are the relationships between choice of seeking-finding behaviour, and the variables of individual, context, and task?

1 The term 'seeking-finding' is discussed in section 1.2.1.
2 The term 'behaviour' is discussed in 1.2.2.
3 The term 'context' is discussed in section 1.2.3.

1.2 / Discussion of key terms

This section contains definitions of key terms used in the research questions, and other terms critical to the discussion in subsequent sections. In so doing it also sets some limits on aspects of the scope of this research. Further clarification of scope comes with the discussion of key frames of reference in 1.3.

1.2.1 / What do I mean by 'seeking-finding'?

Seeking-finding comprises the continuous, recursive series of choices made when an individual purposefully seeks and progresses towards a defined objective. The process is taken to be constructive, dynamic, responsive, and interactive.[4]

To paraphrase Carpman and Grant (2002), defining seeking-finding is one thing, explaining it is another.

The neologism 'seeking-finding' encompasses the behaviours investigated in this research: no existing term could be found serving the purpose in all contexts. The behaviours included are more typically called *wayfinding* in environmental space, and both *information seeking* and *navigation* in documents printed on paper and on-screen. There are many definitions of those terms, some of which have been instrumental in formulating the definition of seeking-finding. Navigation, which first glance might suggest is a suitable candidate given its use in all three contexts, is rejected though because some key authors, such as Golledge (1999: 6–7), explicitly define navigation as different to wayfinding, and consequently, it is possibly *not* the same as seeking-finding in environmental space, and using it could be confusing.

1.2.2 / What do I mean by 'behaviour'?

Behaviour is broken down into three dimensions by Carliner (2003: 45):

- Physical
- Cognitive (intellectual)
- Affective (emotional)

This thesis is concerned principally with the first of these: with observable physical actions, but I acknowledge – and discuss where necessary – cognitive and affective dimensions.[5]

4 This definition is indebted principally to definitions in Gomez, Rousset, and Baciu (2009); Conroy (2001: 23–27); Brown (2003); Allen (1999a); Golledge (1999); Miller and Lewis (1999: 13); Carlson (1997: 74); Pressley and Afflerbach (1995); Passini (1984).

5 That physical and cognitive activity are entwined is emphasised in the term 'perceptual-enactive' used

In this thesis the term *behaviour* refers principally to this physical aspect of a person–environment interaction. I take the position that understanding such a physiological event in a person's life is enhanced when examined in conjunction with the circumstances in which it occurs (Parsons and Tassinary 2002). Such consideration of circumstances is largely contained in discussions prompted by the secondary research question examining the relationships behaviour has with task and context. This attention to how circumstances influence behaviour is informed by the *theory of setting* (Garner 1990) and the concept of *conditional knowledge* (Paris, Lipson, and Wixson 1983). The former proposes that when situation or circumstances vary, the nature of the behaviour is likely to vary as well. And the latter identifies the understanding that guides the individual in knowing when to apply items of procedural or declarative knowledge (here, specifically which seeking-finding behaviours to engage), which enables one to act strategically: '**conditional knowledge includes knowing both when and why to apply various actions**' (p.239). When considering everyday experience of seeking-finding, these suggest not only that there will be differences in how individuals execute the same task (inter-individual difference), but that the same individual may behave differently in trying to achieve the same objective if the circumstances are different (intra-individual difference). The relationship between behaviour and circumstances is a theme that runs throughout this thesis: it emerges in discussions of data from the three user studies in sections 4–6,[6] and it is examined explicitly in section 8. One finding is the variety of courses of action that individuals take, which suggests that conditional knowledge – as used in everyday life – is highly complex.

Behaviours can also be examined at different scales. My research examines behaviours at a relatively small scale: 'tactics' as defined in Marchionini (1995).[7]

One aspect of seeking-finding behaviour – information seeking – is extensively researched in library and information science. The survey by Fidel (2012) raises reservations about this body of research: she notes variations in

in Carlson (1997: 49): '**Perceptual-enactive skills are those that involve movement and physical action on the environment, guided by information currently available to perception. I use the term enactive rather than motor to emphasize the cognitive, intentional character of such skills**', and '**In many perceptual-enactive skills, performance is essentially continuously supported by information available to perception, which specifies the course of performance relative to standards defined over space and time. There are really two points here: First, in perceptual-enactive skills, feedback is usually available for many intermediate stages of performance, if not continuously. Second, perceptual-enactive skills are necessarily organised in space and time.**' While some may find the phrase 'information available to perception' somewhat awkward, I understand it to mean the individual's sensory input from the environment which that individual interprets and uses to inform their actions. Carlson is also of note in terms of this thesis for his emphasis on the *information* used to drive action – this emphasis is key to the taxonomy of seeking-finding behaviours that is introduced in section 2 and which informs the rest of the thesis.

6 The three user studies are described in section 3.

7 The issue of scale is discussed in 1.2.4.

levels of abstraction and differences in understanding of key terms between studies, and a lack of coherence in the overall picture generated, making it difficult to draw general conclusions. Fidel's observations are applicable more generally to the body of research discussing seeking-finding behaviour in all contexts.[8]

1.2.3 / What do I mean by 'context'?

This research examines seeking-finding behaviour in three different contexts:

- Man-made environmental space
- The space of documents printed on paper
- On-screen space

When *context* is used in this thesis, it generally refers to these three sorts of spaces. In order to avoid confusion, the term is employed with its more general meaning only when unavoidable. The circumstances of use in each instance should make clear whether it is being used with its general or specific meaning.

These three contexts are defined in more detail below, but one feature they have in common is that each is '"a space" where the public meets the message' (Frascara 2006). In all three contexts, the information that drives seeking-finding behaviour may employ any mode of symbolisation and any method of configuration (applying the schema developed by Twyman 1979).

Man-made environmental space

The environmental spaces considered here are those that have been subject to human intervention in some way. These include indoor and outdoor spaces, urban environments, and anywhere the natural environment has been modified by mankind – even a seeming wilderness that contains a track worn by human feet contains evidence of activity that can be used as information in seeking-finding. Many studies of seeking-finding in environmental space address public spaces or spaces that many people access.

This context is generally referred to as *environmental space* throughout for reasons of concision.

The space of documents printed on paper

The wording might seem unnecessary redundant in including both *printed* and *on paper* but, in briefing participants for the diary keeping study,[9] I found that they often mistakenly took the terms 'printed documents' and 'paper documents' to include documents viewed on-screen.[10] The phrase 'documents

8 As becomes clear in the literature survey reported in 1.4, 2.3, and 2.4.2.

9 See 3.3.

10 Somewhat supporting the findings of comprehension problems with non-redundant text in Fyfe and Mitchell (1985).

printed on paper' clarified the meaning. Nonetheless, for reasons of brevity, this context is referred to throughout as *paper documents*.

Not all paper documents are included here. I consider only those that (i) cannot be viewed in their entirety at once in a single view, or (ii) whose structure is sufficiently complex to require acts of seeking-finding to locate specific items within them. Neither reading a long, multi-page document as a single continuous narrative from start to finish, nor using a document comprising a single small sheet is the main focus of this research because the seeking-finding demands in these situations are minimal. Documents considered here comprise either one large sheet or multiple pages.

The prediction made in Nielsen (2000: 5) that 'we have to wait until approximately the year 2007 for books to go away and be fully replaced with online information' has proved not accurate. Although the technologies driving on-screen displays have developed considerably in the intervening years, paper documents continue to be present in our lives. And while factual information is largely sought elsewhere,[11] paper documents are still used for seeking-finding, albeit in much reduced amounts.[12]

On-screen space

The on-screen spaces considered here display 'document(s)' that are typically sets of hyperlinked pages, possibly dynamically generated. In addition to the most obvious things – websites, databases, e-books, and apps – this category includes other digital devices that the user interacts with to access content viewed on a screen. The view on-screen may be either illusionistically spatial, or it may be semantic. The list of product platforms by Cooper, Reimann, et al. (2014: 205–206) reflects this scope:

- Desktop software
- Websites and web applications
- Mobile devices such as phones, tablets, and digital cameras
- Kiosks
- In-vehicle systems
- Home entertainment systems such as games consoles, TV set-top boxes, and stereo/home entertainment systems
- Professional devices such as medical and scientific instruments

11 'Penguin's MD Stefan McGrath called me "People have stopped buying dictionaries", he said, "there's this thing called Wikipedia. ..." And there it was: the dictionary had become the first victim of the digital explosion in publishing.' Sudjic (2014: 16–17). Working in publishing for the past three decades, I have seen first-hand the impact of on-screen information sources on reference publishing.
12 See the data from the diary keeping study in sections 5–8 for an insight into the current state of seeking-finding in paper documents, and see also Keim (2014).

They continue: 'Looking at this list, you may notice that "platform" is not a precisely defined concept. Rather, it is shorthand used to describe a number of important product features, such as the physical form, display size and resolution, input methods, network connectivity, operating system, and database capabilities' (p.206). Later, in discussing 'other devices', they give the following list: embedded systems, such as TVs, microwave ovens, automobile dashboards, cameras, bank machines, and laboratory equipment, are unique platforms with their own opportunities and limitations' (p.555). The use of straightforward hyperlinked documents is much studied; the case study in Veyrune (2009), taking a public transport ticket-vending machine as its subject, is a rare examination of one of the 'other devices' from an information design point of view.

Throughout this thesis this context is generally referred to as *on-screen*.

1.2.4 / Scale

Scale can refer to two different factors in seeking-finding: the *environment* in which the seeking-finding occurs or the observed seeking-finding *behaviour* itself. Both are germane to a discusssion of seeking-finding behaviour, but scale of behaviour emerges as particularly critical and recurs repeatedly in this thesis. When scale is discussed here, it is scale of behaviour that is meant. When scale of environment is being referred to, this is explicitly stated.

Scale of behaviour

Seeking-finding behaviours identified in research literature vary considerably in scale from one study to another. They range from the small scale of 'use back arrow' (Cromley and Azevedo 2008: 305) and 'inferring the referent of a pronoun' (Pressley and Afflerbach 1995: 46) to the large scale of choosing routes where there are more people (Zacharias 2006: 11) or skimming as a reading behaviour (Pugh 1979: 434).

Four scales of behaviour are proposed by Marchionini (1995: 72–74). Although formulated for information seeking in electronic environments, these categories are more broadly applicable and are used throughout this thesis. From largest to smallest, Marchionini's scales of behaviour are:

- *Patterns* (groups of strategies or tactics which a person applies to a particular category of problem)
- *Strategies* (the approach a person takes to a particular problem, 'sets of tactics')
- *Tactics* ('discrete intellectual choices')
- *Moves* (discrete actions such as clicking a mouse or walking to a shelf)

The categories sometimes have fuzzy boundaries, but they provide a useful means for thinking about scales of behaviour. Research examining seeking-finding behaviour spans this entire range but is predominantly larger scale.

The terms *social*, *rational*, *cognitive*, and *biological* describe four scales of behaviour as proposed by Pirolli (2008). These have specific durational time-scales: *social* behaviours operate from months to days, *rational* from hours to minutes, *cognitive* from 10 seconds to 100 milliseconds, and *biological* at 1 millisecond. In general, the research surveyed for this thesis examines behaviours that fall into the scale categories of *rational* and *cognitive*.

I concentrate on behaviours at Marchionini's *tactic* scale (which equates to the longer end of Pirolli's *cognitive* scale). In the literature survey, differences in scale emerge as an ongoing issue in research; and my decision to examine behaviour at tactic scale emerged through (i) reflecting on the approach to answering the research questions, (ii) the literature survey, and (iii) conducting the first user study (the task observation).[13] It is also worth noting that the categories of behaviour in the taxonomy, although they have all been formulated to work at tactic scale, may be applicable to other scales.

Scale of environment

Researchers have proposed many ways of thinking about the scale of physical space. I shall consider three models that describe scales of physical space: Tversky (2005), Previc (1998), and Montello (1993). All consider how physical space relates to the body and physical action, and all create four scales of space.

The scales of space by Tversky (2005) are: (i) the space *of the body*, (ii) the space *around the body*, (iii) the space *of navigation*, and (iv) the space *of external representations*. While the first three show increasing physical scale, the fourth relates to the others differently. This last category of space includes representations, such as maps and diagrams, and so contains the types of information that drive semantic seeking-finding behaviours,[14] and allows the offloading of cognitive processing.[15] As with the two following models, paper documents and on-screen spaces are not in the same category of scale as environmental space. They are small manipulable objects, smaller than the individual and readily classed in *the space around the body*. Whereas environmental space is larger than the individual and containing him or her, and here classed as *the space of navigation*. How this category difference may affect the answering of the research questions is discussed below.

Previc's (1998) model, comprises four realms at different physical scales, with each realm associated with a type of physical activity and distinct cortical

13 See 3.2 for a description of this study.

14 Discussed in sections 2 and 5 of this thesis.

15 Discussed in Clark (1997) and Kirsch (1995); and see 1.3.5.

network: (i) *peripersonal* (visuomotor operations in near-body space), (ii) *focal extrapersonal* (visual search and object recognition), (iii) *action extrapersonal* (orienting in topographically defined space), and (iv) *ambient extrapersonal* (orienting in earth-fixed space). As with Tversky's (2005) model, the three contexts under consideration here are in different realms: paper documents and on-screen spaces are readily classed as *peripersonal* space, whereas environmental space is most readily classed as *extrapersonal* space (of any of the three types). Given the connections of these different spaces with activity in different regions of the brain, it suggests a fundamental difference between seeking-finding in environmental space and in paper documents or on-screen.

The final model of spatial scale by Montello (1993) is derived from a survey of studies of spatial scale. From smallest to largest the four scales are:

- *Figural* (small relative to the body, can be apprehended from a single viewpoint; includes both flat pictorial space and volumetric object space that can contain small manipulable objects of the sort often associated with tests of spatial ability).
- *Vista* (larger than the body, can be apprehended from a single viewpoint; the space of single rooms, town squares, small valleys, and horizons).
- *Environmental* (larger than the body and surrounding it, too large to be apprehended from a single viewpoint, so to be seen it requires locomotion and the integration of information over time; the space of buildings, neighbourhoods, and cities).
- *Geographic* (larger than the body, cannot be apprehended by locomotion but requires learning via symbolic representations, such as maps and diagrams, that reduce it to figural space; the space of states, countries, and solar systems).

As with the two previous models, paper documents and on-screen spaces are in a different class of scale (figural) to environmental space (environmental and geographic).

All three models create a distinction between environmental space on the one hand, and paper documents and on-screen spaces on the other; and Previc (1998) further suggests cognition within the different scales is accompanied by neural activity in different regions of the brain. These points suggest fundamental differences between contexts, which could have a bearing the comparability of behaviour across those contexts. And both Previc (1998) and Montello (1993) question the comparability of behaviour at different spatial scales.

However, interacting with paper documents and on-screen spaces *is* comparable with environmental spaces in terms of scale in that the entire space on-screen or in a paper document cannot be apprehended in single view. We cannot simultaneously look at *all* the pages in a book, nor can we simultaneously look at *all* the pages in a website, any more than we can simultaneously see inside all the rooms in a building. Not being able to (i) apprehend my objective from my starting point, nor (ii) see the entire path taken from any point along that path, nor (iii) see the entire space at once: all are germane to the relationship between the space and seeking-finding within it, and are common to all three contexts.

Furthermore, although the survey of research by Hegarty, Montello, et al. (2006) suggests that different brain structures and mechanisms are employed in spatial activities at different scales, their own studies lead them to conclude that there is a stronger relationship between spatial behaviours at different scales than might have been suggested by earlier studies. In particular, abilities relating to (i) the encoding of spatial information from visual input, (ii) maintenance of spatial representations in working memory, and (iii) inferences from spatial representations: these are shared by spatial behaviours at large and small scales, and all are applicable to seeking-finding behaviour in all three contexts.

A sizeable portion of research into spatial behaviour is conducted at the figural scale.[16] As the discussion above suggests, caution must be exercised in assuming that spatial behaviour at small scales is a reliable predictor of spatial behaviour at larger scales: it may be in *some* circumstances.

As well as research that takes small-scale spatial tasks as predictive of large-scale spatial behaviour, some studies use virtual environments to stand in for 'real' environmental space. This can be driven by the wish to exercise more control over variables in the environment than is possible in the messy, unreliable, real world. In such studies, virtual environments range from a simple sequence of photographic prints,[17] through film or video shown on a monitor,[18] and interactive virtual environments shown on a monitor,[19] to more fully immersive environments.[20] Studies using materials such as a sequence of photographic prints or video shown on a monitor are subject to the questions raised above about the applicability of research in the figural scale to behaviours in larger scales.

One important difference between virtual environments and 'real'

16 E.g. Farran, Courbois, et al. (2012); Rodgers, Sindone, and Moffat (2012); Woollett and Maguire (2010); Gomez, Rousset, and Baciu (2009); Tversky and Hard (2009); Peña, Contreras, et al. (2008); Parush and Berman (2004); Wiener, Schnee, and Mallot (2004); Devlin and Bernstein (1995); Magliano, Cohen, et al. (1995).

17 E.g. Magliano, Cohen, et al. (1995).

18 E.g. Woollett and Maguire (2010); Gomez, Rousset, and Baciu (2009).

19 E.g. Farran, Courbois, et al. (2012); Rodgers, Sindone, and Moffat (2012); Parush and Berman (2004).

20 E.g. Henry and Polys (2010); Kelly, McNamara, et al. (2008); Li, (2006); Wiener, Schnee, and Mallot (2004); Lambrey, Samson, et al. (2003).

environments is that many of the former are purely visual. Other stimuli that are usually present in the experience of 'real' environmental spaces – such as vestibular, proprioceptive, locomotor, tactile, auditory, and olfactory stimuli – are absent in many virtual environments. The simplest virtual environments may even limit visual input by not including peripheral vision. Fully immersive virtual environments endeavour to improve the level of comprehensiveness of sensory experience by adding simulations of vestibular, locomotor, and auditory stimuli. However, some studies discuss intersensory and sensory–motor discordances resulting from the mismatch of sensory input from virtual environments in comparison with expectations born of experience in the real world.[21] Furthermore, virtual environments cause nausea in some people who do not suffer comparably in the real world.[22] All of these points suggest that despite conclusions that research in virtual environments is equivalent to research in the real world,[23] there are still limits to the accuracy of these simulations, and hence to the applicability of their findings.

1.2.5 / Abstraction

The literature surveyed describes seeking-finding behaviours in language ranging from the abstract to the highly concrete. The same action can be described at many levels of abstraction (Carlson 1997; Vallacher and Wegner 1987). This difference in degree of abstraction has a bearing on how readily findings from different studies can be compared. Similar concerns about varying levels of abstraction in descriptions of behaviour are made by Fidel (2012: 102) in her survey of information behaviour research. Scale of behaviour (as discussed above) has a relationship with abstraction in very broad terms: larger-scale behaviours tend to be described using more abstract language.

In this thesis, the need to create definitions of behaviour that are applicable across all three contexts pulls language towards abstraction, whereas the requirement that the definitions are applicable to everyday life and useful to design practitioners pulls in the opposite direction towards concreteness. This tension informs both the examination of research literature and the definitions of categories of seeking-finding behaviour that are introduced in section 2.

1.2.6 / Individual, context, and task

These are the three variables that the second research question directs attention to in relation to seeking-finding behaviour. As 2.3.1 makes clear, these are far from the only factors to potentially influence choice of seeking-finding

21 E.g. Sharples, Cobb, et al. (2008); Welch and Sampanes (2008).

22 See Rodgers, Sindone, and Moffat (2012).

23 See Vilar, Rebelo, and Noriega (2012).

behaviour. The number of factors examined in this thesis is limited in order to keep the discussion to a manageable scope: individual, context, and task are selected as most likely to have influence across a broad range of seeking-finding events. Context is defined above in 1.2.3, task and individual are rather more self-evident. The relationships between seeking-finding behaviours and these factors emerge in the analyses of the user research studies in sections 3–6, and those discussions are then gathered together in section 8.

1.2.7 / Further definition of the scope of this research

The scope of this research is further defined in the following ways:

(i) This research concerns itself primarily with behaviour within everyday life.[24]

(ii) It limits itself to seeking-finding within unfamiliar environments.[25]

(iii) In examining behaviour that purposefully seeks and progresses towards an objective, this research excludes behaviours with less defined purposes – such as exploring, browsing, surfing, or ambling.

(iv) This research does not examine the processes of self-monitoring. These include monitoring environment, orientation, location, comprehension, and the effectiveness of a course of action. For the purposes of this research, this monitoring is assumed: an activity that is separate from but entwined with seeking-finding.

1.3 / Frames of reference

In this section I discuss frames of reference that are critical to the approach taken to answering the research questions; and – like the definitions of key terms above – in so doing define aspects of the scope of the research.

1.3.1 / Information design

The origins of this research lie within my practice as an information designer. The importance of seeking-finding behaviour is perhaps best summed-up in

24 See 1.3.3.

25 Although, unfamiliarity can be a slippery thing to define clearly: 'So signage would seem to be useful only for strangers, people unfamiliar with the environment. In principle, this statement is correct, but the snag is that most of us have become more and more like strangers in our own increasingly complex environments. Besides, most of us now live in big metropolitan areas and work in huge buildings, both far too complicated to get completely familiar with. We know only a small part of it and simply need signage to be able to use the rest. We have become extremely mobile in our daily life and therefore rely on signage on a daily basis' Smitshuijzen (2007). And according to the three category scheme of identifying wayfinding tasks in Allen (1999a), seeking-finding an unfamiliar destination is only one of the three categories of task.

'Information is useless if it can't be found' (Kalbach 2007: 18). My practice includes designing systems and artefacts that support seeking-finding in all three contexts, and I have observed that the seeking-finding behaviours which I anticipate users employing have points of comparison across the three contexts. For instance, using the directory in an office building or department store employs tactics comparable with those required in using a contents list in a book. Similarly, the assumptions employed in finding room number 127 in a building have similarities with those used to find page 127 in a printed document. Supporting this is the extensive use of metaphor that takes behaviours from one context to facilitate seeking-finding in another.[26]

As a practitioner, I found it difficult to locate discussions of research or practice relating to these observations: either because they do not exist, or are beyond my information horizon,[27] or are outside of my information grounds[28] as a design practitioner.

My ambition, with this research, is to create something that is useful and relevant to both research and practice in information design.

1.3.2 / Research and practice

Research and practice form two different communities of interest in information design: this thesis addresses itself to both. The *research* may not identify itself as related to information design and may come from diverse disciplines, such as reading research, spatial cognition, or ergonomics. The *practice* is that which information designers do; these practitioners may not identify themselves using this term but may call themselves, for instance, writers, language specialists, user researchers, or architects. Just to further confuse matters, the same individuals may regard themselves as both researchers and practitioners. Nonetheless, this distinction is important because, (i) as noted in the previous section, this thesis aspires to contribute to both research and practice, and (ii) in discussing the literature survey, it is necessary to differentiate between research and practice literatures.[29]

1.3.3 / Everyday life

As part of the ambition to generate an outcome useful to practitioners, my research aims to produce findings and conclusions whose connections to everyday life are direct and explicit.

The use of *everyday life* is based on a general understanding of the term,

26 See 1.5 for a discussion of metaphor in seeking-finding behaviour.
27 Sonnenwald (2005).
28 Fisher (2005).
29 See also 1.4.1.

but also acknowledges the discussion of the concept in cultural studies and sociology.[30] Of particular relevance to seeking-finding behaviour in everyday life are the model of *everyday life information seeking* (ELIS) proposed by Savolainen (1995), and applications of ethnomethodology.[31] Unlike Savolainen, my definition includes work-related seeking-finding and places it within the overall circumstances of a person's life as Chatman (1999) does.

The term *everyday life* differentiates this research from that which is situated (i) within a controlled lab environment, or (ii) exclusively within a professional situation such as the work-related seeking-finding behaviour of engineers or doctors.

Positioning this research in relation to everyday life raises questions about experimental methods. Much has been written about how research in artificial situations relates to the real world (in which everyday life happens). Some studies raise concerns about the applicability of laboratory research when there are few studies in more naturalistic situations against which to judge it.[32] On the other hand, research in real-world environments is problematic due to their dynamic complexity and number of variables (Rose 1997: 26). The debate about 'real world' versus laboratory research has at times been fierce.[33] Broadly, it can be seen as being between greater internal validity in laboratory situations and greater external validity in '"noisy" real-world contexts' (Brewer 2000: 13), or as it is put by Downs and Stea (1977: 224) in the choice between precision in laboratory settings or realism in natural field settings: 'we are often faced with a choice between results that are precisely meaningless or fuzzily meaningful'. Notwithstanding these limitations, research *is* conducted 'in the wild'.[34]

In some studies, virtual environments are used to generate a simulacrum of the real world that can be more precisely controlled.[35] However, the extent to which behaviour in such environments can be used to predict behaviour in the real world is still under debate.[36]

There has been much discussion about the limitations of behavioural models that are built on the assumption that people behave rationally and optimally. Problems arising from such models of behaviour were noted

30 See, e.g., Felski (1999).

31 E.g. those in Buscher and Hughes (1999).

32 E.g. Chang (2013); Spiers and Maguire (2007); Hektner and Csikszentmihalyi (2002); O'Hara and Sellen (1997); Carlson (1997); Dillon (1992).

33 See Banaji and Crowder (1989) for a strong statement in favour of laboratory research, and also Pearson and van Schaik (2003); Iran-Nejad, McKeachie, and Berliner (1990) for more moderate views; and Lave (1988) for an impassioned view against laboratory research.

34 E.g. Crabtree and Tolmie (2016); Blomberg and Karasti (2013); Brown and Laurier (2005a); Brown and Laurier (2005b); Chebat, Gélinas-Chebat, and Therrien (2005).

35 E.g. McKenzie and Klippel (2016); Gardony, Brunyé, and Taylor (2015); Zhang, Zherdeva, and Ekstrom (2014); Arnold, Burles, et al. (2013); Spiers and Maguire (2006); Allahyar and Hunt (2003).

36 As discussed above in 'the scale of the environment' in 1.2.4.

by Herbert Simon in the 1950s,[37] and the issue is extensively discussed by Kahneman (2011) who proposes alternative behavioural models. Issues of bias, bounded rationality, and the contingency of much complex problem solving are widely raised in the literature.[38]

1.3.4 / The user

In this thesis the position is taken that people are the key element within everyday life – not the systems or artefacts that surround them. A central tenet of much information design practice is that understanding the user is essential to knowing how best to design for them.[39] Some suggest that persisting with the term 'user' demonstrates a lingering system-centricity in that it assumes a system – that is, unless there is system there can be no users.[40]

This thesis seeks to understand people by providing a structure to organise aspects of their behaviour – specifically seeking-finding behaviour – and providing evidence of behaviour and behavioural insights organised according to that structure.

1.3.5 / Embodied, embedded, and extended cognition

Embodied cognition is too large a subject to be dealt with in any more than outline here, but in essence it serves to remind us that cognition does not happen in an abstract, disembodied space, but is something that real people with real bodies do in the real world. 'The mind is locked in a body that, at any time, occupies a specific place and faces a specific direction. These undeniable facts form part of the basis for embodied cognition' (Tversky and Hard 2009: 124). Hanna and Maiese (2009) give a good introduction to embodied cognition, and key points are made by Damasio (1994: xvi–xvii) that: 'The human brain and the rest of the body constitute an indissociable organism, integrated by means of mutually interactive biochemical and neural regulatory circuits. … The organism interacts with the environment as an ensemble: the interaction is neither of the body alone nor of the brain alone. … The physiological operations we call mind are derived from the structural and functional ensemble rather than from the brain alone: mental

37 E.g. Simon (1956).
38 E.g. Mottet, Eccles, and Saury (2016: 222); Kalbach (2007: 30); Spiers and Maguire (2007); Morville (2005: 97 and 156); Albers (2003a: 1); Albers (2003b: 267); Toms (2002).
39 E.g. Wragg and Barnes (2016); Cooper, Reimann, et al. (2014: xix); Magee (2013: 262 and 264); Waller (2012: 241); ACRP (2011: 5); Gibson (2009: 36); Smitshuijzen (2007: 35–41); RSSB (2006: 7–9); Berger (2005: 74 and 87); Mitchell and Wightman (2005: 18); Nielsen (2000: 25); Bartram (1999: 65, 67, 134); Miller and Lewis (1999: 30, 108–113); Scott (1998: 165); Schriver (1997); Passini (1996: 321); Meij (1994: 201); Arthur, and Passini (1992: 45); Lee (1979: 364).
40 See Fidel (2012: 142–144).

phenomena can be fully understood only in the context of an organism's acting in an environment.'

Behaviour is identified above, in 1.2.2, as the physical aspect of a person–environment interaction. From an embodied point of view, the person in this seeking-finding interaction can be characterised as an individual human with a physical body that includes a mind, and with a configuration of sensory modalities (such as sight, hearing, touch, balance, smell), and a more or less idiosyncratic set of habits, preferences, and experiences; this individual is seeking-finding for some particular purpose. And the environment, or the space within which their embodied actions occur, can be characterised as having particular material, technical, sensory, and ergonomic affordances.[41]

Bates (2002) identifies the need for an integrated model of information seeking that addresses not only the social and cultural contexts but also the biological and anthropological contexts. Notwithstanding the (small) number of studies to which embodiment is central,[42] the survey in Symonds, Brown, and Lo Iacono (2017) concludes that it is still common for research into seeking-finding behaviour in environmental space to pay scant attention to embodied perspectives. Similar conclusions are reached by Lueg (2014) and Hillesund (2010) in their surveys of studies examining seeking-finding behaviour on-screen and in printed documents. But not all agree that an embodied perspective is relevant: 'human–information interaction is a cognitive process, not a physical or a social one' (Fidel, Mark Pejtersen, et al. 2004: 940).

Embodied cognition is a foundational concept for embedded and extended cognition (Clark 1997). *Embedded* cognition acknowledges that not only is the body integral to the act of cognition, but the environment around it is too. And *extended* cognition acknowledges that vital parts of cognitive processes happen outside of the body – from something as seemingly trivial as using a piece of paper to help figure out a complex calculation (it's too much to keep inside your head), to using signs in wayfinding, to putting a bag of clothes by the front door to remind you to take them to the dry cleaner the following day. In all of these examples, the environment supports and extends the individual's cognitive capabilities.[43] This notion is developed yet further to encompass cognitive acts distributed between multiple individuals, such as the complex multi-person activity of navigating and sailing a large ship – the functional unit engaged in cognition is not one individual but the group of people who each know their role in ensuring the complex navigational

41 This framing of seeking-finding is inspired by the conception of reading as a human–technology interaction in Mangen (2017: 278).

42 Such as Mangen (2017); Wiberg (2016); Cooper, Reimann, et al. (2014); Norman (2013); Oulasvirta, Nivala, et al. (2005); and Dourish (2001).

43 See also Russell Hoban's picturesque identifying of his personal library as his 'exobrain': Hoban (2007).

observations and calculations and piloting actions are executed effectively.[44] As Tversky (2000: 72) says of external cognitive representations: 'One candidate for an intellectual achievement separating humankind from other kinds is the creation of cognitive artifacts, of external devices that extend the human mind. They range from using fingers for counting or fashioning bends in trees to mark trails to powerful computers or global positioning systems. Cognitive tools augment the mind in two major ways: they reduce memory load by externalizing memory, and they reduce processing load by allowing calculations to be done on external rather than internal objects and by externalizing intermediate products. Of course, external representations have other benefits as well. They take advantage of people's facility with spatial representations and reasoning, they are more permanent than thoughts or speech, they are visible to a community.'

Three points arising here are key to addressing the research questions: (i) the individual has only the one body and one set of cognitive capabilities with which to act in all three contexts, (ii) all three contexts are part of the same physical world, and (iii) external information sources permit a range of choices of action that would otherwise be beyond the capacity of the individual.

1.3.6 / Cognitive load and cognitive economy

As noted in 1.2.2, this thesis is concerned primarily with observable physical actions rather than the cognitive or affective aspects of behaviour. However, cognitive load and cognitive economy cannot be ignored because of the roles they play in driving seeking-finding actions.

Cognitive load is defined as 'the amount of "mental energy" required to process a given amount of information. As the amount of information increases, so does the associated cognitive load on our mental resources' (Feinberg, Murphy, and Duda 2003: 103).

The survey of practice literature finds scant consideration of cognitive load: Schriver (1997: 279, 281) is the only author to address it directly. She advises (i) keeping the user's cognitive load as light as possible, and (ii) reducing the number of processing steps in order to minimise the burden during comprehension. The concept of cognitive load is widely used in research literature. It is beyond the scope and competencies here to enter into a detailed discussion of cognitive load theory or how to measure it. For our purposes, understanding of the concept need extend no further than the definition above.[45]

44 See Clark (2011) and Hutchins (1995).

45 Additional discussion can be found in Sweller, Ayres, and Kalyuga (2011).

The principle of *cognitive economy* is underpinned by cognitive load theory and is 'the tendency for cognitive processes to minimize processing effort and resources' (Colman 2008): decisions are driven by swift and intuitive cost–benefit analyses.[46] The urge for cognitive economy is seen as a manifestation of the principle of least effort (also known as Zipf's law);[47] and Clark (1997: 133) sees it as a manifestation of the principle of parsimony,[48] which proposes that metabolic energy will not be expended if it can be avoided: 'a thrifty nature may rely on cheap cues and local environmental state so as to minimise internal computational load'. A comparable idea is expressed by Ballard, Hayhoe, and Pelz (1995: 76): 'Subjects choose not to operate at the maximum capacity of short-term memory but instead seek to minimise its use.' And discussing seeking-finding in environmental space, Hölscher, Tenbrink, and Wiener (2011: 245) observe that seeking-finding behaviours are 'adopted based on a principle of cognitive economy, optimally exploiting the available perceptual information while taking account of the requirements of the task. This results in different route choices, even though other situational factors influencing actual decisions in everyday life … remain stable'.[49]

A study by Butler, Acquino, et al. (1993) suggests that minimising energy expenditure is a higher priority than minimising route complexity during seeking-finding in environmental space, so the desire to minimise cognitive effort may be outweighed by the desire to minimise physical effort.

In terms of the user studies conducted for this thesis, although cognitive load (and cognitive economy) may be important, it is difficult to identify their influence from observing physical actions.

1.3.7 / Complex problem solving

Seeking-finding tasks in everyday life are often best represented as complex problems. These typically have no clear starting point; may be incompletely defined at the outset; and can be dynamic, ill-structured, and open-ended, with ambiguous, inconsistent, or incomplete information. Such tasks necessitate using information that comes from multiple knowledge structures which are intended for other purposes; and the situations are often embedded within an abundance of superfluous, unrelated, distracting information. And they often include factors or circumstances not forseen. See Albers (2004) and Albers and Mazur (2003) for discussions of the question of complex problems and seeking-finding behaviour: 'imagine working on a jigsaw puzzle … where the pieces

46 As discussed in, e.g., Hölscher, Tenbrink, and Wiener (2011: 244); Kahneman (2011: 31–38); Gray, Sims, et al. (2006); Carlson (1997: 248); Clark (1997); Schriver (1997: 379–380); Pirolli and Card (1995).
47 Zipf (1949).
48 Vogel (1981: 182).
49 This is also discussed in Hölscher, Büchner, et al. (2007) and Freksa (1999).

laying on the table change over time and fitting two pieces together changes how the other sides of each piece fit into the puzzle' (Albers 2004: 3). Research into information seeking often uses closed and simple tasks to examine performance (of the information system or its users), but Albers (2004) suggests that such studies may not be representative of or readily applicable to the scope of complex problems in everyday life.

1.4 / Overview of research and practice literature

Literature discussing seeking-finding behaviour in the three contexts (either individually or across more than one context) is sufficiently extensive to be impractical to discuss in depth here. Despite this quantity, there is little that addresses my research questions directly. In addition to this brief overview, literature discussing taxonomies of seeking-finding behaviour is surveyed in section 2, and literature is cited throughout when relevant to particular discussion points.

Four key points emerge from this survey:

- This survey confirms the suggestion in 1.3.2 that research and practice literature discussing seeking-finding behaviour are not strongly linked to each other (see 1.4.1).
- The literatures within research and practice come from many disciplines. Information design is identifiable as a practice with some degree of coherence, but acknowledges its cross-disciplinary nature. Research literature consulted comes from a wide range of disciplines that do not necessarily identify the complementarity of their work (see 1.4.2–1.4.4).
- There is virtually no examination of seeking-finding behaviour that spans all three contexts. There are comparisons between pairs of contexts (see 1.4.5), but most discussions of seeking-finding behaviour are contained within a single context (see 1.4.2–1.4.4).
- Within each context, there are few discussions that systematically or comprehensively examine *all* seeking-finding behaviour in that context. Instead, there tend to be many discussions of individual types of behaviour in a single context, and often these do little to situate that behaviour within a larger gamut of possible behaviours (see 2.3).

These issues identify key dimensions of the research gap that this thesis addresses.

1.4.1 / The research–practice divide

The first point to make is that the research and practice literatures surveyed rarely overlap. This separation is not unusual: Chung, Williamson, and Shorrock (2014) give an overview across a number of disciplines, and Carpman and Grant (2002: 430) note it in seeking-finding in environmental space. There are exceptions to this: a small portion of the literature surveyed spans the research–practice divide;[50] and a small amount of the practice literature surveyed includes reference to research.[51]

The tension between research and practice is well expressed by Fidel (2012: 56–57); although she is discussing information seeking behaviour (ISB), her comments are applicable to seeking-finding more generally: 'In addition, at times, rich and complex theories are used to "discover" new insights that are rather commonsensical. For example, is it necessary to find empirical evidence to demonstrate that information seeking is a complex process or that experience in information seeking shapes a person's seeking behaviour? Although determination of what is common sense and what requires evidence or theoretical backing is shaped by a researcher's experience and point of view, it is easy for researchers to ignore this issue, regardless of their approach. The differentiation between the obvious and a new insight is a particularly sensitive issue in ISB because of the relationships between the theoretical and practical dimensions. Practitioners with experience in helping people when they look for information collect observations about this behaviour, which are validated over time. Researchers who lack such experience may rediscover one of these observed behaviours and consider it to be a new insight. In such cases, experienced information professionals are likely to perceive such a "discovery" as additional evidence of the irrelevance of academic research to their work. Ignoring knowledge gained by practitioners thus affects the quality of research and widens the gap between theory and practice.'

Some research literature discusses seeking-finding behaviours with the aim of aiding/improving practice, but the practitioners are rarely information designers. For instance, they may be library and information science professionals in the case of ISB research, or teachers in the case of reading research. The bulk of the literature surveyed comes from the research side of the research–practice divide. This is principally the result of my preference for assertions to be supported by evidence: research usually provides evidence to support statements made, but practitioners less so. Practitioners typically

50 E.g. Black, Luna, et al. (2017); Lonsdale (2014); Albers and Mazur (2003). The first one is also unusual in addressing all three contexts.

51 E.g. ACRP (2017; 2016; 2011; 2010); RSSB (2006); Miller and Lewis (1999); Schriver (1997); Arthur and Passini (1992).

speak from experience: their evidence lies in their history of practice and this is more often than not unstated. It can, therefore, be problematic to assess objectively the accuracy of a practitioner's statements.[52]

The practice literature in this survey is not comprehensive: it is based on those works that I find useful in my practice, plus additional works identified during this survey. Where possible I have selected practice literature that *does* reference research evidence.

A particular subcategory of practice literature is good practice guides. Typically, these are produced by a specific organisation to ensure (or advise) a standard of practice. Of the three contexts, environmental space has generated the most extensive range of guides.[53] These are largely sector-specific and produced by public bodies. Seeking-finding on-screen has generated some good practice guides.[54] But those regarding seeking-finding in paper documents are rather more problematic. One possible place to find guides to practice is within brand or visual identity manuals produced by businesses and organisations, but I have not succeeded in locating any relevant literature, as such manuals, while in current use, are typically regarded as business sensitive and not for dissemination outside of the organisation. Manuals that are no longer current are presented in Brook, Shaughnessy, and Schrauwen (2014) and Brook and Shaughnessy (2014); however, they show few that pay overt attention to supporting users' seeking-finding behaviour.[55] Several include guidance on what signs should look like (in detail), but few discuss what messages to include, where the signs should be placed, and why to use signs.

1.4.2 / Literature dealing with seeking-finding in environmental space

Practice literature discussing design for seeking-finding in environmental space is extensive. Despite the large quantity, claims are made that 'the rules are largely unwritten' (Uebele 2007: 5), and that the field is 'long on practice but short on theory and formalised methodology' (Calori 2007: xiii). We are cautioned by researchers that practice literature 'is also usually anecdotal but less benignly so than popular press articles, since uncritical readers may not

52 In this survey I could find few instances of practice literature commenting on the lack of evidence for their claims. Arthur and Passini (1992: 188) is one of that small number: 'whether this preference for maps which include photographic information (even though modified) is soundly based or merely subjective must be determined by others'.
53 E.g. ACRP (2017; 2016; 2011; 2010); Adams, Foster, and Sawyer (2012); NDA and DoAHG (2011); RSSB (2006); LUL (2002); DETR and CABE (2000); Miller and Lewis (1999).
54 E.g. Tedesco, Schade, et al. (2008); Bevirt (1996). The former is produced by a commercial consultancy and is likely to be intended to act as an advertisement of their services.
55 To be fair, it is likely that the editors of these two volumes are not motivated by the wish to demonstrate evidence of design for seeking-finding behaviour.

understand its subjectivity or question its constructs, assumptions, evaluation criteria, methodologies, or conclusions. The mere fact of being published lends these pieces and their subjects more credibility than they may merit' (Carpman and Grant 2002: 430).

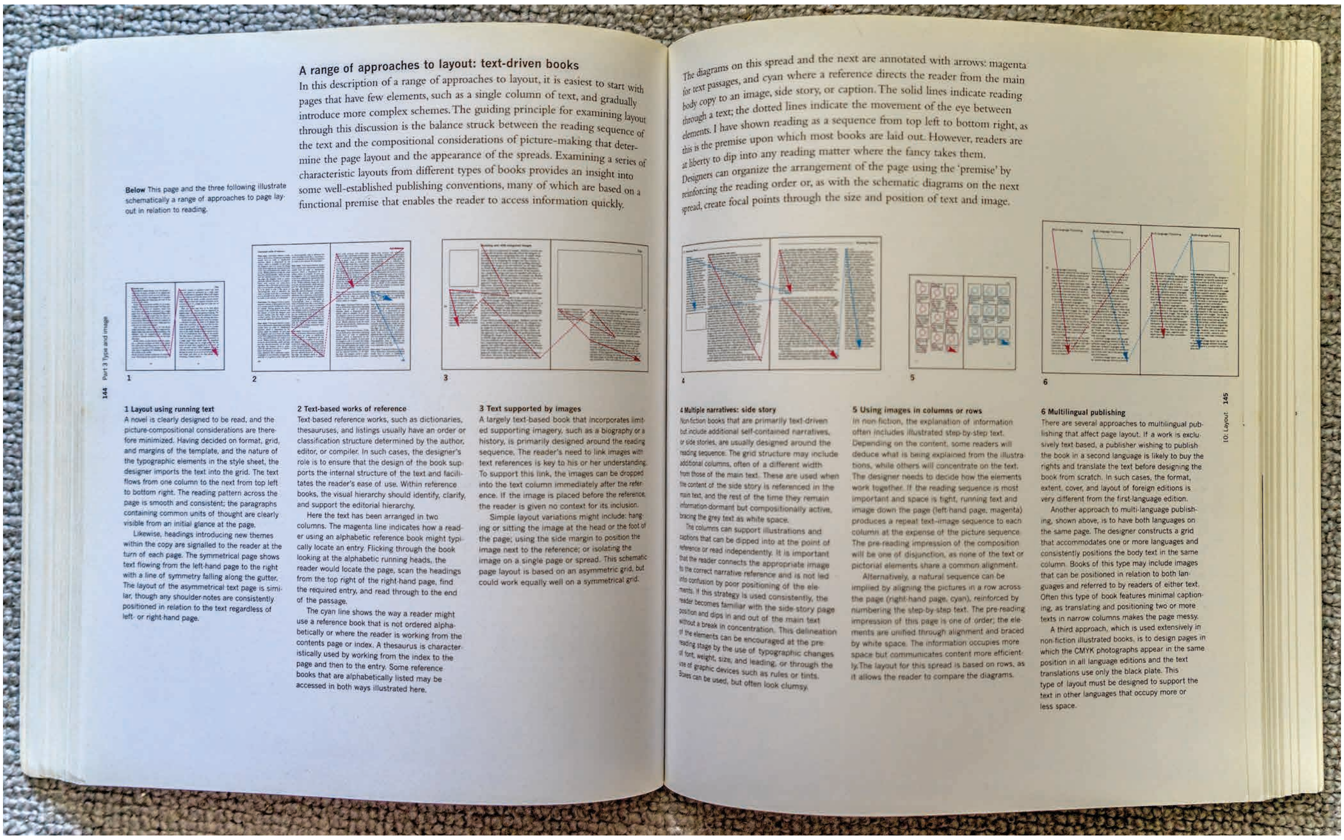
Much of the research literature discussing seeking-finding in environmental space is concerned with learning an environment,[56] or executing tasks within a known environment;[57] neither is directly relevant to the research questions here. In contrast, studies of seeking-finding in unfamiliar environments that are *not* about learning that environment are small in quantity.[58] Buildings containing multiple levels emerge in research literature as particularly problematic for humans to find their way around,[59] but the issue is barely discussed in practice literature.

1.4.3 / Literature dealing with seeking-finding in paper documents

Although there is a substantial body of practice literature dealing with the design of paper documents, there is little that considers seeking-finding behaviour – or how to design to support such behaviours – in depth.[60] One of the few examples that considers different sorts of user behaviour is Haslam (2006: 144–147), which shows the progress of a reader through several different types of page structure. Figures 1.4a and 1.4b show pages from Haslam (2006) that illustrate the discussion and show user progress through spreads of printed books. Figure 1.4c shows a detail of one of the user progress diagrams. No evidence is given to support these models of use.

Some studies suggest that singular linear reading and seeking-finding are separate behaviours requiring different sets of skills,[61] and we are cautioned that 'there are dangers in approaches implicitly defining reading as a sequential activity' (Neville and Pugh 1982: 32). The bulk of research literature discussing the use of paper documents is concerned with reading as a singular

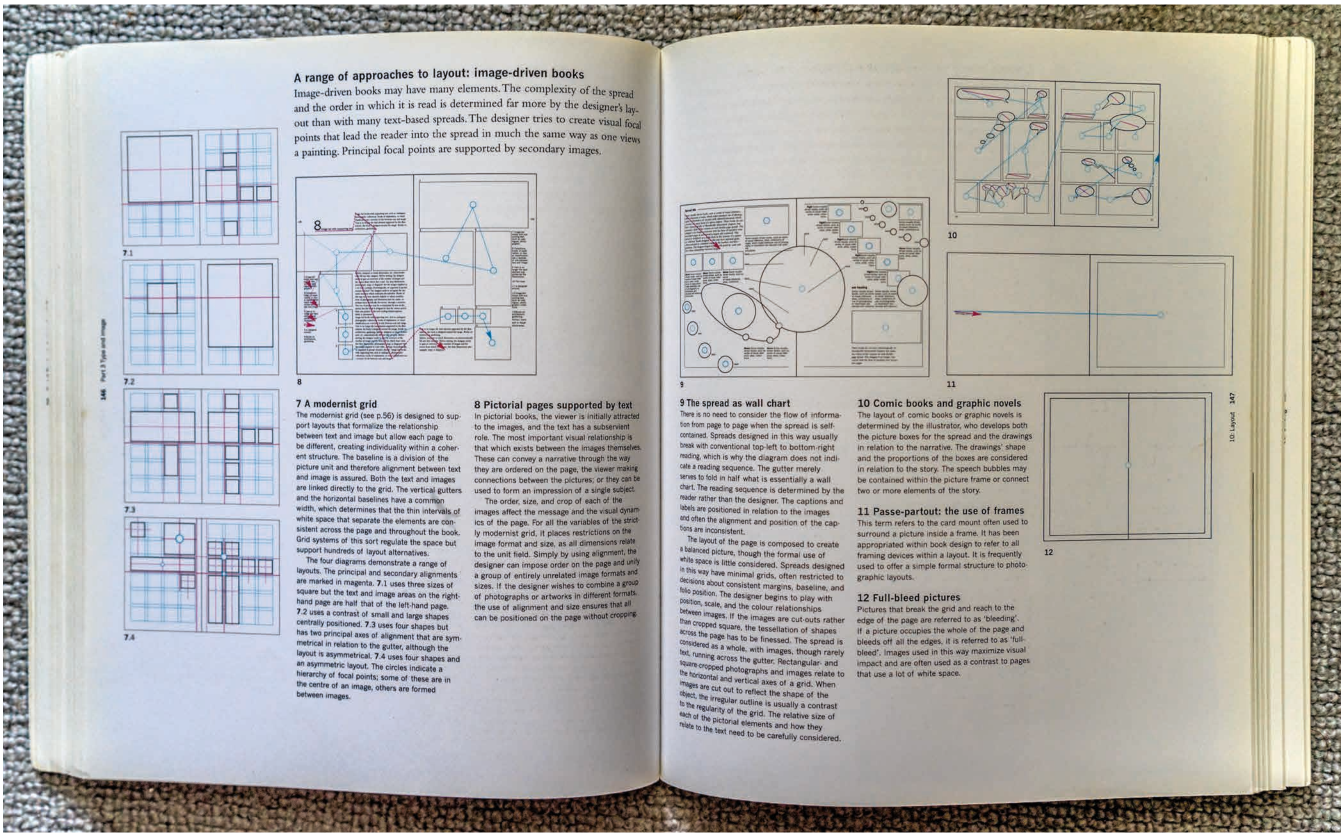
56 E.g. Farran, Courbois, et al. (2012); Rodgers, Sindone, and Moffat (2012); Woollett and Maguire (2010); Kelly, McNamara, et al. (2008); Hegarty, Montello, et al. (2006); Zacharias (2006); Parush and Berman (2004); Wiener, Schnee, and Mallot (2004); Magliano, Cohen, et al. (1995); Lynch (1960).
57 E.g. Hölscher, Tenbrink, and Wiener (2011); Gomez, Rousset, and Baciu (2009); Roger, Bonnardel, and Le Bigot (2009); Tversky and Hard (2009); Parush and Berman (2004); Wiener, Schnee, and Mallot (2004).
58 E.g. Rousek and Hallbeck (2011); Xia, Arrowsmith, et al. (2008); Li (2006); Malinowski and Gillespie (2001).
59 E.g. Hölscher, Brösamle, and Vrachliotis (2012); Vanclooster, Neutens, et al. (2012); Hölscher, Büchner, et al. (2009); Hölscher, Büchner, et al. (2006); Hölscher, Meilinger, et al. (2006).
60 The small number that do consider the issue include Lupton (2004); Schriver (1997); McLean (1980).
61 E.g. Brown (2003); Dreher (2002); Guthrie, Weber, and Kimmerly (1993); Guthrie, Britten, and Barker (1991); Dreher (1992); Dreher and Guthrie (1990); Guthrie and Kirsch (1987); Guthrie and Mosenthal (1987); Neville and Pugh (1982).



A range of approaches to layout: text-driven books

In this description of a range of approaches to layout, it is easiest to start with pages that have few elements, such as a single column of text, and gradually introduce more complex schemes. The guiding principle for examining layout through this discussion is the balance struck between the reading sequence of the text and the compositional considerations of picture-making that determine the page layout and the appearance of the spreads. Examining a series of characteristic layouts from different types of books provides an insight into some well-established publishing conventions, many of which are based on a functional premise that enables the reader to access information quickly.

The diagrams on this spread and the next are annotated with arrows: magenta for text passages, and cyan where a reference directs the reader from the main body copy to an image, side story, or caption. The solid lines indicate reading through a text; the dotted lines indicate the movement of the eye between elements. I have shown reading as a sequence from top left to bottom right, as this is the premise upon which most books are laid out. However, readers are at liberty to dip into any reading matter where the fancy takes them. Designers can organize the arrangement of the page using the 'premise' by reinforcing the reading order or, as with the schematic diagrams on the next spread, create focal points through the size and position of text and image.



A range of approaches to layout: image-driven books

Image-driven books may have many elements. The complexity of the spread and the order in which it is read is determined far more by the designer's layout than with many text-based spreads. The designer tries to create visual focal points that lead the reader into the spread in much the same way as one views a painting. Principal focal points are supported by secondary images.

Figure 1.4a–b: *double-page spreads from Haslam (2006: 144–147) discussing reader progress*

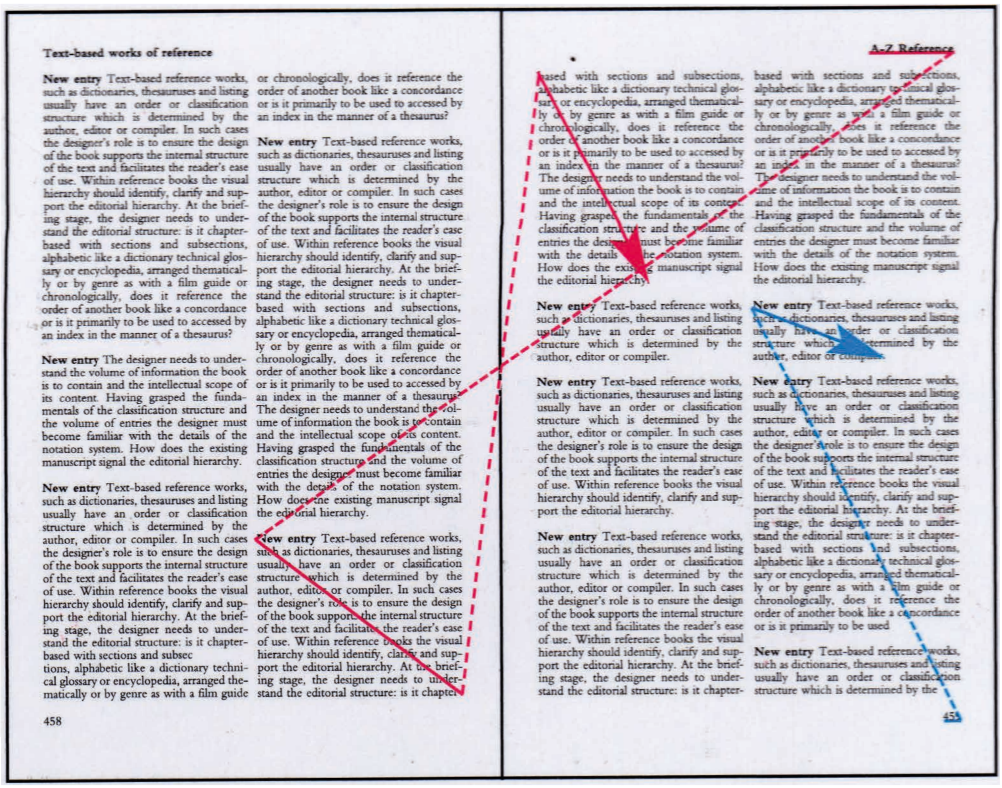


Figure 1.4c: *illustration from Haslam (2006: 144) showing reader progress*

linear activity rather than seeking-finding; consequently, much reading research has little to contribute to this survey.[62]

In their survey of studies of reading processes, Pressley and Afflerbach (1995) examine 37 studies of reading behaviour but find only one that explicitly addresses seeking-finding behaviour.[63] They also find that most research examines the use of single documents rather than examining behaviour across multiple texts.[64] Adler, Gujar, et al. (1998) find that during reading/writing tasks involving seeking-finding, individuals may switch back and forth between multiple documents. This raises cautions about how research into the use of single documents is applicable to behaviour in everyday life.

More than twenty years ago, Sellen and Harper (1997) were prompted to observe that 'paper is an awkward subject to investigate since it is a symbol of the uninteresting past, not the exciting future'. This may suggest why, despite researchers lamenting the lack of available data,[65] such research over the last two decades has been sparse.

62 But see 1.6 for further discussion of how reading itself informs this thesis.

63 Guthrie, Britten, and Barker (1991).

64 Britt and Rouet (2011); Morris, Brush, and Meyers (2007); Adler, Gujar, et al. (1998); O'Hara and Sellen (1997) are rare examples of studies of seeking-finding using multiple texts (postdating the survey in Pressley and Afflerbach 1995).

65 E.g. Schriver (1997: 165); Yussen, Stright, and Payne (1993); Pugh (1979); Waller (1979).

1.4.4 / Literature dealing with seeking-finding on-screen

As with paper documents, practice literature discussing design for on-screen is extensive. Seeking-finding occupies a larger part of this literature than is the case with design for paper documents – too much to be practicably surveyed here, particularly given the variable quality. Two general texts have been consulted,[66] both are widely cited and one – although now possibly dated in some respects – is significant for reference to its evidence base. A small handful of publications dealing specifically with seeking-finding on-screen have also been consulted (because, unlike paper documents, there is a specialised practice literature dealing with seeking-finding behaviour for on-screen spaces).[67]

Websites devote large portions of screen real-estate to 'navigation' (Nielsen 2000: 18–23), which is regarded as distinct from the content of the page and is there to facilitate the user moving between pages. One study linking practice and research concludes that web designers are not good at predicting the strategies of novice searchers and require support in order to design following user-centred approaches (Chevalier and Kicka 2006).

Within research literature, as recently as 2016, Wojdynski and Kalyanaraman (2016: 455) note that 'despite occasional references to the importance of navigability, a unified conceptual framework for navigability is still missing in the literature'. This is despite voluminous quantities of research. Other than surface changes to display technologies, research conducted in the 1980s and 1990s is still largely applicable to seeking-finding on-screen today.[68] That said, the development of mobile devices is giving rise to seeking-finding behaviours different to those employed on static (desktop) devices (Garcia-Lopez, Garcia-Cabot, et al. 2017; Chae and Kim 2004). The challenge of annotating documents on-screen also emerges as a specific research topic.[69]

1.4.5 / Comparisons of seeking-finding behaviour in different contexts

Comparing seeking-finding across all three contexts

My survey finds few comparisons of seeking-finding behaviour across all three contexts. In practice literature discussing seeking-finding in environmental space, Smitshuijzen (2007: 392–393) makes this comparison. Although he supports the notion that seeking-finding behaviours are comparable across

66 Cooper, Reimann, et al. (2014); Nielsen (2000).

67 These include Wendel (2014); Morville and Callender (2010); Kalbach (2007); Morville (2005).

68 E.g. Dillon, Richardson, and McKnight (1990); McAleese and Green (1990); André, Furuta, and Quint (1989); Hammond and Allinson (1989); Simpson (1989); Merrill (1982).

69 E.g. Fortunati and Vincent (2014); Stoop, Kreutzer, and Kircz (2013a); Stoop, Kreutzer, and Kircz (2013b); van der Geest (2004); Adler, Gujar, et al (1998).

the three contexts, this is limited to only a few paragraphs. He makes the questionable assertion that 'nobody gets lost in printed matter' and assumes that paper documents are interacted with one at a time and using a single access strategy – namely, reading from start to finish as a single continuous narrative. Neither of these is representative of real-world seeking-finding in paper documents,[70] and consequently, this comparison is somewhat uneven.

Gibson (2009: 6) makes the comparison too, also within practice literature discussing seeking-finding in environmental space. He quotes Christopher Pullman: 'Exiting the subway in the middle of a city or stepping off the elevator onto a strange floor is momentarily disorienting: you scan the space to figure out where you are and find clues that will lead you where you want to go. This scanning is similar to searching for an article in a magazine or perusing the home page of a website to figure out how it is organised and how to reach a specific section. All these reflex actions are about wayfinding.' Although brief, this suggestion of comparability is similar to that forming the starting point for this thesis.

Calori (2007: 66), again within practice literature discussing seeking-finding in environmental space, compares design practice in all three contexts but contributes little to answering the research questions.

Approaching the subject from a different perspective, recent neurology research suggests that the hippocampus, generally acknowledged to play a role in seeking-finding in environmental space, may have a wider role in task performance in many domains.[71] Buffalo (2015) proposes that mechanisms of memory evolved from neural mechanisms that support navigation in environmental space, and that both episodic and semantic memory formation – whatever the context – are related to mechanisms involved in processing seeking-finding in environmental space. All of which suggests a neural basis for comparing seeking-finding behaviour in the three contexts – somewhat at odds with the conclusions drawn in 1.2.4 from Previc (1998).

Comparing seeking-finding in environmental space and in paper documents

There is little literature that makes explicit comparisons of seeking-finding in these contexts. The key example is Waller (2011), who suggests that these contexts have notable and often overlooked points of comparison. Supporting this he points out that (i) one context may appropriate the terminology of another context in order to metaphorically explain its affordances to users;[72] (ii) an individual's ability to understand and function in an unfamiliar space is in

70 See 1.4.3.
71 Cohen (2015); Olsen, Moses, et al. (2012).
72 This subject is discussed in detail in 1.5.

part dependent on the designer's suitable application of what may be known as genre or pattern language;[73] and (iii) in both contexts, designers organise space using modular systems (grids), and this helps users to anticipate what lies ahead.

Comparing seeking-finding in environmental space and on-screen

Many comparisons of seeking-finding in these two contexts address the issue of using metaphors from environmental space to help users understand the affordances of on-screen space. The role of metaphor is discussed in 1.5.

One study that directly compares the two contexts is González de Cossío (2004), which examines the formation of 'route knowledge' when seeking-finding on-screen and compares it with the formation of route knowledge in environmental space. She examines memory formation, mental processes, and movement through *known* spaces: this is of limited applicability to the research here that examines movement through *unfamiliar* spaces. However, it is worth noting her conclusion: 'This evidence does appear to question the suitability of transferring the navigation metaphor from the understanding of the mental process involved in moving in physical space, to the situation of understanding movement in electronic information space' (González de Cossío 2004: 45). Similar questions about the suitability of spatial metaphors for seeking-finding on-screen are raised in a number of other studies.[74] For example, Weinberger (2002: 50) comments that 'The Web is a public place completely devoid of space. … We can move from place to place but without having to traverse distance.' Notwithstanding questions about its suitability, the metaphor of navigation has been transferred from environmental space to on-screen spaces, and has persisted. Also, van Hooijdonk, Maes, and Ummelen (2006) find that spatial conceptualisations are more prevalent in some categories of on-screen activity than others.

Sorrows and Hirtle (1999) compare the use of landmarks in environmental space and on-screen; they find commonalities between the two that suggest design approaches for both contexts. Similarly, Benyon (2006) examines behaviour in environmental space for insight that it might yield for designers of on-screen spaces. A different approach is taken in Lugli, Ragni, et al. (2017), who find that style of seeking-finding behaviour in environmental space can function as a predictor of seeking-finding style on-screen.

Representing 'semantic' information spaces three-dimensionally on-screen (and immersively in virtual environments) as if they were environmental space somewhat clouds the comparison of these two contexts. The cautions raised in comparisons of virtual and real environmental space in 1.2.4 must be kept in

73 The taxonomy in this thesis identifies this behaviour as using your theoretical cognitive model; see 6.7.
74 E.g. Farris, Jones, and Elgin (2002); Weinberger (2002); Boechler (2001); Vaughan and Dillon (1998); Benyon and Höök (1997); Dillon and Vaughan (1997); Dillon, Richardson, and McKnight (1990).

mind here. 3D information spaces are examined by Parush and Berman (2004). Nielsen (2000: 222) suggests that such interfaces hinder more than they help (despite any entertainment value in using them) because 'Navigating a 3D space is in fact unnatural for us humans. It is much easier to learn to move on a surface than in a volume.'

The berrypicking model of information seeking behaviour developed by Marcia Bates[75] is compared with seeking-finding in environmental space by Lueg and Bidwell (2005). They find many points of similarity, concluding that the comparison highlights that the berrypicking model lacks full consideration of embodied aspects, despite being implicit in its name.

One of the analytical tools of Space Syntax – permeability maps created to analyse the interrelations of cellular rooms[76] – is strikingly similar in appearance and usage to network maps of websites or other hypertext documents.[77] The permeability map describes the ease of accessing a particular cellular space within a building by identifying the number of intervening spaces to be traversed; the hypertext network map describes the ease of accessing a particular hypertext page by identifying the number of intervening pages to be traversed (often described as being a particular number of mouse clicks away). Both make the point that a space is more likely to be accessed if there are fewer intervening spaces (rooms or pages) to pass through. Chalmers (1999) is the only research literature found in this survey that makes explicit links between Space Syntax and seeking-finding on-screen. Although he does not make the comparison suggested above, he concludes that 'it is the common semiological basis of informatics and architecture that makes for these similarities [between use of and circulation through information spaces and use of architectural spaces]. Human activity involving information in computers is not so special. It is little different from activity involving other media of communication and representation' (Chalmers 1999: 77).

Comparing seeking-finding in paper documents and on-screen

There have been many comparisons of seeking-finding in these two contexts.[78] Debate over the differences between print and screen reading has made it into

75 See Fisher, Erdelez, and McKechnie (2005: 58–62).
76 Also called convex maps and depth maps: Bafna (2003: 18–21); and Hillier and Hanson (1984: 147–163).
77 See Kalbach (2007: 9).
78 E.g. Hou, Rashid, and Lee (2017); Mangen (2017); Singer and Alexander (2016); Fortunati, Taipale, and Farinosi (2015); Fortunati and Vincent (2014); Daniel and Woody (2013); Walsh (2016); Stoop, Kreutzer, and Kircz (2013a); Stoop, Kreutzer, and Kircz (2013b); Hutchison, Beschorner, and Schmidt-Crawford (2012); Gerlach and Buxmann (2011); Vörös, Rouet, and Pléh (2011); Afflerbach and Cho (2010); Afflerbach and Cho (2009); Akyel and Erçetin (2009); Zhang and Duke (2008); Coiro and Dobler (2007); Morris, Brush, and Meyers (2007); Noyes and Garland (2005); Marshall and Bly (2005); Wästlund, Reinikka, et al. (2005); Dillon (2004); Guinee, Eagleton, and Hall (2003); Roy and Chi (2003); Roy, Taylor, and Chi (2003); Dreher (1993); McKnight, Dillon, and Richardson (1989).

professional publications,[79] even popular science,[80] and national press.[81]

Walsh (2016) and Dillon (1992) provide useful overviews of the comparative research (from different times in the development of on-screen technologies). Research should be examined with caution because (i) surface changes to display technologies and development of user skills/expectations may lead to some research becoming rapidly outdated; and (ii) it is not always clear that the comparisons made are helpful, as some may not be sufficiently like-for-like, in terms of the scope of what is included in the activity or processes examined.

Many comparisons of seeking-finding in paper documents and on-screen use seeking-finding in a single paper document as their comparator. As noted in 1.4.3, this is not necessarily representative of real-world seeking-finding and, as Afflerbach and Cho (2010, 2009) point out, seeking-finding in multiple paper documents offers a more equal (and possibly more ecologically sound) comparator in that it necessitates *between*-texts tactics as well as *within*-text tactics in the same way as much on-screen seeking-finding does. Multiple document use in seeking-finding is studied in a small body of research literature.[82]

In comparing seeking-finding in paper documents and on-screen, some studies conclude that the behaviours required on-screen are more complex and challenging for the user,[83] while others suggest that the similarities of the two contexts outweigh the differences.[84] In their comparison of seeking-finding in a library and online, Roy, Taylor, and Chi (2003: 251) observe that although the differing affordances of the contexts may make it less physically demanding to get to the required information on-screen, the print documents afford greater opportunity for encountering *related* information that they describe as a 'richer exposure to related contextual information in addition to specific targeted facts'. In their research into on-screen seeking-finding behaviour, Guinee, Eagleton, and Hall (2003: 372) find that their participants 'maintain paradigms from the real world' in their on-screen search behaviours, by which they mean that they try to use natural and socially inflected language in their interactions with computers in ways that work in human interaction.

79 E.g. Pleasant (2016).
80 E.g. Jab (2013).
81 E.g. Kelly (2000).
82 See note 64.
83 E.g. Leu, Forzani, et al. (2014); Hutchison, Beschorner, and Schmidt-Crawford (2012); Vörös, Rouet, and Pléh (2011); Cromley and Azevedo (2008); Zhang and Duke (2008); Coiro and Dobler (2007); Azevedo and Cromley (2004); Leu, Kinzer, et al. (2004); Guinee, Eagleton, and Hall (2003); Roy and Chi (2003); Roy, Taylor, and Chi (2003); Rouet and Levonen (1996); Dreher (1993).
84 E.g. Köpper, Mayr, and Buchner (2016); Singer and Alexander (2016); Walsh (2016); Stoop, Kreutzer, and Kircz (2013b); Afflerbach and Cho (2010); Akyel and Erçetin (2009); Noyes and Garland (2008); NICHHD (2000); Dillon (1992); McKnight, Dillon, and Richardson (1989).

One issue that a number of studies address is that of materiality.[85] Relating to ideas of embodiment discussed in 1.3.5, these studies look at the relationship between the human body and the physical qualities of a particular medium – often highlighting qualities and affordances of paper documents that may have been eclipsed by the greater novelty of on-screen interaction. Related to this, the concept of haptic dissonance (Gerlach and Buxmann 2011) expresses the mismatch between sensory expectations developed through interacting with paper documents and the experience of interacting on-screen, although Hou, Rashid and Lee (2017) find insufficient evidence to support this concept.

1.5 / Metaphor

'It occurred to no one that the book and the labyrinth were one and the same.' (Borges 1944 (1998): 82)

The use of metaphor is one of the ways in which seeking-finding in the three contexts are rendered comparable. Predominantly, paradigms from environmental space are metaphorically applied to paper documents and on-screen, but there is some evidence of metaphors being applied between other permutations of the three contexts.

Metaphor is more than a playful literary notion according to Lakoff and Johnson (1980 (2003)): drawing on ideas of embodiment,[86] they suggest that metaphor forms a fundamental means by which humans understand abstract concepts. They propose that human, physical, bodily experience in the world provides a baseline paradigm onto which experiences in more abstract realms are mapped in order to render them more graspable, and that metaphor is the means of organising this mapping. So perhaps we should not be surprised when metaphors of seeking-finding in environmental space appear in the more abstract realms of paper documents and on-screen, particularly the latter.

Lakoff and Johnson (1980 (2003)) and allied works are cited frequently in research into on-screen spaces.[87] Furthermore, key authors, models, and paradigms from environmental space are similarly used. For example, Arthur and Passini (1992);[88] Whyte (1988);[89] Hillier and Hanson (1984) or other Space

85 E.g. Fortunati, Taipale, and Farinosi (2015); Fortunati and Vincent (2014); Stoop, Kreutzer, and Kircz (2013a); Sellen and Harper (1997); Hillesund (2010); Mangen (2008); Sellen and Harper (1997).

86 See 1.3.5.

87 E.g. in Morville (2005); McCullough (2004); Höök, Benyon, and Munro (2003); Munro, Höök, and Benyon (1999a); Dourish (1999); Waterworth (1999); Maglio and Matlock (1999); Persson (1999).

88 E.g. Mandel (2013); Höök, Benyon, and Munro (2003); Maglio and Matlock (1999); Benyon and Höök (1997).

89 E.g. Höök, Benyon, and Munro (2003); Dieberger (1999); Buscher and Hughes (1999); Dourish (1999); Munro, Höök, and Benyon (1999a).

Syntax texts;[90] Alexander, Ishikawa, et al. (1977) or related pattern language texts;[91] Downs and Stea (1977) or related cognitive mapping texts;[92] and Lynch (1960)[93] are all extensively discussed.

As noted above, the concept of the cognitive map – originating in environmental space – is metaphorically applied to seeking-finding on-screen, and it is also applied to seeking-finding in paper documents to the extent that Akyel and Erçetin (2009) can talk of 'a cognitive map of the text' with no need to explain the concept.[94] Jabr (2013) cites research that suggests that we remember the content of what we have read in relation to the physical location of the information within the document (such as near the front of the book and close to the bottom of the page), building a cognitive map of physical locations of content entwined with a model (or map) of the semantic content.

More general mapping metaphors occur widely outside of environmental space: from the many ideas of mind-mapping (as an internet search of the term will attest) to the concept of information mapping in Horn (1985), who suggests that this process allows the reader 'continuously to be oriented' in much the same way as Afflerbach and Cho (2009: 79) write of readers creating 'a mental bird's eye view' of different texts.

The effectiveness of and ease with which spatial metaphors are used is evident in statements such as this description of problem solving in an on-screen context: 'The step-by-step route to completing a task simply does not exist. In an ill-structured domain, instead of following a set path, the user continuously adjusts their mental path as new information presents itself. As a result, each user takes a slightly different path …' (Albers 2003b: 267–268).

The use of metaphors from environmental space to facilitate understanding of on-screen spaces is studied in Maglio and Matlock (1999). They identify the predominance of trajectory and container metaphors and find them to be ubiquitous and effective.[95] This research is revisited by Matlock, Castro, et al. (2014), who find that spatial language is persisting but that the range of motion verbs is reduced. They conclude that people

90 E.g. Höök, Benyon, and Munro (2003); Chalmers (1999); Buscher and Hughes (1999); Munro, Höök, and Benyon (1999a).

91 E.g. Morville and Callender (2010); McCullough (2004); Borchers (2003); Höök, Benyon, and Munro (2003); Buscher and Hughes (1999); Waterworth (1999).

92 E.g. Vörös, Rouet, and Pléh (2009); McCullough (2004); Höök, Benyon, and Munro (2003); Höök and Svensson (1999); Maglio and Matlock (1999); Rahlff, Rolfsen, and Herstad (1999); Rankin and Spence (1999); Shum (1990).

93 E.g. McCullough (2004).; Höök, Benyon, and Munro (2003); Dourish (1999); Buscher and Hughes (1999); Maglio and Matlock (1999); Benyon and Höök (1997).

94 This thesis makes the same metaphorical usage of cognitive map but calls it a cognitive model; see 2.6, 6.7, and 6.9.

95 Trajectory and container metaphors are two of the fundamental metaphor types identified by Lakoff and Johnson (1980 (2003)). The trajectory metaphor commonly occurs in statements such as 'he *went* mad', and the container metaphor in 'he is *in* love'.

'naturally' produce spatial metaphors when discussing new technological domains and that as time passes those elements that have proved the most useful persist. Arora (2012) and McCullough (2004) examine metaphors applied to on-screen spaces and make the point that these are tethered to the real world through their creation and use by embodied humans. And another point about embodiment providing the link between contexts is made by Jabr (2013): 'As far as our brains are concerned, however, text is a tangible part of the physical world we inhabit.' This is strikingly similar to Eric Gill's observation that 'letters are things, not pictures of things' (Gill 1940: 120).

The metaphorical application of architectural concepts to on-screen space is another way in which paradigms from environmental space are used on-screen. Kalbach (2007) entitles one chapter 'Architecture', and this is by no means uncommon. W3C which sets standards for web use also use the word 'architecture' (W3C 2015), but for web-wide structural properties. The term 'information architect' describing the role of structuring and organising information for display on-screen (and on paper) is often credited to Richard Saul Wurman,[96] and the term has a prehistory described in Resmini and Rosati (2011).

The practice of designing interfaces for on-screen seeking-finding is a relatively new activity, and Dourish (1999: 25) points out that it is perhaps unsurprising to turn to the design of environmental space for ideas 'where issues of space, of interaction and of design have been combined for thousands of years'.

The flow of metaphor is not entirely from environmental space into other contexts. For instance, Marshall and Bly (2005) apply a term from on-screen to paper documents when they refer to the contents list and page numbers as 'explicit metadata', and haptic clues about how heavy or bulky the document feels in the hand as 'implicit metadata'.

One metaphor that moves from paper documents to environmental space is that of legibility. Its introduction is generally credited to Lynch (1960), and Downs and Stea (1977), and many authors since have used it.[97] Notwithstanding Lynch's specific notion of environmental legibility, the city is often thought of as a text to be read. Nineteenth-century American publishers regarded their city directories literally as indexes of cities: one in 1858 describes his as 'an index of the great ledger of the community' (Rose-Redwood 2008: 295). Thale (2007: 126) prosaically points out that 'House numbers are a text written on every building', and Rose-Redwood (2008: 289) writes of 'the "physical typography" of the city-text. The cityscape was conceived of as a "text" that required adequate "page numbers," an alphabetised "index," and a coherent

96 E.g. Gibson (2009: 15).

97 E.g. Li and Klippel (2014); Long and Baran (2011); Li and Klippel (2010); Kelly (2001); Weisman (1987); Weisman (1981).

"page layout." It is my contention that this typographical conception of the "layout" of the city-text is key to understanding the modernist project of constructing legible urban spaces.' Azaryahu (1996: 324) also discusses 'reading' the city: he suggests that a 'city-text provides a toponymical grid that makes the city geographically intelligible' and points out that this city-text is not intended to be read in its entirety, nor is the order of reading prescribed, and that 'the reading of a city-text is embedded in everyday activities'.

Practitioners also use metaphors of legibility and reading environmental space, such as 'we each "read" our environment differently ...' (Smitshuijzen 2007: 13).

1.6 / Reading

Despite the conclusion in 1.4.3 that reading research has little to contribute to this thesis, reading itself is worthy of further attention.

While related to the metaphorical reading discussed at the end of 1.5, what is meant here is largely a more literal act of reading. Seeking-finding is comparable across all three contexts in that all necessitate reading. Predominantly, this is the reading of written language, but it can also include the reading of more symbolic forms such as pictograms, and can even involve 'reading' the space itself.

The different challenges of reading on-screen are often framed in comparison with reading paper documents as 'new literacies'.[98] This is typically done to state their differences, but implicit within this is that people are *reading* irrespective of context.

The reading involved in seeking-finding has already been identified as different to the singular immersive activity as reading is more typically characterised.[99] Here reading is an inter-textual activity that constructs its own meaning, as in these three descriptions of reading activity:

'Constructively responsive reading highlights the importance of readers' cognitive strategies and the construction of meaning as it is situated in relation to individual readers and their goals and characteristics' (Afflerbach and Cho 2010: 202).

'The important theoretical idea here was that readers construct meaning representations of the text as they read and that these representations were essential to memory and use of what was read and understood. ... Here, readers were assumed to construct mental representations of what they read.

98 E.g. Leu, Forzani, et al. (2014).; Leu, Kinzer, et al. (2004).
99 See 1.4.3.

These representations were stored in memory and contained the semantic interpretations of the text made by the reader during reading. The memory representations provided the basis for subsequent use of what was read and understood. … According to this view [that reading is purposeful and active], a reader reads a text to understand what is read, to construct memory representations of what is understood, and to put this understanding to use' (NICHHD 2000: 4-39).

'Reading, however, requires the coordinated and flexible use of several different kinds of strategies. … Skilled reading involves an ongoing adaptation of multiple cognitive processes. … a good strategy user will coordinate strategies and shift strategies as it is appropriate to do so. They will constantly alter, adjust, modify, and test until they construct meaning' (NICHHD 2000: 4-47).

1.7 / Visuospatial thinking

Another approach that suggests the comparability of seeking-finding behaviour in the three contexts comes from research into visuospatial thinking. 'When we use the term "visuospatial", we are referring to information that is visual in nature (initiated by stimulation of the retina by light) and has spatial properties (involving the representation of space including relationships between objects within that space), and this information can either be sensed directly or generated from memory. … Spatial representations can arise from stimulation of any sensory modality – audition or touch as well as vision. Images also can be "schematic", such as those times when a symbol is used as a place holder. … Thus images can vary in the extent to which they convey spatial, visual, or schematic information' (Halpern and Collaer 2005: 171). Seeking-finding behaviour in all three contexts is at least in part reliant on the same visuospatial skills: 'Navigating across town, comprehending an animated display of the functioning of the human heart, viewing complex multivariate data on a business's website, reading an architectural blueprint, and forming a three-dimensional display of a house are all tasks involving visuospatial thinking. As suggested by the breadth of this list of tasks, the field of visuospatial thinking is a relatively diverse interdisciplinary research enterprise' (Shah and Miyake 2005: xi).

1.8 / Conclusion

Having outlined the research questions and discussed issues of terminology and frames of reference, in this section I have summarised the survey of extant literature that compares seeking-finding behaviour in the three contexts, finding suggestions of comparability but little in the way of explicit or detailed comparison.

The rest of this thesis answers the research questions in the following way.

Section 2 proposes a taxonomy of seeking-finding behaviours that is equally applicable to all three contexts. The taxonomy identifies factors within the behaviours that are common across contexts. This not only demonstrates the characteristics that behaviours in different contexts have in common, but also offers a means by which the behaviours themselves can be rendered comparable. (The process of developing the taxonomy is described in section 10.)

Section 3 describes the three user studies carried out as part of this research. Conducting these studies, and the data generated, informs and tests iterations of the taxonomy in the course of arriving at the taxonomy as discussed in section 2 (the possible circularity of using the data to both inform and test the taxonomy is discussed in 10.1). This section finishes with an overview of the data from the user studies sorted and analysed according to the categories of the taxonomy.

Sections 4–6 discuss the individual categories of behaviour identified by the taxonomy, and look in more detail at the data from the user studies when sorted and analysed according to these categories.

Section 7 examines the data from the user studies specifically examining relationships between individual categories of behaviour.

Section 8 examines the data from the user studies specifically examining the individual categories of behaviour in relation to the individual, context, and task.

In doing all of the above I demonstrate and consider ways in which seeking-finding behaviours in the different contexts are comparable; I also examine relationships between behaviours and other factors: the individual, context, and task.

2 / The taxonomy

2.1 / Introduction

As noted in 1.8, a key part of the approach to answering the research questions in this thesis is the formulation of a taxonomy comprising categories of seeking-finding behaviour that are equally applicable to all three contexts. The taxonomy identifies factors within the behaviours that are common across contexts. This not only demonstrates the characteristics that behaviours in different contexts have in common, but also offers a means by which behaviours in different contexts can be rendered comparable.

This section introduces that taxonomy. It begins with a discussion of the activity of category-making. This is included in order to establish the points that category-making is essential to understanding the world but that categories are artificial constructs, and that not all members of a category are equally good examples of it. This is followed by an overview of the research and practice literature that discusses types of seeking-finding behaviour, paying particular attention to other taxonomies of seeking-finding behaviour. After this, the four questions that drive the taxonomy are introduced, and the taxonomy itself is shown and discussed. Finally, there are discussions of general issues raised by this taxonomy.

2.2 / Category-making

Category-making has attracted attention from researchers and theoreticians throughout history: the first appearance of the topic in Western philosophy is often taken as the writings of Plato followed by Aristotle.[100] In the twentieth century, Bruner, Goodnow, and Austin (1956) not only lay foundations for cognitive science, but also promulgate the idea that categorising is fundamental to how humans organise their understanding of and interaction

100 Plato's *Politikos* (*Πολιτικός* / *The statesman*), and Aristotle's *Kategoriai* (*Κατηγορίαι* / *Categories*, part of *Organon* / *Οργανον*) and *Peri aisthisios kai aisthiton* (*Περὶ αἰσθήσεως καὶ αἰσθητῶν* / *Sense and Sensibilia*, part of *Parva naturalia*).

with the world. 'Much of our commerce with the environment involves dealing with classes of things rather than with unique events and objects. Indeed the case can be made that all cognitive activity depends upon a prior placing of events in terms of their category membership. A category is, simply, a range of discriminably different events that are treated "as if" equivalent' (p.231).

Subsequently, both Rosch, and Lakoff, through many publications, contribute to developing the idea that category-making sheds light as much on the category-maker as on the world, and that this may be at the level of the individual or of the society. These ideas make their way into popular understanding through articles such as Deutscher (2010).

This thesis takes the notion from Bruner, Goodnow, and Austin (1956) that the taxonomy presented here is not essential 'truth' but is one of many possible approaches to organising the same body of evidence. The categories in the taxonomy are artificial constructs: 'Science and common-sense inquiry alike do not *discover* the ways in which events are grouped in the world; they *invent* ways of grouping. The test of the invention is the predictive benefits that result from the use of invented categories' (p.7) (my italics). The potential for other different taxonomies is emphasised in the idea that the 'objects of the environment provide cues or features on which our groupings may be based, but they provide cues that could serve for many groupings other than the ones we make. We select and utilise certain cues rather than others' (p.232). Such notions that there is only one world but many ways of knowing it are typically regarded as epistemological relativism: 'we live in a material world which is an ontological unity, but which we approach with epistemological diversity' (Rose 1997: 304).

From Rosch and Lakoff I take the idea that some members of a category may be 'better' or more typical examples of that category than others (even though they are all still within the category). In an example from Rosch (1975), cited in Lakoff (1987: 44): experimental participants regard robins and sparrows as the best examples of the category 'birds', while owls and eagles are ranked lower; and ostriches, emus, and penguins are among the least good examples of the 'bird' category. Rosch makes the point that these rankings do not reflect whether one item is a better *member* of the category – all are equally members of the category 'bird' – but reflects how close it is to the category prototype: some birds are better *examples* of the category 'bird' than others. Seeking-finding behaviours vary in how good an example each is of its category – although members of a category may not be equal in every way, they are all equally valid members of that category.

From Rose (1997) I take an approach to classifying that identifies how observed phenomena most readily group and the points at which they most readily disaggregate: 'carving nature at the joints' as Rose (1997: 42) puts it.

And finally from Tversky (1986) and Rosch, I take further understanding of the hierarchical nesting of categories in a taxonomy.

2.3 / Research into seeking-finding behaviour

The survey of research and practice literature conducted for this thesis[101] finds that seeking-finding behaviour is examined in a multiplicity of ways that can be sorted into a handful of approaches:

- Identifying factors that influence seeking-finding behaviour (see 2.3.1)
- Constructing models of seeking-finding process (see 2.3.2)
- Isolating individual types of seeking-finding behaviour (see 2.3.3)
- Examining particular dimensions to seeking-finding behaviour (see 2.3.4)
- Creating taxonomies of seeking-finding behaviour (see 2.4)

Of these five approaches, this thesis is principally concerned with the last one. Other approaches have been examined, but constraints of space limit their discussion here. As noted in 1.4, the majority of discussions of seeking-finding behaviour, whatever approach they take, examine a single context: leaving us little further ahead with investigating if and how behaviours might be comparable across contexts, and thus emphasising the need for this research. Variations in scale, level of abstraction, and scope also complicate possible comparisons between discussions.[102]

2.3.1 / Factors that influence seeking-finding behaviour

Seeking-finding behaviour is influenced by many factors. A discussion of research into factors influencing information behaviour can be found in Ford (2015: 99–141), and the subject is woven throughout Albers (2004). The following list is not comprehensive: it is a by-product of the literature survey and indicative of the diversity of factors (variables) brought to bear on seeking-finding in everyday life. The list is also divided into person-related and situation-related factors, mainly to render it more manageable, but these are not watertight categories, and it can be argued that most of these factors result from the interaction between person and situation.

101 Outlined in 1.4.
102 See 1.2.4 for discussions of scale, 1.2.5 for discussions of levels of abstraction, and 2.4.1 for discussions of scope.

Person-related factors

- *Inter-individual difference* (Afflerbach and Cho 2010; Nico and Daprati 2009; Kelly, McNamara, et al. 2008; Peña, Contreras, et al. 2008; Hegarty, Montello, et al. 2006; Frascara 2006; Li 2006; Roy and Chi 2003; RRSG 2002; Freksa 1999). This issue is also raised in sections 4–6 and 8.
- *Gender* (see 8.1.2).
- *Socioeconomic status* (Leu, Forzani, et al. 2014; Van Acker, Van Wee, and Witlox 2010; Mondschein, Blumberg, and Taylor 2007).
- *Familiarity of a particular route* (Hölscher, Tenbrink, and Wiener 2011).
- *Prior knowledge of the environment / domain expertise* (Ferrara 2008; RSSB 2006; Miller and Lewis 1999).
- *Attitude to or preconceptions about the environment* (Miller and Lewis 1999).
- *Considerations of the addressee's needs when giving directions* (Hölscher, Tenbrink, and Wiener 2011).
- *Experience of comparable activities* (Ferrara 2008; Peña, Contreras, et al. 2008).
- *Emotional state* (Frascara 2006; Ferrara 2008; Miller and Lewis 1999; Zimring 1981).
- *Level of physical exertion* (Zahabi, Zhang, et al. 2017).
- *Intellectual development* (Frascara 2006; RSSB 2006; Miller and Lewis 1999).
- *Value system* (Frascara 2006).
- *Confidence / spatial anxiety* (Lawton 1996).
- *Seeking-finding experience* (Ferrara 2008).
- *Cognitive style* (Ferrara 2008).
- *Mode of seeking* (Ferrara 2008; Miller and Lewis 1999).
- *Sensory acuity (particularly sight and hearing)* (ACRP 2017; RSSB 2006; Miller and Lewis 1999).

Situation-related factors

- *Information available* (see 2.5).
- *Task or goal type* (Ferrara 2008; Zhang and Duke 2008; Morville 2005; Albers 2004; Allen 1999a; Pugh 1979; Waller 1979) *NB Some of these have strong views on the differences between goal and task – see also 8.4.*
- *Artificial choice constraints* (Hölscher, Tenbrink, and Wiener 2011) 'Throughout the experiment they had no opportunity to look at a map or to ask other people for assistance' (Hölscher, Tenbrink, and Wiener 2011: 231). Excluding variables is a common strategy in conducting research, but the artificial constraining of choices clearly has a bearing on tactics chosen.
- *Relative attractiveness of available options, not only appearance but light levels, heat, odour, and sound* (Hölscher, Tenbrink, and Wiener 2011; Zacharias 2006).
- *Shopping facilities* (Hölscher, Tenbrink, and Wiener 2011).
- *Avoiding traffic* (Hölscher, Tenbrink, and Wiener 2011).

- *Opportunity (such as red or green traffic lights)* (Hölscher, Tenbrink, and Wiener 2011).
- *Time pressure (or not)* (Zacharias 2006; Marchionini 1995).
- *Cultural and subcultural influences* (Frascara 2006).
- *Choosing routes where there are more people* (Zacharias 2006).
- *Modes of transportation/locomotion available* (Freksa 1999).
- *Physical accessibility* (Marchionini 1995).
- *Visual access ('How much of the environment can I see from here?')* (Tianfu, Shanshan, and Xiaopeng 2017; Carlson, Hölscher, et al. 2010).
- *Availability of landmarks* (Xia, Arrowsmith, et al. 2008; Jansen-Osmann 2002; Allen 1999b; Golledge 1999; Sorrows and Hirtle 1999).
- *Comfort* (Marchionini 1995).
- *Degree of distraction* (Miller and Lewis 1999; Marchionini 1995).
- *Cost* (Marchionini 1995).
- *In a private office or in a public place with a line of impatient people nearby* (Marchionini 1995).
- *Proximity of particular resource* (Marchionini 1995).
- *Can sources of help be readily identified?* (Miller and Lewis 1999).
- *Complexity and intelligibility of the environment, intelligibility of routes through the environment* (Tianfu, Shanshan, and Xiaopeng 2017; ACRP 2011; Rousek and Hallbeck 2011; RSSB 2006; Zacharias 2006; Miller and Lewis 1999; O'Neill 1991; Bovy and Stern 1990).
- *Avoidance of apparent dead-ends* (Zacharias 2006).
- *Preference for straight ahead* (Zacharias 2006).
- *Readiness with which the environment supports formation of a cognitive model* (Miller and Lewis 1999).
- *Information such as signage appearing to contradict environmental cues* (RSSB 2006).

Some of these factors are discussed in subsequent sections. The first of the situation-related factors – information available – is the principal variable on which the current taxonomy is built.

2.3.2 / Seeking-finding process models

Research into information behaviour – more so than any of the other disciplines surveyed – has created a number of seeking-finding process models.[103] These may give the impression of being pertinent because, like this thesis, they address the relationship between the seeker and information. However, the models largely concern information *sought* whereas my research

103 See Ford (2015); Case (2012); Fidel (2012); Fisher, Erdelez, and McKechnie (2005) for overviews.

examines information *used* in the process. Surveying other disciplines, reading research provides models of seeking-finding in Armbruster and Armstrong (1993), and Guthrie, Weber, and Kimmerly (1993),[104] and a further model in Brown (2003). Models of seeking-finding in environmental space are found in Raubal and Worboys (1999) and Passini (1996: 322). Questions of scale and scope limit the helpfulness of all of them to my research (in general their scale is too large and their scope too broad).[105]

2.3.3 / Individual types of behaviour

There are considerable bodies of literature identifying different types of seeking-finding behaviour. In her survey of research into information seeking behaviour, Fidel observes that research 'has generated an unruly repertoire of strategies in which each researcher has employed her own view on how to carve out strategies from an analysis of the literature or from the data at hand. In addition the number of search strategies is growing constantly as new ones are discovered, usually without attempting to place them in relation to other strategies … In summary, the unsystematic nature of the use of the concept search strategy, supported by the lack of explicit understanding of the concept, created a muddled trail of research about search strategies in which only the term itself is common to all investigations' (Fidel 2012: 102 and 99). The same can be said of research into seeking-finding behaviour, and spanning several disciplines and three contexts multiplies this. This literature identifying individual types of seeking-finding behaviour is not discussed here because not only is it too extensive (and, to use Fidel's term, unruly), but also it typically examines individual behaviours in isolation (or as part of a small isolated group) and usually in a single context, and so contributes little to answering the research questions here.

2.3.4 / Dimensions of seeking-finding behaviour

This survey finds 11 sets of dimensions of seeking-finding behaviour. These function by (i) creating 2 poles of opposed behaviour styles connected by an axis along which (all) seeking-finding behaviours can be arranged; or (ii) creating a pair of distinct behaviour styles whose interaction with each other is examined.

104 Developed through a series of studies: Guthrie and Mosenthal (1987); Guthrie (1988); Dreher and Guthrie (1990); Guthrie and Dreher (1990); Kirsch and Mosenthal (1990); Dreher (1992).
105 See 1.2.3 for discussions of scale, and 2.4.1 for discussions of scope.

- *Holistic – analytic* (Tate 2011; Peña, Contreras, et al. 2008; Horn 1985): this dimension is researched within all three contexts.
- *Four dimensions of information seeking:*
  - *scanning – searching*
  - *learning – selecting*
  - *recognition – specification*
  - *information items – meta-information*

  (Belkin, Marchetti, and Cool 1993): context-agnostic.
- *Pragmatic actions – epistemic actions* (Nurminen and Oulasvirta 2008; Clark 1997; Kirsch and Maglio 1994): context-agnostic.
- *Analytical strategies – browsing strategies* (Liebscher and Marchionini 1988; cited in Marchionini 1995): context-agnostic but related to behaviour on-screen.
- *Interactive – non-interactive* (Ramirez, Walther, et al. 2002): on-screen.
- *Egocentric – allocentric* (The most salient papers found in this survey: Rodgers, Sindone, and Moffatt 2012; Tversky and Hard 2009; Nico and Daprati 2009; Gomez, Rousset, and Baciu 2009; Iachini, Ruggiero, and Ruotolo 2009; Lambrey, Samson, et al. 2003; Shelton and Gabrieli 2002; Klatzky 1997; Siegel and White 1975): all pertain to environmental space.
- *Direction-based – graph-based* (Hölscher, Tenbrink, and Wiener 2011; Hund and Minarik 2006): environmental space.
- *Route strategy – orientation strategy* (Chang 2013; Lawton 1994): environmental space.
- *Landmark descriptors – cardinal descriptors* (Hund and Minarik 2006; Jansen-Osmann 2002; Pazzaglia and De Beni 2001; Lawton 1996; Lawton 1994): environmental space.
- *Active – passive* (Calori 2007: 82–83): environmental space (examines features of the information artefact rather than the user behaviour).
- *Route choice and sequence heuristics* (Kurose, Borgers, and Timmermans 2001): environmental space.

These sets of dimensions inform this thesis insofar as they provide principles by which a taxonomy *could* be organised. Although context-specific, many of them are sufficiently abstract to be applied across all three contexts. However, alongside this abstraction comes a large scale that is not a good match for the finer-grained examination of behaviour here.

2.4 / Taxonomies of seeking-finding behaviour

This survey finds many taxonomies of seeking-finding behaviour: these have been examined for possible contributions to formulating the taxonomy for this thesis. All are context-specific, meaning that connecting behaviours across contexts remains a pressing concern.

2.4.1 / Scale and scope

Issues of scale and scope limit the contribution that the majority of extant taxonomies of seeking-finding behaviour can make to the taxonomy here.

Scale: This issue is discussed in relation to seeking-finding behaviours in general in 1.2.4. Concerning specifically taxonomies, many define categories of behaviour that are too broad (large-scale) to serve our purposes here.[106] This survey also finds a single taxonomy that defines categories of behaviour at a scale too small (too fine-grained) to be helpful for the research in hand: Pressley and Afflerbach (1995), augmented by Afflerbach and Cho (2009), identify 198 different reading behaviours in paper documents and on-screen.

Scope: As noted in 1.4, in the third and fourth key points emerging from the literature survey, most literature that discusses seeking-finding behaviour covers only one or at most two of the three contexts under consideration here. Also much of the literature surveyed either includes elements excluded here,[107] or excludes elements I have included,[108] and thus much of it has a scope that does not match that defined in this research.

There are two further ways in which other studies have a different scope to my research. First, as discussed in 1.3.7, behaviour in executing closed and simple tasks is not necessarily representative of the scope of the incompletely defined, complex, and shifting goals that typify real world seeking-finding (Albers 2004), and it is the latter that this taxonomy represents. And secondly, research into seeking-finding on-screen often differentiates between search (typically using a search engine) and navigation (typically clicking on hyperlinks either on

106 E.g. Webber, Burnett, and Morley (2012); Morville and Callender (2010: 52–61); Gibson (2009: 37); Ferrara (2008); Smitshuijzen (2007: 112–113); Juvina and van Oostendorp (2006); Spencer (2006); Guinee, Eagleton, and Hall (2003); Kato and Takeuchi (2003); Roy and Chi (2003); Choo, Detlor, and Turnbull (2000); Adler, Gujar, et al. (1998); Schriver (1997: 290–291).

107 E.g Pejtersen (1984) includes seeking-finding by using known route to a known objective; Kallai, Makany, et al. (2005) and Choo, Detlor, and Turnbull (2000) include behaviours that are not purposeful; and Guinee, Eagleton, and Hall (2003) includes changing objective if the original objective proves too difficult. The purposes of reading defined in Afflerbach and Cho (2009); Adler, Gujar, et al. (1998); Schriver (1997); and Pressley and Afflerbach (1995) include other types of reading as well as seeking-finding.

108 Taxonomies that are more constrained than that in this thesis include, e.g. Pugh (1979) limits seeking-finding behaviour to single texts and excludes the activities of selecting the text(s) to search. Kallai, Makany, et al. (2005) examine a particular type of task within a single environment that is more constrained and more artificial than the scope of 'everyday life'.

navigation panels or embedded in page content), and most taxonomies only cover one,[109] whereas my taxonomy covers both.

2.4.2 / Five other taxonomies

The taxonomies discussed below are those that have contributed most directly to the taxonomy proposed in this thesis. They all derive from environmental space or on-screen: none comes from paper documents. Figure 2.10a gives an overview of how their categories relate to the categories in my taxonomy.

Cromley and Azevedo's eleven search moves

Cromley and Azevedo (2008: 298–299): on-screen, research literature.

These search moves are a means to an end for Cromley and Azevedo rather than the goal of the study. Their formulation is not discussed and they are only briefly defined in concrete, context-specific language – which hinders their applicability across contexts. Nonetheless, they are at the same scale as the behaviours in my taxonomy. Although encompassing all seeking-finding behaviour observed within their study, Cromley and Azevedo's eleven moves cover only five of my twelve categories.

Kalbach's twelve mechanisms of navigation

Kalbach (2007: 54–82): on-screen, practice literature.

These mechanisms relate to affordances of information structures rather than user behaviour, and in approaching from the point of view of information provision, align well with my taxonomy. They also operate at a scale comparable with it. However, the mechanisms are described in concrete context-specific language, which hinders their applicability across contexts. Kalbach's twelve mechanisms encompass only four categories in my taxonomy – all semantic behaviours. He also identifies three types of navigation (pp.84–118), but these are too large-scale to contribute to the taxonomy in this thesis.

Mollerup's nine wayfinding strategies

Mollerup (2005): environmental space, practice literature.

These strategies match closely to the scale used in my taxonomy. They are described in context-specific language, but are more abstract than the other taxonomies here. While clearly commonsensical, rooted in everyday life, and possibly observation-based, Mollerup provides no rationale or evidence to support the formulation of his categories.

Mollerup's contribution to my taxonomy is the most evident: seven of Mollerup's categories map closely onto my categories (the other two of Mollerup's both map onto pairs of categories in my taxonomy), and two of

109 E.g., covering search only: Morville and Callender (2010); Adler, Gujar, et al. (1998); Ferrara (2008); Roy and Chi (2003), and covering navigation only: Juvina and van Oostendorp (2006).

the categories use names from Mollerup. However, the structural approach to differentiating between categories in my taxonomy is different to Mollerup's.

Weisman's four wayfinding strategies

Weisman (1987): environmental space, practice literature.

Although not comprehensive, Weisman's strategies are a good match for the scale of behaviours in my taxonomy and map relatively closely onto four categories.

Passini's styles, strategies, and tactics

Passini (1981): environmental space, research literature.

Passini formulates a matrix defined by the interaction of two styles and two strategies (with one of the strategies further subdivided into three tactics applicable to both styles). Individuals typically use both styles, but may show a preference for one. This basic matrix is shown in figure 2.4a.

Passini's definitions are brief and include few examples of behaviour to

Figure 2.4a *the matrix formed by Passini's styles, strategies, and tactics*

strategies		styles: **linear** people rely on signs (i.e. a linearly organised wayfinding support system)	**spatial** people rely on a spatial understanding of their setting (which can include architectural cues and floor plans)
search employed when there is no information available, and may range from random to systematic			
access employed when information is available	***direct*** relies on sensory information to execute a decision (i.e. information in the environment)		
	indirect relies on memory information to execute a task		
	inference relies on information derived by manipulating information in the environment and in memory		

populate the cells, and this limits the sureness with which his matrix can be employed. A tentative overlaying of my taxonomy and Passini's cells (figures 2.10a–b) suggests that the cells cover all of the semantic and spatial behaviours and none of the social behaviours in my taxonomy. However, there is no one-to-one relationship between Passini's matrix cells and my categories: some of his cells span several categories within the taxonomy, and some of the categories in the taxonomy span several of his cells.

The study by Mandel (2013) employs Passini's styles, strategies, and tactics. She finds it problematic to conclusively position behaviour within Passini's matrix based only on interviews or observation of physical action, because these provide only limited evidence of cognitive activity. Nonetheless, she concludes that she can find greater evidence for Passini's styles than for his strategies or tactics.

2.5 / The four questions driving the taxonomy

the categories of behaviour in the taxonomy are differentiated by characteristics of the information that they use. These differences are articulated through four questions about that information.

Examining seeking-finding behaviour from the point of view of information use is one of the ways in which my research aligns itself with the interests of information design practice. Available information as a (possibly critical) behaviour-influencing factor in seeking-finding is identified by many authors:[110] 'This leads one to view the information as being the important variable in determining wayfinding solutions' (Passini 1981: 27). The overview of information processing by Wickens and Carswell (2012) also informs my taxonomy. And four dimensions of information seeking by Belkin, Marchetti, and Cool (1993) inform my four questions.

The questions are:

- What is the **location** of the information?
  – Within you.
  – In the environment: continuing to be accessible as you proceed.
  – In the environment: at a point fixed in space and time.
- What or who **provides** the information?
  – A person.
  – A thing.

110 E.g. Norman (2013); Gibson (2009); Mallot and Basten (2009); Li (2006); Montello and Sas (2006); RSSB (2006); Mollerup (2005: 43); Casakin, Barkowsky, et al. (2000); Miller and Lewis (1999); Passini (1996: 322–326); Freksa (1999: 23); Goodman (1993); Downs and Stea (1977: 67).

- What **choices** does the information give?
  – It affords a single course of action.
  – You must choose your course of action.
- What **form** does the information take?
  – The actions of others.
  – Traces of the actions of others.
  – A symbolic representation of a series of actions.
  – A symbolic representation of the space.
  – A fixed sequence of symbols, one of which is linked to your objective.
  – An objective that can be apprehended from your location.
  – A frame of reference fixed and absolute throughout the space.
  – A defined area known to contain the objective.
  – An internalised representation of the space.

The process of developing my taxonomy is described in 10.1. In brief, these questions were formulated inductively – emerging from examining the relationships between the categories of seeking-finding behaviour in successive iterations of the taxonomy, informed by the literature review and the user research.

The first three questions are qualitatively different to the fourth. They have fewer answer options – only two or three each – and they disaggregate behaviours at a relatively high level. The fourth question has a greater range of answer options that are more specific – each of them relates to only one or two categories of behaviour – and they disaggregate categories at a more specific and concrete level.

As discussed in 1.3.7, the information that the individual requires to achieve their seeking-finding goal may come from multiple sources: it is not all in the same place, and not all available at the same time. Synthesising disparate pieces of information demands that the individual engage in finding, selecting, and discarding information, and this increases cognitive load (Albers 2003b: 270–274).[111] The information available may be unclear, ambiguous, or contradictory (Arthur and Passini 1992: 28–29). Information is characterised as 'clues' to help seeking-finding by Raubal and Egenhofer (1998) and Simon (1956); and 'knowledge in the world' by Norman (2013). It can range from explicit (i.e. signs) to implicit (i.e. qualities of the environment itself such as the presence of an entrance) (Conroy 2001). These differences are reflected in my taxonomy.

The question of **location** of the information – the differences between external and internal information sources – runs through Norman (2013) and is discussed in the context of seeking-finding in environmental space in Tversky and Lee (1999).

111 See 1.3.6 for a discussion of cognitive load.

The question of what or who **provides** the information – in terms of whether it is a person or a thing – is not widely discussed. The assumption is typically made that information will be provided by a thing and not a person. This survey finds only limited consideration in practice literature of information provided by people, and this is discussed in 2.11 and section 4.

The question of **choices** offered by the information source is extensively discussed in terms of factors such as the number of options, their distinctiveness, their ordering, and the probability with which they will achieve the desired outcome.[112]

The question of the **form** of the information is also widely discussed, particularly in information design practice literature. However, form tends to be examined in terms of the affordances of particular objects (or types of objects) in a particular context. This survey has found no context-agnostic exploration of form; consequently, formulating the options this question has presented a particular challenge.

2.6 / Overview of the taxonomy and the categories of behaviours

Figure 2.6a shows how the questions are used to define the twelve individual categories of seeking-finding behaviour in my taxonomy, and the three groups into which behaviours are sorted. Two points to make about this taxonomy: (i) in working at tactic scale, this taxonomy defines behaviours that are sufficiently small such that they are typically used in combination in achieving any real-world seeking-finding goal; and (ii) it is the combinations of behaviour that are of interest, particularly their interaction with other behaviour-influencing factors.

Individual category definitions are outlined below and discussed in detail in sections 4–6. Throughout the rest of this thesis, the names of behaviour categories are underlined thus every time they occur to identify them clearly, particularly when they occur within text.

The social, semantic, and spatial groupings (at the bottom of figure 2.6a) are discussed in section 2.7.

Collaborative seeking-finding

The information is provided by a person who proceeds with you and with whom you interact in real time. The information takes the form of the actions of that person (including speech), and presents a single course of action.

112 E.g. Luce (1959).

Social seeking-finding

The information is provided by someone whom you witness, in real time, at a point fixed in space and time. The information takes the form of the actions of that person (including speech), and presents a single course of action.

Asynchronous social seeking-finding

The carrier of the information is a thing rather than a person; the information takes the form of traces left by the actions of one or more persons; and these traces are at a point fixed in space and time within the environment. The information presents a single course of action.

Following fixed-location instructions

The carrier of the information is a thing rather than a person; the information takes the form of symbols representing a series of actions; and it is at a point fixed in space and time within the environment. The information presents a single course of action.

Following portable instructions

The carrier of the information is a thing rather than a person; the information takes the form of symbols representing a series of actions; and it proceeds with you as you continue your seeking-finding. The information presents a single course of action.

Using a portable overview

The carrier of the information is a thing rather than a person; the information takes the form of symbols representing the affordances of the space within which you are seeking-finding; and it proceeds with you as you continue your seeking-finding. The information presents multiple possible courses of action and you must choose which to take.

Using a fixed-location overview

The carrier of the information is a thing rather than a person; the information takes the form of symbols representing the affordances of the space within which you are seeking-finding; and it is at a point fixed in space and time within the environment. The information presents multiple possible courses of action and you must choose which to take.

Sequencing

The carrier of the information is a thing rather than a person; the information takes the form of a fixed, widely understood, ordinal sequence of symbols, one of which is linked to your objective; and it is at a point fixed in space and time within the environment. The information presents multiple possible courses of action and you must choose which to take.

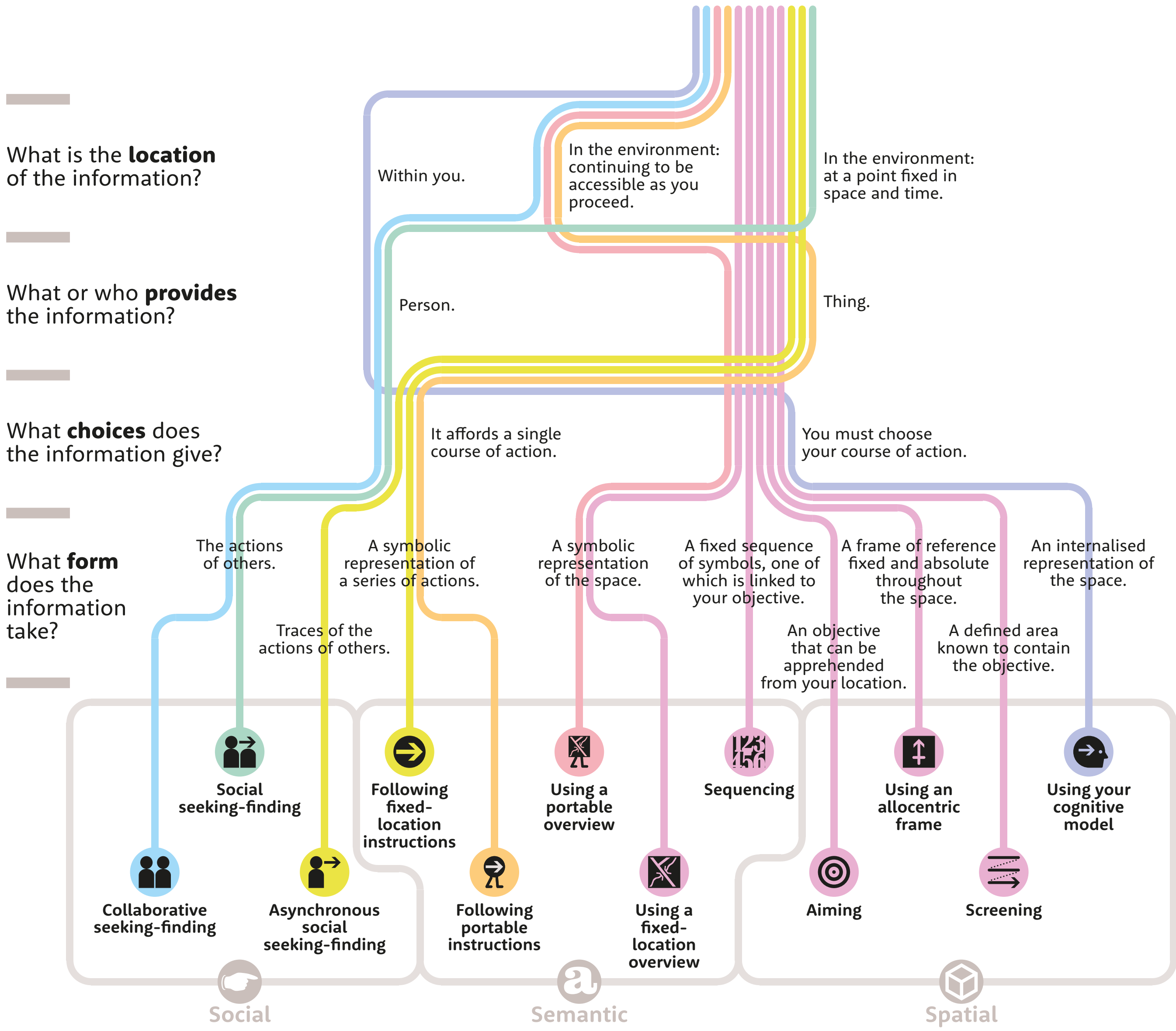


Figure 2.6a: *overview of the taxonomy, showing the 4 questions and their relationships to the categories of behaviour. The three groups of categories, identified as 'social', 'semantic', and 'spatial' are introduced later, see 2.7*

Aiming

The carrier of the information is a thing rather than a person; it takes the form of a marker that is distinct from its surroundings, and that can be apprehended from your location and used as an objective. This objective is at a point fixed in space within the environment, and can be relied upon to remain there for long enough to be useful. The information affords multiple possible courses of action and you must choose which to take based on the information and your objective.

Aiming may be direct or indirect. With direct aiming, the perceptible object is your objective. With indirect aiming, you know that the perceptible object is proximal to your objective (which cannot be apprehended from your location).

Using an allocentric frame

The carrier of the information is a thing rather than a person; it takes the form of a frame of reference that is fixed and absolute throughout the space in which you are seeking-finding; and it is fixed in space within the environment and can be relied upon to remain constant for long enough to be useful. The information affords multiple possible courses of action and you must choose which to take.

Screening

The carrier of the information is a thing rather than a person; it takes the form of a defined area believed to contain your objective; the defined area is fixed in space within the environment and can be relied upon to remain constant for long enough to be useful: you search this defined area according to a system. The information affords multiple possible courses of action and you must choose which to take.

There are three subcategories of screening: targeting, satisficing, and optimising. With targeting screening, the search ends when the predefined objective is found, even if the defined area has not been completely searched. With satisficing screening, the search ends when a 'good enough' solution is found. With optimising screening, the search is comprehensive, and it ends when the defined area has been entirely searched. Only then is the best solution selected from among those available.

Using your cognitive model

The carrier of the information is you yourself: the information is within you and takes the form of an internal representation based on knowledge gained from previous actions within the world, a model of how the world is, and how it can be predicted to operate. The information affords multiple possible courses of action and you must choose which to take.

There are three subcategories of using your cognitive model: direct, indirect, or theoretical. Using your direct cognitive model, your information comes from direct experience of the space. Using your indirect cognitive model, your information has been acquired without direct experience of the space – for instance, from a picture, map, or description of the space. Using your theoretical cognitive model, your information derives from experience of other spaces that fall into the same category.

2.7 / ‘Social’, ‘semantic’, and ‘spatial’ behaviour groups

The twelve categories of behaviour in the taxonomy are sorted into three groups based on characteristics of the information they use: social, semantic and spatial. The insight these groupings afford into differences and similarities between categories of behaviour are woven throughout sections 4–8.

These groupings derive from Dourish and Chalmers (1994), and although formulated for on-screen contexts, they are readily adapted for all three contexts. Dourish and Chalmers seek to define ‘social navigation’, and in the process do the same for behaviours that are *not* social: they characterise these as either ‘spatial’ or ‘semantic’. *Social* navigation happens when ‘movement from one item to another is provoked as an artefact of the activity of another or a group of others’ (Dourish and Chalmers 1994: 1). *Semantic* and *spatial* navigation are described in Dourish (1999: 18): ‘Spatial navigation relies on the structure of the space itself, often a two- or three- dimensional metaphor of some spatially organised real-world phenomenon (such as an office, street or landscape). Virtual reality systems, for example, place considerable reliance on spatial navigation, offering users a spatial organisation by which to explore an environment. “Semantic” navigation, in contrast, relies on the semantic structure of the space. A hypertext system, for example, provides “links” between semantically related items and offers a means to move from one item to another according to these semantic relationships.’

The distinction between semantic and spatial behaviours is broadly comparable with the distinction between verbal and visual cognitive approaches, identified as a fundamental dimension of cognitive style (Riding and Cheema 1991).[113] It is not as widely studied in information science as some of the other dimensions (Ford 2015: 106). The distinctions between social, semantic, and spatial characteristics of information sources in my taxonomy are comparable to the distinctions made in a number of other studies.[114]

Categories of behaviour in my taxonomy are not defined absolutely or exclusively as belonging to the social, semantic, or spatial group. Each category of behaviour in the taxonomy has all three characteristics, but the relative strength of these characteristics varies between behaviours. The groups are formed according to which characteristic is predominant in the information that drives the behaviour. For instance, social behaviours also have both spatial

113 And see also Koć-Januchta, Höffler, et al. (2017); Blazhenkova and Kozhevnikov (2009).

114 Semantic and spatial distinctions are made in van Oostendorp and Juvina (2007); Juvina and van Oostendorp (2006); Waterworth (1999: 136); Carlson (1997: 246, citing Gauvain 1993, and Lave 1988); Bartram (1980: 103, citing Welford 1968). And social, semantic, and spatial distinctions are made in Mallot and Basten (2009); Dogu and Erkip (2000: 736).

and semantic characteristics: finding your way by following someone whom you have identified as heading for your destination clearly has a spatial component, but here the defining factor is that the information is provided by a co-present person – and so it is social. To take another example of social behaviour, indirect social seeking-finding can include finding your objective by using notes written by a previous user in the margins of a book; this too has components that are semantic (the communication is encoded symbolically) and spatial (the note in the margin is most likely to be placed adjacent to the relevant passage in the main text), but the defining factor in this behaviour is that the information is provided by a person in an ad hoc and informal manner – and so it is social despite the semantic and spatial dimensions.

Notwithstanding the fuzziness in these groupings, their utility is demonstrated in sections 4–6 where behaviour groups and individual behaviours are examined in detail, and in sections 7–8 where relationships between behaviours and other variables are considered.

The question of whether space can be semantic is discussed by Dillon, McKnight, and Richardson (1993). My definition does not propose that space itself can (or cannot) be structured semantically, but that the information used for seeking-finding can have semantic (or spatial or social) characteristics (and in section 5, some seeking-finding behaviours that use characteristics of the space are identified as semantic behaviours).

The suggestion is made by Morville (2005: 4) that seeking-finding with spatial characteristics will arise most readily in environmental space and that seeking-finding with semantic characteristics will arise more readily on-screen. However, this is not what emerges from the user studies conducted for this thesis (see 8.3.2).

2.7.1 / Social behaviours

Social behaviours rely on information contained the actions of others. The actions may be witnessed directly or observed through the traces they leave. Arguably, all information used in seeking-finding activities is a consequence of the actions of others – how else did that map, direction sign, hyperlink, or page number come into existence other than through being the result of someone's actions? The key points with social behaviours are: first, whether the person providing the information is present at the time when the seeker-finder uses it. If this is the case then the 'socialness' of the seeking-finding is established. And secondly, the question of agency as discussed in 2.11: if the creator of the information is a non-expert or generates it in a way that is not planned – if it is accidental, ad hoc, amateur – then it is likely to count as social.

The group of social behaviours comprises three categories of behaviour:

- Collaborative seeking-finding
- Social seeking-finding
- Asynchronous social seeking-finding

See section 4 for further discussion of these categories of social behaviour. In particular the issue of social behaviours presenting only a single course of action is discussed in 4.7.

2.7.2 / Semantic behaviours

Semantic behaviours are symbol-driven: they rely on using information that meaningfully represents things, their conceptual organisation, and their interrelation. Their representation is typically by using symbol systems such as words, numbers, letters, or pictograms.

Behaviours in this group use symbols in one of three ways: (i) representing a series of actions, (ii) representing the affordances of a space, or (iii) in a fixed and known ordinal sequence with the objective associated with one symbol in that sequence. In the case of a symbolic representation of a space, one might wonder which takes priority: the space or the symbol system, thus raising the question of whether it is a spatial or semantic behaviour. However, given that the symbolic representations of space can include such things as contents lists in which the spatiality is highly schematic, the priorities become clearer.

The group of semantic behaviours comprises five categories:

- Following fixed-location instructions
- Following portable instructions
- Using a portable overview
- Using a fixed-location overview
- Sequencing

See section 5 for further discussion of these categories of semantic behaviour.

2.7.3 / Spatial behaviours

Spatial behaviours rely on information integral to the space in which they take place, and access to that information is distributed throughout the space. This sort of information includes landmarks and points of the compass.

The group of spatial behaviours comprises four categories:

- Aiming
- Using an allocentric frame
- Screening
- Using your cognitive model

See section 6 for further discussion of spatial behaviours. The inclusion of using your cognitive model in the spatial group may be questioned: this is discussed in 6.9.1.

2.8 / Five behaviours with similar definitions

The taxonomy contains five categories of behaviour that are notable for using the same answers to the first three questions and are only differentiated by the fourth (**form**) question.

Using a fixed-location overview, sequencing, aiming, using an allocentric frame, and screening (in figure 2.6a, in pink) all use information that is (i) in the environment, (ii) provided by an inanimate thing (rather than a person), and (iii) requires the user to choose a course of action rather than providing a single possible course of action. It is *only* the form of the information that differentiates them.

There are several factors pertaining to these behaviours that may give us insight into the significance of this cluste. The first is that their **form** definitions are the most wordy (i.e. least readily reduced to a simple verbal formula). Possibly this is a reflection of this being the only factor that differentiates these categories. Also they span the semantic and spatial groups. And finally, several of the categories can be regarded as variants of another category. For instance, sequencing can be regarded as a particular form of aiming that uses semantic cues to permit you to head for an objective that is not directly perceptible from your current location; or perhaps it is a particular form of screening which structures its search using semantic cues. Using an allocentric frame depends on global characteristics of the environment to afford aiming for an objective that is not visible from your location. Also perhaps screening can be regarded as a form of aiming in which the objective is not visible. Using a fixed-location overview is absent from this speculative discussion, and while the significance of this cluster of behaviours is as yet obscure, it is hard to know what may be signified by this qualitative difference.

If nothing else, this discussion serves to highlight the interrelatedness of seeking-finding behaviour categories: how one may be nested within another or the consequence of it (see section 8). What this demonstrates is that while physical or cognitive acts may be similar across these categories, they are distinguished from each other by material differences in the information they use.

2.9 / Empty sets in the taxonomy

Not all possible permutations of answers have been used in the categories of behaviour defined within the taxonomy (see figure 2.6a). Figure 2.9a shows how it might look if all possible permutations to answers of the first three questions are included. Question four is omitted here because (i) it is qualitatively different to the first three questions, and (ii) including permutations of its nine possible answers increases the number of options from 12 to 108, and in so doing contributes little to this discussion.

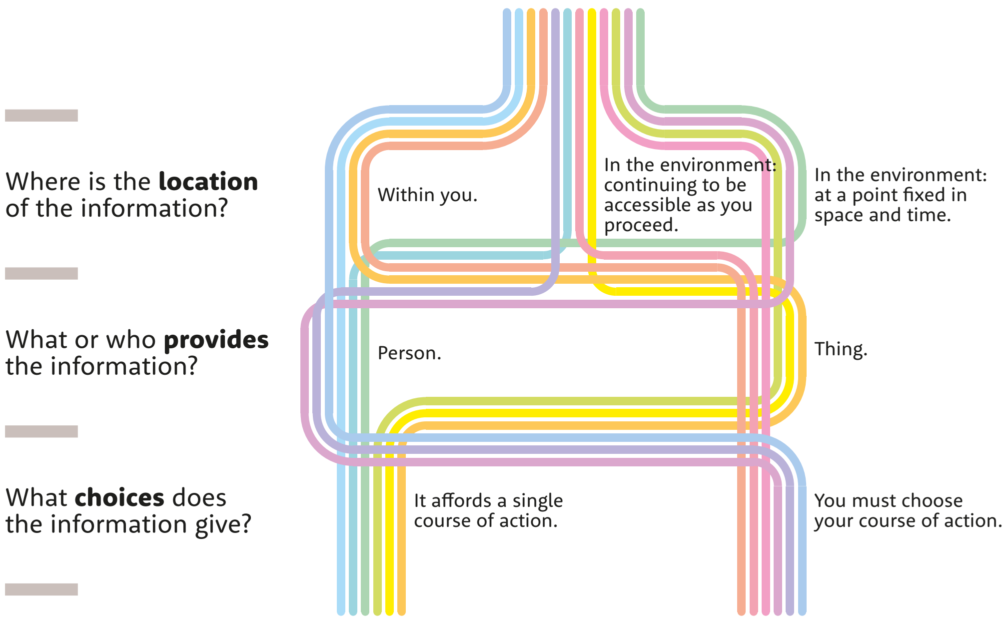


Figure 2.9a: *all possible permutations of answers to the first three questions*

Figure 2.9b shows how the actual taxonomy (the coloured lines) relates to the unused 'possible' categories that it could also contain (the grey lines): as such this is a hybrid between figures 2.6a and 2.9a. It reveals some of the 'gaps' in the taxonomy and helps in understanding the behaviours that the unused 'possible' categories describe.

For example, there are four possible categories that use 'within you' to answer the '**location**' question: only one of these appears in the taxonomy. Two of these three unused categories answer 'thing' to the '**provides**' question: having a 'thing' that is 'within you' to provide the information to drive these behaviours

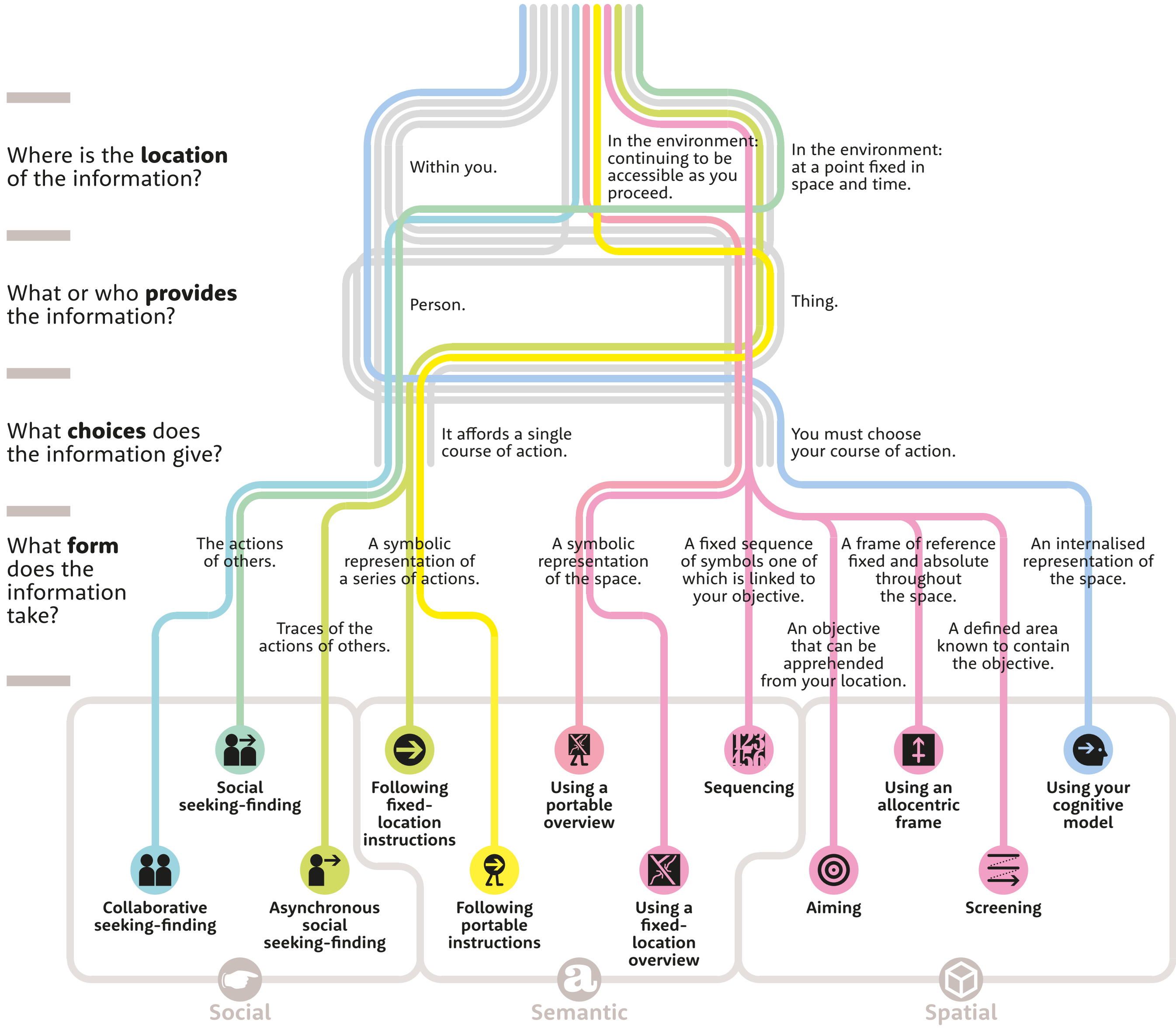


Figure 2.9b: *the grey lines show the permutations of answers not included in the current taxonomy*

possibly requires the implantation of some sort of interactive information-providing technology within the human body. This is not yet possible.[115]

The point is that this taxonomy as it stands does not include all of the possible permutations of answers to the questions. This does not deny that these permutations *can* exist, but for the purposes of this thesis they are excluded for reasons of their (currently) limited presence in everyday life.

The three behaviours in the social group all answer 'it affords a single course of action' to the **choices** question. This is discussed further in 4.7, but it is worth

115 Although some sort of future hybrid of Google Glass combined with subdermal implant technology and cochlear implants could possibly create an information type that fulfils the definition.

noting here that the three parallel categories that answer 'you must choose your course of action' have each been conflated with their 'single course of action' counterparts for the purposes of this thesis because they are infrequently used. This decision is not intended to deny their existence: the larger categories have pragmatically subsumed the very much smaller sibling categories in order to manageably contain the discussion within the limits set here.

Similar reasoning applies to the empty category that answers 'single course of action' to the **choices** question but is otherwise identical to the profile for using your cognitive model. It is more likely that one's cognitive model will bring forth a number of possible courses of action from which one must choose, rather than a single course of action with no possible alternatives. There are undoubtedly occasions when one's cognitive model does bring forth a single course of action but, as with the social behaviours, this is sufficiently infrequent as to be unproductive here. It is nonetheless a valid category.

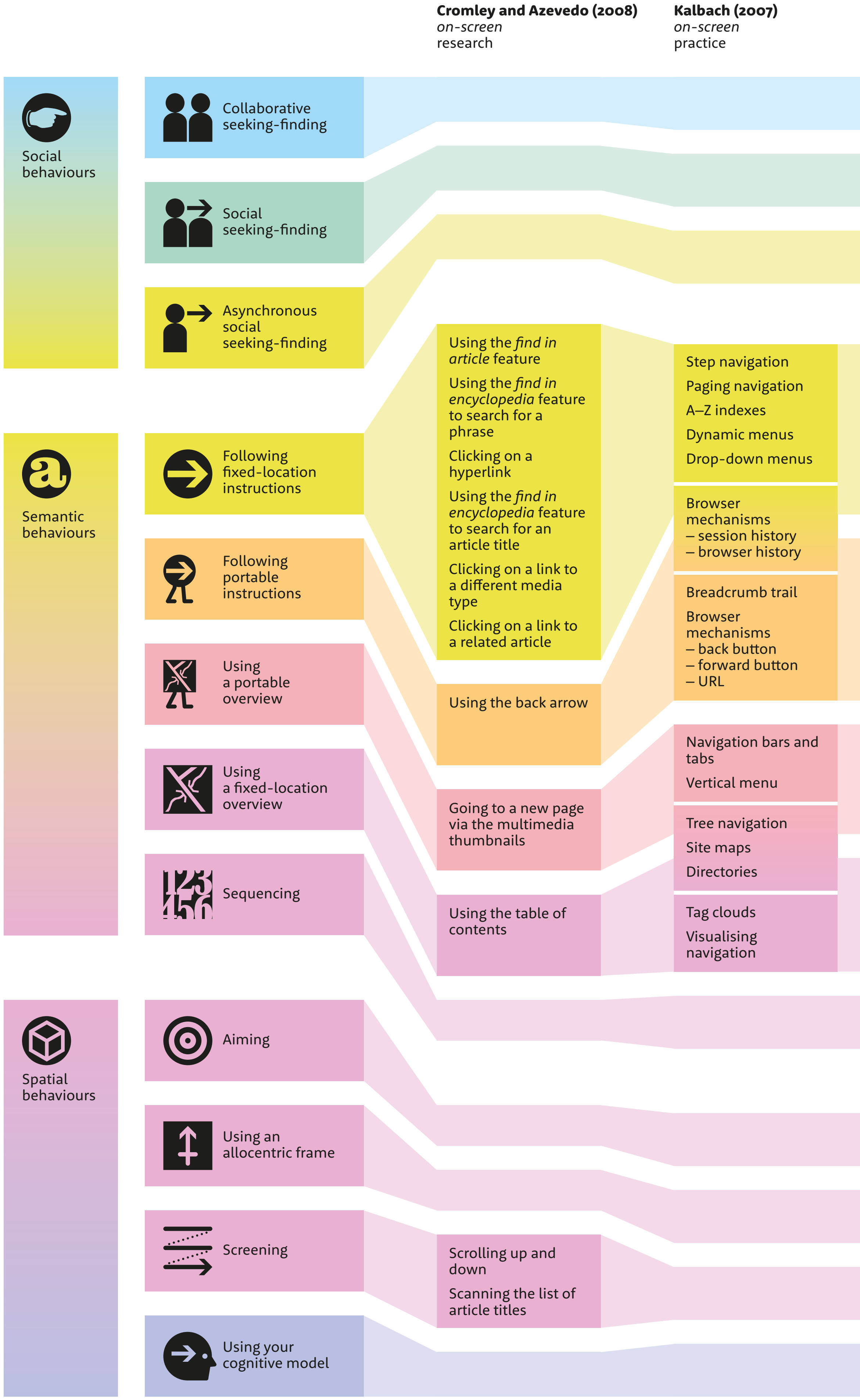
2.10 / Comparing taxonomies

Figure 2.10a gives an overview of how the categories in the five other taxonomies in 2.4.2 map onto the categories defined in my taxonomy.

Of these, only Mollerup (2005) addresses social behaviours: he creates a single category that subsumes two categories from my taxonomy, and none of the taxonomies addresses collaborative seeking-finding.

The two taxonomies from on-screen space both identify behaviours that fall mainly within the semantic group, specifically instruction-following or overview-using in both portable and fixed-location forms. Kalbach (2007) identifies multiple behaviours in each of the four categories in this group in my taxonomy, including some that span categories: some count as instruction-following and can be either fixed-location or portable, and others count as overview-using and can be either portable or fixed-location. Cromley and Azevedo (2008) formulate six behaviours that are all classed as following fixed-location instructions. They also have two behaviours that are the only ones from on-screen taxonomies that fall outside of the semantic group: they are both classed as screening – part of the spatial group of behaviours.

Of the five taxonomies under consideration here, those by Mollerup (2005) and Passini (1981) – both from environmental space – cover the greatest number of categories in my current taxonomy. Mollerup largely has a 1:1 relationship with categories in my taxonomy, with only two instances where my taxonomy subdivides his categories. Passini's matrix of categories has the most complex relationship with my taxonomy. The dotted lines in figure 2.10a



Cromley and Azevedo (2008)
on-screen
research
Kalbach (2007)
on-screen
practice
Social behaviours
Collaborative seeking-finding
Social seeking-finding
Asynchronous social seeking-finding
Semantic behaviours
Following fixed-location instructions
Following portable instructions
Using a portable overview
Using a fixed-location overview
Sequencing
123
456
Spatial behaviours
Aiming
Using an allocentric frame
Screening
Using your cognitive model
Using the find in article feature
Using the find in encyclopedia feature to search for a phrase
Clicking on a hyperlink
Using the find in encyclopedia feature to search for an article title
Clicking on a link to a different media type
Clicking on a link to a related article
Using the back arrow
Going to a new page via the multimedia thumbnails
Using the table of contents
Scrolling up and down
Scanning the list of article titles
Step navigation
Paging navigation
A–Z indexes
Dynamic menus
Drop-down menus
Browser mechanisms
– session history
– browser history
Breadcrumb trail
Browser mechanisms
– back button
– forward button
– URL
Navigation bars and tabs
Vertical menu
Tree navigation
Site maps
Directories
Tag clouds
Visualising navigation

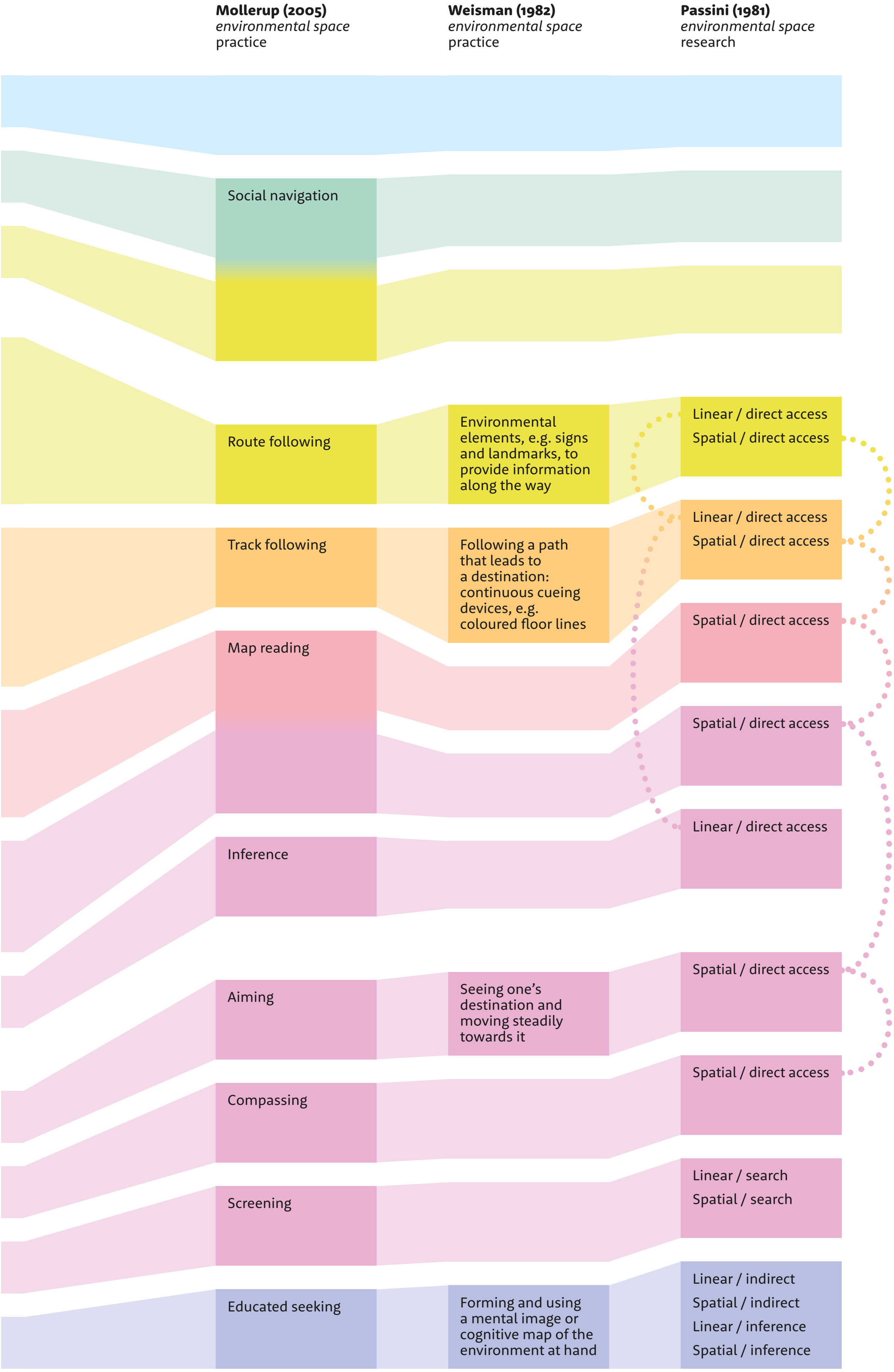


Figure 2.10a (above and facing): *how the categories of behaviour in the five taxonomies described in 2.4 relate to the categories of behaviour in my taxonomy*

strategies		**styles** **linear** people rely on signs (i.e. a linearly organised wayfinding support system)	 **spatial** people rely on a spatial understanding of their setting (which can include architectural cues and floor plans)
search employed when there is no information available, and may range from random to systematic		Screening	
access employed when information is available	***direct*** relies on sensory information to execute a decision (i.e. information in the environment)	following fixed-location instructions following portable instructions sequencing	using a fixed-location overview using a portable overview aiming using an allocentric frame
	indirect relies on memory information to execute a task	using your cognitive model	
	inference relies on information derived by manipulating information in the environment and in memory		

Figure 2.10b: *the matrix of Passini's styles, strategies, and tactics (as in 2.4a) with the categories of my taxonomy mapped onto it*

show how his categories span mine; figure 2.10b, overlays the categories of my taxonomy into Passini's matrix, and may be easier to assimilate.

2.11 / The question of agency

While developing this taxonomy, the fourth question (**form**) was resolved later than the **location**, **provides**, and **choices** questions. Other possibilities considered included the question: *Was the information deliberately created to facilitate seeking-finding?* The issue of agency it raises was not chosen, but is worth discussing. There are two further issues entwined with this question:

- Was the information created by specialists as part of their professional activities, or was it produced by non-experts?
- Was the information created in a planned and considered manner, or was it created on-the-fly?

Information that is *not* deliberately created to facilitate seeking-finding is more likely to be created by non-experts and on-the-fly: it is typically incidental, amateur, and ad hoc.[116]

Information design practice (assuming a reasonable degree of practitioner expertise) as a frame of reference within this thesis[117] implies a concern with information materials made in a deliberate, planned, and professional manner. Observation of everyday life may lead to the conclusion that information materials produced by experts (in such a manner) to support seeking-finding behaviour are more prevalent for some categories of behaviour than others; and on the other hand, some behaviours more often use information that is incidental, ad hoc, and amateur. It is as if the attention and output of information design professionals is unevenly distributed across the twelve categories of behaviour.[118] The information design profession largely has yet to address the questions of (i) how best to design for each category of behaviour, and (ii) whether incidental, ad hoc, and amateur sources of information can be effectively harnessed in strategies formulated by information design practitioners for providing information. This issue arises particularly within social behaviours where such sources of information are more widespread.

Practice literature frequently has little to say on the subject of social behaviours (with the exception of that dealing with social behaviour on-screen): they receive considerably less attention than semantic and spatial behaviours in practice literature.

2.12 / Portable or fixed-location?

This taxonomy makes a distinction between information at a point fixed in space and time and that which continues to be available as you proceed with your seeking-finding. In so doing it makes distinctions that may seem tricky (or tricksy). For example, in environmental space, the categories of behaviour distinguish between (i) using a series of directional signs – each is discrete and fixed in space and time – hence classed as following fixed-location instructions; and (ii) following a track, such as a line painted on the floor of a healthcare

116 None of which is intended pejoratively.

117 See 1.3.1.

118 It is beyond the scope of this thesis to examine why this might be. See Walker (2001) for discussion of non-expert production of graphical material.

facility to show the route from the entrance to a particular department – the track proceeds with you as you continue your journey and hence the behaviour is classed as following portable instructions. The name of the latter is somewhat counterintuitive in this instance – is a line painted on the floor *really* portable? But this is a consequence of the problem of finding suitable names for the categories rather than the categories per se: the definitions make the distinctions apparent, even if the names are not entirely satisfactory. A similar distinction on-screen is made between clicking on a hyperlink within the body of a web page (following fixed-location instructions) and clicking on a hyperlink that is part of the navigation infrastructure common to every page within that website (following portable instructions).

Section 5 deals with the individual behaviours for which this distinction is most critical particularly in 5.4.

3 / User Research

‘For all our waking lives … we are hard at work imposing significance and form upon what comes to us as a mere phantasmagoria of sense.’ (Innes 1946: 8)

‘As you see, it is impossible for us to bring order out of the chaos of evidence.’ (Downs and Stea 1977: 138–139)

‘Our tools are inadequate, and the more we try to sharpen them, the more inadequate they become.’ (Dürrenmatt 1964: 12)

‘It could be argued that we cannot effectively describe experiences with words but, as Samuel Beckett remarked, they are all we have.’ (Waterworth 1999: 144)

‘A great teacher once described the activity of science as “the orderly arrangement of what, at the moment, appear to be facts”.’ (Hastie and Stasser 2000: 85)

3.1 / Introduction

This section discusses the user research studies conducted for this thesis. It starts with a brief discussion of the principles informing the approach to the user research conducted for this thesis. This is followed by descriptions of how the three user studies were carried out, then overviews of their results, and finally, discussion of some initial observations from the results. Detailed analysis and discussion of the studies are in sections 4–8.

3.1.1 / Research approach

Answering the research questions in this thesis requires investigation into human behaviour – specifically seeking-finding behaviour. These questions also direct attention to processes rather than outcomes. As outlined in 1.8, I approach the research questions through formulating a taxonomy of seeking-finding behaviours applicable across all three contexts, using it as a lens through which to examine seeking-finding behaviour. A corpus of accounts of everyday-life seeking-finding behaviour not only provides evidence on which to base an investigation of this behaviour across the three contexts, but also informs and tests the taxonomy during its creation.[119] The literature review has not revealed the existence of such a corpus:[120] the obvious conclusion is to conduct user research to collect a suitable body of accounts of everyday-life seeking-finding behaviour. This user research is described in this section.

Exploratory studies

The research questions do not suggest the formulation of an a priori hypothesis that can be tested, and so the user studies are primarily exploratory and observational. Such studies can be effectively conducted with small numbers of participants. The task observation and diary keeping studies each use twelve participants; this quantity is sufficiently small to allow for examination of individuals while sufficiently large to allow for some patterns across the group of participants to begin to emerge (Coiro and Dobler 2007: 221; Kerr, Aronoff, and Messé 2000: 163).[121]

Real-world settings

As noted in 1.3.3, the debate about real world versus laboratory settings for studies is strongly polarised. This thesis chooses to conduct studies in real-world settings for three reasons: (i) exploratory and observational research is readily conducted in such settings, while laboratory settings might exclude factors whose significance has not yet been identified; (ii) in being exploratory, issues of internal validity (which are more likely to arise in real-world settings) are less critical; and (iii) these settings allow the relationship between the research and the real world of everyday life to be as explicitly clear and direct as possible. In so doing, this research prioritises being fuzzily meaningful over being precisely meaningless (Downs and Stea 1977: 224); and accepts the possibility of reduced internal validity in order to ensure external validity (Brewer 2000: 13).

Qualitative and quantitative data

Debates regarding the relative merits of qualitative and quantitative data are as entrenched as those regarding laboratory versus real-world settings for research. The studies conducted here collect both types of data, in part prompted by Cooper, Reimann, et al. (2014: 31–35) (from practice literature).

119 See 10.1 for a discussion of the possible circularity of this approach.

120 See 1.4, 2.3, and 2.4.

121 See 3.2 for detail of the task observation and 3.4 for the diary keeping, and see 3.8.1 for a discussion of sample size and selection.

These studies also collect data that is principally observational, and examine process rather than outcome.

Contextual enquiry

The approach taken in these studies is broadly ethnographic, observational, and in-context. It is informed by the practices of contextual enquiry formulated by Beyer and Holzblatt (1998); and modified by Cooper, Reimann, et al. (2014: 44–46), whose research approach is expressly formulated to inform practice.

Ethical issues

These studies involving human participation have been subject to ethical review and procedures contributing to this work comply with the ethical standards of the relevant national and institutional committees on human experimentation and with the Helsinki Declaration of 1975, as revised in 2008. Amongst other actions, all participants names have been changed.

The three user studies

These studies examine seeking-finding behaviour in all three contexts, using a variety of methods to collect both qualitative and quantitative data. They gather a diverse, broad, and rich body of information about seeking-finding behaviour. All three studies yield accounts of behaviour in the form of lists of behaviours used by individuals in the execution of particular seeking-finding tasks, and more discursive open-ended comments by participants on their seeking-finding behaviour.

The first study – *the task observation* – examines seeking-finding behaviour using a single document printed on paper. Twelve participants separately execute the same six seeking-finding tasks in a reference book: their actions are filmed and they speak out loud their thought processes as they execute the tasks. This study collects not only lists of behaviours, but also (i) the order in which the behaviours are used, (ii) the duration of each behaviour, and (iii) the possibility of distinguishing between successful and unsuccessful behaviours. Because the participants all execute the same set of tasks, we can examine the same task executed by different individuals, and the same individual executing different tasks. One limitation is that the tasks are artificially imposed, whereas the tasks involved in the wayfinding survey and the diary keeping all arise within the individuals' everyday lives. Also, whether this study is regarded as taking place in a real-world setting is debatable. See 3.2 for a full description of this study.

The second study – *the wayfinding survey* – examines seeking-finding behaviour in environmental space. Forty-three participants, all invited to attend the same event, are surveyed about the seeking-finding tactics that they use to reach the location. Unlike the task observation and the diary keeping, the wayfinding survey involves a larger number of participants, but each makes only a single report. See 3.3 for a full description of this study.

The third study – *the diary keeping* – examines seeking-finding behaviour in all three contexts. Twelve participants keep diaries of their everyday-life seeking-finding behaviour in all three contexts for the course of a month. This study yields a substantial number of reports, as each participant makes multiple reports in each context. This allows for the data to be separated and compared on a number of dimensions: for instance, individuals, contexts, and individual categories of behaviour can all be examined. See 3.4 for a full description of this study.

The diary keeping allows seeking-finding behaviour to be examined in a number of ways: for instance, different individuals can be examined and compared, and individual contexts can be examined and compared. The task observation and wayfinding survey provide data about particular contexts that can be compared with data from the same contexts in the diary keeping to see the differences and similarities in behaviour between different studies in the same context. The diary keeping, with its diversity of tasks, allows us to examine an ecologically sound sample of the tasks that drive seeking-finding behaviour, and to consider how task relates to behaviour choice, context, and individual.

3.2 / The 'task observation' study

This study forms an early step in my exploration of seeking-finding behaviour. Individuals are observed executing given seeking-finding tasks within a complex printed document.[122]

The literature survey finds few comparable studies, but there is one by Yussen, Stright, and Payne (1993): 'Suppose someone handed you the self-same book on cognitive development and asked you to find the meaning of "metacognitive experience." … What would you do? Very little empirical evidence exists about what adults actually do in circumstances like these' (p.242). 'So far as we know, this study is the first formal investigation of how adults think about the properties of a book that can help them find information in it. There remains much to do to explore the topic further' (pp.253–254).

Little further research has been undertaken in the twenty-five years since this study.[123]

122 Prior to this study I spent many years designing such documents, but that employment offered no opportunity to investigate the behaviour of their users.
123 In all fairness, in the intervening years the rise of screen-based information seeking primarily on the World Wide Web attracted a great deal of research attention. See 1.4.3 for an overview of the literature

Issues with verbal protocols

This study asks participants to speak out loud their thought processes: a method commonly known as *think aloud* or *verbal protocol analysis*. Although widely used, this method has limitations, including (i) cognitive activities being too swift or otherwise inaccessible to conscious attention and articulation,[124] and (ii) speaking aloud affecting the behaviour that the test observes (possibly due to issues of cognitive load, presenting oneself favourably, differences in how readily individual behaviours can be put into words, or being made self-conscious of activities normally undertaken automatically).[125]

Within the context of this study, it was not possible to mitigate these issues, but given the early-stage and exploratory nature of the study, these limitations are regarded as acceptable.

3.2.1 / Participants

The twelve participants are friends and neighbours of the researcher.[126] They comprise five men and seven women, ages ranging from 39 to 75 (mean age 58) at the time of the study, all are broadly middle-class professionals and speak English fluently.

3.2.2 / Materials

This study takes *Pears Cyclopedia* (Cook 2012) – referred to hereafter as *Pears* or 'the book' – as the printed document to test. Figures 3.2a–f show representative spreads of the book illustrating its various elements.

Pears was chosen as the test material because while in many ways it is a conventional reference book, some idiosyncratic aspects mean that user assumptions do not always hold true. Although it is more customary to choose a generically typical example as test material, *Pears*' unusual features necessitate that the user think more consciously than they might otherwise do about the seeking-finding tactics that they choose. The intention is to bring these cognitive processes closer to conscious attention and facilitate the participants articulating these processes in their utterances. A similar research approach is used in Afflerbach and Cho (2009).

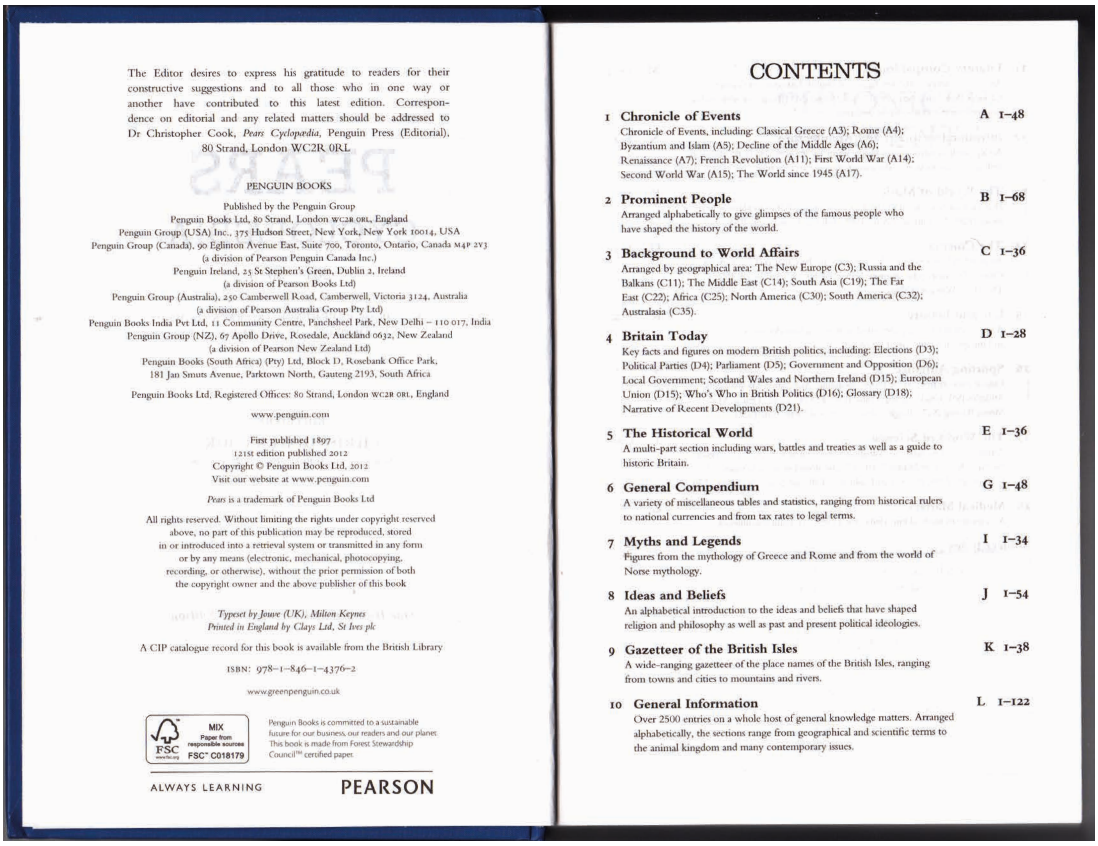
The page numbering system in *Pears* provides a good example of how the book makes idiosyncratic use of conventional structures. The pages are

survey for seeking-finding in paper documents. The literature survey finds only four studies comparable to mine: Kools, Ruiter, et al. (2007); Klusewitz and Lorch (2000); Dreher and Sammons (1994); Yussen, Stright, and Payne (1993).

124 Visser, Krosnick, and Lavrakas (2000); Nisbett and Wilson (1977).

125 Webber, Burnett, and Morley (2012); Carlson (1997: 166); Russo, Johnson and Stephens (1989); Schumacher and Waller (1985: 389).

126 The possible limitations of this sample are discussed in 3.8.1.



The Editor desires to express his gratitude to readers for their constructive suggestions and to all those who in one way or another have contributed to this latest edition. Correspondence on editorial and any related matters should be addressed to Dr Christopher Cook, *Pears Cyclopædia*, Penguin Press (Editorial), 80 Strand, London WC2R 0RL

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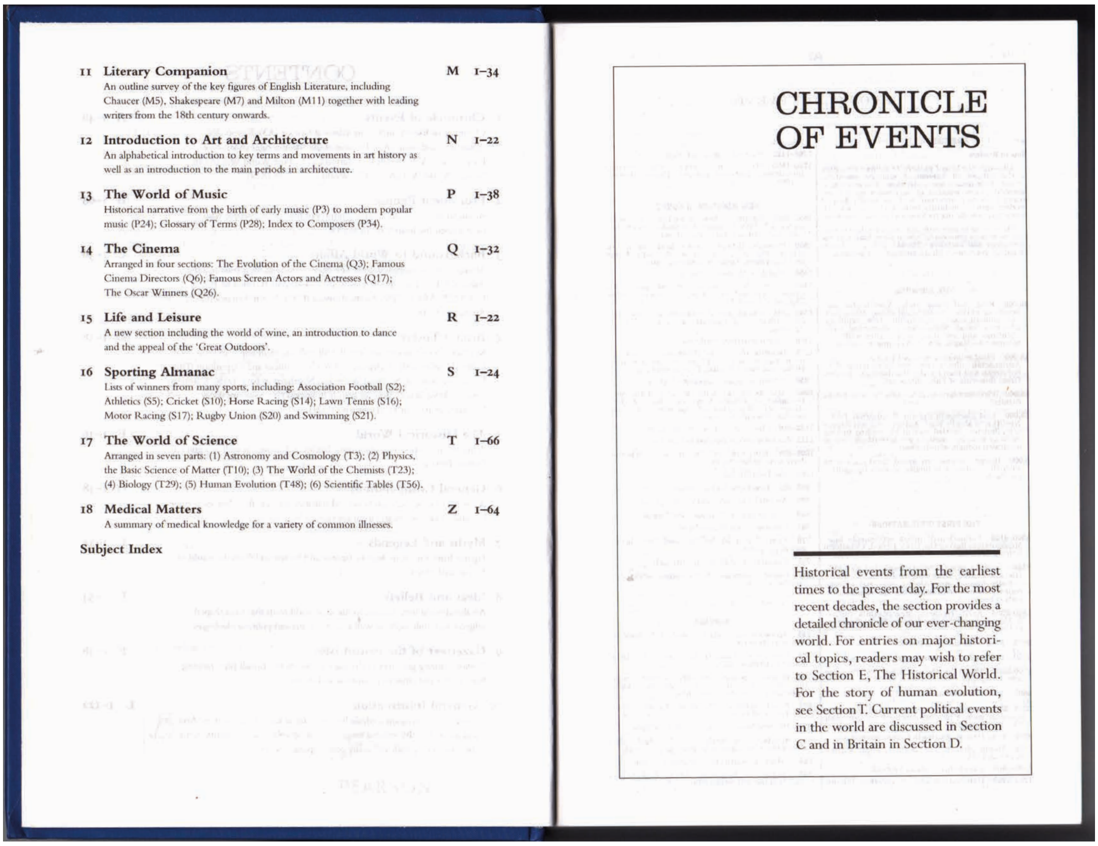
ALWAYS LEARNING PEARSON

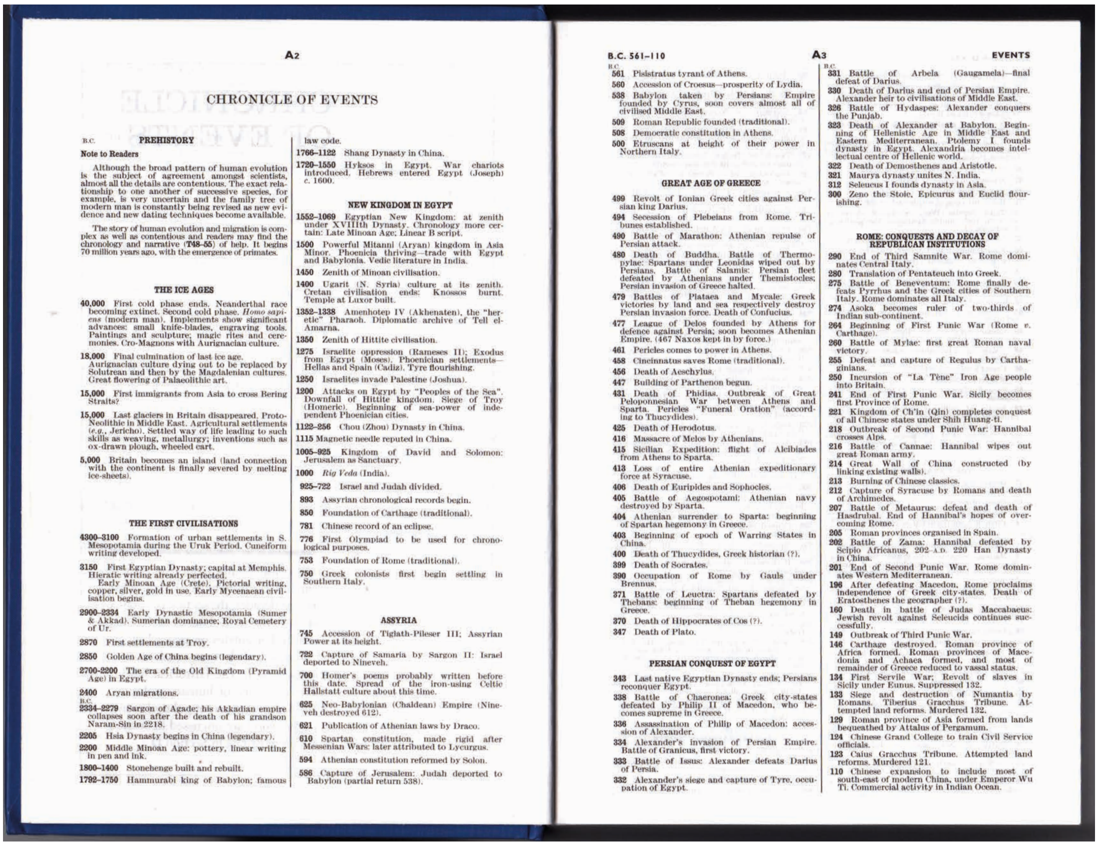
CONTENTS



CHRONICLE OF EVENTS

Historical events from the earliest times to the present day. For the most recent decades, the section provides a detailed chronicle of our ever-changing world. For entries on major historical topics, readers may wish to refer to Section E, The Historical World. For the story of human evolution, see Section T. Current political events in the world are discussed in Section C and in Britain in Section D.

Figure 3.2a (top): Pears*: (all 54% of actual size) the start of the contents list on page v. The contents list shows page references in a column down the right-hand side of the page*
Figure 3.2b (below): Pears*: the end of the contents list on page vi, and the chapter 1 opening on page A1 showing the brief prose summary of the chapter content*



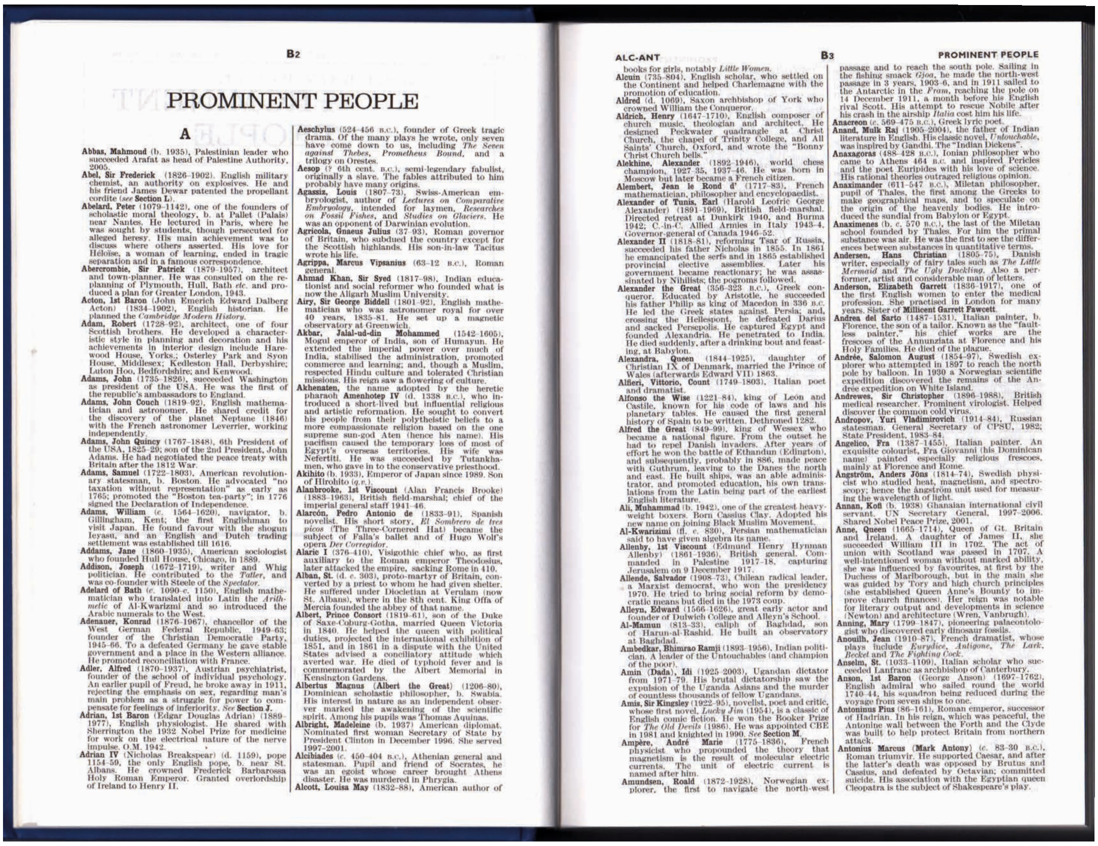
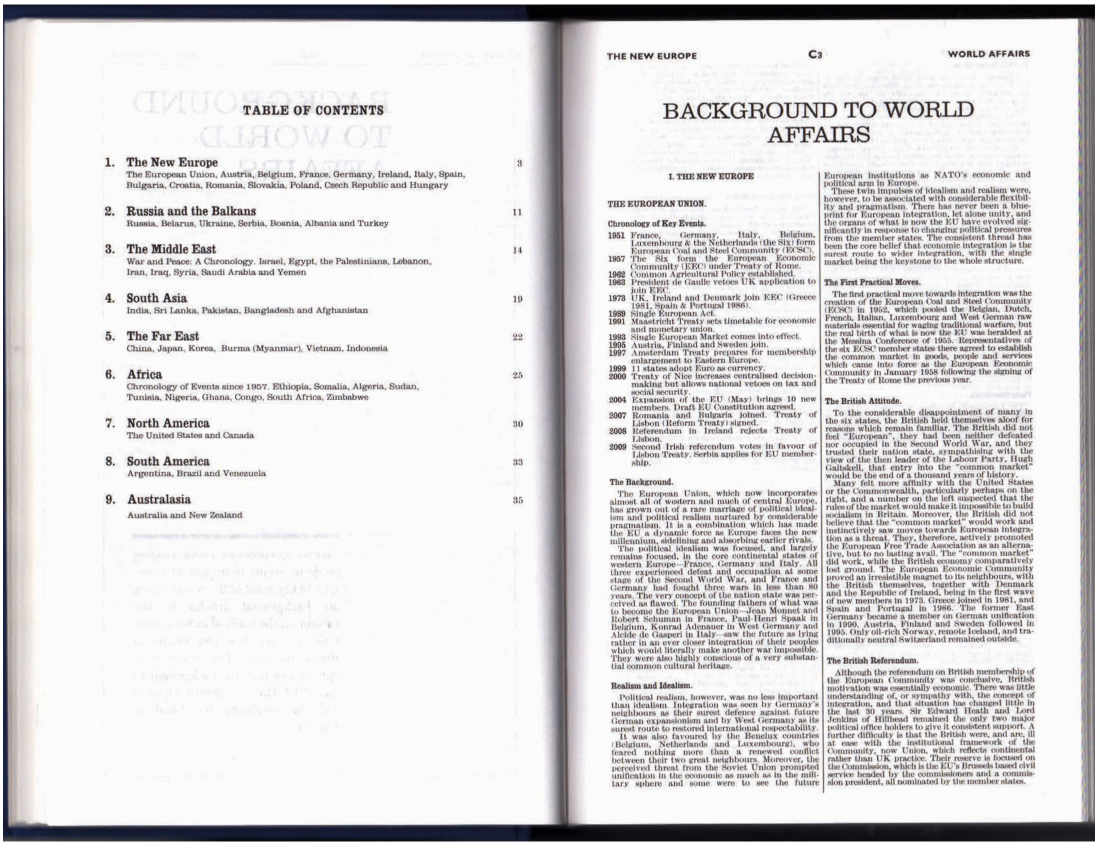


Figure 3.2c (top): Pears*: the start of chapter 1 showing content comprising short items arranged chronologically. The page numbers are at the top of each page and are centred in the width of the text. Running heads sit at the top of the page on the same baseline as the page numbers; they are ranged left and right, to align with the edges of the text area, shown here only on the right-hand page*

Figure 3.2d (below): Pears*: the start of chapter 2 content comprising short items arranged alphabetically*



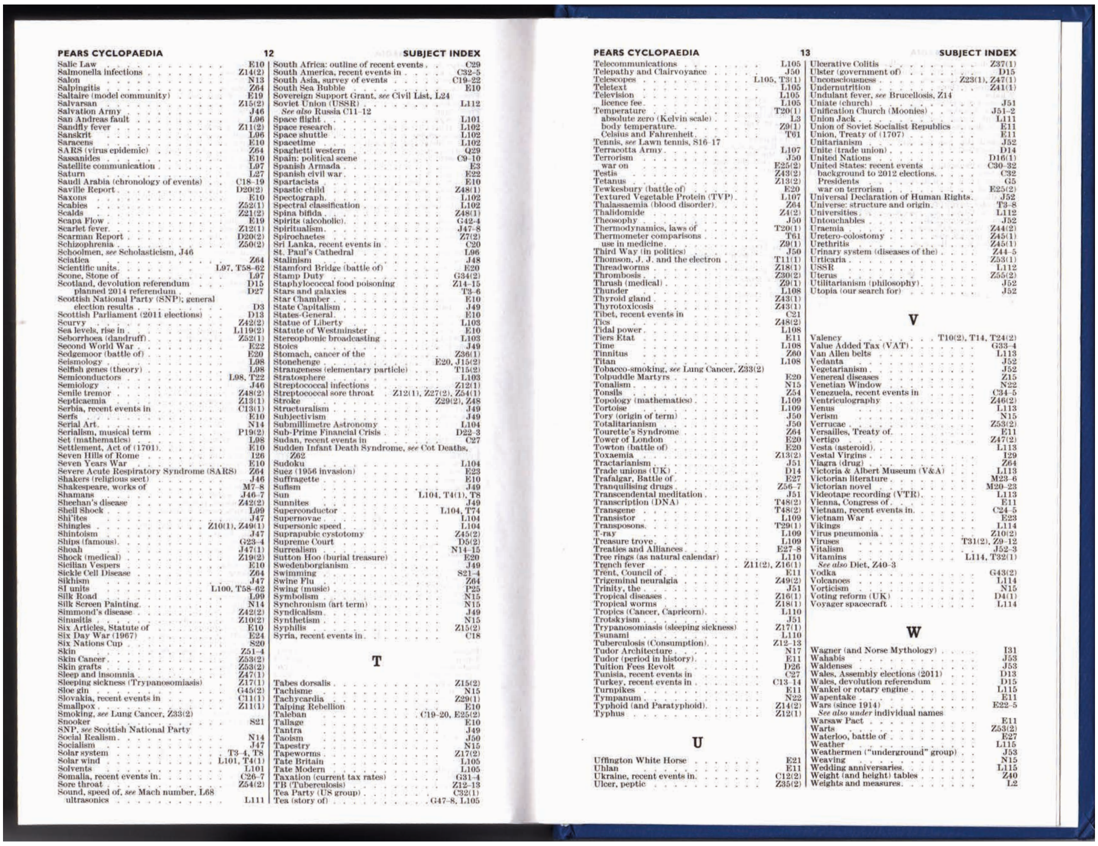


Figure 3.2e (top): Pears*: the start of chapter 3 with mini-contents list on page C2 (left), and the text start comprising prose narrative arranged thematically on C3 (right)*
Figure 3.2f (below): Pears*: typical double-page spread of the subject index at the back of the book. Page references are shown ranged right in each column on the page*

numbered sequentially from the front of the book. But atypically, in *Pears*, each thematic section (chapter) of the book restarts the page numbering sequence from 1, and in each chapter the page numbers are distinguished from other chapters by being prefixed by a different letter of the alphabet. So, the pages in the first chapter of the book are numbered A1–A48, the second chapter is numbered B1–B68, and so on. The system uses sequential numbers and letters in a way that employs familiar principles, but is not the most common page-numbering system.

3.2.3 / Method

The participants are each asked to execute the same set of six tasks in the same order. The order of tasks is kept the same because (i) the sequence is planned to become progressively more challenging, using understanding of the book from previous tasks in order to render the later tasks more likely to be completed successfully; and (ii) it facilitates comparisons between participants performing the same task – they are expected to perform tasks based on previous experience and so there is no requirement to mitigate for learning during each participant's test.

Each task requires the participant to find a place or piece of information within *Pears*:

1. Page Q15 in the book.
2. The start of the section about music.
3. The start of the article on Norse mythology.
4. The name of a person executed in the Tower of London.
5. The number of symphonies Beethoven wrote after the *Eroica* symphony.
6. The year in which Barack Obama was born.

The information sought in each task is explicitly stated in *Pears*. None of the tasks requires integration of information from multiple locations in the book (although some require the sequential use of information from more than one location). No answer requires inference or other intellectual calculation.

Participants are tested in their own homes, in a quiet room. Each session is filmed with camera position recording the book and participant's hands; head and eye movement are not recorded.

Each participant is informed that the session will be filmed, and they are asked to speak out loud their thought processes. They are also informed that there are no 'trick questions',[127] and that they can abandon any task at any time.

127 The intention of this was to reassure the participant that there was no hidden agenda in the research or covert intention to 'trick' the participant into doing or saying anything unwitting. Several participants

Each task is instructed and the participant expected to complete (or abandon) that task before the next task is instructed. Instructions are repeated as requested. Participants are asked not to answer tasks from existing knowledge, although they can use their existing knowledge to help find answers within the book.

On completion of the six tasks, each participant is asked to reflect and comment on the book and the execution of the tasks.

3.2.4 / Data collection and analytical approach

Directly after completing the twelve test sessions, the data was coded and analysed. This contributed both to early iterations of my taxonomy (coding required putting observed behaviour into categories) and development of the analytical approaches employed (approaches to how to interrogate the data that were applied to the subsequent user studies). This original analysis is *not* reported here, because the categories of behaviour that it uses are not those of the taxonomy as it appears here. That original analysis forms part of the process of developing the taxonomy reported in 10.1. The data from this study that are reported in 3.5, and discussed in sections 4–8, are that undertaken once the taxonomy arrived at its current form.

As with the two subsequent studies, the task observation yields lists of behaviours: one list for each task executed by each participant. However, this study also provides several other dimensions to the data: a *sequence* for the use of those behaviours, the *duration* of each behaviour, and the possibility to discern between 'successful' and 'unsuccessful' sequences of behaviour. On this last point, all analysis of task observation data (except where explicitly stated) includes all recorded behaviours – whether successful or not – because, first, the research questions direct attention to process rather than outcome; and secondly, when a participant chooses one behaviour over another, they make that choice in the expectation of success.[128]

The task observation – as with the subsequent pieces of user research – gives reports of multiple participants. But unlike the other two, all participants undertake the same tasks. This affords inter- and intra-individual comparisons with fewer other variables, and these factors and dimensions permit insights unavailable from the two other studies.

In this study, data is captured by reviewing the recordings of the sessions

took this statement to mean that all of the tasks could be completed using the book; this is true but had not been the intention of this statement.

128 It is not a new insight that human decision-making is fallible: for an overview of the biases and other issues involved, see Kahneman (2011). And, although not reliably definitive or comprehensive, as a measure of the extensiveness and complexity of the issue, Wikipedia has a list of 104 biases in decision-making, belief, and behaviour (https://en.wikipedia.org/wiki/List_of_cognitive_biases accessed 15/03/2017).

and coding observed actions and spoken comments directly into the categories in the taxonomy. Some categories of behaviour are absent from this study: they are simply outside of the range of behaviours possible in this study; this is an artefact of the early stage at which this study was conducted. It should also be reiterated that the data from this study presented here is *not* the data as coded directly after the study sessions, but as coded some time later when the taxonomy had reached its current form, in order to render it comparable with the data from the wayfinding survey and the diary keeping.

3.3 / The 'wayfinding survey' study

This study took advantage of an opportunity to capture multiple accounts of everyday-life seeking-finding in environmental space. People had been invited to a social event, providing an opportunity to collect data about their seeking-finding behaviour in reaching the same unfamiliar destination at about the same time. As with the task observation, this study collects data about a single context – environmental space. The wayfinding survey differs from the other two studies in involving a larger number of participants, but each completing only a single task. Unlike the task observation study, the task here is part of everyday life, and not artificially imposed.

Studies of seeking-finding behaviour in environmental space are relatively numerous, but few are comparable with this one. As discussed in 1.4.2, the majority of studies of behaviour in environmental space examine either learning an environment, seeking-finding performance factors, or behaviour in a known environment; the current study is unlike these in examining seeking-finding processes in an unfamiliar environment.

This study collects data by survey methods; specifically it uses a self-administered questionnaire. This means of data collection is much studied. For practical and theoretical advice, my study relies on Dillman, Smyth, and Christian (2014), Fowler (2002), and Visser, Krosnick, and Lavrakas (2000). I follow their suggestion that if the questionnaire is to be self-administered, closed questions yield more reliable data, with open questions providing supporting data.

Issues of inter-rater reliability

Coding data from the questionnaire used in this study raises issues of inter-rater reliability, due to there not being a 1:1 relationship between the tactics in the questionnaires and the categories of behaviour in the taxonomy (Gwet 2014; Holt and Walker 2009). Although establishing formal inter-rater reliability is less critical in exploratory studies such as this (Adler, Gujar, et al. 1998), it nonetheless deserves attention. The same issues also apply to the coding of data from the diary keeping, and they were resolved together.

Resolving these questions of inter-rater reliability became part of the process of developing the taxonomy (this is discussed in section 10.1). Briefly, they were resolved through a series of discussions with non-specialists about the relationship between the tactics listed in the questionnaires and the categories of behaviour in the taxonomy. These discussions raised issues around (i) the definitions of the categories of behaviour, (ii) the organisation of the taxonomy, and (iii) the relationships of the categories to each other. Addressing these questions informed the process of refining the structure of the taxonomy and writing the definitions of individual behaviours. The outcomes of this process are (i) a set of coding protocols that assign each tactic on the questionnaires to a specific category in the taxonomy, and heuristics governing the open responses, leaving little room for inter-rater variation,[129] and (ii) a more robust taxonomy.

3.3.1 / Participants

The participants are friends and family of the researcher; this is a consequence of the survey being opportunistic (making use of an event that was already planned).[130] The participants represent a broad spread of ages, equal numbers of men and women, all with a good level of spoken and written English. When people arrived as groups, only one person in each group was asked to participate in the survey.

3.3.2 / Materials

Data is gathered via a self-administered, brief paper questionnaire taking the form of an A4 landscape-format sheet, printed on both sides and folded to give an A5 portrait-format 4-page document (see figure 3.3a). The questionnaire asks the participant to identify from a fixed list as many as possible of the tactics that they used in finding their way to their destination (such as '**I used street-name signs**' and '**I used a map fixed to a wall (or similar)**'). In addition to closed questions, the questionnaire includes open questions to permit certain aspects to be described in more detail. It concludes with supporting questions about modes of transport and whether the participant was making the journey alone or in company. There is a final open question giving the participant opportunity to add any further information they believe to be useful.

The list of tactics in the questionnaire aims to identify as many as possible of the seeking-finding behaviours used in this task. This list is not

129 The tactics in the questionnaires that are coded into each category of behaviour are listed in the discussions of each category of behaviour in sections 4–6.
130 The possible limitations of this sample are discussed in 3.8.1.

University of Reading

Wayfinding survey

This survey is part of a study investigating the strategies that people use to find their way to a destination.

This project is devised by Andrew Barker and forms part of the research for his PhD. It is supervised by Dr Mary Dyson and Dr Ruth Blacksell.

Andrew is conducting the study and will provide any further explanation that you need to answer the questions in the survey. After you have completed the survey, Andrew can provide you with an explanation of the research.

All adult guests this evening are invited to participate in this study.

All test results are anonymous and your name does not form part of the data.

This study has been subject to ethical review according to the procedures specified by the University of Reading Research Ethics Committee, and has been given a favourable ethical opinion for conduct.

By completing this survey you are acknowledging that:

- you understand the terms of participation described above.
- you consent to these terms.
- you consent for the responses you give to be used in this study.

Please turn the page and start the survey »

What forms of transport did you use on your journey?
(*Please tick all that apply*)

☐ Car ☐ Bus
☐ Bike ☐ Network Rail
☐ Foot ☐ Light railway such as the Underground
☐ Taxi ☐ Tram

Were you travelling alone or with others?

☐ Alone ☐ With others

Are there any other comments you'd like to make about how you found your way this evening?

Thank you for your participation.
Please hand this completed form to Andrew Barker.
And enjoy the rest of your evening!

Thinking about your journey here this evening, which of the following did you use to help you find your way?
Tick all that apply.

☐ I used direction signs
(signs that point the way to a named destination).

☐ I used signs marking the location of something
(such as the sign at the entrance to this gallery).
Please give more details: what did the sign identify, how close did you have to get before you could read the sign?

☐ I orientated myself using the points of the compass.

☐ I used street name signs.

☐ I followed a line marked on a wall, floor, or similar.

☐ I followed spoken announcements
(such as from a sat nav, or those on public transport).

☐ I used a set of written-down directions.

☐ I used landmarks.
Please give more details: did you see the landmark from a distance and head for it, did you know where you were because of the landmark, or what?

☐ I used a map on paper that I carried with me.

☐ I used a map on my phone (or similar digital device).

☐ I checked a map that was fixed to a wall, or similar.

If you used a map, did it have your route marked on it?
☐ Yes ☐ No

☐ I made a guess because I've been somewhere similar before. *Please give more details*:

☐ I used house numbers.

☐ I made a systematic search of the area in order to find what I was looking for.

☐ I asked a member of the public for directions.

☐ I asked 'someone official' for directions.

☐ I followed other people.

☐ I followed a track that other people had made.

☐ I stopped to think about how to find my way.

☐ I used a strategy that's not on this list.
Please give more details:

Figure 3.3a: *the questionnaire for the wayfinding survey: front cover (top left), back cover (top right), and inside pages (below) (50% of actual size)* a straightforward mirror of the categories of seeking-finding behaviour in the taxonomy, and the tactic descriptions may be regarded as simplistic: this format is driven by a wish to use language that is accessible and user-friendly, naturalistically reflecting everyday-life experience of seeking-finding in environmental space. The effectiveness of this approach is indicated by none of the participants reporting or demonstrating difficulties completing the questions. The brevity of this questionnaire may render it a relatively crude tool affording limited depth of insight, but it is regarded as optimal in the circumstances for two principal reasons: (i) the need to avoid overtaxing the participants' willingness to participate, and (ii) the exploratory nature of this research prioritising breadth over depth. This also applies to the questionnaires used in the diary keeping (see 3.4).

The invitations to the event include a custom-made map of the area around the destination showing the configuration and names of roads, pedestrian alleys, green spaces, and London Underground stations (see figure 3.3b). This might bias behaviour (increasing the number of reports of using a paper map with no route marked on it), but sending out the map was part of the event planning independent of undertaking this study. Because the research is exploratory, this potential bias is not judged to be a problem sufficient to discourage taking this opportunity to collect data.

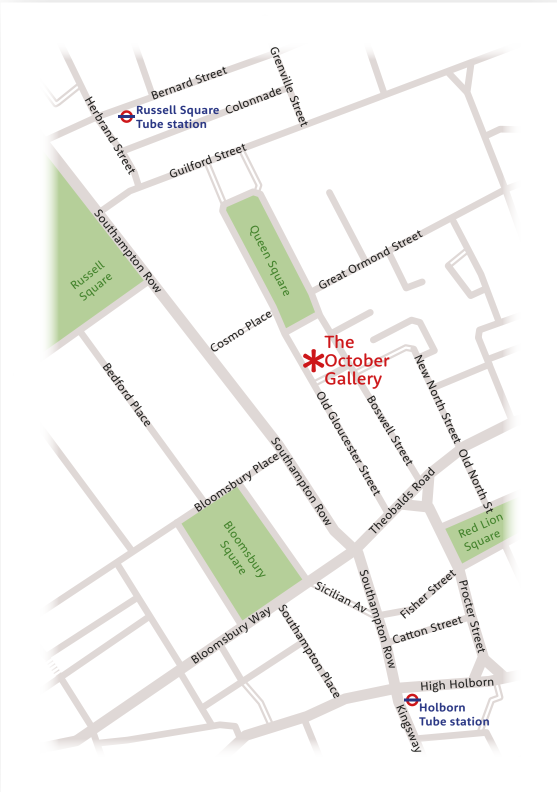


Figure 3.3b: *the map accompanying the invitation (50% of actual size)*

3.3.3 / Method

Invitations are sent to 120 people to attend a social event (unrelated to this research) one evening in central London, at a location unfamiliar to the majority. During the event, individuals were asked by the researcher to complete a short questionnaire identifying the seeking-finding tactics that they had used to find their way to this destination. Participants were not informed before arriving that the survey was being conducted. They were asked to complete and return the questionnaire during the event. Participation was not obligatory, and no inducement was offered. The questionnaire was planned to be brief and easy to complete.

A total of 43 completed usable questionnaires were collected.

3.3.4 / Data collection and analytical approach

Each closed question in the questionnaire is assigned to a category of behaviour in the taxonomy. The open question responses serve one of two functions: to confirm coding of certain closed questions, or to provide additional data. In both cases, a set of heuristics govern how they are coded.

This coding process raises issues of inter-rater reliability (see 3.3). Once these were resolved, the responses in the questionnaires were coded and collected in a spreadsheet that permitted their analysis. The discursive responses were transcribed and organised into groupings pertinent to the research in hand.

3.4 / The 'diary keeping' study

Twelve individuals keep diaries for one month recording their behaviour whenever they are seeking-finding in an unfamiliar environment in one of the three contexts in their everyday life. A pilot study with two participants was conducted prior to the main exercise with ten participants.

As discussed in 1.4, the literature survey locates no research that examines seeking-finding behaviour across all three contexts – and that is what this study examines.

Issues with diary keeping

Diary keeping – the method of data capture used in this research – is a type of self-reporting. It is one of the group of research approaches known as 'everyday-experience methods' (another is the experience-sampling method (Hektner and Csikszentmihalyi 2002)). A strength of this approach is its ecological validity: 'examining ongoing experience as it occurs in the ebb and flow of daily life. … The payoff is a detailed, accurate, and multifaceted portrait of social behaviour embedded in its natural context. … [based on] an appreciation for the complexity, richness, and informativeness of ordinary activity' (Reis and Gable 2000: 190).

As a data capture tool, diary keeping is widely used in many fields such as information design,[131] human-computer interaction,[132] human geography,[133]

131 E.g. Black and Stanbridge (2012).
132 E.g. Brown and Laurier (2005a); Adler, Gujar, et al. (1998); Sellen and Harper (1997); Eldridge and Newman (1996).
133 E.g. Crosbie (2006).

medicine,[134] psychology,[135] and travel behaviour research.[136] Diary keeping has two key advantages: the researcher is not present (thereby reducing their influence on behaviour), and the behaviour recorded is part of everyday life and not the result of externally contrived tasks or artificial situations. It is also time-efficient for the researcher, and relatively minimal in the resources required. The key disadvantage is that it relies on the recall of the participants and the biases that can affect this are legion,[137] and consequently, data may be lacking in good or consistent level of detail (Crosbie 2006; Stone and Shiffman 2002; Yarmey 1979). This disadvantage can be minimised by ensuring that the participant completes each report soon after the event, and such timeliness in reporting can be encouraged by making the diary portable (Reis and Gable 2000: 207). Diary keeping was chosen instead of the more usual method of task observation (as used in 3.2) because of difficulties formulating sufficiently ecologically valid tasks. During the task observation study, several participants commented that they were performing tasks that they would not undertake of their own accord. This raises questions of ecological validity that also arise in the survey of research literature. Diary keeping sidesteps the need to formulate artificial tasks and affords the capture of data with greater ecological validity, although the trade-offs may be a lessening of the quality and consistency of detail captured and a lack of control over extraneous variables.

3.4.1 / Participants

The participants are selected by a user research recruitment agency to form a group balanced for gender, and with a range of ethnicities, ages, and educational levels. All speak English as a first language.[138] To permit face-to-face briefing, all participants are living in north London at the start of the study. Each participant is paid £200 on completion.

3.4.2 / Materials

The format for reporting seeking-finding behaviour (the 'diary') is formed of self-administered questionnaires, one copy completed for each seeking-finding event, and three different questionnaires – one for each context (figures

134 E.g. Stone and Shiffman (2002).
135 E.g. Reis and Gable (2000). These authors note the 'sheer number' of studies in social and personality psychology using methods of this type (p.201).
136 E.g. Raux, Ma, and Cornelis (2016); Tarigan, Fujii, and Kitamura (2013); Brown and Laurier (2005a).
137 As an indication of the extensiveness and complexity of the issue, Wikipedia (which is not taken as an authoritative, comprehensive, or definitive source) has a list of 50 memory biases (https://en.wikipedia.org/wiki/List_of_memory_biases accessed 15/03/2017), and a separate list of 49 memory errors and biases (https://en.wikipedia.org/wiki/List_of_cognitive_biases accessed 15/03/2017). These lists are only partially overlapping.
138 The possible limitations of this sample are discussed in 3.8.1.

3.4a–c). The questionnaires are based on that used in the wayfinding survey (figure 3.3a), because (i) the data collection objectives are the same, (ii) it speeds up the coding of the data by using the same protocol, (iii) it avoids a further set of inter-rater reliability issues, and (iv) it permits comparison more readily between the two data sets.

The questionnaires start with an open question asking the participant to describe the goal of their seeking-finding activity. They then ask the participant to identify from a fixed list as many as possible of the seeking-finding tactics that they used in this task (such as '**I used street-name signs**' and '**I looked something up in the index**'). In addition to tactics identified in closed questions, the open questions are included to permit certain aspects to be described in more detail.

Analysing the results from both the wayfinding survey and the two pilot participants in this study reveals that seeking-finding in environmental space often follows advance planning.[139] This is a factor that the literature survey had not strongly identified. As a consequence, an open question about planning ahead is added to the questionnaire for environmental space in the main study. Similar questions are not included in the questionnaires for seeking-finding in paper documents and on-screen because there was not the same evidence of planning ahead in these contexts in the pilot questionnaires.

For the main study the questionnaires are also available in online versions, accessible by links emailed to the participants by the researcher. None of the participants chose to use the online versions.

3.4.3 / Method

Each participant is briefed in a face-to-face meeting in their home or in a location of their choice (such as a cafe if the briefing is conducted in their lunch break). The briefing starts with the participant being asked to describe from their recent past a seeking-finding instance in each of the three contexts, with the researcher facilitating their describing the tactics they had used.[140] This is followed by the researcher describing in more detail what is expected of the participant (relating it back to the participant's descriptions of seeking-finding), showing them the questionnaires, and asking the participant to read through them to check that they understand the task and all of the terms used

139 The wayfinding survey and the piloting of the diary keeping happened in quick succession, and their data was initially analysed in parallel. That is why they are both instrumental in the decision to make this change after the pilot of the diary keeping.
140 The two pilot participants were asked slightly different questions: they were asked to describe how they would approach given hypothetical seeking-finding situations. Their negative responses highlight the already-discussed problems of contrived scenarios with insufficient verisimilitude in the participant's everyday life. This drove the replacement of this section of externally imposed tasks.

Wayfinding in environmental space

t03_p01_env

Date ______________ 2015

Please describe briefly where you were finding your way to (and any other relevant context):

Please describe briefly any preparation you made for finding your way *before you set out* (such as checking a map or journeyplanner website):

If you find this please contact a.g.barker@reading.ac.uk

Are there any other comments you'd like to make about how you found your way?

What forms of transport did you use on your journey?
(*Please tick all that apply*)

- [ ] Car
- [ ] Bus
- [ ] Bike
- [ ] Network Rail
- [ ] Foot
- [ ] Light railway such as the Underground
- [ ] Taxi
- [ ] Tram
- [ ] Some other form of transport. *Please give more details*:

Were you travelling alone or with others?

- [ ] Alone
- [ ] With others

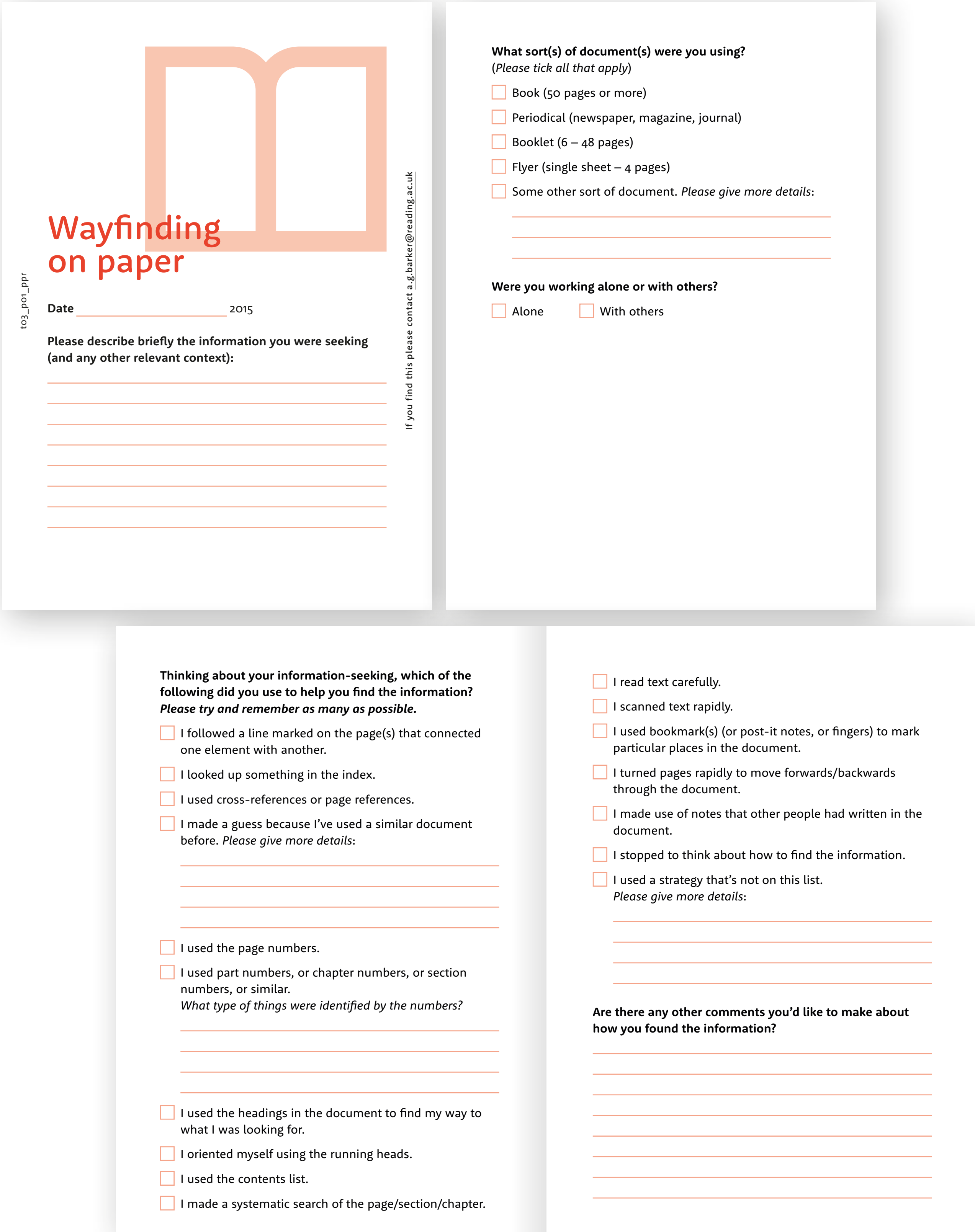
Thinking about your journey, which of the following did you use to help you find your way?
Please try and remember as many as possible.

- [ ] I used direction signs (signs that point the way to a named destination).
- [ ] I oriented myself using the points of the compass.
- [ ] I used street name signs.
- [ ] I followed a line marked on a wall, floor, or similar.
- [ ] I followed spoken announcements (such as from a sat nav, or those on public transport).
- [ ] I used a set of written-down directions.
- [ ] I used signs marking the location of something (such as the name of a shop above the door). *Please give more details: what did the sign identify, how close did you have to get before you could read the sign?*
- [ ] I used landmarks. *Please give more details: did you see the landmark from a distance and head for it, did you know where you were because of the landmark, or what?*
- [ ] I used a map on paper that I carried with me.
- [ ] I used a map on my phone (or similar digital device).
- [ ] I checked a map that was fixed to a wall, or similar.

If you used a map, did it have your route marked on it?
- [ ] Yes
- [ ] No

- [ ] I made a guess because I've been somewhere similar before. *Please give more details*:
- [ ] I used house/room numbers or similar.
- [ ] I made a systematic search of the area to find what I was looking for.
- [ ] I asked a member of the public for directions.
- [ ] I asked 'someone official' for directions.
- [ ] I followed other people.
- [ ] I followed a track that other people had made.
- [ ] I stopped to think about how to find my way.
- [ ] I used a strategy that's not on this list. *Please give more details*:

Figure 3.3a: *the questionnaire used to report seeking-finding in environmental space for the diary keeping: front cover (top left), back cover (top right), and inside pages (below) (50% of actual size)*



Wayfinding
on paper

t03_p01_ppr

Date ______________________ 2015

Please describe briefly the information you were seeking (and any other relevant context):

If you find this please contact a.g.barker@reading.ac.uk

What sort(s) of document(s) were you using?
(*Please tick all that apply*)

- [ ] Book (50 pages or more)
- [ ] Periodical (newspaper, magazine, journal)
- [ ] Booklet (6 – 48 pages)
- [ ] Flyer (single sheet – 4 pages)
- [ ] Some other sort of document. *Please give more details*:

Were you working alone or with others?

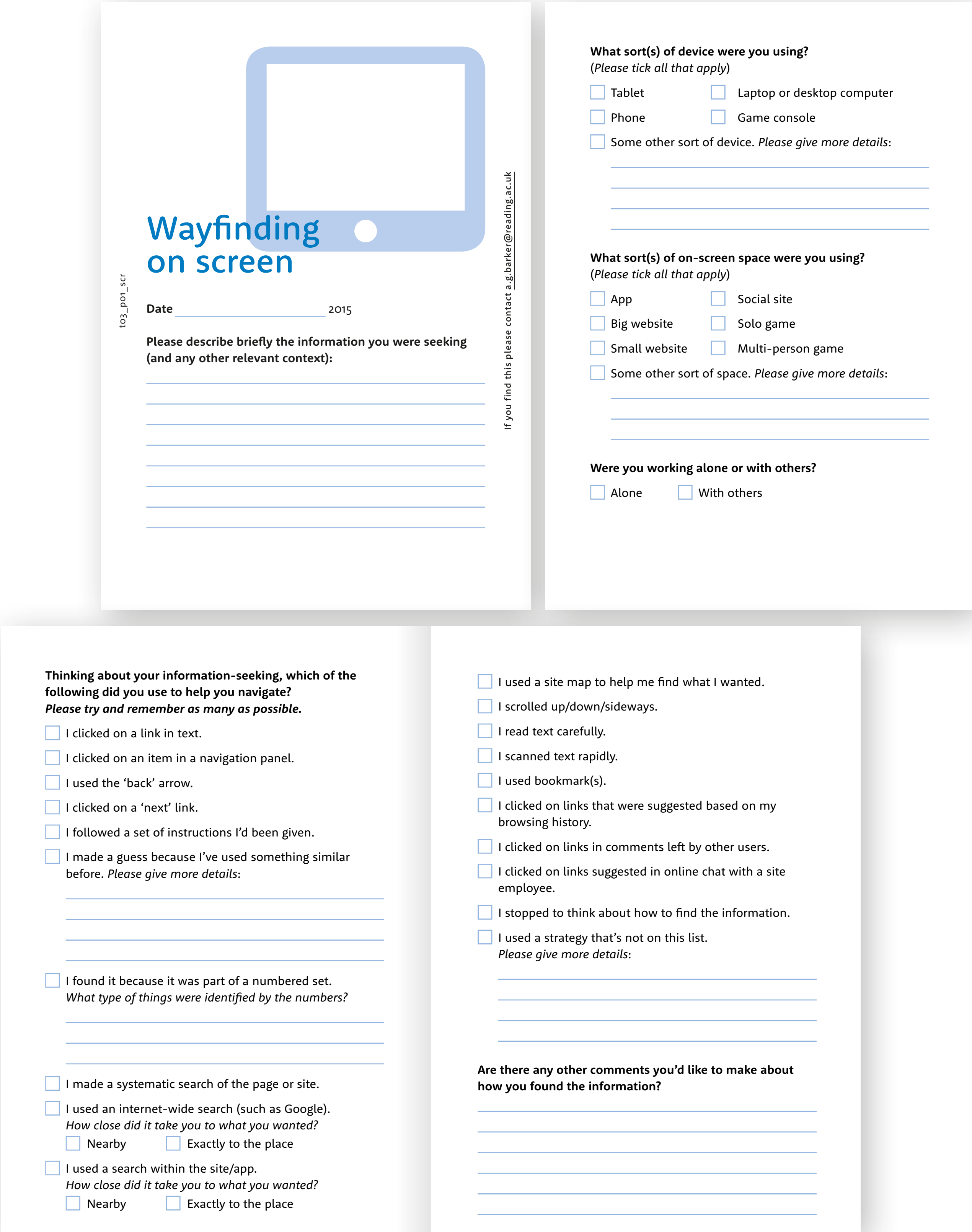
- [ ] Alone
- [ ] With others

Thinking about your information-seeking, which of the following did you use to help you find the information?
Please try and remember as many as possible.

- [ ] I followed a line marked on the page(s) that connected one element with another.
- [ ] I looked up something in the index.
- [ ] I used cross-references or page references.
- [ ] I made a guess because I've used a similar document before. *Please give more details*:
- [ ] I used the page numbers.
- [ ] I used part numbers, or chapter numbers, or section numbers, or similar.
What type of things were identified by the numbers?
- [ ] I used the headings in the document to find my way to what I was looking for.
- [ ] I oriented myself using the running heads.
- [ ] I used the contents list.
- [ ] I made a systematic search of the page/section/chapter.
- [ ] I read text carefully.
- [ ] I scanned text rapidly.
- [ ] I used bookmark(s) (or post-it notes, or fingers) to mark particular places in the document.
- [ ] I turned pages rapidly to move forwards/backwards through the document.
- [ ] I made use of notes that other people had written in the document.
- [ ] I stopped to think about how to find the information.
- [ ] I used a strategy that's not on this list.
Please give more details:

Are there any other comments you'd like to make about how you found the information?

Figure 3.3b: *the questionnaire used to report seeking-finding in paper documents for the diary keeping: front cover (top left), back cover (top right), and inside pages (below) (50% of actual size)*



Wayfinding on screen

t03_p01_scr

Date ______________ 2015

Please describe briefly the information you were seeking (and any other relevant context):

If you find this please contact a.g.barker@reading.ac.uk

What sort(s) of device were you using?
(*Please tick all that apply*)

- ☐ Tablet
- ☐ Laptop or desktop computer
- ☐ Phone
- ☐ Game console
- ☐ Some other sort of device. *Please give more details*:

What sort(s) of on-screen space were you using?
(*Please tick all that apply*)

- ☐ App
- ☐ Social site
- ☐ Big website
- ☐ Solo game
- ☐ Small website
- ☐ Multi-person game
- ☐ Some other sort of space. *Please give more details*:

Were you working alone or with others?

- ☐ Alone
- ☐ With others

Thinking about your information-seeking, which of the following did you use to help you navigate?
Please try and remember as many as possible.

- ☐ I clicked on a link in text.
- ☐ I clicked on an item in a navigation panel.
- ☐ I used the 'back' arrow.
- ☐ I clicked on a 'next' link.
- ☐ I followed a set of instructions I'd been given.
- ☐ I made a guess because I've used something similar before. *Please give more details*:
- ☐ I found it because it was part of a numbered set. *What type of things were identified by the numbers?*
- ☐ I made a systematic search of the page or site.
- ☐ I used an internet-wide search (such as Google). *How close did it take you to what you wanted?*
  - ☐ Nearby
  - ☐ Exactly to the place
- ☐ I used a search within the site/app. *How close did it take you to what you wanted?*
  - ☐ Nearby
  - ☐ Exactly to the place
- ☐ I used a site map to help me find what I wanted.
- ☐ I scrolled up/down/sideways.
- ☐ I read text carefully.
- ☐ I scanned text rapidly.
- ☐ I used bookmark(s).
- ☐ I clicked on links that were suggested based on my browsing history.
- ☐ I clicked on links in comments left by other users.
- ☐ I clicked on links suggested in online chat with a site employee.
- ☐ I stopped to think about how to find the information.
- ☐ I used a strategy that's not on this list. *Please give more details*:

Are there any other comments you'd like to make about how you found the information?

Figure 3.3c: *the questionnaire used to report seeking-finding in on-screen for the diary keeping: front cover (top left), back cover (top right), and inside pages (below) (50% of actual size)* in the questionnaires. The researcher confirms the time and place of the exit meeting and leaves the participant.

Each participant then spends a period of one month recording the instances of seeking-finding behaviour in the three contexts as they arise in their everyday life.

At the end of the month, the researcher and the participant meet as agreed in a similar situation to the briefing meeting. The researcher has a set of questions to structure the exit interview:

- Do you have any general comments or observations about the diary keeping that you've been doing?
- Did you encounter any difficulties?
- Did you start to notice patterns in your choices of tactics as the month progressed?
- Did you notice a change in your choice of tactics over the month, as a result of observing yourself?
- Did you notice yourself planning ahead for information seeking on-screen or on paper? Did you notice that you had expectations about how the process would unfold?
- Can you say anything about why you chose not to use the online version of the questionnaire?
- Do you have any other comments to make about the process, anything else you think it might be useful for me to know?

Wider discussion as appropriate takes place. The participant hands over their completed questionnaires, and is paid.

Both the briefing and the exit interviews are recorded (sound only).

3.4.4 / Data collection and analytical approach

Having resolved issues of inter-rater reliability as discussed in 3.3, the responses in the questionnaires are coded and collected in a spreadsheet that permits their analysis. The briefing and exit interviews are selectively transcribed for more discursive responses pertinent to the research in hand.

3.5 / Overview of data from the task observation study

This study gives data for 12 participants each performing the same set of 6 tasks, giving a total of 72 reports of seeking-finding events (n=72).[141] Each report includes the order in which behaviours are used, their duration, and whether that tactic contributed to the successful execution of the task. This data is only for a single context – paper documents.

This study includes data for only 7 of the 12 categories of behaviour – a consequence of being conducted at an early stage in the research process.

Figures 3.5a–b show the percentages of the 72 reports that include semantic and spatial behaviours in this study. The percentage that include any semantic behaviour is shown by the top (pink) bar in figure 3.5a, and the percentages that contain each of the 5 individual categories of semantic behaviour are shown by the orange bars. Figure 3.5b does the same for spatial behaviours.

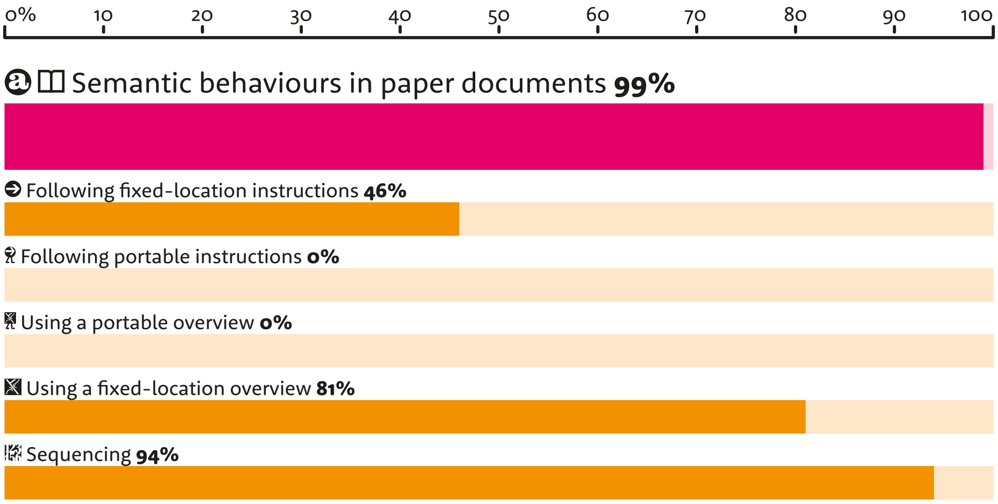


Figure 3.5a: *proportions of all reports that include semantic behaviours in the task observation study*

Figures 3.5a–b show that almost all reports include both semantic and spatial behaviours, but that individual categories of behaviour are included in varying percentages of reports. Using a fixed-location overview, sequencing, and screening are included in the greatest proportions (each appearing in 81–94% of reports); and following fixed-location instructions, aiming, using an allocentric frame, and using your cognitive model are all included in smaller proportions (each appearing in 28–50% of reports).

141 In this study, a report refers to the data from 1 task executed by 1 participant. 12 participants each performed 6 tasks, hence 12 × 6 = 72 reports.

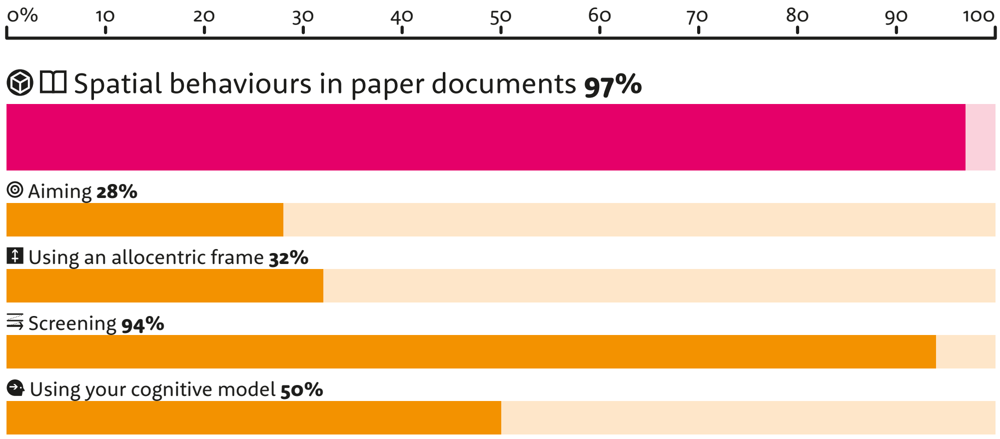
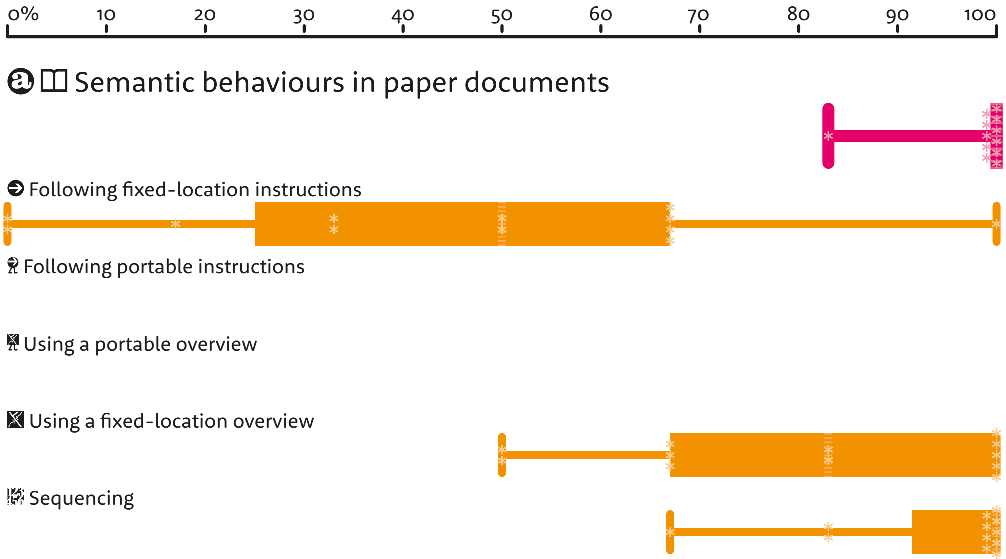


Figure 3.5b: *proportions of all reports that include spatial behaviours in the task observation study*

Figures 3.5c–d shows the same data as 3.5a–b, but with the individual participants separated out. On the box-and-whisker bars, each star represents one participant: we can see the distribution of participants based on the proportion of their reports containing that behaviour. In figure 3.5c, the top (pink) bar shows the proportions of reports that include all behaviours in the semantic group for each participant. The 5 orange bars show the same for each individual category of semantic behaviour. Figure 3.5d does the same for spatial behaviours.

Figures 3.5c–d show the inter-individual variation between participants in the proportion of their reports including each category of behaviour. We can see that some participants never included following fixed-location instructions

Figure 3.5c: *distribution of the proportions of individual participants' reports that include semantic behaviours in the task observation study*



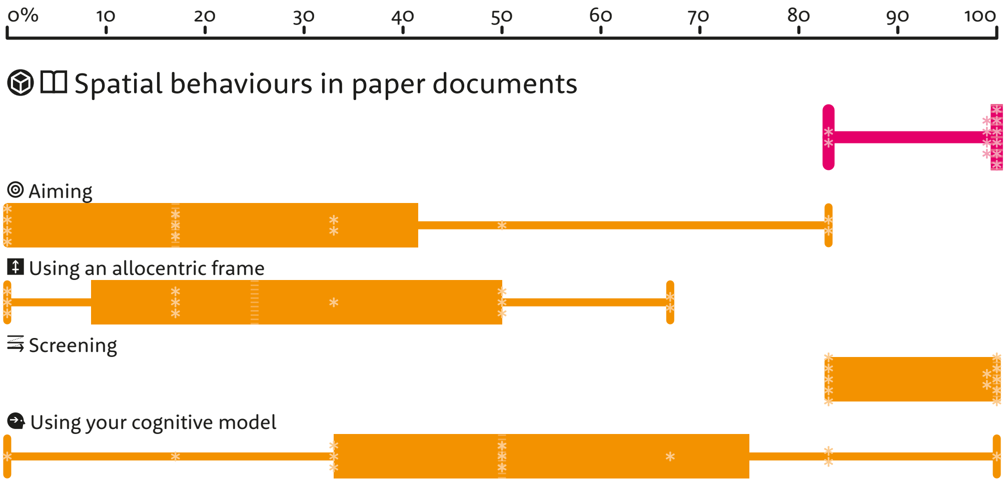


Figure 3.5d: *distribution of the proportions of individual participants' reports that include spatial behaviours in the task observation study*

in any report whereas others included it in all reports; likewise for using your cognitive model. Other behaviours show less inter-individual variation. It is striking, though, that although there is clearly considerable variation in the proportion of reports including each category of behaviour, and considerable inter-individual variation in the proportion of each individual's reports that include each category of behaviour, almost all participants include both semantic and spatial behaviours in almost all of their reports.

3.6 / Overview of data from the wayfinding survey study

This study gives data about a large number of participants performing a single task. This is only in one context – environmental space. A total of 43 usable surveys (reports) were returned (n=43).

Figures 3.6a–c show the percentages of the 43 reports that include social, semantic, and spatial behaviours in this study. The percentage of reports that include *any* social behaviour is shown by the top (pink) bar in figure 3.6a, and the percentages of reports that contain each of the 3 individual categories of social behaviour are shown by the orange bars in this figure. Figure 3.6b does the same for semantic behaviours, and 3.6c for spatial behaviours.

Examining the returned questionnaires, it emerges that open responses to the statement 'I made a guess because I've been somewhere similar before. Please give details', are consistently about using your cognitive model. Typical open responses are: 'I work nearby so was able to remember how to get to the general area', 'Familiar with neighbouring streets and parks',

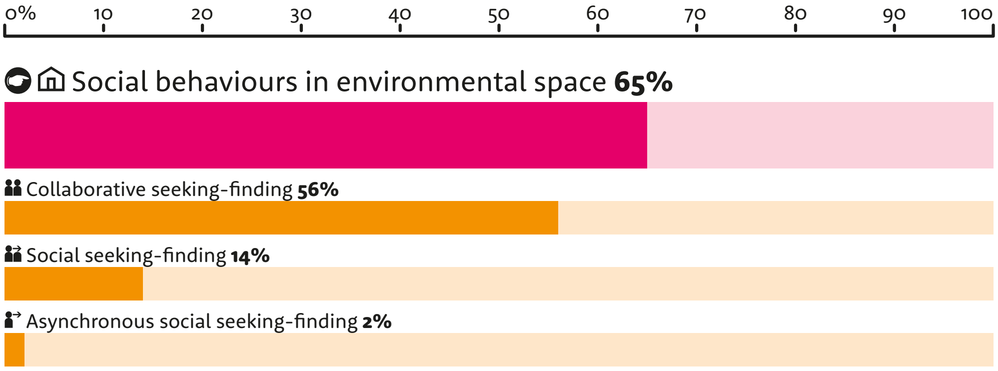


Figure 3.6a: *proportions of all reports that include social behaviours in the wayfinding survey study*

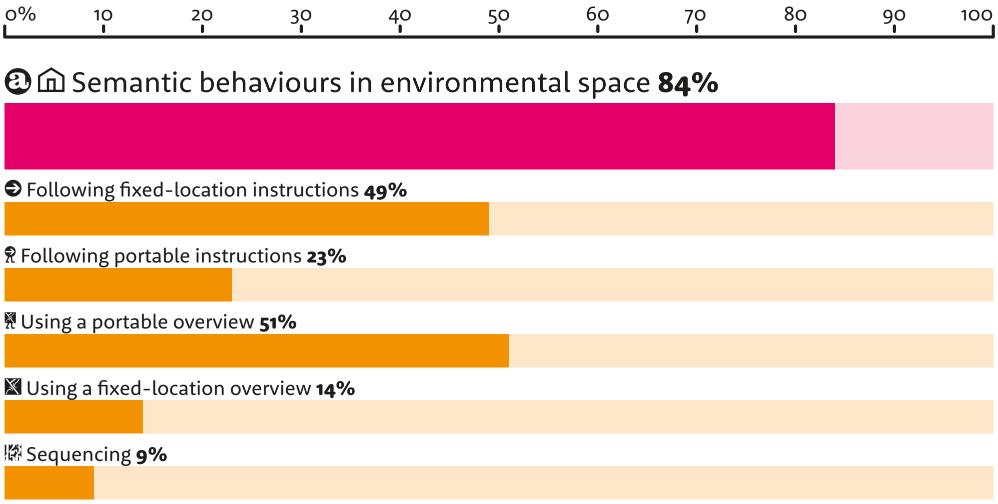


Figure 3.6b: *proportions of all reports that include semantic behaviours in the wayfinding survey study*

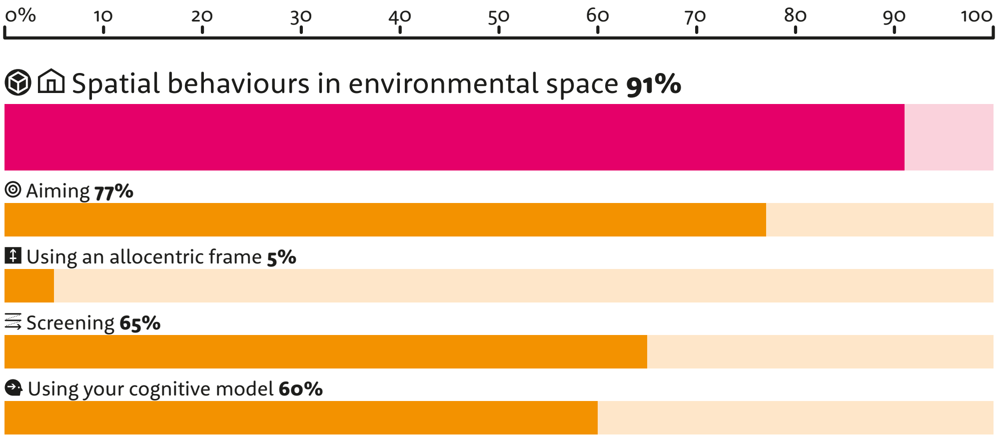


Figure 3.6c: *proportions of all reports that include spatial behaviours in the wayfinding survey study*

Social			Semantic					Spatial			
Collaborative seeking-finding	Social seeking-finding	Asynchronous social seeking-finding	Following fixed-location instructions	Following portable instructions	Using a portable overview	Using a fixed-location overview	Sequencing	Aiming	Using an allocentric frame	Screening	Using your cognitive model
✓					✓						✓
						✓					✓
✓											✓
								✓			
✓					✓			✓			
✓								✓			✓
✓								✓			✓
								✓			✓
			✓		✓			✓			✓
			✓					✓			✓
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✓			✓					✓		✓	✓
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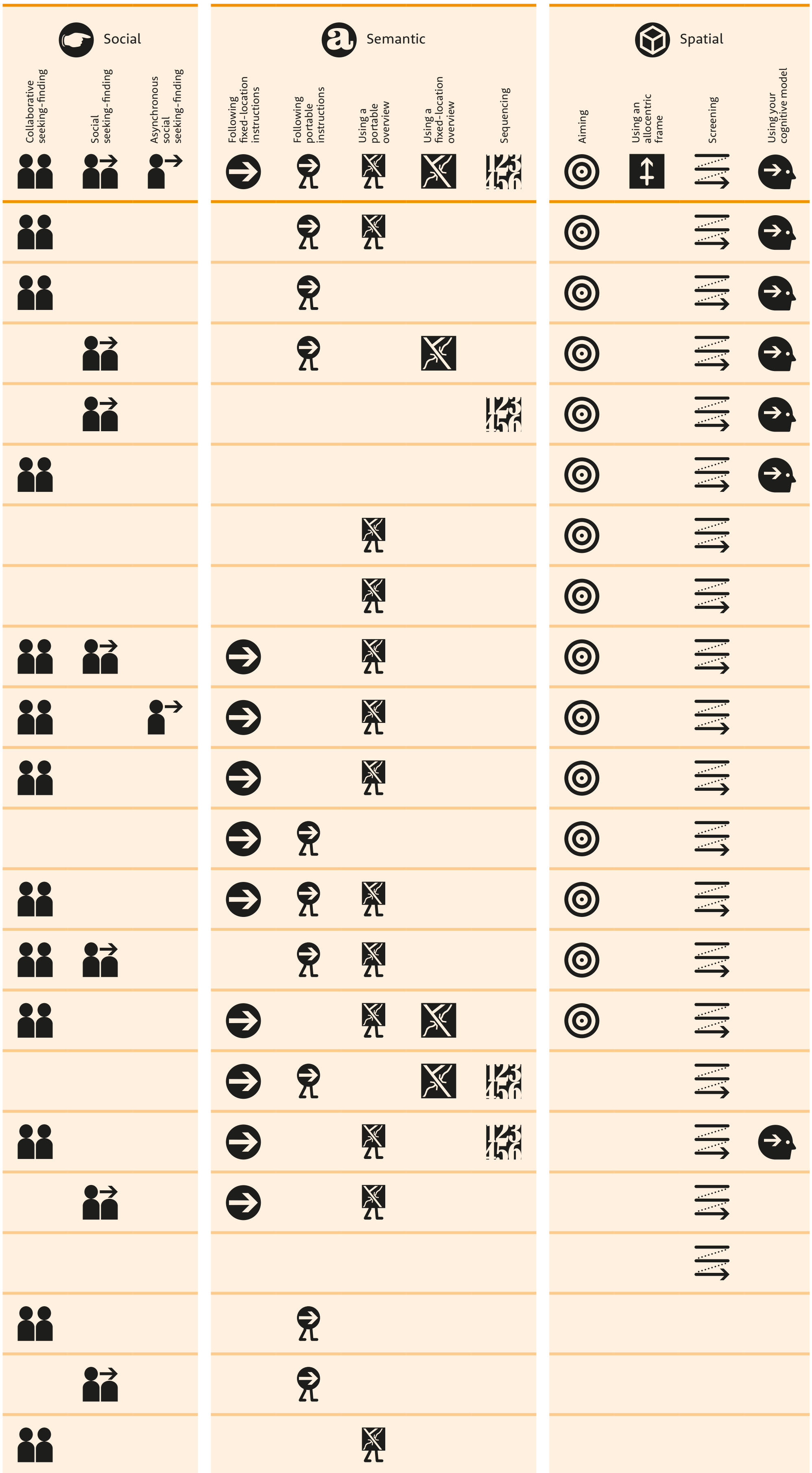


Figure 3.6d (above and facing): *each row shows the combination of behaviours in one report from the wayfinding survey*

'Knew Great Ormond Street Hospital and Queen Square … knew the gallery was off the square', and 'This is just off my daily cycling route back from work.' This was not anticipated: prior to this point in the development of the taxonomy, behaviours encompassed within using your cognitive model had been regarded as out of scope because they presuppose familiarity with the space (whereas this research examines behaviour in unfamiliar environments). This insight that cognitive models are employed in seeking-finding in unfamiliar environments prompted the inclusion of using your cognitive model in the taxonomy. One note of caution is that this behaviour is the most obliquely identified in the questionnaire, and although the responses are consistently related to using your cognitive model, it is not possible to state with confidence that all participants understood this equally. Possibly some participants did not understand this statement in this way, but their behaviours did not include whatever they took it to mean, and so they left it blank (leaving us none the wiser about what they did think it means). A consequence of this is the possibility of greater inter-individual variation in reporting of this behaviour (due to not all participants understanding it similarly).[142]

Figure 3.6d shows a different overview of behaviour in the wayfinding survey. Each row shows a single report detailing the particular combination of behaviours used. In this tabulation, the ordering of the rows has been organised so that reports including similar combinations of behaviours are placed adjacently. This is in order to make patterns and tendencies more visually apparent. There is no longitudinal aspect to this study, and so there is no reason for prioritising one order of the rows over another.

3.7 / Overview of data from the diary keeping study

This study gives data for 12 participants' seeking-finding activities in their everyday lives over the course of a month. This study covers all three contexts, with 299 reports returned. Each report is for a different task; different participants return different number of reports (range: 14–42); and the proportion in each context varies between participants.

Figure 3.7a shows how the individual participants vary in the proportions of their reports from each context. Overall, reports from paper documents form the smallest portion (17%), with environmental space next (34%), and

142 This is, of course, an issue with all items in this questionnaire, but perhaps more so with this one in particular.

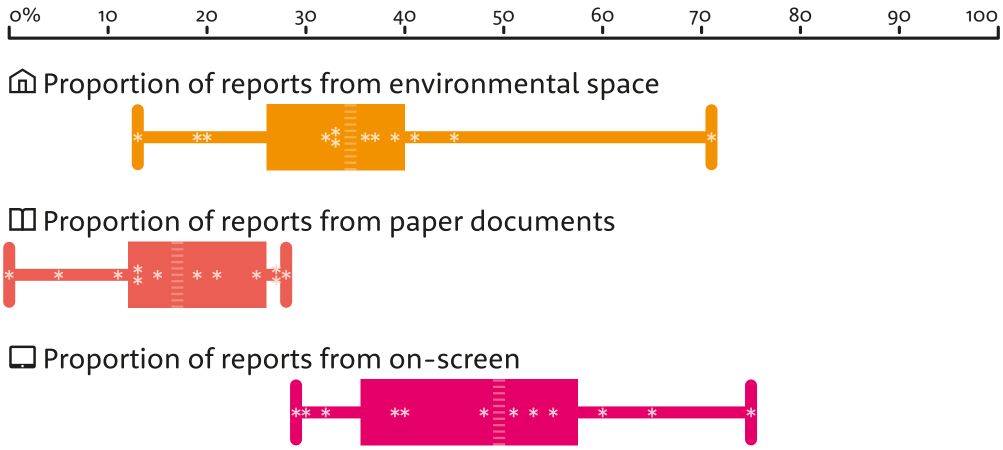


Figure 3.7a: *distribution of the proportions of individual participants' reports from each context in the diary keeping study*

the largest from on-screen (48%). This small proportion of reports from paper documents and the high proportion from on-screen is probably a reflection of the amount of information seeking that has migrated from paper documents to on-screen (see 8.3.1). On the box-and-whisker bars each star represents one participant, so we can see the distribution of participants based on the proportion of their reports from that context. Individual participants differ in the proportions of their reports from each context. While reports from paper documents are consistently the smallest portion and those from on-screen are the largest, the variation is considerable.

Figures 3.7b–d show the percentages of all reports that include social, semantic, and spatial behaviours in this study. The percentage of reports that include *any* social behaviour is shown by the top (pink) bar in figure 3.7b, and the percentages of reports that contain each individual category of social behaviour are shown by the orange bars. Figure 3.7c does the same for semantic behaviours, and 3.7d for spatial behaviours.

The data from one of the participants – Mary – is excluded from the discussion of social behaviours because, in some instances, her 'collaborators' were her infant children (and so not eligible to be counted as collaborators in the terms of this research that only looks at the behaviour of adults). As a precautionary measure her data set is excluded from considerations of social navigation.[143] This means that for 3.7b, n=260, whereas for 3.7c–d, n=299.

143 This is the result of an insufficiently explicit question in the questionnaires that was not identified during the piloting.

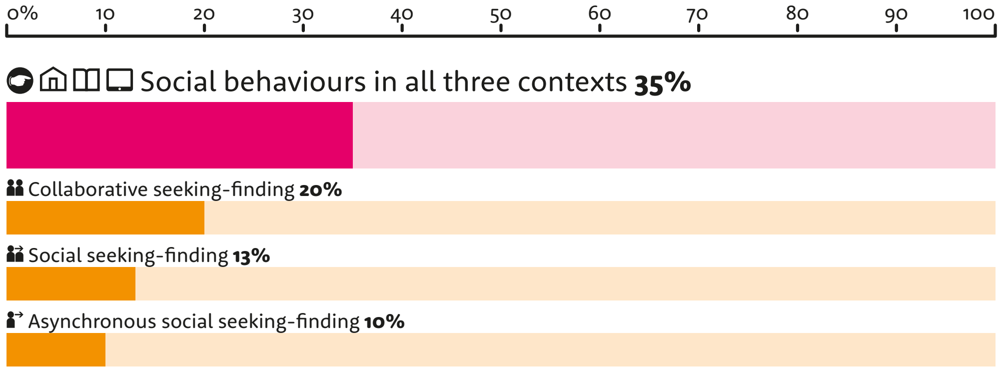


Figure 3.7b: *proportions of all reports that include social behaviours across all contexts in the diary keeping study*

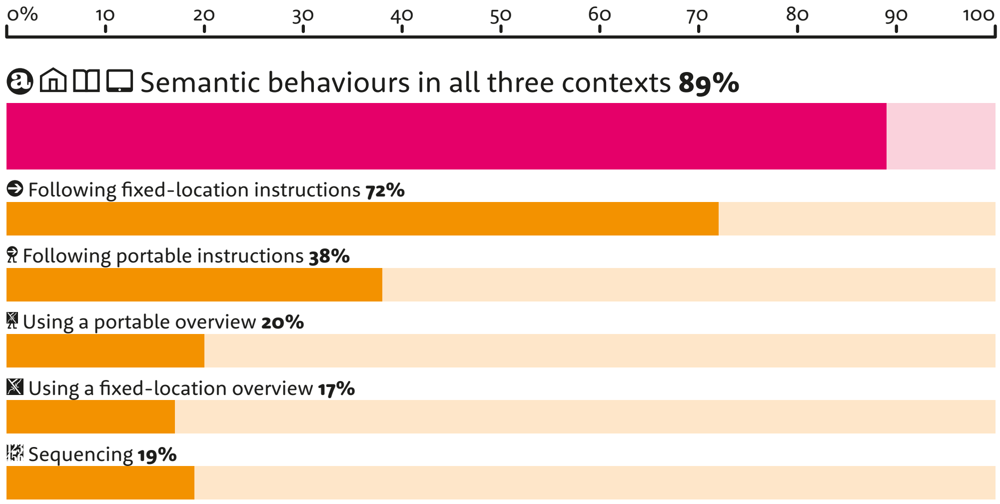


Figure 3.7c: *proportions of all reports that include semantic behaviours across all contexts in the diary keeping study*

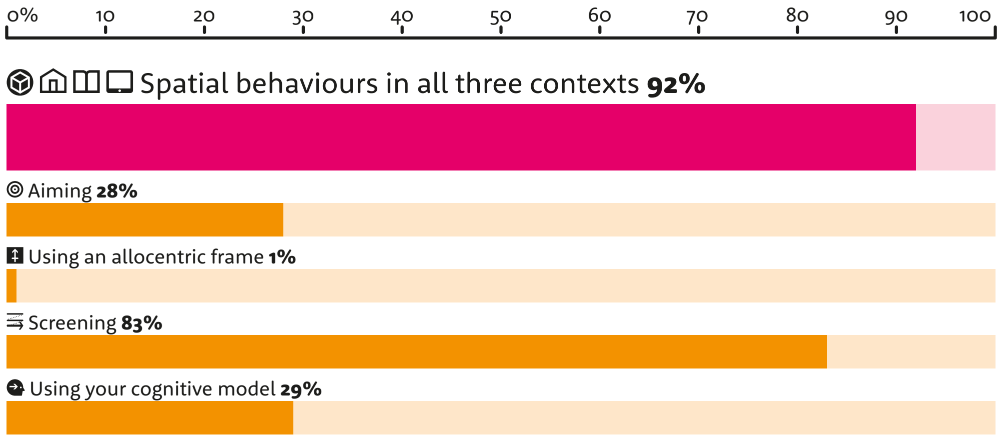
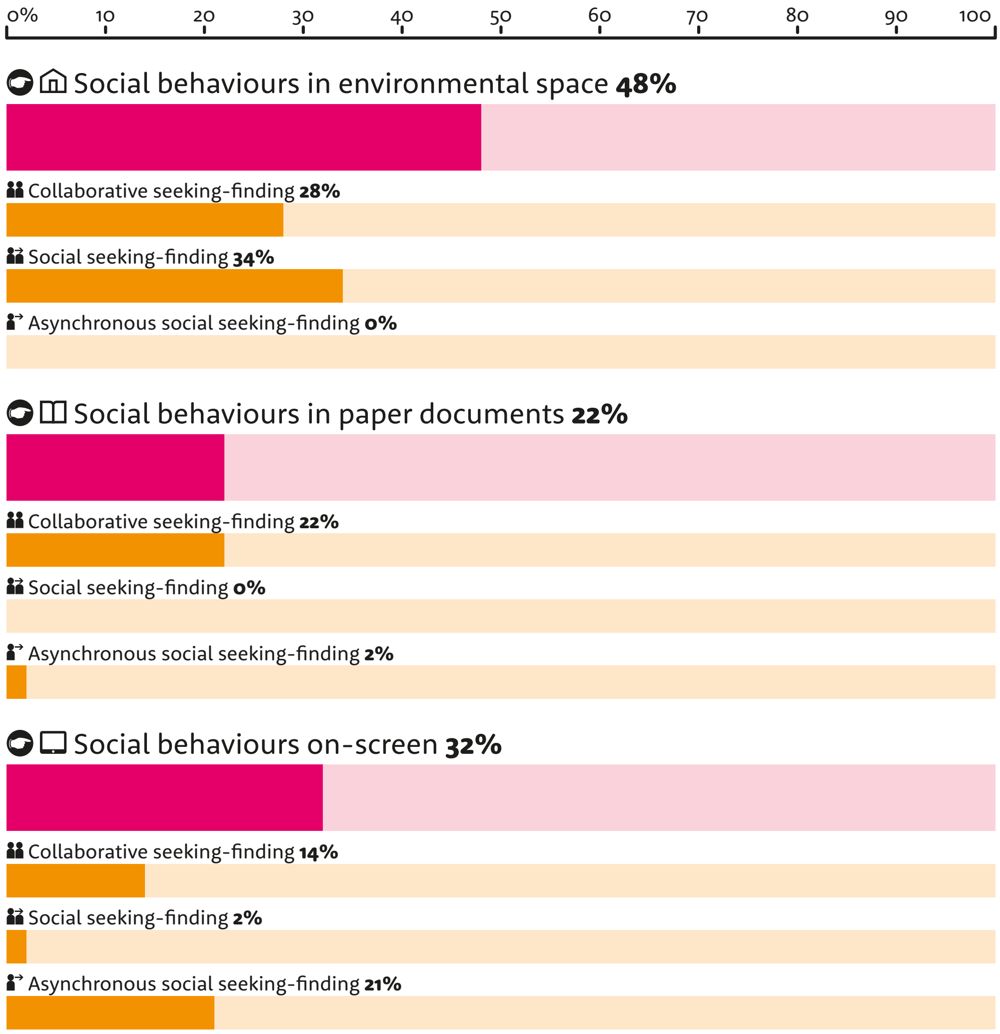


Figure 3.7d: *proportions of all reports that include spatial behaviours across all contexts in the diary keeping study*

Figures 3.7e–g shows the same data as figure 3.7b–d, but separated by context (and the individual participants' reports are still consolidated). For social behaviour, in total there are 89 reports from environmental space (n=89), 46 reports from paper documents (n=46), and 125 reports from on-screen space (n=125). For semantic and spatial behaviour, in total there are 103 reports from environmental space (n=103), 51 reports from paper documents (n=51), and 145 reports from on-screen space (n=145).

Figure 3.7e: *proportions of all reports that include social behaviours in the diary keeping study, separated by context*



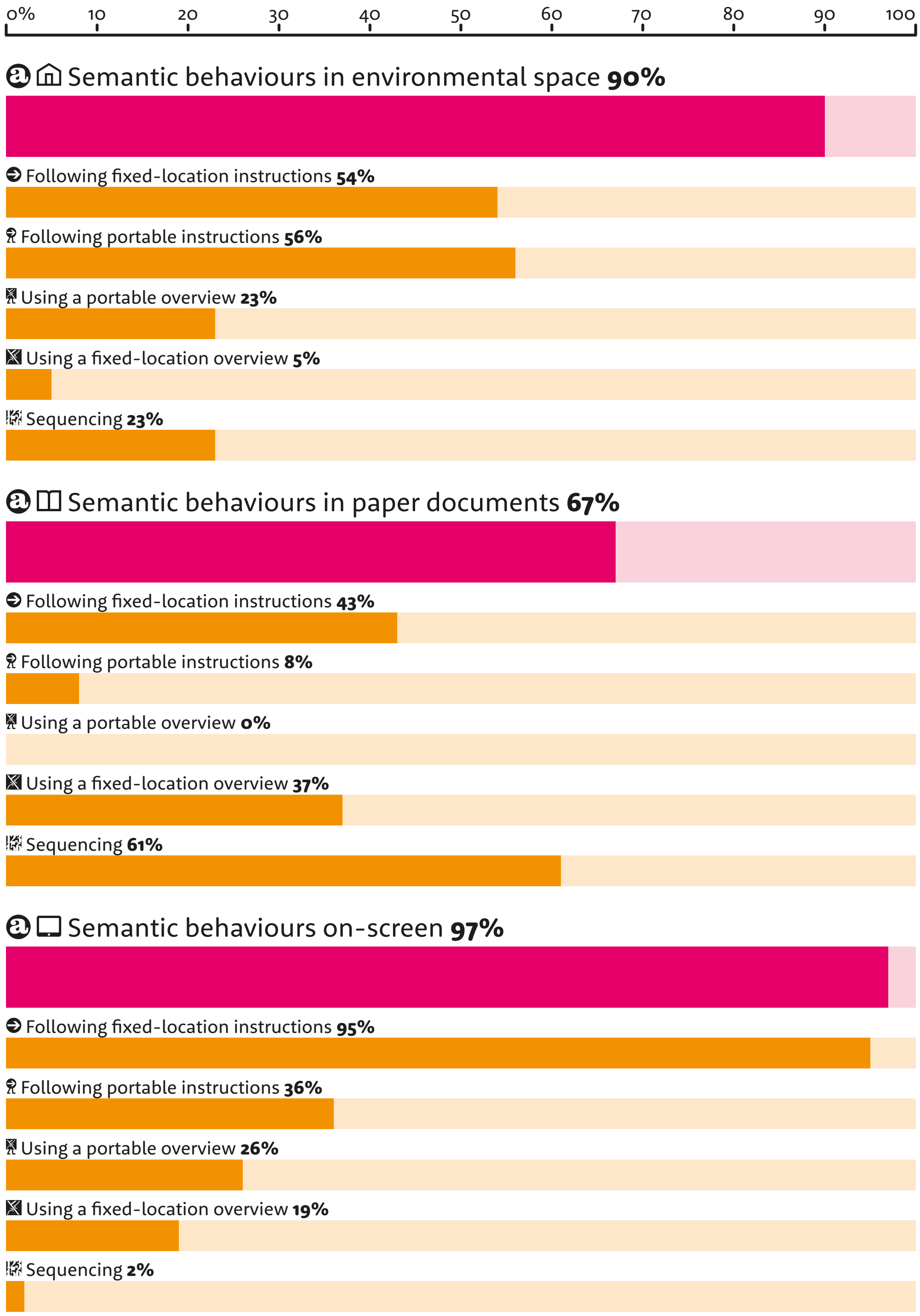


Figure 3.7f: *proportions of all reports that include semantic behaviours in the diary keeping study, separated by context*

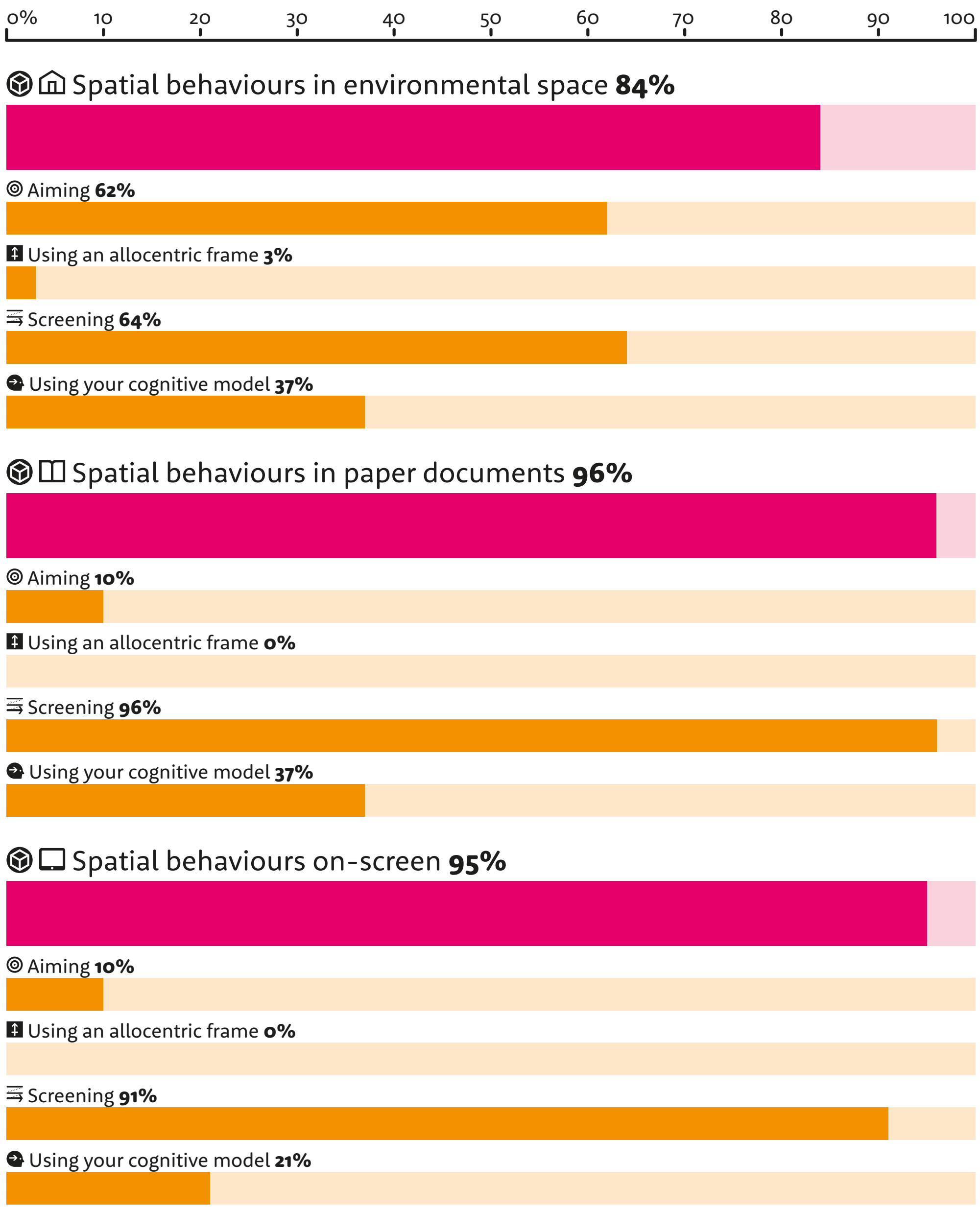


Figure 3.7g: *proportions of all reports that include spatial behaviours in the diary keeping study, separated by context*

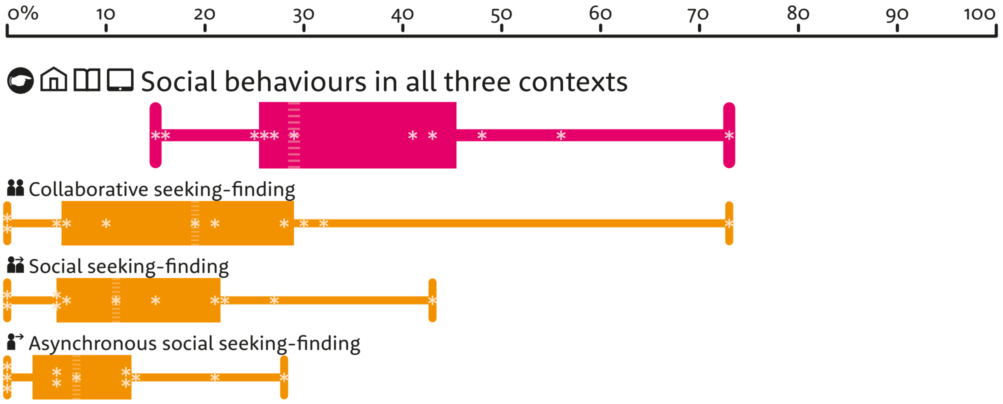


Figure 3.7h: *distribution of the proportions of individual participants' reports that include social behaviours across all contexts in the diary keeping study*

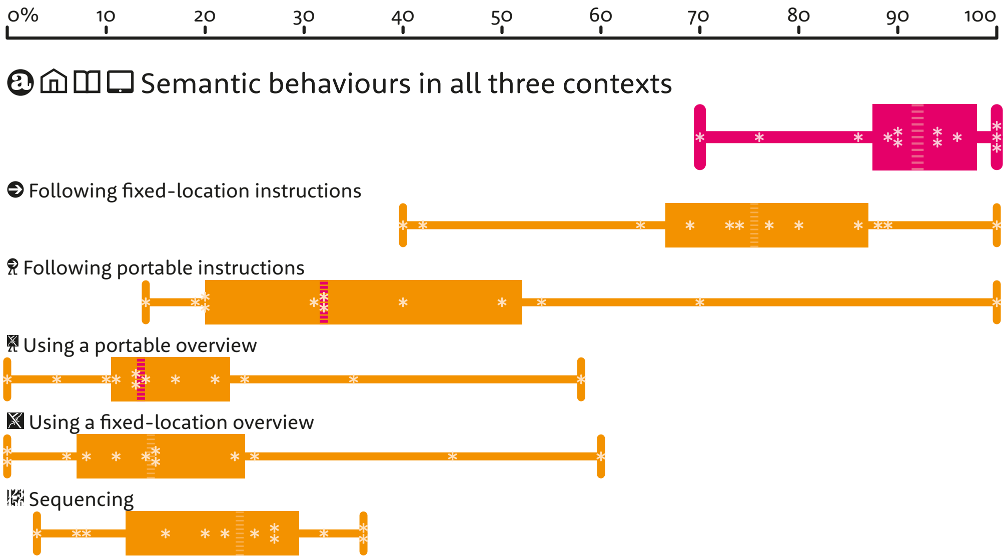


Figure 3.7i: *distribution of the proportions of individual participants' reports that include semantic behaviours across all contexts in the diary keeping study*

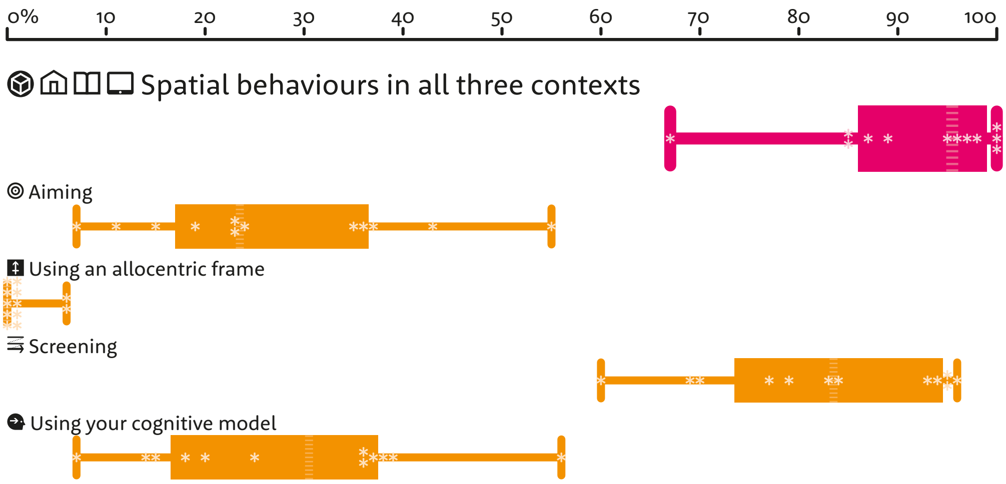
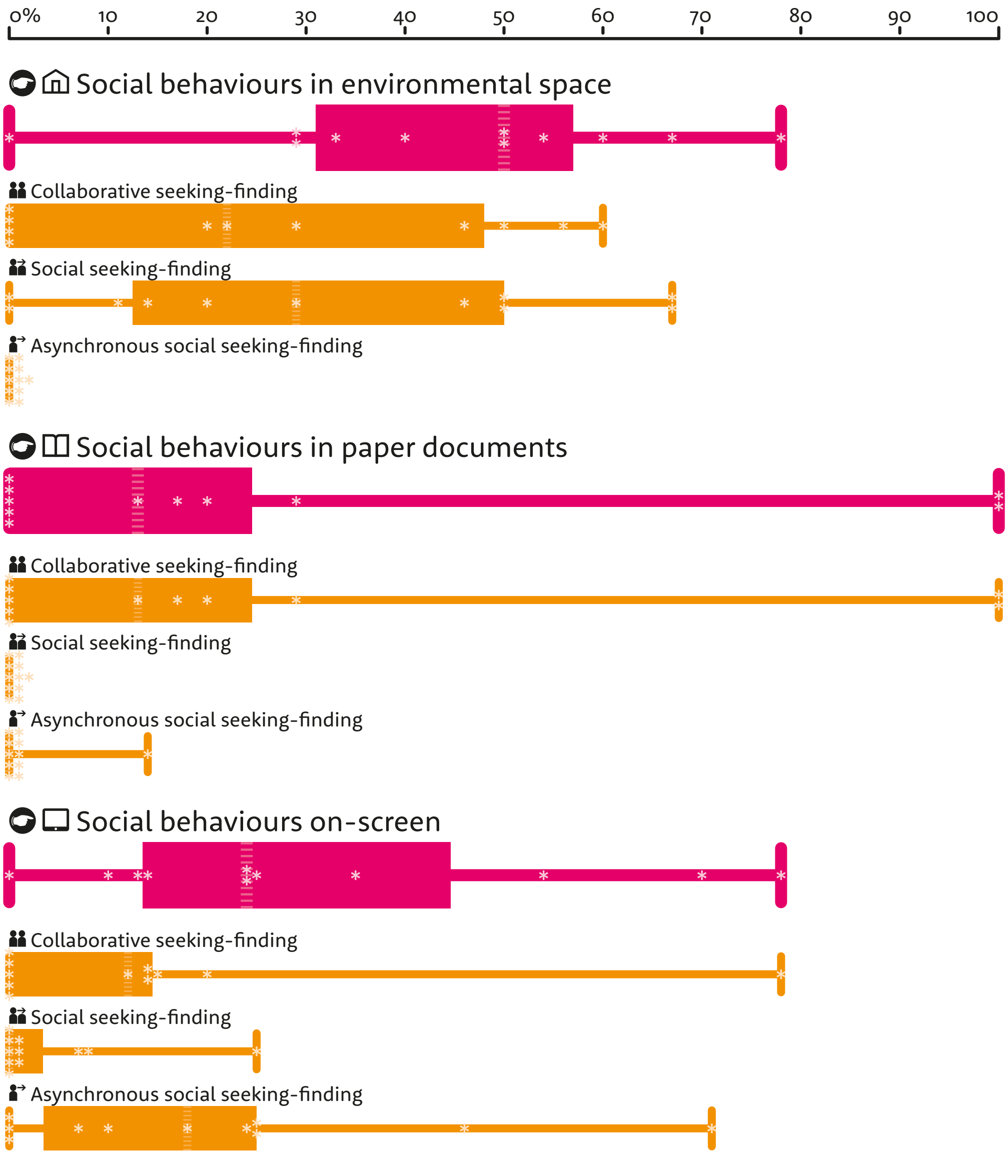


Figure 3.7j: *distribution of the proportions of individual participants' reports that include spatial behaviours across all contexts in the diary keeping study*

Figures 3.7h–j show the same data as 3.7b–d but with the individual participants separated out. On the box-and-whisker bars, each star represents one participant, so we can see the distribution of participants based on the proportion of their reports that contain that behaviour. In figure 3.7g, the top (pink) bar shows the proportions of reports that include all behaviours in the social group for each participant. The orange bars show the same for each individual category of social behaviour. Figure 3.7h does likewise for semantic behaviours, and 3.7i for spatial behaviours.

Figures 3.7k–m show the same data as 3.7b–d, but separated by context as well as individual participant. On the box-and-whisker bars, each star represents one participant, so we can see the distribution of participants based

Figure 3.7k: *distribution of the proportions of individual participants' reports that include social behaviours in the diary keeping study, separated by context*



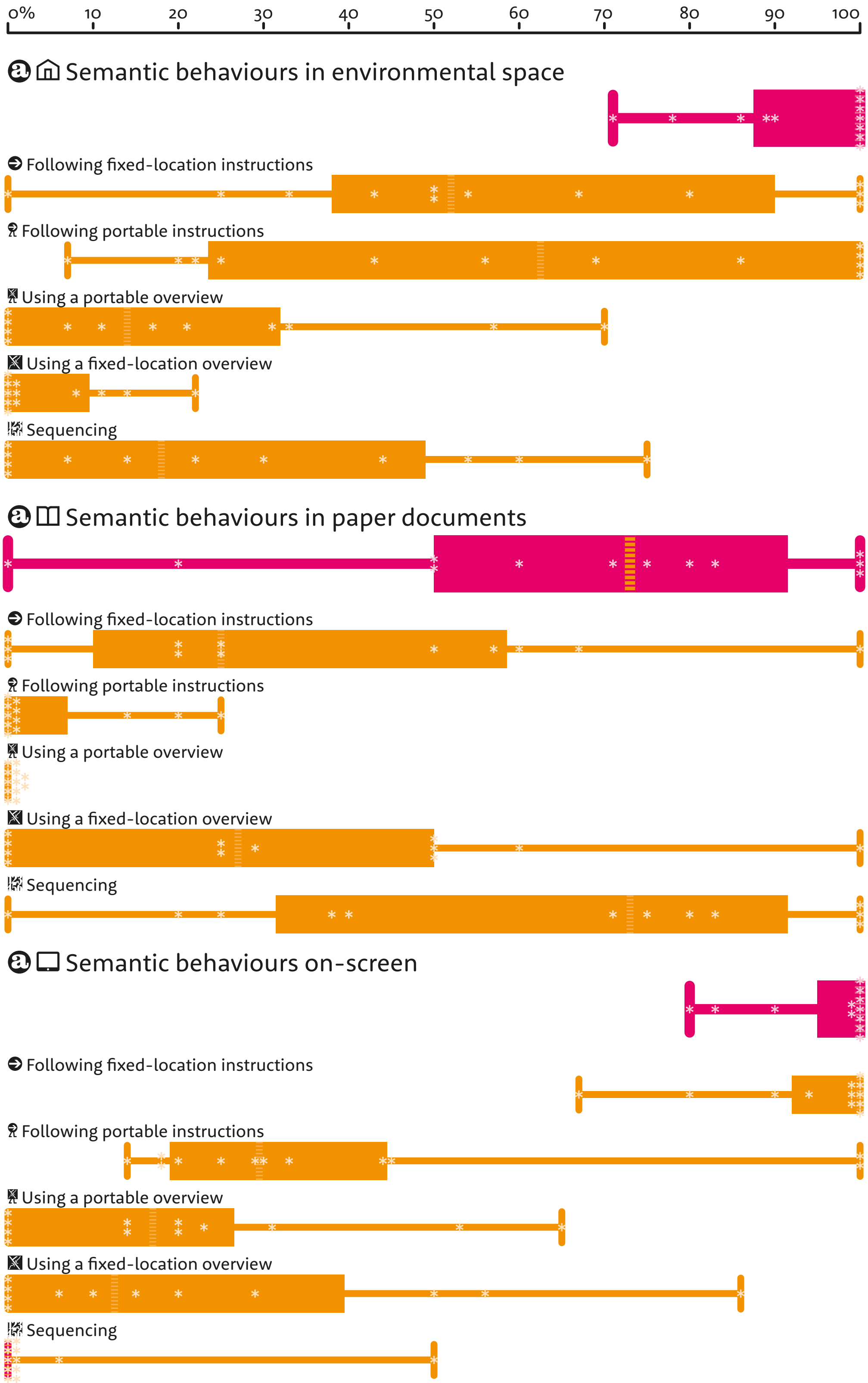


Figure 3.7l: *distribution of the proportions of individual participants' reports that include semantic behaviours in the diary keeping study, separated by context*

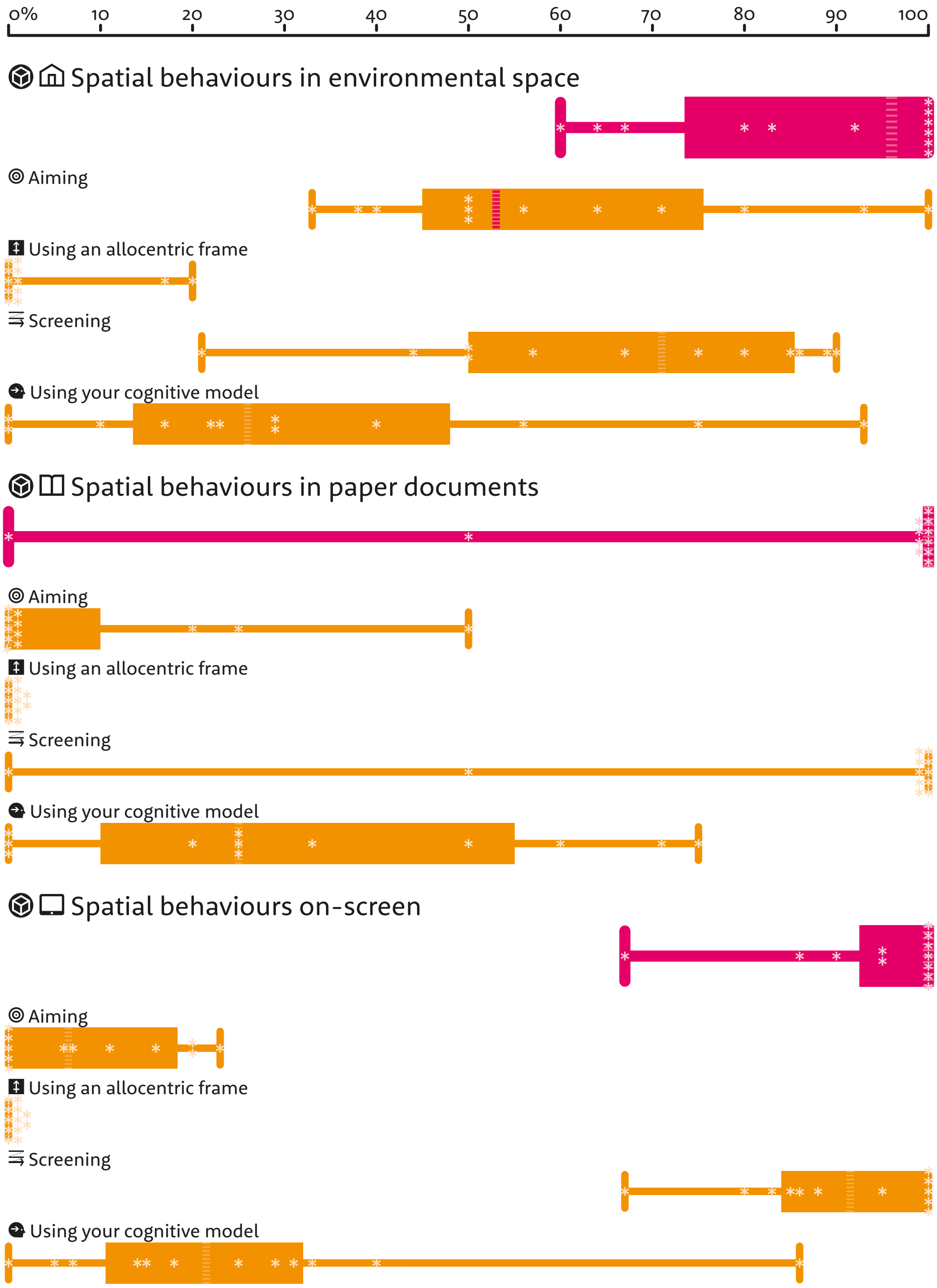


Figure 3.7m: *distribution of the proportions of individual participants' reports that include spatial behaviours in the diary keeping study, separated by context*

on the proportion of their reports that contain that behaviour. In figure 3.7k, the pink bars show the proportions of reports that include all behaviours in the social group for each participant in each context, as do the orange bars for each category of social behaviour in each context. Figure 3.7l does the same for semantic behaviours, and 3.7m for spatial behaviours.

3.8 / General discussion of the results

The results from these three studies form the key resource in exploring the categories of seeking-finding behaviour in sections 4–8. The discussions below are of issues that do not readily find a place there.

3.8.1 / Questions about method

Before the results can be analysed and discussed, and in addition to issues noted above,[144] there are other points to note about methods used. These are raised here (i) in order to explain why the approach was used despite limitations, (ii) how the limitation was mitigated, and (iii) to foreground these issues so that they can be kept in mind during the discussions in subsequent sections.

Sample size and selection

All three studies raise questions about participant selection. The first point is that everyday life covers a wide and hard-to-define population. Even restricting to English-speaking adults in developed countries does little to limit the breadth and diversity of the population in question.

The task observation and wayfinding survey use friends, neighbours, and family as the participants;[145] the diary keeping uses participants selected via a user research recruitment agency. A sample of people known to the researcher is unlikely to be balanced or entirely representative. Although the diary keeping participants are selected to represent a range of ages, educational achievement, ethnicities and balanced for gender, the small sample means that it too is unlikely to be fully representative.

The exploratory nature of the research means that questions about the representativeness and the size of the samples are less critical, and thus the sampling approaches used are regarded as acceptable. Twelve participants, as used in the task observation and the diary keeping, is sufficiently small to be able to examine individuals in detail, and sufficiently large for patterns across participants to start to emerge.

144 About verbal protocols in 3.2, inter-rater reliability in 3.3, and diary keeping in 3.4.
145 The wayfinding survey was an opportunistic study making the most of a situation that incidentally arose, and the participant sample is part of that opportunity.

Small data sets can be unreliable because they are more likely to yield extreme results than bigger ones (Tversky and Kahneman 1971). While, for instance, the full set of 299 reports in the diary keeping is a substantial body of data, once it starts to be disaggregated (by context, participant, or category of behaviour for instance), it rapidly devolves to small numbers. This places limits on how far down into the quantitative data it is possible to drill in any of the three studies. Furthermore, because this data captures everyday life, the range of possible behaviour-influencing factors and other variables means that the data is noisy and dirty, and it is difficult to make categorical statements about the relationships of factors (let alone causality).

Nested behaviours

An issue that emerges through reflection on the data is the likelihood of instances where behaviours have subsidiary relationships with or are nested within other behaviours. This may be reported in some instances, but it is also possible that some may go unreported. Possibly this is an issue of scale (the nested or subsidiary behaviour is smaller scale, possibly below the threshold of scale used in this thesis).[146] This cannot be investigated using the data collected in the wayfinding survey and the diary keeping, but the task observation permits some insight into these subsidiary relationships, and this is discussed in section 7.

Level of detail

Self-reporting makes it difficult to know or control the level of detail reported. Some participants may be predisposed to report in more detail than others. And it is possible that an individual will vary in the degree of detail they include from one report to another. The degree of intra- and inter-individual variation in the level of detail reported cannot be assessed from the data collected. The quantitative analysis used in sections 4–8 is sufficiently coarse-grained that such variation is unlikely to have significant impact.

Are all behaviours equally accessible to self-reflection?

It is also possible that behaviours differ in how accessible they are to self-observation and recording. For example, the questions designed to elicit information about using your cognitive model are asked more indirectly than some other behaviours: this behaviour is particularly problematic to prompt reflection on and reporting of, and there is no reason to assume that the other categories of behaviour, while being more accessible to self-reflection are equally so. This issue arises with the wayfinding survey and the diary keeping: the data collected does not allow us to investigate this issue, and caution must be exercised in too-fine comparisons between categories of behaviour.

146 See 1.2.4.

Defining the boundaries of a seeking-finding event

A further question for the wayfinding survey and the diary keeping is defining the boundaries of a seeking-finding event (particularly its start). As discussed in 1.3.7, seeking-finding tasks in everyday life are often best represented as complex problems that may be incompletely defined at the outset, dynamic, ill-structured, and open-ended, all of which makes it difficult to define their boundaries. This was deliberately not discussed in the diary keeping briefings and none of the participants asked for clarification. Examining the open responses in the questionnaires reveals that, for the purposes of this research, event reports generally start when the participant leaves territory with which they are familiar (which may be a fuzzy boundary). End points of events are more identifiable in that they are the point at which the participant concludes that they have achieved their objective, even if it is only a 'milestone' in a larger project.

The effect of these limitations

These limitations are no more than typical challenges facing research that is exploratory or conducted in real-world settings (Crosbie 2006; Stone and Shiffman 2002), and I accept that the consequence may be results that are fuzzily meaningful (Downs and Stea 1977: 224). It is nonetheless necessary to raise these possible limitations prior to the discussions in sections 4–8.

3.8.2 / The full repertoire of seeking-finding tactics

The lists of tactics in the questionnaires for the wayfinding survey and the diary keeping emerge as comprehensive lists of seeking-finding tactics for the purposes of this research. Because this list was generated from the literature review plus everyday experience, there was no guarantee that it would prove to be comprehensive – who would confidently claim that they were able to list *all* seeking-finding tactics? One of the first questions to answer using the data from the wayfinding survey and the diary keeping is: *What are the other tactics that the participants identify?* The few instances where participants list additional behaviours, using the 'other' category on the questionnaires, either emerge as assignable to extant categories by the researcher (e.g. 'we followed our noses' is recoded as using your theoretical cognitive model) or omitted for reasons of plausibility (e.g. 'I used telepathy'). People completing questionnaires are typically disinclined to use the 'other' option that requires them to write out their answer. This means that the small number of instances in which it is used cannot be taken as completely representative of the number of instances in which other tactics were actually used. So, we cannot take the absence of any other tactics proposed by participants to mean that the lists are exhaustive, but they form a core that covers the majority of behaviours in seeking-finding.

3.8.3 / Different or similar?

An issue that emerges repeatedly in sections 4–8 is inter-individual difference. This is discussed in 8.1, but it is worth noting here how different all of the individuals are in their choices of seeking-finding tactics. Figures 3.5c–5 and 3.7h–m give an overview of the extent of inter-individual difference in seeking-finding behaviour. If one tries to plot individuals across multiple box-and-whisker charts, patterns are hard to discern. There are patterns that emerge across participants, but the differences between individuals stand out more strongly.

3.8.4 / In a group or solo

The difference between seeking-finding as a solo activity and in a group emerges as an issue in the wayfinding survey. The literature survey finds little research into seeking-finding behaviour in environmental space examining the differences between group and solo behaviours.[147] The study of collaborative tourist seeking-finding in Brown and Laurier (2005a) is an exception: tourists work as a group to find their way, and they interact not only with each other but also with passers-by and 'officially knowledgeable' locals, such as tourist office staff and police.

One outcome of this issue emerging in the research is that the taxonomy has evolved to include a category of behaviours that employ the help of other people who accompany one on the seeking-finding 'journey' – namely, collaborative seeking-finding. As part of the briefing interviews in the diary keeping, participants were asked if their seeking-finding behaviour would be affected by whether they were in a group or on their own. Several stated that their behaviour would be different in these two situations. However, the data from both the wayfinding survey and the diary keeping demonstrate no meaningful differences in seeking-finding behaviour choice between group and solo situations. Differences do emerge in other ways, and these are discussed in more detail in section 4.

3.8.5 / Planning ahead

The issue of planning ahead also emerges in the wayfinding survey. It is sufficiently present in the additional comments to warrant including it explicitly in the diary keeping. The data captured regarding planning ahead for seeking-finding in paper documents and on-screen is insufficient to draw any conclusions, but that gathered from the diaries regarding seeking-finding in environmental space reveals some interesting points.

147 See 4.4.

Figure 3.8a shows the percentages of all reports that include planning ahead in the wayfinding survey. The percentage that include *any* planning ahead is shown by the top (pink) bar, and the percentages of reports that contain each of the individual categories of planning ahead are shown by the orange bars in this figure. This is information proffered in open responses and not specifically asked for in the questionnaire. Figure 3.8b shows the same breakdown of data from the diary keeping reports from environmental space. This is information collected by the open question: '**Please describe briefly any preparation you made for finding your way before you set out (such as checking a map or journeyplanner website).**' The four categories of behaviour emerge from the open responses. The pilot participants are excluded because their questionnaires did not include this question.

Figure 3.8a: *the proportion of reports in the wayfinding survey that include unsolicited comments about advance planning*

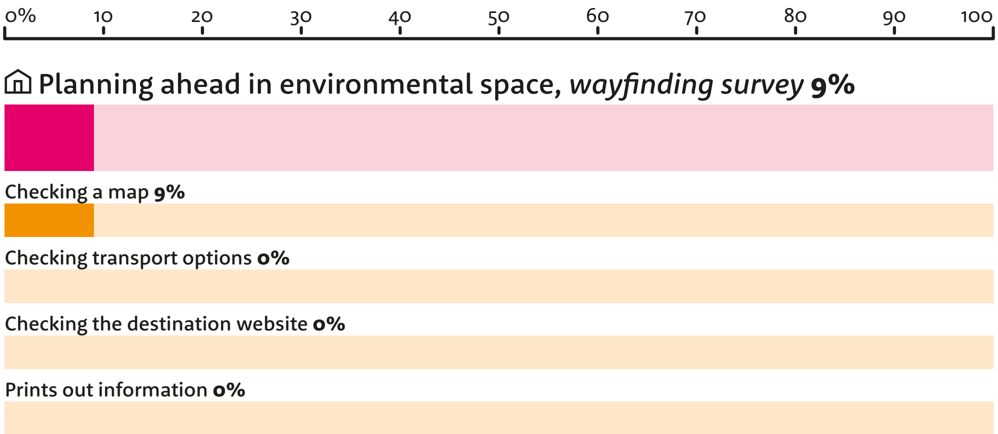
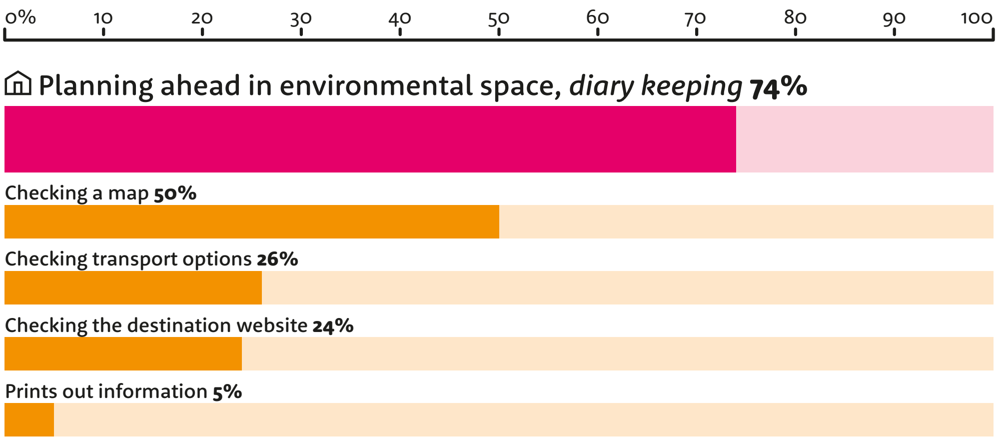


Figure 3.8b: *the proportion of reports in the diary keeping that include evidence of advance planning*



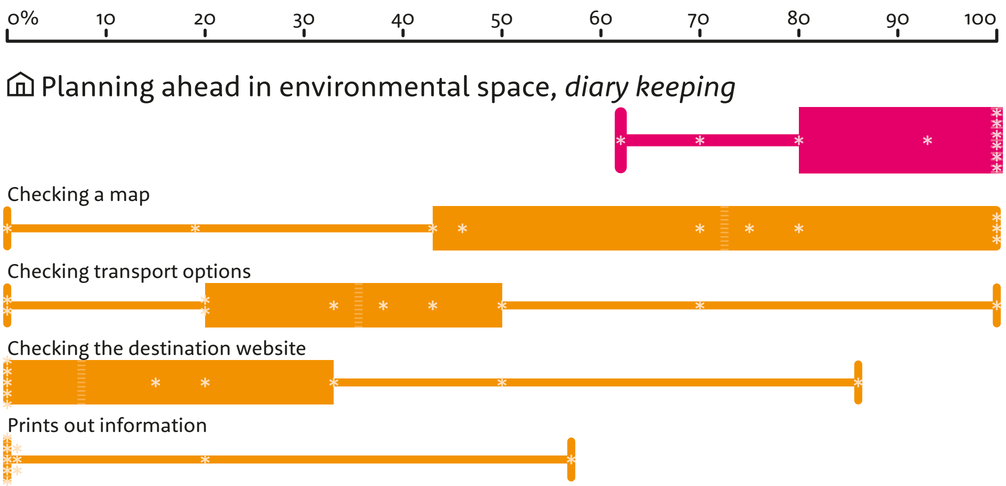


Figure 3.8c: *distribution of the proportions of individual participants' reports that include advance planning in the diary keeping study*

Figure 3.8c shows the same data as 3.8b but with the individual participants separated. On the box-and-whisker bars, each star represents one participant, so we can see the distribution of participants based on the proportion of their reports that contain planning ahead. The top (pink) bar shows the proportion of reports that include *any* planning ahead for each participant, and the orange bars show the same for each category of planning ahead.

The difference between figures 3.8a and 3.8b shows that even though the small response in 3.8a is sufficient to raise this as an issue worthy of further investigation, the greater amount of planning ahead that is actually happening is shown in figure 3.8b.

Figure 3.8c gives further insight into the range of planning ahead. Of the 10 participants, 6 plan ahead before each of their seeking-finding events in environmental space, and even the participant who plans ahead the least is still doing so in 62% of their reports. Although all participants plan ahead in the majority of their journeys, all categories of planning ahead are unused by at least one participant. Of the four categories of planning ahead, checking a map is included in the largest proportion of reports, and printing out information is the least reported category.

Some seeking-finding in environmental space cannot be planned ahead: such as when Mary's young son tells her he needs a toilet while they are out shopping. And different categories of planning ahead may better suit some types of seeking-finding than others. For instance, for a journey on foot or by car, checking a map may be the best way; whereas a journey on public transport may be best planned by checking a website such as *TfL Journeyplanner* or *Citymapper*.[148]

148 https://tfl.gov.uk/plan-a-journey/ and https://citymapper.com/london both accessed 22/12/2016.

The pilot participants in the diary keeping report planning ahead for seeking-finding in environmental space in 17% of their reports: this is higher than the percentage in the wayfinding survey, but not as high as the 74% in diary keeping main study when the question is asked explicitly. However, the pilot participants' reports of seeking-finding on-screen and in paper documents do not elicit any reports of advance planning, and although the 10 participants in the main study were asked to report any instances of advance planning before seeking-finding on-screen or in paper documents, none did.

That much of the advance planning for seeking-finding in environmental space involves seeking-finding in paper documents or on-screen illustrates how seeking-finding is connected across contexts. A further illustration of this can be found in the case study of Jess in 4.9 when she is helping a friend find a room to rent: they look at classified ads in a local newspaper (paper documents), check websites (on-screen), and (after the study period ends, presumably) go to visit rental properties (in environmental space).

The literature survey has located scant discussion of advance planning for seeking-finding in environmental space. Some practice literature notes that planning ahead happens,[149] but the only attention in more depth comes in 2 of the good practice guides.[150] Some research into seeking-finding in environmental space does examine the planning that occurs when the participant is about to embark on the task.[151] For example, Lawton, Charleston, and Zieles (1996) study real navigation environments and find that most people lack a successful initial plan: they start by taking an approximate route that they adjust while travelling. The planning examined in these studies is primarily reliant on the internal resources of using your cognitive model. It differs from the planning ahead captured in the diary keeping that often occurs some time before the seeking-finding starts and largely uses external resources.

I can only speculate, but it is possible that there is deliberate and conscious advance planning before seeking-finding in environmental space (and less evidence of it in paper documents or on-screen) because it typically requires a greater investment of physical effort and time than seeking-finding in paper documents or on-screen, and this drives a greater desire to plan before making this investment. It is possible that the planning ahead that precedes seeking-finding in paper documents and on-screen is more akin to that reported in the research into seeking-finding in environmental space that employs the internal resources of using your cognitive model rather than the pre-visit planning

149 E.g. Berger (2005: 137); Mollerup (2005: 31).

150 NDA and DoAHG (2011: 119–123) for heritage sites; and Miller and Lewis (1999: 41–59) for healthcare facilities.

151 E.g. Ohtsu (2017); van Schaik, Mayouf, and Aranyi (2015); Wilson, Curzon, and Duncker (2014); Peña, Contreras, et al. (2008); Spiers and Maguire (2008); Passini (1996).

that uses external information sources captured in the diary keeping. In their study of seeking-finding in an on-screen textbook, (Dreher and Guthrie 1990) find that overall effective or successful performance is linked to a methodical approach that includes planning ahead.

Overviews of planning as an activity can be found in Hayes-Roth and Hayes-Roth (1979) and Suchman (1987); the former gives a more theoretical overview of the activity while the latter takes a more ethnographic approach but is in some respects equally theoretical.

The study by Brown and Laurier (2005a) is one of the few to examine the same type of advance planning (in environmental space) as that in the diary keeping. Looking specifically at tourists, Brown and Laurier find that they make ad hoc, partial rough plans that are adjusted en route – perhaps reflecting their less time-constrained and less goal-driven attitude to their seeking-finding. Brown and Laurier also make the point that such pre-visit planning adds information to an indirect cognitive model that allows the tourist to spend more time experiencing the environment and less time head-down studying the guidebook.

The question of a negative relationship between planning ahead and using your cognitive model when on-task is raised in 4.10.6 and discussed in 6.9.3.

4 / Social behaviours

'… and from the conversations of which he had caught snatches he had realised that they were going to the same conference as him. That was why he had decided, with a typically Japanese mixture of shyness and resolution, not to lose sight of the group of compatriots and to follow them discreetly, but without introducing himself. He was quite determined to shadow his countrymen and to use them as guide dogs, especially on arriving at Fiumicino where, he was convinced, he would find himself facing a state of chaos worthy of Dante.'[152]
(Mavaldi 2008: 14)

4.1 / Introduction

This section introduces the group of seeking-finding behaviours that are identified as social. It is one of 3 groups that together encompass all types of seeking-finding behaviour, and are introduced in section 3 (semantic and spatial groups are discussed in sections 5 and 6).

This section starts by describing the factors that identify behaviours as social. It is followed by discussions of each category of social behaviour: definition and examples, how the behaviour is coded from the user research, and the current taxonomy in relation to comparable taxonomies. Following this is discussion of a further factor germane to a discussion of social behaviours. This is followed by a presentation of social behaviour data from the user studies.

This section ends with 3 case studies. Two examine individual participants from the diary keeping study, chosen because they illustrate different characteristics of social seeking-finding behaviour: Jess is often seeking-finding in the interests of other people, and Fergus is unusually willing to engage

152 Fiumicino is the international airport serving Rome, Italy (full name: Leonardo da Vinci–Fiumicino Airport).

strangers to help him in seeking-finding. The final case study examines social behaviours in seeking-finding in paper documents.

The picture that emerges from the user studies is that social behaviours are used less intensively than either semantic or spatial behaviours. There is considerable inter-individual difference – principally quantitative but also with differences in how behaviours are combined – and there are clear relationships between context and individual categories of social behaviour.

The relationship between social, semantic, and spatial behaviours is discussed in section 7. And social behaviours in relation to other factors involved in seeking-finding behaviour are discussed in section 8.

4.2 / What distinguishes social behaviours?

Broadly speaking, social behaviours are those that use other people as a resource in seeking-finding – such as the way in which the protagonist in the quotation at the start of this section identifies some people heading for the same destination as himself and decides to use them to guide him through a complex and unfamiliar environment. The term *social navigation* is often used to describe these sorts of behaviours.[153] As a means to achieving one's ends, social behaviours in seeking-finding are widespread, but are somewhat overlooked in the literature of relevant disciplines. In design practice, social behaviours in seeking-finding are rarely given more than fleeting attention.[154]

The means of differentiating social, semantic, and spatial behaviours are discussed in 2.7. Two key factors, either of which can characterise a behaviour as social, are: (i) the person providing the information is present when the seeker-finder uses it; and (ii) the information is generated in a way that is incidental, amateur, or ad hoc.

This second factor raises the question of agency: *Was this deliberately created to facilitate seeking-finding?* Social behaviours often rely on information that is not created expressly to support seeking-finding activity, that is created by lay-persons, and on the fly. These three factors are each atypical (to a greater or lesser extent) of the bulk of information 'officially' produced to support

153 The first use of this term is in Dourish and Chalmers (1994). See also Dourish (1999); Dieberger (1999: 36). Hirtle (2011) and Mollerup (2005) are rare examples of the term used in environmental space.

154 Practice literature often pithily recommends the incorporation of social behaviours in seeking-finding strategy, for instance: 'People ask for directions first. Design a program that helps people give directions.' (Berger 2005: 97); see also ACRP (2011: 109–110); NDA and DoAHG (2011: 56); Calori (2007: 6); Smitshuijzen (2007: 13); RSSB (2006: 62); Berger (2005: 97, 111, 159); Carpman and Grant (2002: 433); Kelly (2001: 39); Arthur and Passini (1992: 57, 210–211). While such literature typically provides extensive guidance on the design of direction signs (following fixed-location instructions – see 5.7), it typically provides scant guidance on how to support or include social behaviours within a seeking-finding strategy.

seeking-finding. This makes social behaviours qualitatively different to much seeking-finding behaviour and differentiates them in ways additional to those brought out by the taxonomy.[155]

It may be helpful to reiterate the point made in 2.7 that all seeking-finding behaviours have social, semantic, and spatial aspects but each behaviour is put into one group depending on which aspect predominates.

4.3 / Behaviours in the social group

The group of social behaviours in the taxonomy comprises 3 categories:

- Collaborative seeking-finding
- Social seeking-finding
- Asynchronous social seeking-finding

The place of these behaviours within the taxonomy is shown in figure 4.3a.

4.4 / Collaborative seeking-finding

4.4.1 / Definition and examples

The information is provided by a person who proceeds with you and with whom you interact in real time. The information takes the form of the actions of that person (including speech), and presents a single course of action.

Examples:

- Wayfinding on a journey made with one or more other people, or with a guide employed for the purpose.
- Looking at a printed catalogue with your partner in order to choose home furnishings.
- Researching holiday options online with your friends.

In the quotation at the head of this section, the protagonist follows a group of people who are using collaborative seeking-finding in that they are seeking-finding as a group.

The 'socialness' of collaborative seeking-finding is well illustrated by the following response from the wayfinding survey: 'As we approached the gallery, we passed by/through places we'd both been and had connections with in the past and which affected the course of our conversation during the journey. In this way it enabled us to reveal things to each other about our

155 See section 2.11 for more discussion of the question of agency.

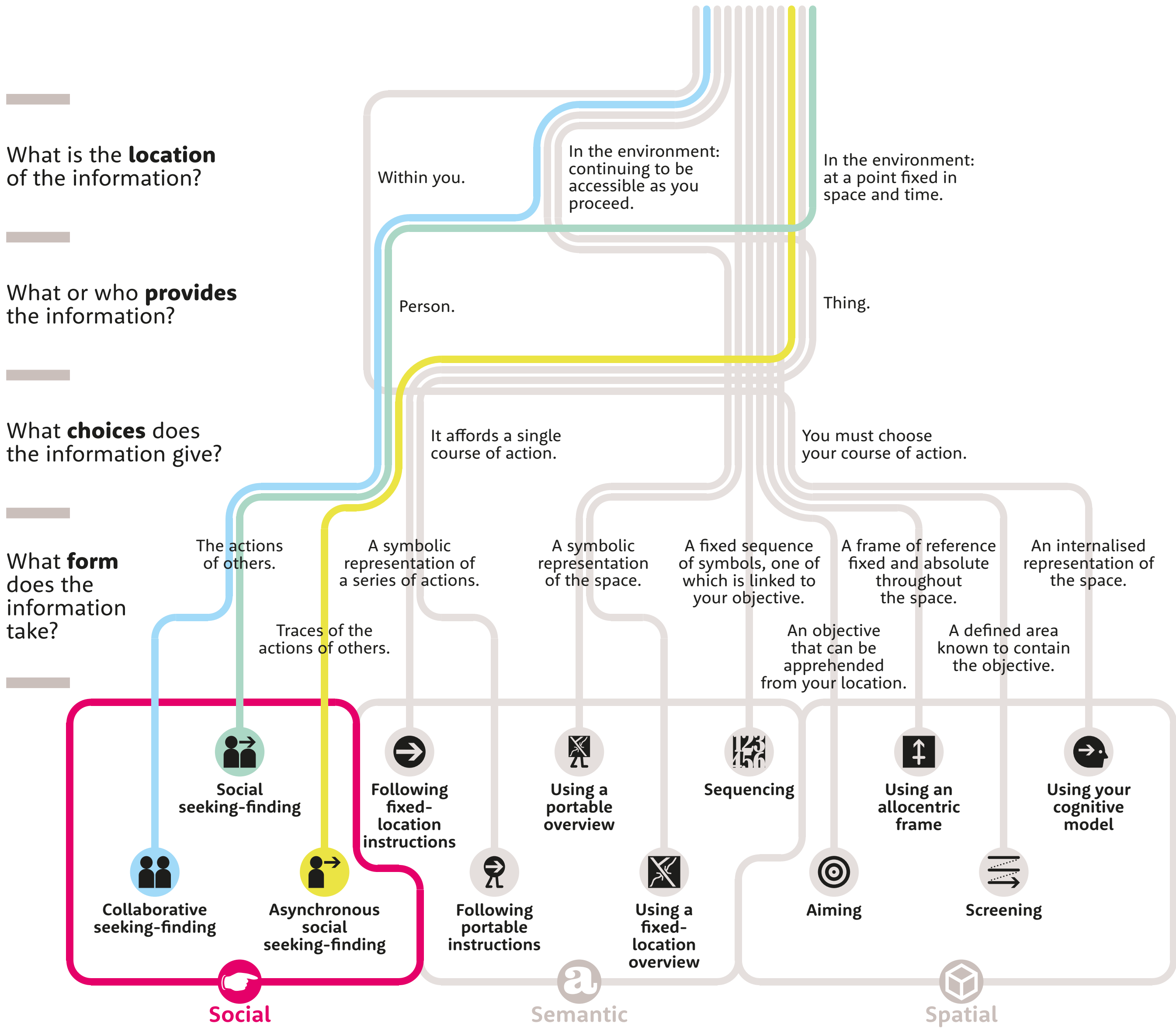


Figure 4.3a: *the place of social behaviours within the taxonomy*

past lives.' This behaviour is rooted within an extant personal relationship and serves purposes that can extend beyond the utilitarian. It also demonstrates the richness of observing behaviour in everyday life.

4.4.2 / How this behaviour is captured in the user research

The **task observation** required the participants to work on their own and thus collected no data regarding collaborative seeking-finding.

In the questionnaires used in the **wayfinding survey** and **diary keeping**, this behaviour is coded from the responses to the question on page 4:

In environmental space:

- 'Were you travelling alone or with others?'

In paper documents and on-screen:

- 'Were you working alone or with others?'

If the 'With others' box is ticked in response to these questions, it is coded as collaborative seeking-finding.

These questions are not part of the main list of behaviour questions that comprise pages 2–3 of the questionnaires, and are framed differently to those questions.[156] A consequence of this difference in data capture is that it is possible that collaborative seeking-finding is more readily reported than other behaviours. A precise value cannot be attached to this difference.

4.4.3 / Collaborative seeking-finding in other taxonomies

This category of seeking-finding behaviour is not encompassed by any of the taxonomies from research or practice in any of the three contexts. And although collaborative seeking-finding has been the subject of research on-screen (and to a lesser extent in paper documents), much research and practice literature discussing seeking-finding in environmental space assumes solitary individuals and the processes of collaborative seeking-finding in this context are little examined.[157]

4.5 / Social seeking-finding

4.5.1 / Definition and examples

The information is provided by someone whom you witness, in real time, at a point fixed in space and time. The information takes the form of the actions of that person (including speech), and presents a single course of action.

Examples:

- Asking a passer-by for directions to a particular place.
- Following someone's spoken instructions to locate a particular piece of information within a printed document.
- Finding something on a website guided by online chat with an employee of that website.

156 The difference in this question in comparison to the other behaviour questions is a consequence of the taxonomy being still work-in-progress at the time of this user research (indeed, one purpose of the user research was to test the taxonomy). Adding collaborative seeking-finding to the taxonomy was one consequence of the analysis of the data collected from the studies.

157 This category of social behaviour *is* studied in Mandel (2013); Forlizzi, Barley, and Seder (2010); Roger, Bonnardel, and Le Bigot (2009); Brown and Laurier (2005b); Montello (2005).

In the quotation at the head of this section, the protagonist is engaging in social seeking-finding in that he is using the actions of others (which he witnesses in real time) to help him find his way.

A further example of social seeking-finding in environmental space is provided by Mollerup (2005: 67): 'Consider a traveler who has lost his way in Venice to find himself in a small campo (Venetian for square), from which seven alleys lead away. A time-honoured practice is to learn from other people. If all people leaving the campo use one of two alleys, and the traveler came in by one, then he should leave by the other. The other five alleys probably lead nowhere.' He goes on to describe these traces as making the environment 'history enriched' (p.67). The 2013 revision of this work adds a further comment: 'crowdsourcing says so' (Mollerup 2013: 46).

A similar example comes from the wayfinding survey: 'I followed a lady with red shoes who was carrying your invitation.' Such a tactic can only be opportunistic: if one is planning how to reach a destination before starting the journey, there is no way of being sure that such an opportunity will arise, or the form that it will take. However, the desire for cognitive economy and the swift and intuitive cost–benefit analyses that humans engage in mean that identifying this opportunity (*that person must be going to the same place as me because I recognise the invitation they are carrying*) permits the individual to switch to a course of action with lower cognitive load than that which they had anticipated using.[158]

4.5.2 / How this behaviour is captured in the user research

The **task observation** required the participants to work on their own and thus collected no data regarding social seeking-finding.

In the questionnaires used in the **wayfinding survey** and the **diary keeping**, this behaviour is coded from the following responses to the questions on page 3.

In environmental space:

- 'I asked a member of the public for directions'
- 'I asked "someone official" for directions'
- 'I followed other people'

On-screen:

- 'I clicked on links suggested in online chat with a site employee'

In the questionnaire for paper documents, there is *no* item that is coded for social seeking-finding. The reason for this is that a simple concrete description

158 See 1.3.6 for a discussion of cognitive load and cognitive economy.

of such a tactic could not be satisfactorily formulated. The participants had the option of using the item 'I used a strategy that's not on the list' to make a note of any other behaviours that they observed in their activity. None of them did so, which cannot be taken as proof that such behaviours do or do not happen.[159]

4.5.3 / Social seeking-finding in other taxonomies

Within taxonomies surveyed from practice literature, in **environmental space** this category of behaviour is derived from 'social navigation', the last of 9 strategies for seeking-finding in environmental space proposed by (Mollerup 2005: 66–67), specifically the 'direct' sub-strategy. This strategy in Mollerup also covers asynchronous social seeking-finding.[160]

This category of seeking-finding behaviour is not encompassed by any other taxonomies from research or practice in any of the 3 contexts.

4.6 / Asynchronous social seeking-finding

4.6.1 / Definition and examples

The carrier of the information is a thing rather than a person; the information takes the form of traces left by the actions of people (or one person); and these traces are at a point fixed in space and time within the environment. The information presents a single course of action.

Examples:

- Following the track worn by countless previous people across the common.
- Knowing which part of a reference book to check because of the marks made by other people.
- Using comments left by people in an online forum in order to find a particular element of functionality in software.
- Using the 'frequently asked questions' page on a website.
- Using the 'customers who bought this item also bought . . .' recommendations on a shopping website.

159 The use of the 'other' category in questionnaires in relation to the lists of tactics in the questionnaires is discussed in 3.8.2.

160 See 4.6.

4.6.2 / How this behaviour is captured in the user research

The **task observation** required the participants to work on their own with an unmarked copy of the book and so collected no data on asynchronous social seeking-finding.

In the questionnaires used in the **wayfinding survey** and the **diary keeping**, this behaviour is coded from the following responses to the questions on page 3.

In environmental space:

- 'I followed a track that other people had made'

In paper documents:

- 'I made use of notes that other people had written in the document'

On-screen:

- 'I clicked on links that were suggested based on my browsing history'
- 'I clicked on links in comments left by other users'

4.6.3 / Asynchronous social seeking-finding in other taxonomies

Within taxonomies surveyed from practice literature, in **environmental space** this category of behaviour is derived from 'social navigation', the last of 9 strategies for seeking-finding in environmental space proposed in (Mollerup 2005: 66–67), specifically the 'indirect' sub-strategy. This strategy in Mollerup also covers social seeking-finding.[161]

This category of seeking-finding behaviour is not encompassed by any other taxonomies from research or practice in any of the 3 contexts.

4.7 / Do social behaviours present a single course of action?

All 3 social behaviours are defined as presenting single courses of action, rather than providing information that permits the individual to choose their course of action. But is this really the case: *are* social behaviours in seeking-finding in everyday life quite so unequivocally restricted in the choices they offer?

It is certainly the case that the social behaviours that most readily spring to mind – following someone or asking someone for directions – are both likely to offer a single course of action. If you follow someone, the only choice you get is to follow them or not: any choices occur earlier in the process as you choose *whether* and *who* to follow. If you ask someone for directions, you

161 See 4.5.

are likely to be frustrated if they reply: *Well, you can get there by going this way, or by going that way*. In order to ease cognitive load, it is preferable to remember directions for a single route rather than multiple options.[162]

There are undoubtedly occasions when social navigation offers choices rather than a single course of action. I have found little evidence of them, but do not deny their existence (absence of evidence is not evidence of absence). Furthermore, the taxonomy creates the space to include such behaviours, even if these empty (or quantitatively small) categories remain undiscussed at present due to the lack of data.[163]

For the purposes of this discussion, social behaviours that present choices in terms of course of action are regarded as being sufficiently limited in number to be below the level of granularity employed here, and so are grouped with the otherwise comparable behaviours that present single courses of action.

4.8 / Social behaviour in the user research

Of the 3 user studies, only 2 collect evidence of social behaviours. The task observation study does not. This is because the participants work alone and so cannot engage in collaborative seeking-finding or social seeking-finding; and the document they use is sufficiently new and unmarked to include no clues from previous users and so they cannot engage in asynchronous social seeking-finding.

4.8.1 / Data from the wayfinding survey

This study provides data from 43 participants performing a single task in environmental space. An overview of the data from this study is in 3.6, with social behaviours shown in figures 3.6a and 3.6d.

Comparisons with the other study that reports seeking-finding in environmental space – the diary keeping – are discussed in 4.8.3.

In the wayfinding survey (and in the diary keeping – see 4.8.2), social behaviours are included in smaller proportions of reports than either semantic or spatial behaviours.

Figure 3.6a shows the most reported social behaviour in this study is collaborative seeking-finding: it is included in 56% of reports, social seeking-finding is included in 14% of reports, and asynchronous social seeking-finding in only 2%. The greater reporting of collaborative seeking-finding may be

162 See 1.3.6 for a discussion of cognitive load.
163 See 2.9 for a discussion of the 'empty' sets in the taxonomy.

influenced by the destination of the seeking-finding task in this study being a social event – people go to parties in company. It is also possibly due to differences in how the data for this behaviour are collected.[164] The reports shed no light on the influence of these two factors: it is possible that both contribute to the large percentage of reports including collaborative seeking-finding in comparison with the other two social behaviours.

The reports of social seeking-finding in this study comprise: an instance of asking a member of the public, an instance of asking someone official, 3 instances of following other people, and 1 that includes all 3 of these tactics. The last – reporting all 3 tactics when the majority of participants report none – could indicate an individual who is particularly attuned to using other people as a resource in seeking-finding.

Looking at figure 3.6d, we can see that 2 of the instances of social seeking-finding co-occur with collaborative seeking-finding (comprising an instance of asking a member of the public and one of following someone else), and the other 4 co-occur with no other categories of social behaviour. The only instance of asynchronous social seeking-finding also co-occurs with collaborative seeking-finding. These co-occurrences are discussed further in 4.8.3, which compares the data from the wayfinding survey with that collected from environmental space in the diary keeping.

One of the discursive questionnaire responses is quoted in 4.4.1. Others include the following:

'I followed a lady with red shoes who was carrying your invitation – she and her husband were reading signs marking the way to the venue.'

'I followed J— and E—.'

4.8.2 / Data from the diary keeping

This study provides data from 12 participants' seeking-finding activities in their everyday lives over the course of a month, covering all 3 contexts. An overview of the data from this study is in 3.7, with social behaviours shown in figures 3.7b, 3.7e, 3.7h, and 3.7k.

The data from the diary keeping (figures 3.7b and 3.7e) offers less strong evidence than that from the wayfinding survey (figure 3.6a) to support the suggestion in 4.4.2 that the method of data collection for collaborative seeking-finding in these 2 studies could lead to it being reported more readily than other categories of behaviour.

If we compare the proportions of reports including social behaviours with those including semantic and spatial behaviours across all three contexts

164 See 4.4.2.

in the diary keeping (figures 3.7b–d), social behaviours are some of the least reported categories of behaviour. Almost all categories of semantic and spatial behaviour are included in greater proportions of reports than individual categories of social behaviour. This difference is even more marked when groups as a whole are compared (the top pink bars in the three figures): social behaviours are included in only 35% of reports, whereas semantic behaviours are included in 89% and spatial in 92%. The data do not allow us to look further, but we might speculate as to whether there is a relationship between the lack of coverage of social behaviours in practitioner literature and the lesser usage of this group of behaviours.[165]

When we look at the data broken down by individual participants (figure 3.7h), we can see that 2–3 participants do not report each category of social behaviour, but we know that these are not the same participants in each category of behaviour (because the pink bar does not extend to zero), and all participants include social behaviours of some sort in at least 15% of their reports.

The data from the diary keeping allows comparisons of seeking-finding behaviour across contexts (see 4.8.4). And when viewed in conjunction with data from the wayfinding survey, it offers the opportunity to compare data sets within the same context (although from different studies); this is discussed below.

4.8.3 / Comparing social behaviours in environmental space

Both the wayfinding survey and the diary keeping collect data for social behaviours in environmental space. Data from the wayfinding survey are shown in figure 3.6a, and from the diary keeping in figure 3.7e (environmental space is in the top portion). These figures allow some comparisons, bearing in mind the effect of other variables, such as task and sample. The wayfinding survey has a higher proportion of reports including social behaviours than the diary keeping (65% rather than 48%). This is largely due to the larger proportion of reports including collaborative seeking-finding in the wayfinding survey (56% in comparison with 28%), and this may be a consequence of the wayfinding survey collecting data pertaining to a task with a social objective. Not only is the proportion of reports including collaborative seeking-finding less in the diary keeping, but the proportion of reports including social seeking-finding is greater (34% rather than 14%).

We might speculate about a possible relationship between collaborative seeking-finding and social seeking-finding in that when in company (collaborative seeking-finding), the resources of one's collaborators reduces the

165 See 4.2.

need to seek information from other people (social seeking-finding). However, the data from the studies does not support this hypothesis: or at least the data from the wayfinding survey does but that from the diary keeping does not, and the quantities are too small to be reliable. An alternative relationship between these 2 behaviours emerges in Jess' data (see 4.9.4), and this is a gender difference discussed further in 8.2.2.

Across these studies, there is a single report of asynchronous social seeking-finding in environmental space. In the wayfinding survey, a participant ticked 'I followed a track that other people had made'; but their questionnaire gives no further information about this.

4.8.4 / Comparing social behaviours across contexts

The diary keeping allows us to examine the same group of participants' social behaviours across all 3 contexts (figures 3.7e and 3.7k). When making such comparisons, however, we must bear in mind the influence of other factors, such as task.

In figure 3.7e, we can see that social behaviours as a group (the pink bars) are included in the greatest proportion of reports from environmental space, and the smallest proportion in paper documents. The low figures in the latter may be due to more limited opportunities to report this in the questionnaires. While the behaviour predominantly reported in this context is collaborative seeking-finding, which may be more readily reported in the questionnaires.[166]

The relatively modest differences between the percentages of reports including each category of social behaviour across all reports in all contexts (the orange bars in figure 3.7b) become more pronounced when broken down by context, and they are different in each context (figure 3.7e). In each context, a different social behaviour is the most reported: social seeking-finding in environmental space, collaborative seeking-finding in paper documents, and asynchronous social seeking-finding on-screen. Social seeking-finding in environmental space is the behaviour included in the largest proportion of reports (34%) of any social behaviour in any context, but on-screen this proportion drops to 2%: of the 34 instances of social seeking-finding, all bar 3 are in environmental space (these 3 are all on-screen).[167]

Collaborative seeking-finding varies least – ranging from 14% of reports on-screen to 28% in environmental space. That seeking-finding in paper documents and on-screen is such a collaborative activity is intriguing; social behaviours in paper documents are investigated further in the case study in 4.11. Of the 64 reports containing this behaviour across all participants, 37 (58%)

166 See 4.4.2.

167 The questionnaires did not collect data for social seeking-finding in paper documents.

are from environmental space, 10 (16%) from paper documents, and 17 (27%) on-screen (figure 4.9e). The instances of collaborative seeking-finding do not break down between contexts in the same proportions as reports in general do (see figure 8.3c). So for the participants as a whole, collaborative seeking-finding is included in a disproportionately large proportion of reports from environmental space and a disproportionately small proportion of reports from on-screen.

Asynchronous social seeking-finding is barely reported in environmental space and in paper documents (0% and 2% of reports respectively), but on-screen this increases to 21%, making it the most reported social behaviour in this context (of the 30 instances of asynchronous social seeking-finding all bar 1 is on-screen, and that is in a paper document). On-screen this comprises 10 instances of clicking on links suggested by browsing history and 21 instances of clicking on links in comments left by others. The comments made by the participants give us further insight into what is going on when people use social behaviours in seeking-finding. Mary is finding out how to stop cats scratching furniture; she comments: 'It was difficult to find conclusive information – lots of opinions online, but not much seems useful.' When looking for running costs for a tumble dryer, Mary says, 'It was difficult to actually find the information I wanted. I ended up getting a reasonable estimate from an Internet forum site.' And when looking for information about school starting for summer-born children, Mary states, 'I followed a link to a Facebook group sent by a friend, and she tagged a relevant comment with my name.' When troubleshooting a problem with a digital device on a user forum, Tanveer says, 'I look for solutions given by more than one user and check their feedback score or other information related to experience' and 'If the solution is technical I will check other forums to see if it is used and its success rate.' Mike is looking for a beard trimmer online and says, 'I changed priority of search results based on user reviews.' Annabelle is looking at offers online and finds a good deal on a watch that she thinks her partner might be interested in, 'so I emailed him the link'. Joyce is looking for a book for her 12-year-old son to read, 'I asked a few other mothers for ideas but wasn't sure'; on Amazon she did a search for books suitable for the gender and age range and extended her search by clicking on links based on other peoples' searches or purchases. This last instance highlights a use of social seeking-finding: if you are looking for something for someone else and your judgement is not a good match for theirs, you can use other people (who may be a better match for the person you are choosing for or who have had to make similar choices themselves) to help make up for your limitations.

The minimal amount of collaborative seeking-finding and social seeking-finding on-screen might serve to confirm the isolating (in real-world terms) effect of on-screen seeking-finding,[168] but the large proportion of asynchronous social seeking-finding demonstrates the ways that people interact in the course of seeking-finding on-screen: largely the individuals involved are dislocated in time or space: there is person–person interaction happening albeit in a somewhat dislocated manner. The same observation of only limited social behaviour could be made of seeking-finding in paper documents, and without even asynchronous social seeking-finding.

When we look at how individual participants differ in their reporting of social behaviours across the 3 contexts (figure 3.7k), we can see that in each context there are participants who do not report social behaviours as a group (the pink bars), but these are not the same participants in all contexts.[169] Lily who reports no social behaviours in environmental space reports them in both other contexts, while Alison who reports no social behaviours in either paper documents or on-screen is unusual in the limited amount of social behaviour she reports at all (see the case study in 5.15). The other four participants who report no social behaviour in paper documents (Jai, Tanveer, Mike, and Joyce) all report social behaviours in both other contexts.[170] Most categories of social behaviour in most contexts also show considerable inter-individual variation in the proportion of reports in which they are included.

4.9 / Case study: Jess

Jess is 1 of the 12 participants in the diary keeping. At the time of research Jess is 49 years old, single, educated to degree level, and describes her profession as 'artist/singer'.

Jess includes social behaviours in a relatively small proportion of her reports, but this is typical of all participants in this study. Notable features of Jess' social behaviour are that (i) her repertoire of semantic behaviours is constrained when combined with social behaviours; (ii) she only uses social seeking-finding when she is in company; and (iii) despite the small proportion of social behaviours, Jess emerges as a gregarious person who uses her seeking-finding skills to help her friends as well as her own ends.

168 Nie and Erbring (2000); Kraut, Patterson, et al. (1998).
169 Because we know from figure 3.7h that all participants include social behaviours in at least 15% of their reports.
170 Tanveer makes *no* reports of seeking-finding in paper documents; see the case study in 5.16.

4.9.1 / Overview of Jess' data

Figure 4.9a shows Jess relative to other participants in terms of the proportion of each participant's reports that come from each context (based on figure 3.7a with Jess highlighted and all other participants greyed out). The proportion of Jess' reports from each context hovers close to the median. In environmental space and on-screen, Jess is just below the median, meaning that there are only 5 other participants who include smaller proportions of reports from these contexts. In paper documents, Jess is just above the median, and although she makes fewer reports from this context than the others, it is a greater proportion than is the case for 6 other participants.

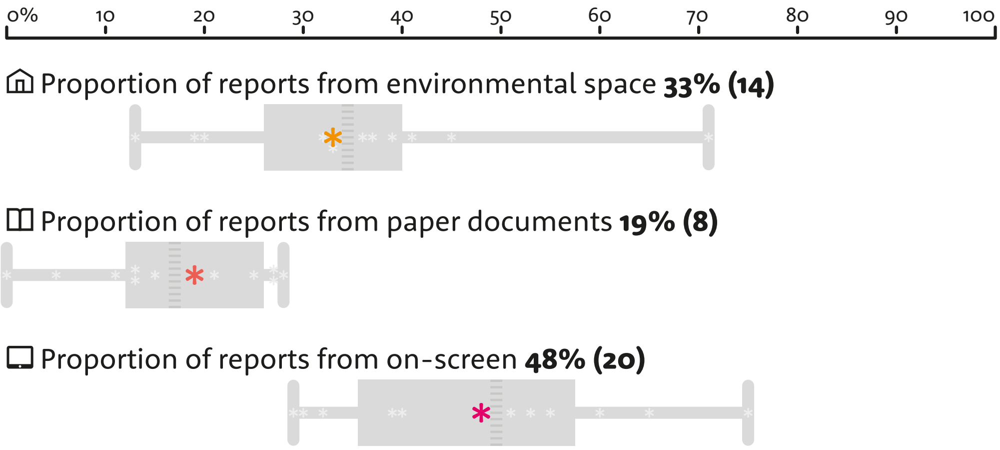


Figure 4.9a: (based on 3.7a): *breakdown of Jess' reports by context, in relation to other participants*

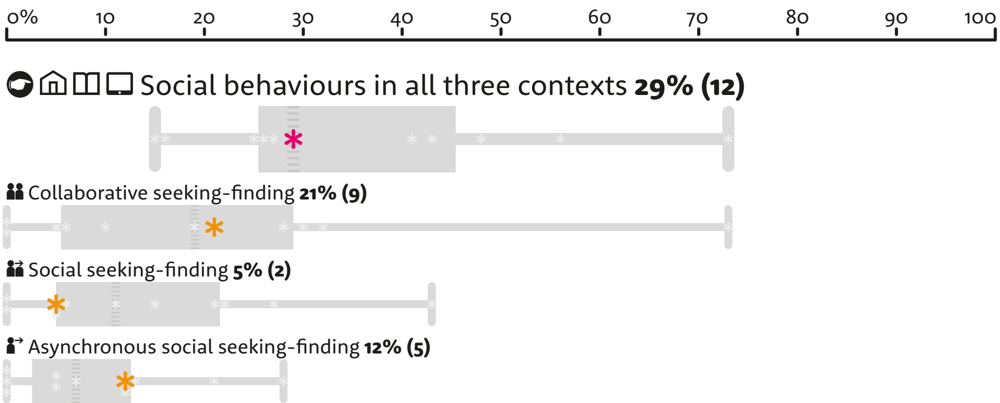


Figure 4.9b: (based on figure 3.7h): *the proportions of Jess' reports that include social behaviours across all contexts, in relation to other participants*

Figure 4.9b shows Jess relative to other participants in terms of the proportion of each participant's reports that include social behaviours across all 3 contexts (based on figure 3.7h with Jess highlighted and other data greyed out). Social behaviours occur in 29% of Jess' reports (shown by the pink star). This puts her on the median for social behaviours in this group of participants.

The orange stars in figure 4.9b separate the percentages of Jess' reports that include each category of social behaviour (with contexts consolidated). For collaborative seeking-finding and asynchronous social seeking-finding, Jess is in the quartile about the median: in comparison with other participants in this study, she is slightly more likely to be seeking-finding in the company of other people or using traces other people have left in order to guide seeking-finding. And for social seeking-finding she is on the border between the lowest 2 quartiles: she is less likely to use the immediate presence of strangers to guide her seeking-finding. Although there is variation in the proportions of her reports that include each category of social behaviour, she never strays far from the median of this group of participants for social behaviours.

Figure 4.9c shows Jess relative to the other participants in terms of the proportion of each participant's reports that include social behaviours with the data broken down by context (based on figure 3.7k, with Jess highlighted and other data greyed out). The pink stars show the percentages of Jess' reports that contain social behaviours when separated into the 3 contexts. The percentages of her reports broken down by category of social behaviour and by context are shown as orange stars.

In environmental space, Jess is in the quartile above the median for collaborative seeking-finding, but in the one below the median for social seeking-finding – broadly meaning that in comparison with the other participants in the study, she is slightly more likely to go out with other people and slightly less likely to ask for directions. And in common with all other participants, Jess reports no asynchronous social seeking-finding in this context.

In paper documents, Jess is exactly on the median: for the context in general, and for collaborative seeking-finding in this context. Both other social behaviours are unreported by Jess in paper documents, but this is not uncommon in this study.[171] As noted in 4.11.1, collaborative seeking-finding in paper documents elicits largely quantitatively extreme reports from participants, but Jess is one of the group of 4 participants whose reports include moderate use of this behaviour.

On-screen, Jess' behaviour is on or above the median. For both collaborative seeking-finding and asynchronous social seeking-finding, Jess

171 Reporting social seeking-finding in paper documents is not well supported in the questionnaires used for this study (see 4.5.2).

Figure 4.9c: (based on figure 3.7k): *the proportions of Jess' reports that include social behaviours, broken down by context, in relation to other participants*

is close to the top of the range in terms of the proportion of her reports that include these behaviours – for each of them there are only 1–2 participants who include that behaviour in a larger proportion of their reports (and in both cases these participants are considerable outliers). As with environmental space and in paper documents, on-screen Jess emerges as seeking-finding in the company of others but in this context she also uses the traces that others have left. The traces that Jess uses on-screen are comments and links that people have posted on social sites and suggestions made by websites based on Jess' browsing history (and what the site predicts that Jess will be interested in based on how her browsing history matches those of previous users). On the other hand, Jess does not report social seeking-finding on-screen, but this is the case with 8 of the 11 participants.[172]

Figure 4.9d presents a different view of Jess' behaviour. It shows her behaviour without the comparison of other participants. Each row shows a single report: detailing the task, context, and particular combination of behaviours used. This allows us to examine the combinations of behaviour in each report. The rows are ordered so that categories of social behaviour are grouped in order to give the clearest possible overview of groupings within social behaviours and to see if groupings also emerge elsewhere in the table.

The issues emerging from Jess' data form the rest of this case study.

4.9.2 / Social behaviours in relation to each other

Jess returns 42 reports – one of the largest returns. Of these, 12 (29%) include social behaviour, this is relatively small in comparison with the proportion of her reports that include semantic and spatial behaviours (79% and 98% respectively), as is typical of all participants. And as noted earlier, Jess is on the median for the proportion of her reports that include social behaviours.

Collaborative seeking-finding and asynchronous social seeking-finding are both included in reports as the only social behaviour; they also co-occur in 2 of Jess' reports. Social seeking-finding occurs in 2 reports, in which it co-occurs with collaborative seeking-finding; it never appears as the only social behaviour in any of Jess' reports, and it never co-occurs with asynchronous social seeking-finding.

As figure 4.9d shows, Jess' social behaviour is predominantly collaborative.[173] Of the 12 seeking-finding reports including social behaviour, there are only 3 that do *not* include collaborative seeking-finding, and these all include asynchronous social seeking-finding. Social seeking-finding is the social behaviour least frequently reported by Jess, and it is reported only in conjunction with collaborative seeking-finding – Jess engages in social seeking-finding (she asks strangers for directions) *only* when she is in company and not on her own. In her exit interview, Jess commented that she prefers not to ask people for directions because it makes her feel vulnerable. We can only speculate on whether this may be urban/cultural bias,[174] or an effect of Jess being a single woman, or some other reason(s). This possible relationship between social behaviours and gender is discussed further in 8.2.2.

172 Only 11 participants because Mary's data is not included here; see 3.7.

173 Bearing in mind the likely positive bias in reporting collaborative seeking-finding in comparison with other behaviours, as discussed in 4.4.3.

174 Anecdotally people in London (or south-east England in general) are predisposed not to interact socially with strangers (see e.g. Micklethwaite 2016).

Task				Context			Social			Semantic					Spatial			
	Work	Domestic	Leisure	Environmental space	Paper document	On-screen	Collaborative seeking-finding	Social seeking-finding	Asynchronous social seeking-finding	Following fixed-location instructions	Following portable instructions	Using a portable overview	Using a fixed-location overview	Sequencing	Aiming	Using an allocentric frame	Screening	Using your cognitive model
Finding live coverage of a particular football match			●			●	●			●								
Finding the location of the closest branch of a chain of stores			●			●	●			●							●	
Finding a particular part of a park iin central London			●	●			●			●					●		●	
Helping a friend find a room to rent locally		●			●		●										●	●
Finding a nightclub in inner London	●		●	●			●			●					●			●
Finding a particular shopping location in inner London			●	●			●	●		●					●			●
Finding a particular shopping location in inner London			●	●			●	●		●					●			●
Finding live coverage of a particular football match			●			●	●		●	●							●	
Finding a room to rent locally for a friend		●				●	●		●						●		●	
Information gathering about local room rentals		●				●			●	●							●	
Finding out about what's on at an arts centre in central London	●		●			●			●	●		●					●	
Finding information about a person's work	●		●			●			●	●		●					●	
Finding a particular shop in inner London	●			●													●	●
Finding information about an entertainment event			●		●												●	●
Finding a particular shop in central London			●	●											●			●
Finding a particular location in greater London			●	●											●			●
Finding a particular location in greater London			●	●								●			●			●
Finding a friend's house in inner London			●	●								●			●		●	●
Finding a particular location in inner London			●	●								●			●		●	●
Finding a particular location in central London			●	●											●		●	●
Finding a particular location in inner London	●			●						●					●		●	●
Finding a particular location in inner London			●	●						●					●		●	●
Finding a particular shop in inner London			●	●						●	●				●		●	●
Finding information about an artist's work	●					●				●	●				●		●	●
Finding out about what's on in the local area in the coming weeks			●			●				●	●				●			
Finding information about a work opportunity	●					●				●					●			
Information seeking about a gift idea for a friend			●			●				●					●		●	

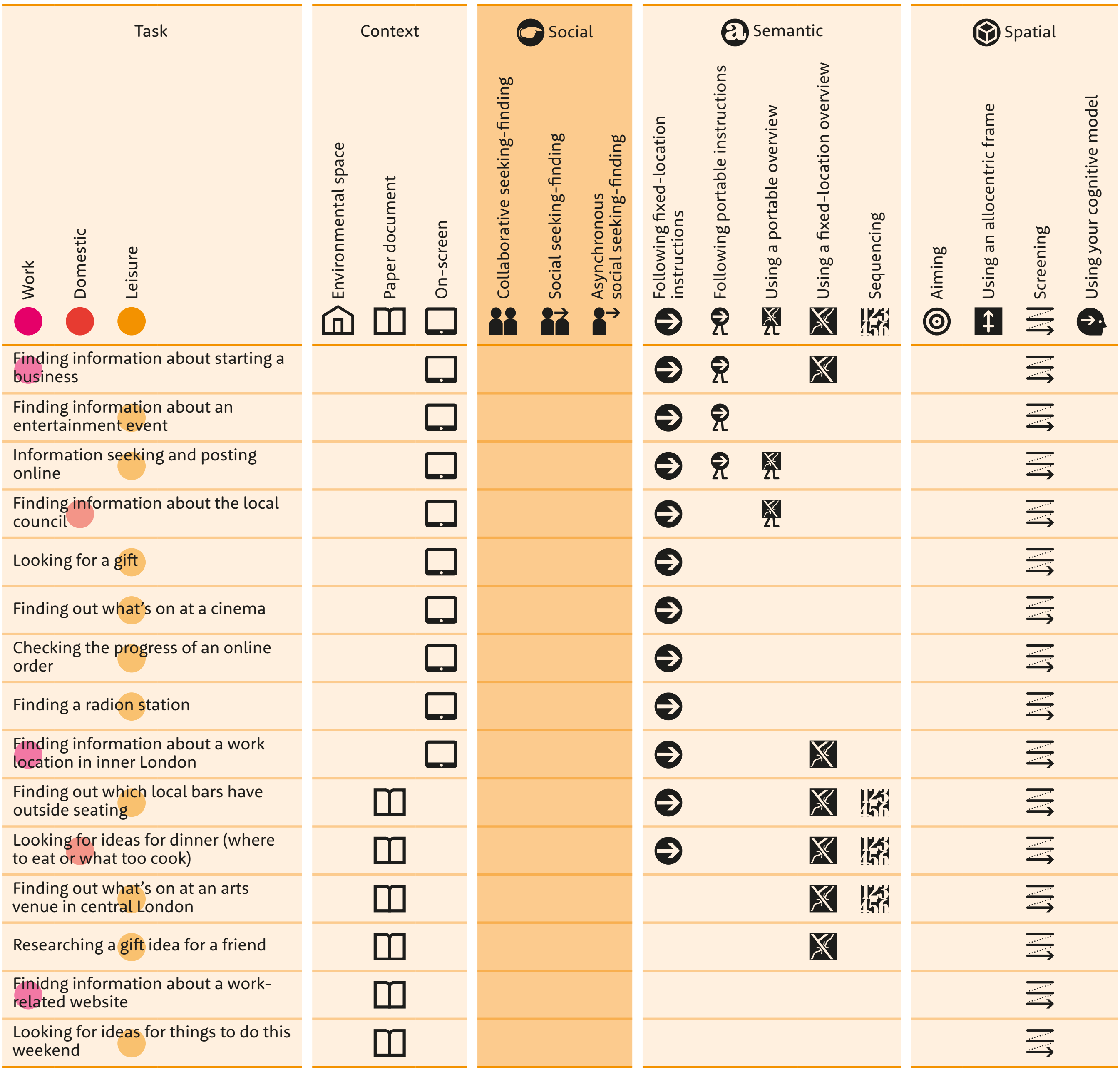


Figure 4.9d (above and facing): *each row shows the combination of behaviours in one of Jess' reports*

Figure 4.9e shows three rows extracted from figure 4.9d. They show an extended instance of social behaviours in which Jess is helping a friend find a room to rent locally. They engage in collaborative seeking-finding – both on-screen and in paper documents – in that they are co-present while seeking-finding. On-screen, Jess has bookmarked the web page on a previous visit, and so uses aiming to help her go straight to the page when her friend arrives. On-screen they also use asynchronous social seeking-finding in using links suggested by their browsing history. The paper document they use is a local newspaper and Jess and her friend look at it together. This is Jess' *only* report of social behaviours using a paper document.[175] Jess is familiar with the

175 Social behaviours when seeking-finding in paper documents is discussed in the case study in 4.11.

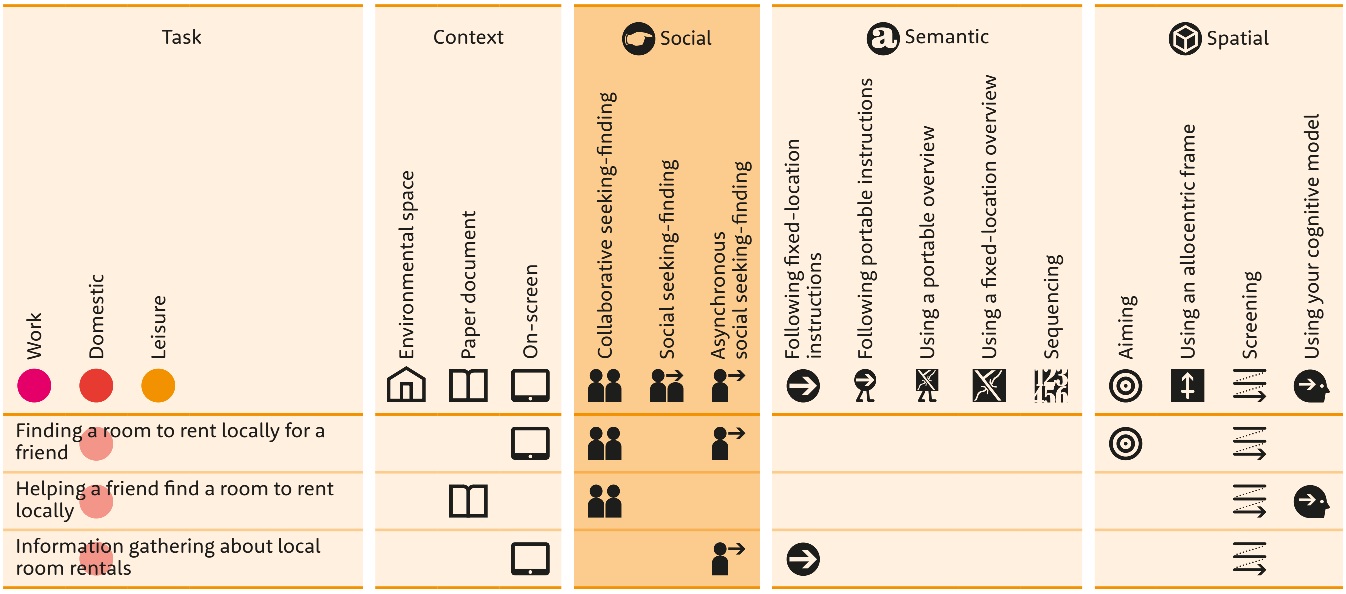


Figure 4.9e: *an extended instance of social behaviours from Jess' reports*

way the local paper is organised and is using her cognitive model to find the section they require. When her friend has left, Jess once again looks online at rooms to rent, and makes use of links suggested based on her browsing history (asynchronous social seeking-finding). Jess also bookmarks other relevant pages to show to her friend when she next visits. It is likely that this sequence of events leads to seeking-finding in environmental space when Jess or her friend (or both of them) goes out to look at rooms they have identified from their research online and in the newspaper. This is a good example of how seeking-finding behaviour in everyday life spills across all 3 contexts: it illustrates how the contexts are intertwined and how seeking-finding switches between contexts.

This also illustrates aspects of the behaviour examined by Pettigrew, Durrance, and Unruh (2002: 899) where individuals search online community information (CI) sources in order to find information for another person in their social group. They refer to these individuals as 'information gatherers' or 'monitors' and comment, 'In our study, these active CI seekers, who may be considered similar to information gatekeepers, relished time spent browsing and poking about the community network and the Internet. But their greatest satisfaction was when they found something they believed might be of interest to someone else, which they would quickly pass on, either by email or in person. Hence a distinguishing feature of these CI gatherers is that they are socially connected or active.'

4.9.3 / Social behaviours in relation to semantic and spatial behaviours

In relation to semantic behaviours

In Jess' reports, the range of categories of semantic behaviour that co-occur with social behaviours is highly constrained in comparison with the rest of her reports. Semantic behaviours occur in 10 of the 12 instances including social behaviours, and all of these instances include following fixed-location instructions. The only other semantic behaviour to co-occur with social behaviours is using a portable overview (which accompanies following fixed-location instructions in 2 of these reports). The rest of Jess' reports include the full range of categories of semantic behaviour. This suggests a negative relationship between social behaviours and semantic behaviours (in range of semantic behaviours, if not in quantity): when social behaviours appear in a seeking-finding report, the range of semantic behaviours is constrained. The data cannot reveal causality here – whether one factor influences the other or whether they are both influenced by some other factor.

In relation to spatial behaviours

There is no comparable relationship between social behaviours and spatial behaviours. Unlike semantic behaviours, all of the spatial behaviours that Jess reports co-occur with social behaviours. It is possible that aiming and using her cognitive model have a negative relationship with social behaviours, but it is only suggested and not strongly indicated by the data.

4.9.4 / Comparison of social behaviours across contexts

Jess reports collaborative seeking-finding in all contexts, but she only reports social seeking-finding in environmental space, and asynchronous social seeking-finding on-screen. The quantities involved are too small for any conclusions to be drawn, but the relationships between these categories of social behaviour and context that appear in Jess' reports are common to the entire group of participants. This is discussed further in 8.3.3.

4.10 / Case study: Fergus

Fergus is another of the participants in the diary study. At the time of research he is 28 years old, cohabiting and with children, educated to degree level, and working in the construction industry.

Fergus' approach to seeking-finding can be characterised as both fearless and social: he is happy to start with not much more than a rough plan, relying heavily on his cognitive model, trusting to opportunism and the willingness of other people to interact with him; and even when he does have a plan, he still chooses to interact socially with strangers.

4.10.1 / Overview of Fergus' data

Figure 4.10a shows Fergus relative to other participants in terms of the proportion of each participant's reports that come from each context (based on figure 3.7a with Fergus highlighted and all other participants greyed out).

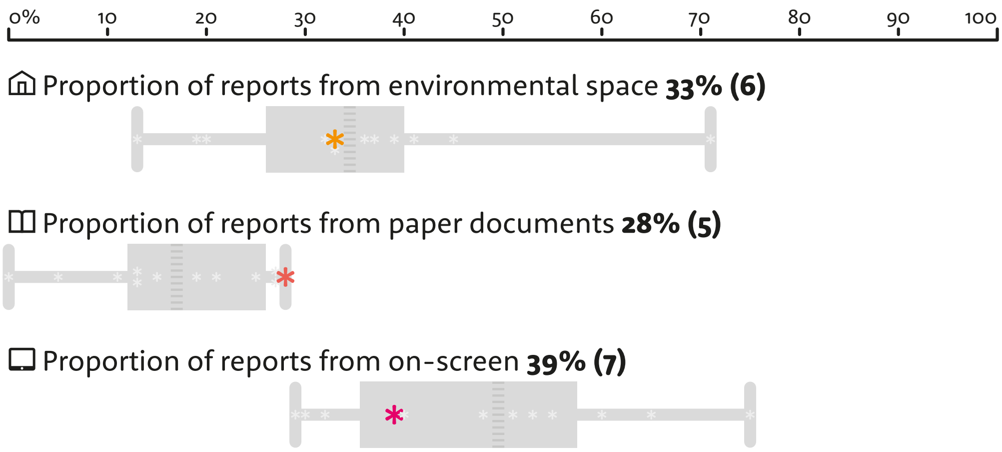


Figure 4.10a (based on 3.7a): *breakdown of Fergus' reports by context, in relation to other participants*

The proportion of Fergus' reports from environmental space is just below the median, meaning that 6 other participants include larger proportions of reports from environmental space. Even though reports from paper documents form a smaller proportion of his reports than those from the other contexts, Fergus is at the top of the range for this context, meaning that no other participant included a greater proportion of reports. And even though reports from on-screen make up the largest proportion of Fergus' reports, he is close to the bottom of the range, only 3 other participants submitted a smaller proportion of reports.

Figure 4.10b shows Fergus relative to other participants in terms of the proportion of each participant's reports that include social behaviours across all 3 contexts (based on figure 3.7h with Fergus highlighted and other data greyed out). Social behaviours occur in 56% of Fergus' reports (shown by the pink star). There is only 1 participant who includes social behaviours in a greater proportion of their reports.

The orange stars in figure 4.10b separate out the percentages of Fergus' reports that include each category of social behaviour (with contexts consolidated). For all 3 behaviours, he is above the median. For collaborative

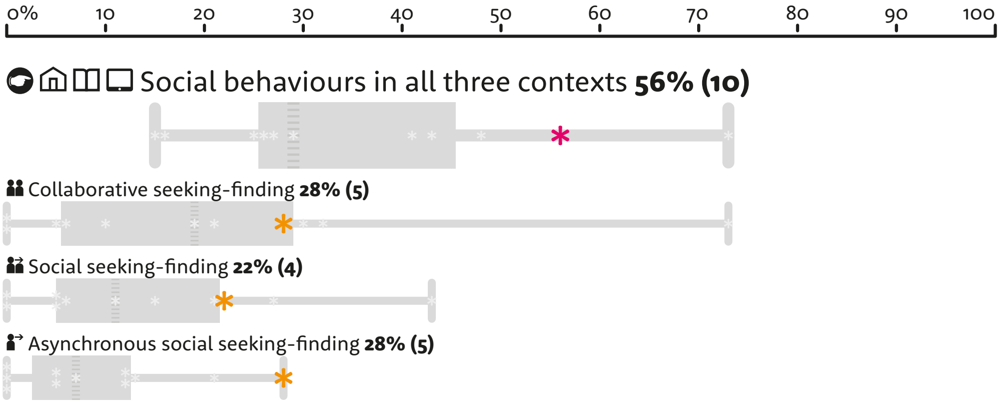


Figure 4.10b (based on figure 3.7h): *the proportions of Fergus' reports that include social behaviours across all contexts, in relation to other participants*

seeking-finding, he is in the quartile above the median, meaning that broadly he includes each category of social behaviour in more of his reports than is typical for the other participants. For social seeking-finding and asynchronous social seeking-finding, he is in the top quartile: he includes these behaviours in larger proportions of his reports than most other participants. For asynchronous social seeking-finding, he is at the top of the range even though the percentage of his reports is the same as that for collaborative seeking-finding (29%): he uses the traces of other people's actions in a greater proportion of his reports than any other participant.

Figure 4.10c shows Fergus relative to the other participants in terms of the proportion of each participant's reports that include social behaviours with the data broken down by context (based on figure 3.7k, with Fergus highlighted and other data greyed out). The pink stars show the percentages of Fergus' reports that contain social behaviours when separated into the 3 contexts. The percentages of his reports broken down by category of social behaviour and by context are shown as orange stars.

The proportions of Fergus' reports including social behaviours in environmental space and on-screen (67% and 71%) are higher than most other participants and put him in the top quartile for both: in both cases, there is only 1 participant who includes that behaviour in a greater proportion of their reports.[176] In paper documents, the percentage of his reports including social behaviours is low (20%), but because the majority of participants report less social behaviour in this context, he is still above the median; there are 3 participants who include social behaviours in larger proportions of their reports.

When broken down into individual categories of behaviour, Fergus' patterns of behaviour are different in each context. What they do have in

176 A different participant in each context.

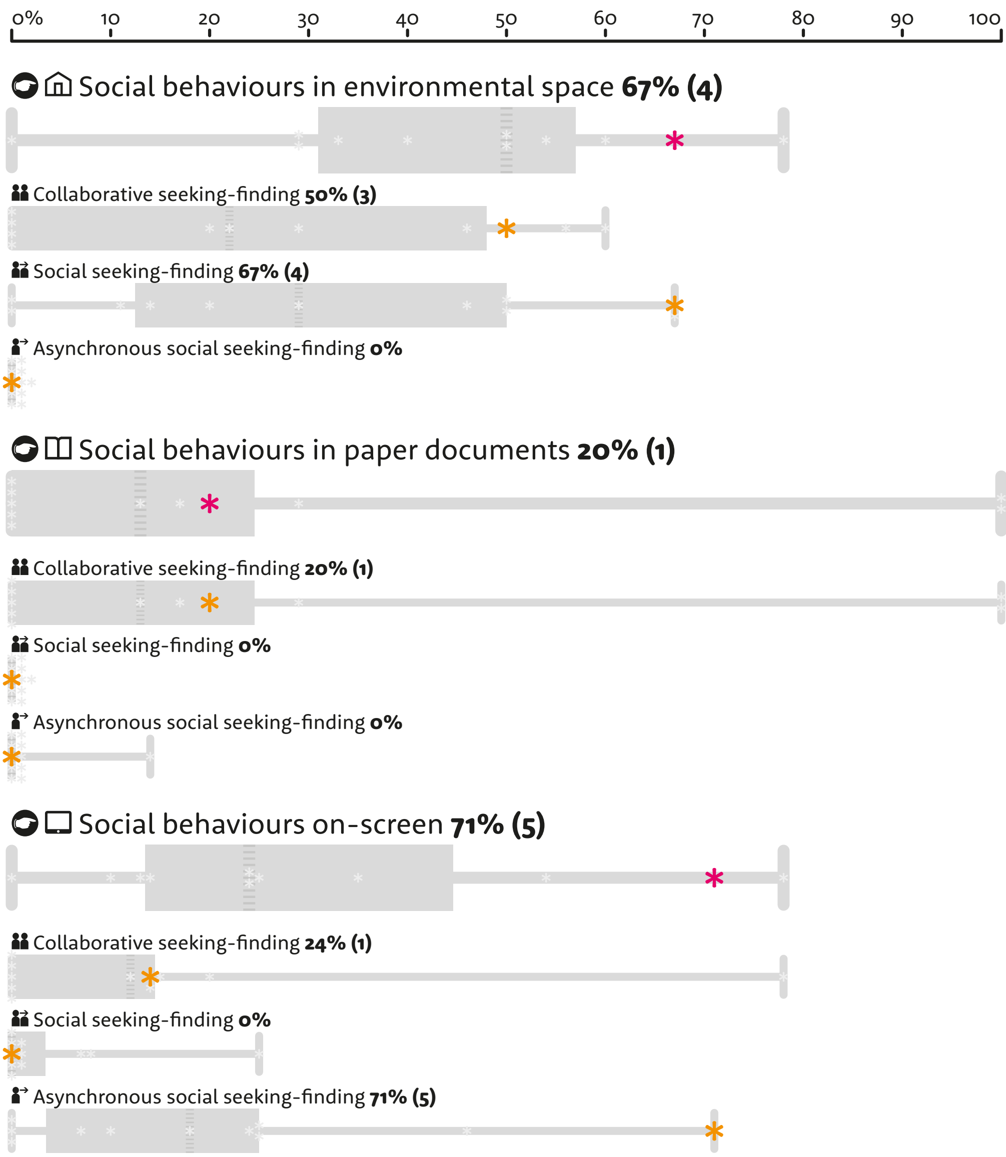


Figure 4.10c (based on figure 3.7k): *the proportions of Fergus' reports that include social behaviours, broken down by context, in relation to other participants*

common is that he reports some behaviours a lot (including them in a greater proportion of his reports than most other participants); and other behaviours are unreported (asynchronous social seeking-finding in environmental space; social seeking-finding and asynchronous social seeking-finding in paper documents; and social seeking-finding on-screen). The behaviours that he does not report are unreported by the majority of participants.

Particularly striking is that asynchronous social seeking-finding is unreported in environmental space and in paper documents, but heavily reported on-screen. It is true that this is the case with the majority of participants, but Fergus is a quantitatively extreme version of this pattern.

Additional information about Fergus' social behaviours comes from his briefing and exit interviews. In his briefing interview, Fergus described an instance of seeking-finding in environmental space. He is meeting friends in a pub in a part of London he has never visited before and does no overt route planning before setting out. Fergus starts his journey by going to his local Tube station and asking the staff for the best route to his destination. On reaching the Tube station to which they give him directions, he 'went to a taxi office and asked them for directions'. He goes on to say, 'I got lost once or twice and I had to ask a couple of people – I asked one person and I could tell he wasn't a hundred per cent sure what he was saying – so I asked somebody else – and they said, "no, it's that way" and I asked a couple more and they pointed me in the right direction.' This strategy of asking multiple people for directions to find a consensus is intriguing (but perhaps labour-intensive).

In his exit interview, Fergus says, 'I notice a lot of the time, even when I have a route for somewhere – maybe it's just for peace of mind – "Am I going the right way? Can you give me directions?" – And if I don't trust somebody I'll ask somebody else – Even if I've got the route on Citymapper I'll still ask someone.'[177]

These instances highlight Fergus' approach to seeking-finding in environmental space which might be characterised as both fearless and social: he will set off with not much more than a sketchy plan, relying more than any other participant on his cognitive model, trusting to opportunism and the willingness of people to give him directions; and even when he does have a plan, he still chooses to interact socially with strangers.

Figure 4.10d presents a different view of Fergus' behaviour. It shows his behaviour without the comparison of other participants. Each row shows a single report: detailing the task, context, and particular combination of behaviours used. This allows us to examine the combinations of behaviour in each report. The rows are ordered so that categories of social behaviour are grouped in order to give the clearest possible overview of groupings within social behaviours and to see if groupings also emerge elsewhere in the table.

Fergus returned 18 reports of seeking-finding behaviour, and 10 (56%) of these include social behaviours. This is a far smaller total number of reports than Jess, but a far larger proportion of his reports include social behaviour.

The issues emerging from Fergus' data form the rest of this case study.

177 https://citymapper.com/london/ accessed 22/12/2016.

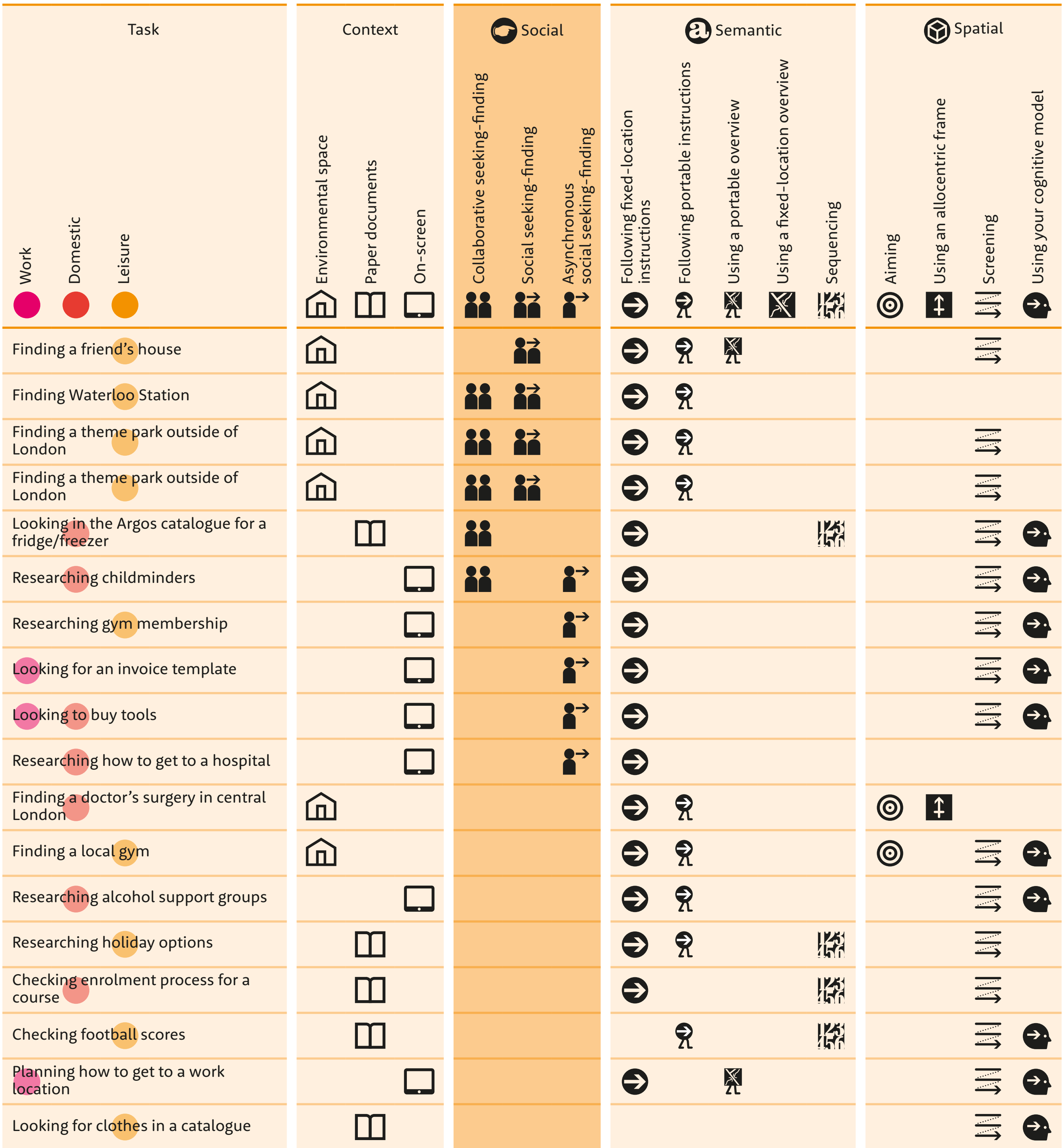


Figure 4.10d: *each row shows the combination of behaviours in one of Fergus' reports*

4.10.2 / Social behaviours in relation to each other

Fergus reports all three categories of social behaviour in almost equal amounts. This is not typical of the other participants who generally include them in more unequal proportions.

Fergus uses each of the 3 social behaviours as the *only* social behaviour in at least 1 report, but asynchronous social seeking-finding appears as the only social behaviour in a greater number of reports than either other social behaviour.

As with Jess, collaborative seeking-finding co-occurs with both other social behaviours, but the other 2 never co-occur.

4.10.3 / Social behaviours in relation to semantic and spatial behaviours

Looking at figure 4.10d, patterns of co-occurrence between social behaviours and semantic and spatial behaviours are not evident. The only suggestion of pattern is a negative relationship between asynchronous social seeking-finding and following portable instructions: of Fergus' 18 reports, there is no co-occurrence of these 2 behaviours, and only 4 reports that contain neither of them – the rest contain either one or the other. This is as likely to be a relationship with context as it is a relationship between behaviours: asynchronous social seeking-finding occurs on-screen, and following portable instructions occurs predominantly in environmental space.

4.10.4 / Comparison of social behaviours across contexts

Fergus' pattern of reporting social behaviours across contexts is the same as Jess': collaborative seeking-finding is the only social behaviour he reports in all three contexts; he only reports social seeking-finding in environmental space, and asynchronous social seeking-finding on-screen. This is largely the pattern with all participants in this study – see 8.3.3.

4.10.5 / Social seeking-finding

Unlike Jess, all of Fergus' social seeking-finding involves talking to strangers: in asking for directions, Fergus reports 2 instances of asking someone official and 2 instances of asking a member of the public. Fergus is also typically with others when he asks for directions, but unlike Jess there is an instance when he is on his own and asks for directions, and this is one of the times when he asks a member of the public rather than someone official. On this occasion he is on his way to a friend's house, and his seeking-finding behaviour has also included asking his friend to text him directions.

The single instance of following other people is in a report that also includes asking someone official, and on this occasion he is with other people making his way to a theme park.

4.10.6 / Social behaviours in planning beforehand

Fergus' responses also highlight another aspect of social behaviour: that of using it in *planning* seeking-finding activities. In one report, Fergus is going to visit a friend and texts that friend beforehand asking for directions, so the seeking-finding in environmental space is preceded by social behaviours on-screen. In the instance above that includes following other people, Fergus also comments, 'I had a fair idea [of how to get there] as friends had guided me.' He does not elaborate on the means of guiding that the friends used. Social behaviours in planning ahead are not specifically gathered in this research, but their presence is unsurprising: it shows the pervasiveness of social behaviours (despite being included in smaller proportions of reports than either semantic or spatial behviours) and suggests opportunities for further research.

Fergus is the participant to make *least* use of planning beforehand.[178] He also includes social behaviours in a greater proportion of his reports than almost all other participants. We might speculate that Fergus' planning ahead largely consists of deciding to ask the way as he goes rather than making a detailed plan. Because social behaviours are often opportunistic (see 4.5.1), one can only plan to use them but not exactly how and where one will do so.

4.11 / Case study: social behaviours in paper documents

This case study takes a different slice through the data from the diary keeping study to examine social behaviours in paper documents. As figure 3.7a shows, the proportion of seeking-finding in paper documents reported in the diary keeping is relatively small. Much seeking-finding in everyday life that formerly used paper documents now happens on-screen. This case study is motivated by the desire to examine the role of social activities in seeking-finding activities that still use paper documents.

4.11.1 / Overview of the data

Of the 46 reports including seeking-finding in paper documents, 10 include social behaviours. These reports are unevenly distributed among the 11 participants.[179] The participants of the diary keeping study fall into 3 broad groups in terms of their reporting of social behaviour in paper documents. This can be seen in figure 3.7k (the pink bar in the middle for social behaviours in paper documents): 5

178 See 3.8.5 for an overview of planning ahead data from the diary keeping study.
179 Only 11 participants because Mary's data is not included here; see 3.7.

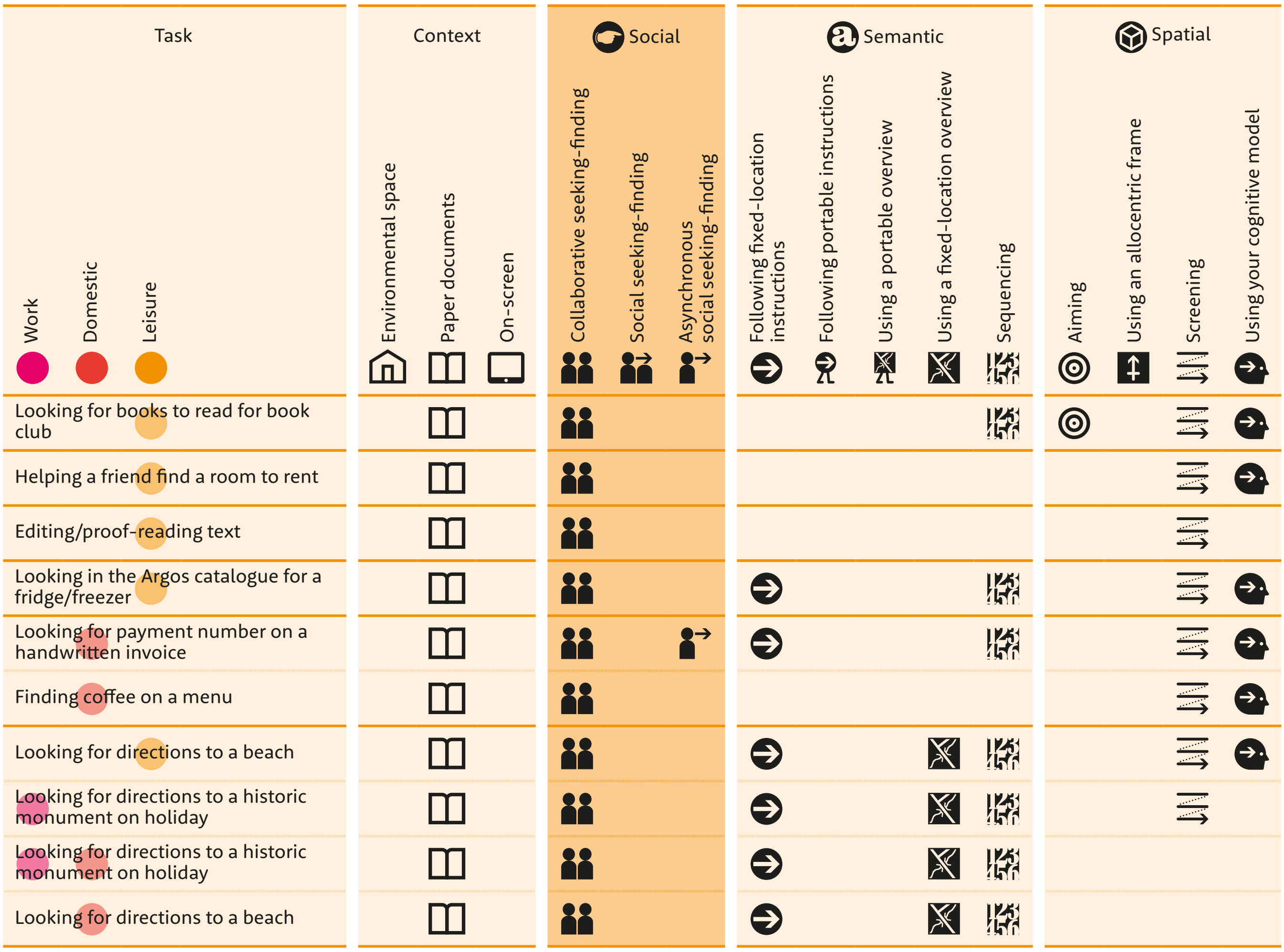


Figure 4.11a: *each row shows the combination of behaviours in one of the reports that includes social behaviour in paper documents*

participants report *no* social behaviours, 4 participants include social behaviours in 13–29% of their reports, and 2 participants include social behaviours in *all* of their reports. When seeking-finding in paper documents, the participants in this study use social behaviours either never, always, or occasionally, and these three groups are quantitatively distinct.

Figure 4.11a shows the 10 reports of seeking-finding in paper documents that involve social behaviours. Each row shows a single report: detailing the task, context, and particular combination of behaviours used in that report. This allows us to examine the combinations of behaviour in each report. Rows separated by dashed rules are from the same participant.

4.11.2 / Individual categories of social behaviour

All reports of social behaviours in paper documents include collaborative seeking-finding. In absolute quantities, there are more reports of this behaviour in environmental space or on-screen than in paper documents; nonetheless, it is by far the most reported social behaviour in paper documents. Other than including collaborative seeking-finding, a single report also includes asynchronous social seeking-finding, and *none* includes social seeking-finding.

The ubiquity of collaborative seeking-finding in these 10 reports means that any observations made in this case study about social behaviours in paper documents, largely refer to collaborative seeking-finding.

The absence of social seeking-finding is largely the result of the questionnaire for seeking-finding in paper documents offering only limited opportunities to report this behaviour.[180] It requires additional research to uncover the place of social seeking-finding within seeking-finding in paper documents.

4.11.3 / Social behaviours in paper documents in relation to semantic and spatial behaviours

In order to answer the question of whether social behaviours in paper documents co-occur with other seeking-finding behaviours in atypical proportions, we might compare these reports with (i) those from all participants in all contexts, (ii) those from all participants but only in paper documents, or (iii) those from all participants but only those containing reports of social behaviour (figure 4.11b shows all of these comparisons).

The quantities shown in figure 4.11b are percentages of reports. The numbers in the first column are the percentages (across all reports in all contexts) containing the behaviours listed down the left. These act as baseline percentages. The second column lists the percentages of reports containing those behaviours but with the sample reduced to only reports of paper documents; when compared with the first column, a higher number indicates that a behaviour is more likely than usual to be reported in paper documents (and a lower number indicates a behaviour that is less likely to be reported in a paper document). The third column lists percentages of reports containing the behaviours but with the sample reduced to only those reports that also include social behaviours; when compared with the first column, a higher number indicates that the behaviour is more likely than usual to co-occur with social behaviours (and a lower number indicates a behaviour that is less likely to co-occur with social behaviours). The fourth column lists percentages of reports containing the behaviours listed on the left but with the sample reduced to only those reports from paper documents that also include social behaviours (i.e. the 10 reports in figure 4.11a); when compared with the first column, a higher number indicates that the behaviour is more likely than usual to co-occur with social behaviours in paper documents (and a lower number

180 See 4.5.2.

indicates a behaviour that is less likely to co-occur with social behaviours in paper documents). Comparison with the quantities in the second and third columns allows us to check whether percentages in this last column are artefacts of being in paper documents or social behaviours in general rather than specifically social behaviours in paper documents.

	Reports from all participants and all contexts (n=299)	Reports from all participants but only in paper documents (n=51)	Reports from all participants but only containing social behaviour (n=90)	Only reports containing social behaviours in paper documents (n=10)
Following fixed-location instructions	74	47	56	60
Following portable instructions	38	8	39	0
Using a portable overview	20	0	22	0
Using a fixed-location overview	17	37	17	40
Sequencing	19	61	18	70
Aiming	28	11	33	10
Using an allocentric frame	1	0	0	0
Screening	80	96	79	80
Using your cognitive model	29	37	28	60

Figure 4.11b: *tabulated comparison of proportions of reports in certain subsamples of the full group of reports in order to examine co-occurrence*

Comparing all three of the above, a number of behaviours emerge as having relationships with context; none emerges as having a relationship with social behaviours in general. Using your cognitive model is the only behaviour to have a relationship with using social behaviours in paper documents. It is considerably more likely to be reported in conjunction with social behaviours in paper documents than to be reported in conjunction with social behaviours across all contexts, or in general in paper documents, or in general across all reports in this study.[181]

When reported in conjunction with social behaviours in paper documents, these are how using your cognitive model is reported:

- Frances is using the *Observer* and *Guardian* newspapers to look for books to read for her book club (using her direct cognitive model gained from previous occasions to help her find the book reviews).
- Jess is using a local newspaper to help her friend find a room to rent (using her direct cognitive model gained from previous occasions to help her find the listings of rooms to rent).
- Fergus is looking in the Argos catalogue for a new fridge/freezer (using his theoretical cognitive model to guess that the catalogue would have an index at the back).
- Alex is looking for coffee on a menu (using his theoretical cognitive model to guess that 'drinks are usually on the backs of menus').
- Alex is looking for the payment number on a handwritten invoice (using his theoretical cognitive model to guess that 'payment usually located on the top of the page').
- Lily is looking in a guidebook for directions to a beach (using her direct cognitive model: 'we looked in the section we knew from before (looked up a separate beach a few days beforehand)').

They are using a wide range of types of documents, and there is nothing that readily characterises this selection of reports. They are evenly divided between direct and theoretical cognitive models, with no indirect cognitive models. Lily makes the largest number of reports of social seeking-finding in paper documents, but 3 of her 4 reports shown here do not include using her cognitive model and that is the majority of reports that do not include this behaviour (there is only 1 other participant who makes a report of social seeking-finding in paper documents that does not include using her cognitive model).

4.11.4 / Social behaviours in relation to task

The tasks reported are predominantly leisure activities; there are also work and domestic business activities, but these are in the minority. Although, when viewed simply per participant, the bias towards leisure is less apparent: 2 participants use social behaviours in seeking-finding for work, 2 for domestic business, and 3 for leisure.

181 This latter sample (of social behaviours in paper documents) is sufficiently small to suggest caution in using it as the basis for anything more than tentative conclusions.

5 / Semantic behaviours

'Man's achievement rests upon the use of symbols.'
(Alfred Korzybski)[182]

5.1 / Introduction

This section introduces the group of seeking-finding behaviours that are identified as semantic. It is one of 3 groups that together encompass all types of seeking-finding behaviour, and are introduced in section 3 (social and spatial groups are discussed in sections 4 and 6).

This section starts by describing the factors that identify behaviours as semantic and considers some other factors germane to semantic behaviours. It is followed by discussions of each category of semantic behaviour: definition and examples, how the behaviour is coded from the user research, and the current taxonomy in relation to comparable taxonomies. Following this is a presentation of semantic behaviour data from the three user studies.

This section ends with 5 case studies: 2 that examine particular categories of behaviour in the task observation (5.13–5.14), and 3 that examine individual participants in the diary keeping (5.15–5.17). These participants – Alison, Tanveer, and Mike – are selected because each illuminates different aspects of semantic behaviour in seeking-finding.

The picture that emerges of semantic behaviour is one of considerable inter-individual difference.

The relationship between social, semantic, and spatial behaviours is discussed in section 7. And semantic behaviours in relation to other factors involved in seeking-finding behaviour are discussed in section 8.

182 Quoted in Morville (2005: 119)

5.2 / What distinguishes semantic behaviours?

Broadly speaking, semantic behaviours are symbol-driven: they rely on using information that meaningfully represents things, their conceptual organisation, and their interrelation. Their representation typically uses symbol systems (such as words, numbers, letters, or pictograms).

Each category of behaviour in this group uses symbols in 1 of 3 ways: (i) representing a series of actions, (ii) representing the affordances of a space, or (iii) in a fixed and known ordinal sequence with the objective associated with one symbol in that sequence.[183]

It may be helpful to reiterate the point made in 2.7 that all seeking-finding behaviours have social, semantic, and spatial aspects, but each behaviour is put into one group depending on which aspect predominates. Two illustrations of the fuzziness of these groupings: first, meaning is conveyed not only by symbols themselves, but also by their spatial configuration (Fathulla 2008; Tversky 2000); even the practice of putting space between written words is a use of space to organise semantically meaningful groupings of symbols (Tversky 2000). And secondly, in a symbolic representation of a space, which should take priority: the space or the symbol system? The priority of the semantic aspect becomes clear when one considers that symbolic representations of space can include things such as contents lists in which the spatiality is highly schematic.

5.3 / Behaviours in the semantic group

The group of semantic behaviours comprises 5 categories:

- Following fixed-location instructions
- Following portable instructions
- Using a portable overview
- Using a fixed-location overview
- Sequencing

The place of these behaviours within the taxonomy is shown in figure 5.3a.

183 Without wanting to over-complicate matters, it could be argued that the third way uses a sequence of symbols applied to a sequence of locations in the space, and so could be regarded as simply further instances of representing the affordances of the space.

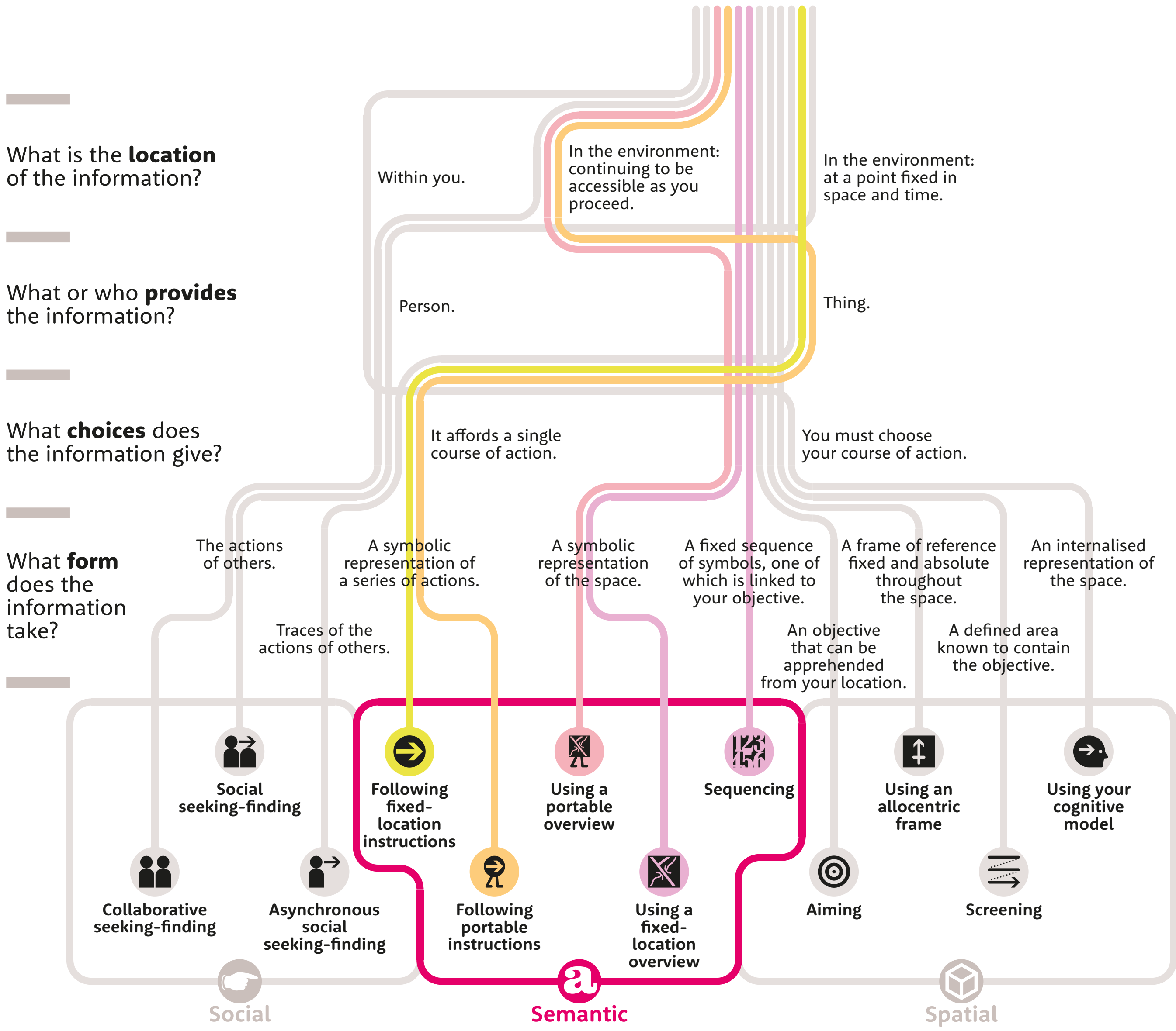


Figure 5.3a: *the place of semantic behaviours within the taxonomy*

5.4 / Maps: instructions and overviews, portable and fixed-location

Apart from sequencing, all categories of behaviour in this group include the use of broadly map-like artefacts as information sources. These are differentiated according to whether they offer instruction or overview, and whether they count as fixed-location or portable.

Following a route marked on a map counts as **following instructions**, because it presents a single course of action. If the map does not have your route marked on it (or if you choose to *not* follow the route marked) and so you plan the route yourself, it counts as **using an overview**, because you must choose your course of action based on the choices presented.

How choices are presented in an overview is critical to the efficacy of that overview, but the literature survey finds few explicit discussions of the topic in either practice or research literature. The practice-based discussions in Norman (2008) and Kalbach (2007) (both relating to on-screen spaces) are exceptions.

The distinction between instructions and overviews mirrors those between route knowledge and survey knowledge that are widely used in research into spatial cognition in environmental space.[184] Route knowledge is the knowledge of single linear routes – such as is created from following instructions. On the other hand, survey knowledge is the understanding of how an environment is configured, possibly containing multiple routes – such as is created from an overview of that environment.

The distinction between **portable** and **fixed-location** information sources is discussed in 2.12. For maps (whether being used as instructions or overviews) it is typically self-evident whether they are portable or fixed-location. Other sources of information are not so readily separated along these lines but – as specified in the definitions of these categories of behaviour – fixed-location information is at a point fixed in space and time within the environment and portable information continues to be available to you as you proceed with your seeking-finding. These definitions can be more helpful than the terms 'fixed-location' and 'portable'.

Discussions of map use in both research and practice literature are not always explicit about whether they refer to maps with or without routes marked on them and whether they discuss portable or fixed-location maps (possibly because they believe their comments to be applicable to more than one of these four categories), and this can be problematic in terms of knowing how to situate the discussions within my taxonomy. Explorations of map use are split across four categories of behaviour in the taxonomy: this may seem fragmentary but it is the consequence of closely related information artefacts (all commonly referred to as 'maps') affording different categories of behaviour. The taxonomy allows different types of map use to be categorised with other behaviours in other contexts with which they are comparable – thereby affording different insights.

184 E.g. Chang (2013); Lawton (1994); Siegel and White (1975).

5.5 / Cognitive load

The concepts of cognitive load and cognitive economy are introduced in 1.3.6. Instructions theoretically impose a smaller cognitive load than overviews because they do not require you to make decisions (you simply follow the instructions). And portable information theoretically imposes a smaller load than fixed-location information because you can take the information with you as you proceed.[185] By this logic, and all other things being equal, of the four categories of following instructions and using overviews (whether fixed-location or portable), following portable instructions imposes the smallest cognitive load and using a fixed-location overview imposes the greatest.

According to principles of cognitive economy, one factor that will influence choice of information source is the cognitive load it imposes. This suggests, based on the reasoning above, that following portable instructions will be more readily chosen than using a fixed-location overview. As we have seen in 2.3.1, there are many possible factors influencing behaviour: isolating any single one is not straightforward when examining data from observational studies in everyday life, and so this hypothesis is difficult to verify from the user studies conducted for this thesis. Support for this hypothesis comes from studies in environmental space,[186] but some studies in on-screen contexts do not support this hypothesis.[187]

The only item of practice literature surveyed that explicitly considers cognitive load is Schriver (1997) discussing paper documents. She advises keeping the user's cognitive load as light as possible (p.279) and reducing number of processing steps (p.281) in order to reduce the burden during comprehension.

5.6 / A question about materials

One issue rarely discussed in studies of semantic behaviours in seeking-finding is the design of test materials (maps, signs, etc.). Often when researchers compare performance of different types of artefact (for instance using a map

185 A claim also made in practice literature: Smitshuijzen (2007: 105); Berger (2005: 28–29).
186 Waters and Winter (2011); Huang and Gartner (2010); Hölscher, Büchner, et al. (2007); Münzer, Zimmer, et al. (2006); Butler, Acquino, et al. (1993).
187 E.g. Seufert and Brünken (2006). However their research involved hyperlink use (following fixed-location instructions) and their results may be explained by taking into account the impact on performance of the explicitness and informativeness (or otherwise) in hyperlink wording (see Wojdynski and Kalyanaraman 2016; Spyridakis, Mobrand, et al. 2007). Further discussions of cognitive load and cognitive economy in seeking-finding on-screen are in Fitzsimmons (2016); Cuddihy and Spyridakis (2012); Vörös, Rouet, and Pléh (2009); DeStefano and LeFevre (2007); Bunch and Lloyd (2006); Gray, Sims, et al. (2006); Seufert and Brünken (2006); McDonald and Stevenson (1996); Dee-Lucas and Larkin (1995).

and using signs), we cannot be sure whether differences in performance are a consequence of the type of artefact *per se* or are due to one artefact being simply a better designed example of its type. By which I mean, taking a hypothetical scenario, if a study finds that signs lead to more effective seeking-finding behaviour than maps, can we be sure that they are not comparing particularly well-designed signs with exceptionally poor maps? We have to assume that the quality of the test materials is consistent, although this variable is rarely discussed.[188]

5.7 / Following fixed-location instructions

5.7.1 / Definition and examples

The carrier of the information is a thing rather than a person; the information takes the form of symbols representing a series of actions; and it is at a point fixed in space and time within the environment. The information presents a single course of action.

Examples:

- Following a direction sign that names your destination and points the way to it.
- Using a map that is fixed to a wall, that identifies your current location and your destination, and marks a route between these points.
- Using a set of written directions in a notice fixed to a wall that describe a route to your destination.
- Using cues implicit within the environment (such as the presence of a door to afford the existence of and the possibility to enter an adjacent space).
- Using the index in a book to find the information you seek in that book.
- Using a cross-reference to find further information about the topic you're researching elsewhere in the same book.
- Clicking a hyperlink in text on a web page in order to get to another page.
- Using a website's site map in the form of an alphabetical index to find the page containing the information you seek.
- Using an internet-wide search, such as Google.
- Using a search system within an intranet.

A large class of information across all 3 contexts, whose use is classed as following fixed-location instructions, is that which is implicit within the structure of the environment. This is most easily illustrated in environmental

188 The limited number of studies that raise this issue includes Westendorp, Wever, and Mijksenaar (2004) and Kaplan (1976: 54).

space where, as described above, the visible presence of a door can signal that there is an adjacent space and that we can enter it here. Similarly the visible presence of a staircase signals (i) that there is at least one more floor to the building, (ii) whether it is above or below, and (iii) that we can access it at this point. Such information sources largely count as fixed-location instructions, but they can also afford aiming (although principally at a smaller scale of behaviour than is considered in this thesis). It is perhaps contentious for information implicit in an environment to be regarded as a semantic (rather than spatial) information source but, without wanting to stray too far into semiotics, the environment is signifying – and the user is interpreting – meaningful information about how it can be used. Furthermore, with this information whose use counts as following fixed-location instructions, the particular information (in the form of environmental affordance) is localised, whereas spatial behaviours use information more widely accessible throughout the space.

Route diagrams are commonly used to explain public transport networks. Instances showing a single route – sometimes referred to as 'thermometer diagrams' if they form a straight line (Campbell 2000) – are classed as *instructions* in this taxonomy. They are in the current category if they are *fixed-location*, otherwise they are classed as following portable instructions. If more than one route is shown, requiring the individual to make a decision about the path they follow, route diagrams are classed as *overviews*. These differences are discussed in Avelar and Hurni (2006).

In paper documents and on-screen contexts, index use (a form of following fixed-location instructions) contains smaller-scale sequencing. This occurs in using ordering principles (for instance, alphabetical) to find items within the index. In paper documents, this is followed by further sequencing as you use the page numbers within the document to find the page whose number you were given by the index. And on-screen, it is followed typically by following fixed-location instructions as you click on a hyperlink to take you from the index to the relevant page (or by following portable instructions if the hyperlink causes the new page to open in a new tab or window).

In paper documents, using a cross-reference counts as following instructions, and may be classed as fixed-location or portable depending on the circumstances of use. If the cross-reference directs you to another page in the same document, it is classed as following fixed-location instructions because you must leave the instruction behind in order to proceed towards your objective. The same is true if, for instance, the cross-reference is in a book that you do not intend to buy in a bookshop (again, you cannot take it with you). On the other hand, it is classed as following portable instructions most typically if the cross-reference directs you to a different document and you take the document containing the cross-reference with you as you seek the reference (so the instruction remains accessible to you as you proceed). It also counts as following portable instructions if the cross-reference is to the same document, but the cross-reference remains accessible to you as you proceed because (i) it is on a bookmark or fold-out flap; (ii) the document is loose-leaf and you take out the page with the cross-reference in order to refer to it as you track down the reference; (iii) the document is bound but you choose to tear out the page with the cross-reference in order to be able to refer to it as you proceed; and (iv) you make a note of the cross-reference on a separate piece of paper so you can refer to it as you track down the reference.

On-screen, using a cross-reference in text in the form of a hyperlink counts as instruction following. And this is classed as following fixed-location instructions if clicking on the link opens the new page in the same tab or window thereby leaving the old page. If clicking on the link opens the new page in a new tab or window, then it counts as following portable instructions because you still have access to the original page with the cross-reference.

On-screen, hyperlink use can be examined at the smaller scale of a move as well as a tactic, but this taxonomy takes a slightly less tightly focused view of the actions involved in using a hyperlink and examines them at the scale of tactics.[189]

5.7.2 / How this behaviour is captured in the user research

In the **task observation**, this behaviour is coded in response to observing the participant using the index, or using a cross-reference within the text.

In the questionnaires used in the **wayfinding survey** and the **diary keeping**, this behaviour is coded from the following responses to the questions on pages 2–3.

In environmental space:

- 'I used direction signs (signs that point the way to a named destination)'
- 'I followed spoken announcements (such as those from a satnav or on public transport)' if other data on the questionnaire makes it clear that this is on public transport (such as the form of transport question on page 4). For the purposes of this discussion, the announcement is regarded as being fixed-location (even if it is on a moving bus for instance) because the individual cannot replay the announcement at will, or take it with them when they leave the transport. On the other hand, if the spoken instructions are from a satnav device,[190] they are classed as following portable instructions (see 5.8).

189 See 1.2.4 for a discussion of 'moves', 'tactics', 'strategies', and 'patterns' – four scales of behaviour based on Marchionini (1995: 71–74).

190 For the purposes of this discussion, we are assuming that the satnav is in the possession of the

- ‘I checked a map that was fixed to a wall or similar’
  + checking *yes* to the question ‘if you used a map, did it have your route marked on it?’

In paper documents:

- ‘I looked up something in the index’
- ‘I used cross-references or page references’

On-screen:

- ‘I clicked on a link in text’
- ‘I clicked on a “next” link’
- ‘I used an internet-wide search (such as Google)’
- ‘I used a search within the site/app’

5.7.3 / Following fixed-location instructions in other taxonomies

Within the taxonomies surveyed from practice literature, in **environmental space** this category of behaviour is largely comparable with ‘route following’: the second seeking-finding strategy proposed by Mollerup (2005: 48–49): he describes the information as ‘instruction’ and observes that ‘in route following we get the information off-location and store it internally in the mind’. Mollerup’s category also includes storing such information on a piece of paper to be consulted en route, which the current taxonomy classes as following portable instructions because the information continues to be available to you as you proceed. Mollerup places emphasis on the information source being off-route, whereas the current taxonomy’s priority is that the information is at a point fixed in space and time. But what both have in common is that the information source does not proceed with you.

It is also comparable with the third strategy in Weisman (1987: 444–445) in which ‘signs … clarify choices where decisions must be made’. Again, the point is that the information source is at a point fixed in space and time. Weisman includes landmarks in this category, but this is not indicative of him including aiming here.[191] Rather that he is including orientation behaviours, as is made explicit in ‘landmarks along with explicit or “manifest” signs can assist in the determination of both present location [i.e. orientation] and the next subgoal or destination [i.e. seeking-finding]’.[192]

In research literature on environmental space, this behaviour category covers part of the area defined by the ‘direct access’ tactic in both ‘linear’ and

individual doing the seeking-finding, and not the satnav of another person which they happen to fortuitously overhear.

191 The first of Weisman’s four strategies is comparable with aiming – see 6.4.3.

192 Orientation is out of scope of this thesis – see 1.2.1 – but other discussions may include orientation alongside seeking-finding.

'spatial' styles in Passini (1981). When used in the 'linear' style, the 'direct access' tactic also covers following portable instructions and sequencing; and when used in the 'spatial' style, it also covers following portable instructions, using a portable overview, using a fixed-location overview, aiming, and using an allocentric frame.[193]

This survey of research and practice literature finds no comparable taxonomies dealing with **paper documents**.

Within taxonomies surveyed from research literature, in **on-screen** following fixed-location instructions is comparable with 6 of the search moves that Cromley and Azevedo (2008: 289–299) identify: 'using the "find in article" feature', 'using the "find in encyclopedia" feature to search for a phrase', 'clicking on a hyperlink', 'using the "find in encyclopedia" feature to search for an article title', 'clicking on a link to a different media type', and 'clicking on a link to a related article'. And within practice literature, 6 of the 'mechanisms of navigation' in Kalbach (2007: 54–82) count as following fixed-location instructions for on-screen:

- 'Step navigation' (pp.55–56) and 'paging navigation' (pp.56–59) both present links whose destinations are relative to the page on view.
- 'A–Z indexes' (pp.67–69) function much like indexes in paper documents (except that their clickable links eliminate the need for this behaviour to be followed by sequencing).
- 'Dynamic menus' (pp.73–75) and 'drop-down menus' (pp.75–76) have a pull-down/pop-up dynamic classing them as fixed-location clickable links but whose content offers no useful overview of the space.
- Some 'browser mechanisms' (pp.79–80) are included within this category: '*session history*' and '*browser history*' are classed as following fixed-location instructions if they present themselves as a drop-down/pop-up list (however, if they open in a separate window, they count as following portable instructions).

5.8 / Following portable instructions

5.8.1 / Definition and examples

The carrier of the information is a thing rather than a person; the information takes the form of symbols representing a series of actions; and it continues to be accessible to you as you proceed with your seeking-finding. The information presents a single course of action.

193 See 2.4 and 2.10 for more detail of Passini's taxonomy and how it corresponds to mine.

Examples:

- Finding your destination by following a set of written directions or a route diagram that you carry with you (on a piece of paper or on a mobile device).
- 'Follow the yellow brick road!' (from *The Wizard of Oz*).
- Following a line painted on the floor of a hospital that takes you to the department you require.
- Finding a particular piece of information in a book by using a cross-reference in a different document.
- Following the row of leader dots in a contents list that link the section title to the page number.
- Identifying an element in a diagram by following the leader line connecting it to a piece of annotation.
- Using the breadcrumb trail on a website to find a page that you have previously passed through.
- Finding a particular element of functionality within a software application by following instructions on a website that you refer back to while on task.
- Using the back arrow on a web browser to return to the previous page.

Route diagrams – as used to explain public transport networks in environmental space – that show a single route are included in this category if they are portable, but are discussed in 5.7 alongside their fixed-location counterparts.[194]

In paper documents, and on-screen, leader lines and the like rarely extend beyond a single page. This means that they typically start and end within a single field of view and in this sense are unlike tracks marked by lines in environmental space. This makes using these lines somewhat small-scale both in environmental and behavioural terms.[195] However, they are included here because they can form a step in a series of seeking-finding actions in which the final objective cannot be directly apprehended at the start point.

In paper documents, and on-screen, using a cross-reference counts as following instructions, and these may be classed as following portable instructions or following fixed-location instructions depending on the particular circumstances of their use. This is discussed in 5.7.1.

In on-screen, the use of the 'back' button counts as following portable instructions because it is part of the browser's interface infrastructure and is available irrespective of the page displayed by the browser.

In on-screen, 'breadcrumb trails' typically comprise a string of (i) the names of the sequence of pages that user has passed through on their way to their

194 Route diagrams that show multiple routes count as overviews because they require the user to make a choice about which route to follow. See 5.9.
195 See 1.2.3.

current location, (ii) the names of the sequence of pages that mark the path from the current location back up the hierarchy to the home page, or (iii) the names of a sequence of pages that identify position within the metadata. In all cases the names are customarily hyperlinks to those destinations. Using these counts as following portable instructions because they are part of the site's navigation infrastructure and are accessible irrespective of the page displayed (and they count as instructions because the view they offer of site organisation shows a single route and affords no choice of path).[196]

Other than using the 'back' button or 'breadcrumb trails', there are few behaviours that count as following portable instructions on-screen. Most count as either following fixed-location instructions (for instance, using a hyperlink in the body of a particular page that opens a new page in the same tab or window, and hence the original link does not continue to be accessible once you have clicked on it), or using a portable overview (for instance, using a hyperlink in the infrastructure of a website, grouped and organised in such a way as to afford an overview of the contents of the site).

5.8.2 / How this behaviour is captured in the user research

In the **task observation**, the test materials contain no suitable apparatus to support this behaviour and so it is not coded.

In the questionnaires used in the **wayfinding survey** and the **diary keeping**, this behaviour is coded from the following responses to the questions on pages 2–3.

In environmental space:

- 'I followed spoken announcements (such as those from a satnav or on public transport)' if other data on the questionnaire makes it clear that this was in a private mode of transport (such as the form of transport question on page 4). The spoken instructions from a satnav type of device are taken to form an ongoing narrative (a track) that extends across space and time as the individual travels and so are classed as following portable instructions.[197] On the other hand, if the spoken announcement is on public transport, it is regarded as following fixed-location instructions (see 5.7).
- 'I followed a line marked on a wall, floor, or similar'
- 'I used a set of written-down directions'

196 A 'breadcrumb trail' is a metaphor from environmental space; see 1.5 for a discussion of metaphor in seeking-finding.
197 See note 190.

- 'I used a map on paper that I carried with me'
  + checking *yes* to the question 'if you used a map, did it have your route marked on it?'
- 'I used a map on my phone (or similar digital device)'
  + checking *yes* to the question 'if you used a map, did it have your route marked on it?'

In paper documents:

- 'I followed a line marked on the page(s) that connected one element with another'

On-screen:

- 'I used the back arrow'
- 'I followed a set of instructions I'd been given'

5.8.3 / Following portable instructions other taxonomies

Within the taxonomies surveyed from practice literature, in **environmental space** this category of behaviour is largely comparable with 'track following': the first seeking-finding strategy proposed by Mollerup (2005: 44–47). Mollerup notes coloured lines on the floor affording this behaviour, and he refers to Ariadne's thread and to breadcrumb trails on-screen. His category also includes directional signs on the premise that these signs collectively denote a track as one passes from one sign to the next; however, the current taxonomy classes using directional signs as following fixed-location instructions because each sign is at a point fixed in space and time and cannot proceed with you (and as unfortunate experience may show, the presence of one sign pointing to a destination is no guarantee that there will be such signs at all subsequent decision points).

It is also comparable with the second strategy in Weisman (1987: 444): 'follow a trail or pathway that leads to the goal'. Weisman goes on to point out that 'experience suggests that this seemingly simple approach to way-finding quickly grows in complexity and diminishes in effectiveness as it attempts to deal with branching paths, crossings, and changes in level'.

In research literature on environmental space, this category covers part of the area defined by the 'direct access' tactic in both 'linear' and 'spatial' styles in Passini (1981). When used in the 'linear' style, the 'direct access' tactic also covers following fixed-location instructions and sequencing; and when used in the 'spatial' style, it also covers following fixed-location instructions, using a portable overview, using a fixed-location overview, aiming, and using an allocentric frame.[198]

198 See 2.4 and 2.10 for more detail of Passini's taxonomy and how it corresponds to mine.

This survey of research and practice literature finds no comparable taxonomies dealing with **paper documents**.

Within taxonomies surveyed from research literature, in **on-screen**, following portable instructions is comparable with 1 of the 11 search moves in Cromley and Azevedo (2008: 289–299): 'using the back arrow'. And within practice literature, this category of behaviour is comparable with 2 of the 'mechanisms of navigation' in Kalbach (2007: 54–82):

- A 'breadcrumb trail' may show either the sequence of pages previously visited within the site (*path* breadcrumb trail); the route from the current page back up through the hierarchy to a home page (*location* breadcrumb trail); or some sort of position within a metadata hierarchy (*attribute* breadcrumb trail).
- Some 'browser mechanisms' (pp.79–80) are included in this category: *back button*, *forward button*, and *URL* present links that are part of the browser infrastructure and consistently available whichever page the person is actually viewing using that browser; they are always counted in this category. Of the back button, Kalbach (2007: 79) comments that 'it is perhaps one of the most frequently performed actions while navigating the web'. The other two browser mechanisms – *session history* and *browser history* – count as following portable instructions if they open in a separate window and do not present an overview (however, if they present themselves as a drop-down/pop-up list they count as using fixed-location instructions).

5.9 / Using a portable overview

5.9.1 / Definition and examples

The carrier of the information is a thing rather than a person; the information takes the form of symbols representing the affordances of the space within which you are seeking-finding; and it continues to be accessible to you as you proceed with your seeking-finding. The information affords multiple possible courses of action and you must choose which to take.

Examples:

- Finding your way using a map that you carry with you (on paper or on a digital device), which doesn't have your route marked on it and so you have to plan your route.
- Finding information in a book by using a contents list that is printed on a fold-out page in the book so that you can still refer to it when looking at other pages in the book.

- Deciding which item to click on in the navigation panel of a website.
- Accessing the content a document, such as a pdf, using an application that also shows an overview of the document either by thumbnails of the individual pages or by bookmarks.

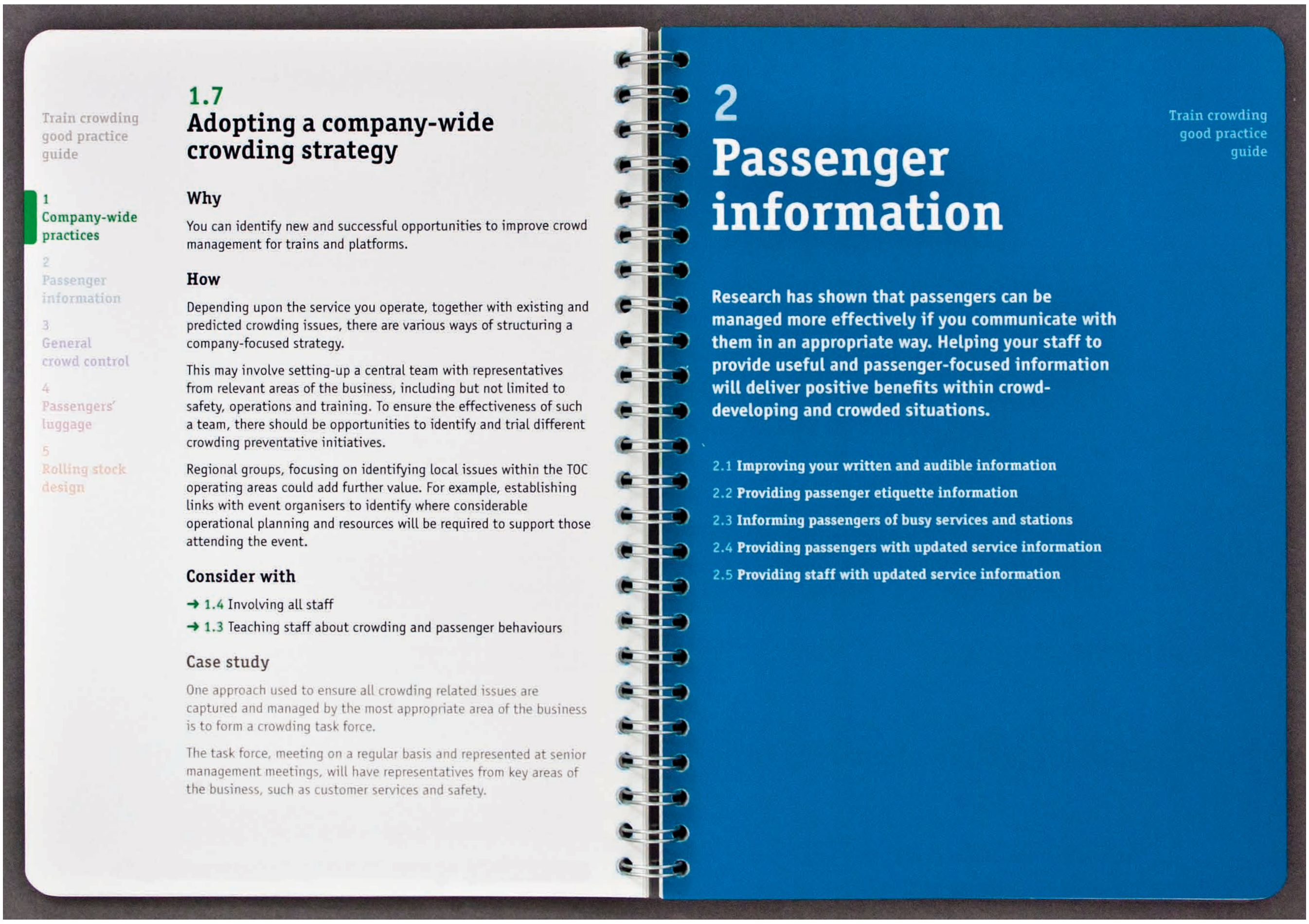
In environmental space, using an overview predominantly means using a map – whether portable (this category) or fixed-location (see 5.10). However, if you are following a route marked on the map, this counts as instructions rather than an overview because it affords a single course of action (see 5.7 and 5.8). This applies even to highly schematic maps such as transport network diagrams that count as an overview if they include more than one route.

Between the route diagram and the general map is a type of map known as a destination map. These are intended to help people anywhere within the area depicted on the map to reach a specific destination within the map. Broadly, the closer one is to the destination, the more detail is shown. By omitting some of the possible routes (routes that the map-maker has decided are unnecessary or suboptimal), the choices available to the map user are limited: but there are still choices, so such maps still count as overviews rather than instructions.[199]

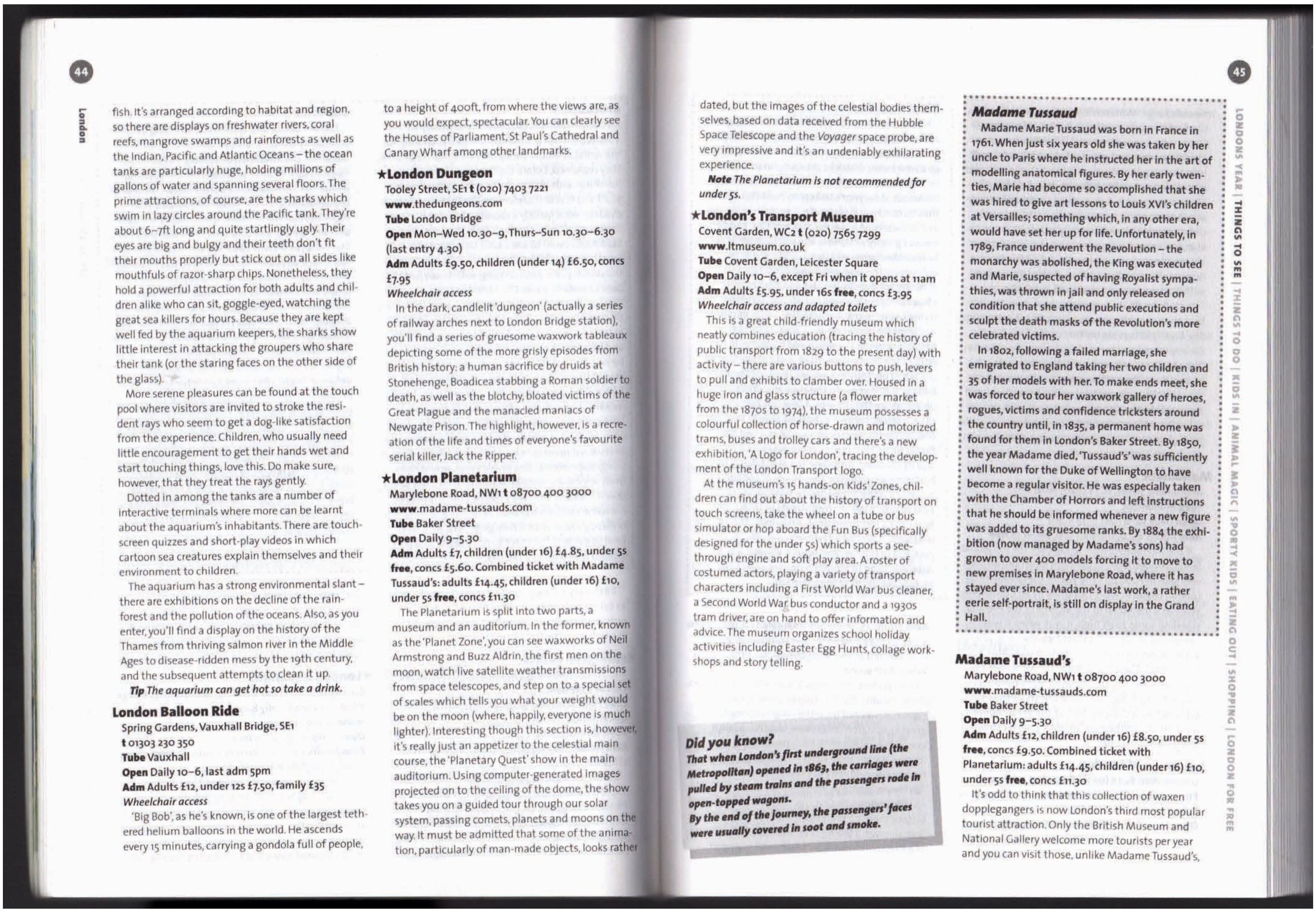
Plausible examples of using a portable overview in paper documents are scarce. This is attested not only by the single slightly awkward example above, but also the fact that neither the task observation nor the diary keeping study – both of which captured seeking-finding behaviour in paper documents – includes a description of such a tactic (see 5.9.2). Two examples using this behaviour from my own practice as a designer are books in which the running heads are elaborated in order to afford overviews in much the same way as the navigation infrastructure on a website.

The first example is from *Crowd management on trains* (RSSB 2006), in figures 5.9a–b. The document is divided into five thematic sections, the names of all five sections are printed down the fore-edge of each page in the same order as the sections occur in the document. The current section is highlighted – allowing the user to know which sections precede and follow their present location in the book. Pages also contain cross-references, whose use counts as following fixed-location instructions. The second example is from *Take the kids: England* (Fullman 2001), shown in figures 5.9c–d. Each chapter comprises a region of England, and each region is divided into the same set of thematic sections. The names of these sections are printed in the right-hand fore-edge in the same order as the sections occur in the chapter. The current section is highlighted, so that the reader can use this device to navigate forwards or backwards to other thematic sections within the chapter.

199 See Kopf, Agrawala, et al. (2010).



Figures 5.9a and **5.9b**: Crowd management on trains *(RSSB 2006), showing (portable) overviews of the book structure down the page fore-edge*



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fish. It's arranged according to habitat and region, so there are displays on freshwater rivers, coral reefs, mangrove swamps and rainforests as well as the Indian, Pacific and Atlantic Oceans – the ocean tanks are particularly huge, holding millions of gallons of water and spanning several floors. The prime attractions, of course, are the sharks which swim in lazy circles around the Pacific tank. They're about 6–7ft long and quite startlingly ugly. Their eyes are big and bulgy and their teeth don't fit their mouths properly but stick out on all sides like mouthfuls of razor-sharp chips. Nonetheless, they hold a powerful attraction for both adults and children alike who can sit, goggle-eyed, watching the great sea killers for hours. Because they are kept well fed by the aquarium keepers, the sharks show little interest in attacking the groupers who share their tank (or the staring faces on the other side of the glass).

More serene pleasures can be found at the touch pool where visitors are invited to stroke the resident rays who seem to get a dog-like satisfaction from the experience. Children, who usually need little encouragement to get their hands wet and start touching things, love this. Do make sure, however, that they treat the rays gently.

Dotted in among the tanks are a number of interactive terminals where more can be learnt about the aquarium's inhabitants. There are touch-screen quizzes and short-play videos in which cartoon sea creatures explain themselves and their environment to children.

The aquarium has a strong environmental slant – there are exhibitions on the decline of the rainforest and the pollution of the oceans. Also, as you enter, you'll find a display on the history of the Thames from thriving salmon river in the Middle Ages to disease-ridden mess by the 19th century, and the subsequent attempts to clean it up.

***Tip** The aquarium can get hot so take a drink.*

London Balloon Ride
Spring Gardens, Vauxhall Bridge, SE1
t 01303 230 350
Tube Vauxhall
Open Daily 10–6, last adm 5pm
Adm Adults £12, under 12s £7.50, family £35
Wheelchair access

'Big Bob', as he's known, is one of the largest tethered helium balloons in the world. He ascends every 15 minutes, carrying a gondola full of people, to a height of 400ft, from where the views are, as you would expect, spectacular. You can clearly see the Houses of Parliament, St Paul's Cathedral and Canary Wharf among other landmarks.

★London Dungeon
Tooley Street, SE1 **t** (020) 7403 7221
www.thedungeons.com
Tube London Bridge
Open Mon–Wed 10.30–9, Thurs–Sun 10.30–6.30 (last entry 4.30)
Adm Adults £9.50, children (under 14) £6.50, concs £7.95
Wheelchair access

In the dark, candlelit 'dungeon' (actually a series of railway arches next to London Bridge station), you'll find a series of gruesome waxwork tableaux depicting some of the more grisly episodes from British history: a human sacrifice by druids at Stonehenge, Boadicea stabbing a Roman soldier to death, as well as the blotchy, bloated victims of the Great Plague and the manacled maniacs of Newgate Prison. The highlight, however, is a recreation of the life and times of everyone's favourite serial killer, Jack the Ripper.

★London Planetarium
Marylebone Road, NW1 **t** 08700 400 3000
www.madame-tussauds.com
Tube Baker Street
Open Daily 9–5.30
Adm Adults £7, children (under 16) £4.85, under 5s **free**, concs £5.60. Combined ticket with Madame Tussaud's: adults £14.45, children (under 16) £10, under 5s **free**, concs £11.30

The Planetarium is split into two parts, a museum and an auditorium. In the former, known as the 'Planet Zone', you can see waxworks of Neil Armstrong and Buzz Aldrin, the first men on the moon, watch live satellite weather transmissions from space telescopes, and step on to a special set of scales which tells you what your weight would be on the moon (where, happily, everyone is much lighter). Interesting though this section is, however, it's really just an appetizer to the celestial main course, the 'Planetary Quest' show in the main auditorium. Using computer-generated images projected on to the ceiling of the dome, the show takes you on a guided tour through our solar system, passing comets, planets and moons on the way. It must be admitted that some of the animation, particularly of man-made objects, looks rather dated, but the images of the celestial bodies themselves, based on data received from the Hubble Space Telescope and the *Voyager* space probe, are very impressive and it's an undeniably exhilarating experience.

***Note** The Planetarium is not recommended for under 5s.*

★London's Transport Museum
Covent Garden, WC2 **t** (020) 7565 7299
www.ltmuseum.co.uk
Tube Covent Garden, Leicester Square
Open Daily 10–6, except Fri when it opens at 11am
Adm Adults £5.95, under 16s **free**, concs £3.95
Wheelchair access and adapted toilets

This is a great child-friendly museum which neatly combines education (tracing the history of public transport from 1829 to the present day) with activity – there are various buttons to push, levers to pull and exhibits to clamber over. Housed in a huge iron and glass structure (a flower market from the 1870s to 1974), the museum possesses a colourful collection of horse-drawn and motorized trams, buses and trolley cars and there's a new exhibition, 'A Logo for London', tracing the development of the London Transport logo.

At the museum's 15 hands-on Kids' Zones, children can find out about the history of transport on touch screens, take the wheel on a tube or bus simulator or hop aboard the Fun Bus (specifically designed for the under 5s) which sports a see-through engine and soft play area. A roster of costumed actors, playing a variety of transport characters including a First World War bus cleaner, a Second World War bus conductor and a 1930s tram driver, are on hand to offer information and advice. The museum organizes school holiday activities including Easter Egg Hunts, collage workshops and story telling.

Did you know?
That when London's first underground line (the Metropolitan) opened in 1863, the carriages were pulled by steam trains and the passengers rode in open-topped wagons.
By the end of the journey, the passengers' faces were usually covered in soot and smoke.

Madame Tussaud
Madame Marie Tussaud was born in France in 1761. When just six years old she was taken by her uncle to Paris where he instructed her in the art of modelling anatomical figures. By her early twenties, Marie had become so accomplished that she was hired to give art lessons to Louis XVI's children at Versailles; something which, in any other era, would have set her up for life. Unfortunately, in 1789, France underwent the Revolution – the monarchy was abolished, the King was executed and Marie, suspected of having Royalist sympathies, was thrown in jail and only released on condition that she attend public executions and sculpt the death masks of the Revolution's more celebrated victims.
In 1802, following a failed marriage, she emigrated to England taking her two children and 35 of her models with her. To make ends meet, she was forced to tour her waxwork gallery of heroes, rogues, victims and confidence tricksters around the country until, in 1835, a permanent home was found for them in London's Baker Street. By 1850, the year Madame died, 'Tussaud's' was sufficiently well known for the Duke of Wellington to have become a regular visitor. He was especially taken with the Chamber of Horrors and left instructions that he should be informed whenever a new figure was added to its gruesome ranks. By 1884 the exhibition (now managed by Madame's sons) had grown to over 400 models forcing it to move to new premises in Marylebone Road, where it has stayed ever since. Madame's last work, a rather eerie self-portrait, is still on display in the Grand Hall.

Madame Tussaud's
Marylebone Road, NW1 **t** 08700 400 3000
www.madame-tussauds.com
Tube Baker Street
Open Daily 9–5.30
Adm Adults £12, children (under 16) £8.50, under 5s **free**, concs £9.50. Combined ticket with Planetarium: adults £14.45, children (under 16) £10, under 5s **free**, concs £11.30

It's odd to think that this collection of waxen dopplegangers is now London's third most popular tourist attraction. Only the British Museum and National Gallery welcome more tourists per year and you can visit those, unlike Madame Tussaud's,

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London

Question
Other than being next to each other, what do Piccadilly Circus, Coventry Street and Leicester Square have in Common?

Answer
They make up the yellow set on the board of the London version of Monopoly.

3-D rides, £2 – 3 (there are small savings to be made by buying a combined ticket to several rides).

Tip The noise and flashing lights may make it a little overwhelming for very young children. Older children (over 7), however, will love it.

Pepsi Drop You can snatch a fleeting glance at all six floors of the Trocadero aboard the Pepsi Max Drop. This 130ft vertical drop ride is not for the faint-hearted but gung-ho children might be tempted. Each ride costs £3. For £3.99 you can buy a picture of yourself and your children looking terrified as you plummet for posterity.

★Victoria & Albert Museum
Cromwell Road, SW7 **t** (020) 7942 2000
www.vam.ac.uk
Tube South Kensington
Open Daily 10 – 5.45 (Wed and last Fri of each month till 10)
Free
*Wheelchair access (use Exhibition Road entrance or **t** (020) 7942 2197 to book an escort in advance*

Dedicated to the decorative arts, the Victoria & Albert (or the V & A as it is known) has, over the course of its long history, gathered together a huge collection of treasures from all over the world: silverware from European royal palaces, ceramics from eastern temples, sculptures by African tribesmen and vast hoards of jewellery, furniture, textiles, tapestries and paintings – it's like an enormous magpie nest full of the world's most gaudy, glittery things. The dress gallery usually appeals to clothes-conscious teenagers. It traces the evolution of fashion from the 17th century to the present day, from ruffs and puffy sleeves to mini skirts and platform heels.

For that all important 'wow!' factor, head to the Cast Court where you'll find an exhibition of plastercasts of some of the world's greatest (and biggest) statues and monuments – Michelangelo's *David* and the enormous Trajan's column (in two pieces) among them.

Although there's not much to push or pull in the galleries themselves, the museum more than compensates by organizing plenty of arts and crafts activities for kids to take part in. These are usually themed according to the gallery in which they are being held – so you might have origami in the Japanese Gallery, paper clothes-making in the Dress Gallery and jewellery-making in the Silver Gallery. Activity backpacks are available for kids on Saturday afternoons (1–4.30) which are full of jigsaws, stories, puzzles and construction games relating to the collections. There are six themed packs to choose from – including 'The Explorer' and 'Magic Glasses' and are suitable for ages 5–11. On Sundays and in the school holidays a roving activity cart tours the museum's seven miles of corridors.

Westminster Abbey
Broad Sanctuary, SW1 **t** (020) 7222 7110
www.westminster-abbey.org
Tube Westminster
Open Mon–Fri 9.30–4.45, Sat 9.30–2.45
Adm Adults £6, children and concs £3
Wheelchair access

The Abbey could be described, if you were feeling a little disrespectful, as a great indoor graveyard filled with the remains, relics and reminders of the last thousand years of British history. You enter through Statesmen's Aisle, which features memorials to three of the country's most famous past prime ministers, Gladstone, Disraeli and Palmerston. On your travels around the building you'll find the tombs of Elizabeth I and Mary, Queen of Scots, and the centrepiece of the Abbey – the shrine of St Edward. Explore further and you'll also come across what is thought to be the last resting place of the two young princes murdered in the Tower of London in 1483. Or, at least, you will if you can come to terms with the rather higgledy-piggledy layout. The clutter, however, just makes it more interesting for kids who happily make their way through, under and around the assorted statues, stones, memorials and shrines. See if they can find Poets' Corner where Shakespeare, Shelley and Keats are memorialized or the throne on which every monarch since 1296, except for Edward V and Edward VIII, has been crowned (it's behind the high altar next to the shrine of St Edward and is rather less magnificent than its history would suggest. Unless you knew differently, you would probably describe it as an old, dusty, rather beaten up chair.)

The Abbey is a very beautiful place with great vaulted ceilings and richly coloured stained-glass windows, but the best thing about it is that it manages both to engage the macabre interest of children while, at the same time, offering a more serene, reflective air which adults will appreciate. In recent decades, views of the Abbey have been beamed around the world at times of great national significance. Two of the most watched TV events in history, the coronation of Elizabeth II and the funeral of Princess Diana, took place here, when the wonderful interior became the image of England for the whole world. There's a café and a souvenir shop in the cloisters, the area where the Abbey's monks lived and worked until the middle of the 16th century.

THINGS TO DO

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There's no shortage of things to do for children in London from trips on the river to surfing the World Wide Web at an Internet café. Listed below are just a selection of ideas and contacts. For theatre and puppet workshops *see* 'Kids in' pp.65–71. In addition, many of London's museums run children's workshops at various times of the year. See individual entries for details.

Art activities

Art 4 Fun: The Creative Café
444 Chiswick High Road, W4 **t** (020) 8994 4100
Tube Chiswick Park
Open Mon–Fri 10 – 8, Sat and Sun 10 – 7
Cost £3.95 for unlimited use of materials; objects are £2.75 upwards

Although it calls itself a café you can actually bring your own food (and this is advisable as a full menu is not always available). The accent here is on creativity and you can decorate greeting cards, mugs, plates, T-shirts – even a cardboard box. Decide what you want to beautify, and one of the helpful staff will bring it over together with paints, brushes and whatever else you may need or desire. For more structured lessons, there are Saturday clubs which cost £15 and last for two hours.

Boat trips

The following companies offer sightseeing boat trips along stretches of the Thames. For details and times call the London Tourist Board's River Trip line on **t** 0839 123432 or pick up the London Tourist Board booklet, 'Discover the Thames'.

Catamaran Cruises
t (020) 7987 1185 **www.bateauxlondon.com**
Fares To Tower of London: adults single £5.50, children single £3.50; to Greenwich: adults single £8, children single £5
Greenwich pass: adults £20, children £7 (includes entry to National Maritime Museum, Royal Observatory, and *Cutty Sark*).
Tower Pass: adults £15.50, children £10 (includes entry to Tower of London).
River pass: adults £10, children £5 (unlimited one-day use of all cruisers)

Downriver from Embankment Pier to the Tower of London, Greenwich and the Thames Barrier. Boats going to the Tower also stop at St Katherine's Pier.

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Figures 5.9c and **5.9d**: Take the kids: England *(Fullman 2001: 44–45, 58–59), showing (portable) overviews of the book structure down the page fore-edge*

5.9.2 / How this behaviour is captured in the user research

In the **task observation**, the test materials contain no suitable apparatus to afford this behaviour and so it is not coded.

In the questionnaires used in the **wayfinding survey** and the **diary keeping**, this behaviour is coded from the following responses to the questions on pages 2–3.

In environmental space:

- 'I used a map on paper that I carried with me'
  + checking *no* to the question 'if you used a map, did it have your route marked on it?'
- 'I used a map on my phone (or similar digital device)'
  + checking *no* to the question 'if you used a map, did it have your route marked on it?'

The questionnaire for seeking-finding in paper documents does not contain a question directly addressing this behaviour because, as with the task observation, paper documents rarely afford portable overviews.

On-screen:

- 'I clicked on an item in a navigation panel'

5.9.3 / Using a portable overview in other taxonomies

Within the taxonomies surveyed from practice literature, in **environmental space**, 'map reading', seventh seeking-finding strategy proposed by Mollerup (2005: 62–63 and 152–157), is largely comparable with the two categories of using a portable overview and using a fixed-location overview. Mollerup comments that a map allows the individual to get an 'overview'. And like the current taxonomy, Mollerup excludes from 'map reading' instances of using a map with the route marked on (see 5.7.3 and 5.8.3 for Mollerup's approach to these behaviours).

The wayfinding strategies identified by Weisman (1987) do not include anything that falls into this category of using a portable overview.

In research literature on environmental space, this behaviour category covers part of the area defined by the 'direct access' tactic in the 'spatial' style in Passini (1981). This also includes following fixed-location instructions, following portable instructions, using a fixed-location overview, aiming, and using an allocentric frame.[200]

The survey of research and practice literature finds no comparable taxonomies dealing with **paper documents**.

200 See 2.4 and 2.10 for more detail of Passini's taxonomy and how it corresponds to mine.

Within taxonomies surveyed from research literature, in **on-screen**, using a portable overview is comparable with 1 of the search moves in Cromley and Azevedo (2008: 289–299): 'going to a new page via the multimedia thumbnails'. And within practice literature, this category of behaviour is comparable with 5 of the 'mechanisms of navigation' in Kalbach (2007: 54–82) – they count as an *overview* insofar as the configuration of the hyperlinks provides an accurate overview of the organisation of the various pages of the website, and count as *portable* insofar as they are part of the browser/website infrastructure and consistently available on every page:

- 'Navigation bars and tabs' (pp.69–72) present hyperlinks typically across the top of the screen as part of the consistently available browser/website infrastructure.
- 'Vertical menu' (p. 72) present hyperlinks typically down the side of the screen as part of the consistently available browser/website infrastructure.
- 'Tree navigation' (p.63) takes the form of a hierarchical list, typically in an expandable or drop-down menu, that is consistently available as part of the browser/website infrastructure; however, if it occupies its own page within the site, then it counts as using a fixed-location overview (see 5.10).
- 'Site maps' and 'directories' (pp.63–66) typically occupy a page of their own in a website and so count as using a fixed-location overview (see 5.10), but instances where such an overview opens in a separate window counts as portable and so falls into this category.

5.10 / Using a fixed-location overview

5.10.1 / Definition and examples

The carrier of the information is a thing rather than a person; the information takes the form of symbols representing the affordances of the space within which you are seeking-finding; and it is at a point fixed in space and time within the environment. The information affords multiple possible courses of action and you must choose which to take.

Examples:

- Planning a route to your destination using a you-are-here map.
- Using a store directory in a department store to find the location of the department you require.
- Using the London Underground map in a station in order to plan the route to your destination station.

- Using the contents list in a book to find the most likely location for the information you seek.
- Checking a site map on a website in order to understand how to access a particular page.
- Using the contents list at the start of a long article on Wikipedia to find the section with the information you seek.

You-are-here (y-a-h) maps are typically at a fixed location within environmental space (unless they are on a portable digital device in which case they count as using a portable overview). As the name suggests, they have a graphical marker to indicate the location of the viewer within the overview. Ideally, they also indicate the orientation of the viewer. The orientation of the overview itself may be north-up (as is conventional for Western maps), they may alternatively be 'heads-up' (so that the orientation of the map is aligned with the orientation of the viewer), or they may be oriented according to some other system. This question of orientation in y-a-h maps is extensively discussed in research literature.[201] Practice literature in general advises heads-up orientation in y-a-h maps,[202] but some authors suggest approaches that are more nuanced.[203]

5.10.2 / How this behaviour is coded from the user research

In the **task observation**, this behaviour is coded in response to observing the participant using the contents list at the front of the book, or a mini-contents list at the start of a section.

In the questionnaires used in the **wayfinding survey** and the **diary keeping**, this behaviour is coded from the following responses to the questions on pages 2–3.

In environmental space:

- 'I checked a map that was fixed to a wall or similar'
  + checking *no* to the question 'if you used a map, did it have your route marked on it?'

In paper documents:

- 'I used the contents list'

201 An overview of research is in Montello (2010). Other studies can be found in e.g. McKenzie and Klippel (2016); Münzer, Zimmer, and Baus (2012); Richter and Klippel (2002); Fewings (2001); Dogu and Erkip (2000); May, Peruch, and Savoyant (1995); Butler, Acquino, et al. (1993); Warren and Scott (1993); Andre (1991); Levine, Marchon, and Hanley (1984); Palij, Levine, and Kahan (1984); Levine (1982); Levine, Jankovic, and Palij (1982).
202 Smitshuijzen (2007: 104–105) expresses this view strongly, but it is also made by, e.g., ACRP (2011: 110–111); RSSB (2006: 35); Berger (2005: 32); Calori, C. (2007: 123); Miller and Lewis (1999: 102); Arthur and Passini (1992: 187).
203 E.g. Gibson (2009: 53 and 100); Mollerup (2005: 155).

On-screen:

- 'I used a site map to help me find what I wanted'

5.10.3 / Using a fixed-location overview in other taxonomies

Within the taxonomies surveyed from practice literature, in **environmental space**, 'map reading', seventh seeking-finding strategy proposed by Mollerup (2005: 62–63 and 154–157), is largely comparable with the two categories of using a portable overview and using a fixed-location overview. And like the current taxonomy, Mollerup excludes from 'map reading' instances of using a map with the route marked on (see 5.7.3 and 5.8.3 for Mollerup's approach to these behaviours).

The wayfinding strategies identified by Weisman (1987) do not include anything that falls into this category.

In research literature on environmental space, this behaviour category covers part of the area defined by the 'direct access' tactic in the 'spatial' style in Passini (1981). This cell in Passini's matrix also includes following fixed-location instructions, following portable instructions, using a portable overview, aiming, and using an allocentric frame.[204]

The survey of research and practice literature finds no comparable taxonomies dealing with **paper documents**.

Within the taxonomies surveyed from research literature, in **on-screen** using a fixed-location overview is comparable with 1 of the 11 search moves in Cromley and Azevedo (2008: 289–299): 'using the table of contents'. And within practice literature, this category of behaviour is comparable with 5 of the 'mechanisms of navigation' in Kalbach (2007):

- 'Tree navigation' (p.63) takes the form of a hierarchical list and only counts in the current category when it occupies its own page within the site; more typically, it is an expandable or drop-down menu that is consistently available as part of the browser/website infrastructure and so is classed as using a portable overview.
- 'Site maps' and 'directories' (pp.63–66) both take the form of an overview that is typically on its own page within the site; however, instances that open in a separate window count as using a portable overview.
- 'Tag clouds' (pp.66–67) provide an alphabetic list of all of the tags contained within a particular space, with each tag scaled to reflect a value such as frequency of occurrence. This gives a different sort of overview to those discussed above: it does not demonstrate relationships of adjacency or hierarchy of content, but reflects the relative frequency (for instance) of the terms included. Their value as a navigational mechanism may be limited.

204 See 2.4 and 2.10 for more detail of Passini's taxonomy and how it corresponds to mine.

- ‘Visualising navigation’ (pp.76–79) is a somewhat catch-all term for information structures that give a visual (and often dynamic and interactive) overview of the semantic content of the space. Of one such visualisation, Kalbach (2007: 79) makes comments that are more widely applicable to such tools: ‘this seems quite useful. But it does take some getting used to – something people may not want to invest time in. What’s more, categories that are generated on the fly are often too broad, too narrow, or just plain meaningless.’

5.11 / Sequencing

5.11.1 / Definition and examples

The carrier of the information is a thing rather than a person; the information takes the form of a fixed, widely understood, ordinal sequence of symbols one of which is linked to your objective; and it is at a point fixed in space and time within the environment. The information affords multiple possible courses of action and you must choose which to take.

The most typical symbol sequence used in relation to sequencing is numbers: these are usually presented as cardinal numbers, standing-in for ordinal numbers. Numbers can be presented as figures (1, 2, 3, etc.), or spelt out (one, two, three, etc.), or in roman numerals (i, ii, iii, etc.) in capitals or lower-case. Letters of the alphabet can also be used, either in capitals or in lower-case, and, most typically, using the Latin alphabet, although the Greek alphabet is also occasionally used. Using roman numerals or Greek letters are likely to tax many users because they are unfamiliar. There is a further symbol sequence used specifically to identify footnote sequences: * † ‡ § || ¶ with each one used to identify a different footnote (the symbol appears in the text at the point at which the footnote is required, and is repeated at the start of the footnote text).

Groups of items that are differentiated by sequential identifiers (such as houses in a street, pages in a book) are a particular type of contrast set. The concept of the contrast set was originally developed by Harold Conklin and Charles Frake and is described in Frake (1969). Practices for labelling contrast sets are discussed in Watson (2017).

Within modern Western culture sequencing passes largely unacknowledged, perhaps because it is so embedded and widely understood. For instance, can you remember when you were taught how to use page numbers – did you figure it out for yourself, or was it explained to you, and how old were you at the time? And imagine you are talking to someone from Mars: you have to explain to them how page numbering and house numbering work. It is surprisingly complicated to explain this system that we take for granted.

Examples:

- Finding your destination by using house numbers in a street (you know your objective is, for instance, number 33, and you know that you will be likely to find that between numbers 31 and 35[205]).
- Finding your seat in a theatre using the row letter and seat number (two sets of sequencing: if you know that your seat is, for instance, H33, you would first look for row H, expecting to find it between rows G and I, and then seek along row H expecting to find seat 33 between seats 32 and 34).
- Finding the information that you seek in a document by using its page numbers (you know that the information you seek is, for instance, on page 33 and you expect to find page 33 between pages 32 and 34).
- Finding the information you seek in a dictionary by using your understanding of alphabetic ordering (you are looking up, for instance, the term 'numbering': you seek first of all for words beginning with 'n', expecting to find them between words beginning with the letters 'm' and 'o', and then within words starting with the letter 'n' look for words whose second letter is 'u', expecting to find these between words whose second letters are 't' and 'v', and then within words that start 'nu' looking for words whose third letter is 'm', expecting to find these between words whose third letter is 'l' and 'n', and so on until the search is narrowed down to the particular word sought).
- Finding the information in a complex online legal document by using a multi-level decimal numbering system (such as the three-level numbering system used in this thesis: this section is numbered 5.11.1, and we can reasonably expect it to be followed by section 5.11.2).

5.11.2 / How this behaviour is captured in the user research

In the **task observation**, this behaviour is coded in response to observing one of the three following behaviours:

- The participant uses the sequentiality of page numbers to navigate through the book to a particular page.
- The participant scans the alphabetic sequence of index entries to find the one they seek.
- The participant scans text within the main body of a book which is organised as alphabetically or chronologically sequenced entries.

205 Assuming the house-numbering system that is most common in the UK.

In the questionnaires used in the **wayfinding survey** and the **diary keeping**, this behaviour is coded from the following responses to the questions on pages 2–3:

In environmental space:

- 'I used house/room numbers or similar'

In paper documents:

- 'I used the page numbers'
- 'I used part numbers, or section numbers, or section numbers, or similar'

On-screen:

- 'I found what I wanted because it was part of a numbered set'

5.11.3 / Sequencing in other taxonomies

Within the taxonomies surveyed from practice literature, in **environmental space** 'inference', fourth seeking-finding strategy proposed by Mollerup (2005: 54–57) is largely comparable with sequencing. Mollerup defines it as 'using the structural qualities of street numbers, house numbers, entrance letters, and other ordinal information given on signs to infer the larger structure of the environment' and goes on to make the point that 'The organising principle can be any string of entities used in a generally accepted sequence' (p.55).

The wayfinding strategies identified by Weisman (1987) do not include anything that falls into this category of sequencing.

In research literature on environmental space, this behaviour category covers part of the area defined by the 'direct access' tactic in the 'linear' style in Passini (1981). This cell in Passini's matrix also includes following fixed-location instructions and following portable instructions.[206]

The survey of research and practice literature finds no comparable taxonomies dealing with **paper documents**. And of those from **on-screen**, none includes behaviours comparable with sequencing.

206 See 2.4 and 2.10 for more detail of Passini's taxonomy and how it corresponds to mine.

5.12 / Semantic behaviour in the user research

All 3 of the user studies conducted for this thesis collect evidence of semantic behaviours.

5.12.1 / Data from the task observation

This study provides data from 12 participants each performing the same set of 6 tasks, giving a total of 72 reports of seeking-finding events (6 × 12 = 72). Each report includes the order in which behaviours are deployed. This data is only for a single context: paper documents. An overview of the data from this study is in 3.5, with semantic behaviours shown in figures 3.5a and 3.5c. Comparisons with the other study that reports seeking-finding in paper documents – the diary keeping – are discussed in 5.12.6.

This study provides data for only 3 of the 5 semantic behaviours because the document used for the study – in common with many paper documents – does not afford following portable instructions or using a portable overview. However, see the case study in 5.14 for an insight into using a fixed-location overview *as if* portable.

In this study, following fixed-location instructions almost invariably means using the index. There is only one other tactic recorded for this category of behaviour: a single instance of using a cross-reference. Using a fixed-location overview means using the contents list – either the main contents list at the start of the book or one of the mini-contents lists that come at the start of some chapters. Sequencing means using the page numbers or using other alphanumeric sequencing structures in the book. Some chapters comprise dictionary-style entries arranged alphabetically by headword; others are organised chronologically; the index is (as is customary) organised alphabetically: using these structures is classed as sequencing.

As the top (pink) bar in figure 3.5c shows, there is only 1 participant who does not employ semantic behviours in all reports. This participant (John) successfully complets task 2 using screening and luck. The other 71 reports all employ semantic behaviours. The ubiquity of semantic behaviours might seem not surprising given that the seeking-finding is taking place in a document filled with symbols arranged according to syntactic rules in semantically meaningful permutations. However, 70 of the 72 reports also employ spatial behaviours (Cilla/task 1, and Jovair/task 5 employ no spatial behaviours).[207] Considered together, the ubiquity of both semantic and spatial behaviours might suggest either the richness of individual's seeking-finding repertoires, or

207 This study does not afford the opportunity for social behaviours and so they are excluded from this discussion. This is no reflection on their significance within seeking-finding behaviour.

their opportunistic or eclectic approaches to solving seeking-finding problems (or both).

There is only one instance of a cross-reference within text being used (Maggie/task 4). It is the only time in this study that following fixed-location instructions is not index use.[208]

Using the index (following fixed-location instructions) and the contents list (using a fixed-location overview) are alternative approaches to accessing the content of a document. Participants in this study differ in *when* during the course of the tasks they discover these access structures. Some participants show preferences for one or the other of these structures, and others demonstrate a consideration of fitness of each approach for each task. This is discussed in the case study in 5.13.

In the document used in this study, using the page numbers (one of several structures within the book that all afford sequencing) is unusually challenging because of the idiosyncratic page numbering system.[209] Individuals differ in when during the course of the tasks they demonstrate a working understanding of the page numbering system. This is discussed in the case study in 5.14.

5.12.2 / Data from the wayfinding survey

This study provides data from 43 participants performing a single task in environmental space. An overview of the data from this study is in 3.6, with semantic behaviours shown in figures 3.6b and 3.6d.

Comparisons with the other study that reports seeking-finding in environmental space – the diary keeping – are discussed in 5.12.6.

Figure 3.6b shows that following fixed-location instructions and using a portable overview emerge as the most frequently reported semantic behaviours in this study. Each is reported in about half of all surveys. Examining the pattern of reporting these two behaviours (in figure 3.6d), reveals that 13 surveys report using both, 13 report using neither, 9 report following fixed-location instructions, and 8 report using a portable overview. What this pattern might signify is unclear. The other semantic behaviours are reported considerably less frequently.

5.12.3 / Data from the diary keeping

This study provides data from 12 participants' seeking-finding activities in their everyday lives over the course of a month. This study covers all 3 contexts. An

208 This is an unsuccessful behaviour. None of the tasks was formulated to optimally require using a cross-reference, and none of the other participants makes use of any cross-references in the book.
209 Described in 3.2.2.

overview of the data from this study is in 3.7, with semantic behaviours shown in figures 3.7c, 3.7f, 3.7i, and 3.7l.

Across all participants in all contexts, in this study following fixed-location instructions emerges as the most reported semantic behaviour: it is included in 72% of reports, almost double the percentage of reports including any other semantic behaviour (see figure 3.7b). Following portable instructions is the next most reported behaviour, although this is only included in 38% of reports. The other three semantic behaviours – using a portable overview, using a fixed-location overview, and sequencing – are all reported considerably less: in the 17–20% range.

The data from the diary keeping allows comparisons of seeking-finding behaviour across contexts (see 5.12.6). And when viewed in conjunction with data from the task observation and the wayfinding survey, it offers the opportunity to compare data sets within the same context (although from different studies). These are discussed below in 5.12.4 and 5.12.5.

5.12.4 / Comparing semantic behaviours in paper documents

Both the task observation and the diary keeping include data for semantic behaviours in paper documents. The task observation data is shown in figures 3.5a and 3.5c, and diary keeping in figures 3.7f and 3.7l.

The diary keeping shows a smaller overall proportion of reports including semantic behaviours in paper documents than the task observation study (in 89% of all reports as opposed to 99%). This suggests that semantic behaviours are less extensively used for seeking-finding in paper documents in the real world than in the artificial circumstances of the task observation.

In the task observation, 11 of the 12 participants use semantic behaviours in all of the tasks, and the other participant includes semantic behaviours in only 5 of the 6 tasks (as shown in the top (pink) bar in figure 3.5c). However, in the diary keeping, only 3 of the 12 participants include semantic behaviours in all of their reports for paper documents; the majority of participants include semantic behaviours in paper documents in 50–83% of their reports, and 2 participants report using semantic behaviours in paper documents even less (as shown in the pink bar in the middle section of figure 3.7l). One (Tanveer) reports no semantic behaviours in paper documents because he reports *no* seeking-finding in paper documents – see the case study in 5.16.

Following fixed-location instructions is the only behaviour that is included in equal proportions of reports in both studies (see figures 3.5a and 3.7f). Even when the distribution of individual participants is compared (see figures 3.5c and 3.7l), this behaviour is strikingly comparable between the studies.

Following portable instructions and using a portable overview are not included in the task observation data because the test materials used in this study did not support these behaviours. In the diary keeping, these behaviours are included, but their minimal use may be indicative of how infrequently these behaviours are supported by paper documents in general.[210]

In the diary keeping, following portable instructions in a paper document is included in 3 reports. The tactic coded in each of these instances is following a line on a page; the specific tasks are (i) finding out about holiday options in a travel brochure, (ii) checking football scores in a newspaper, and (iii) checking out things to do over the weekend in a listings magazine. This evidence suggests that paper documents *do* support this behaviour but only infrequently.

In comparison with the task observation, reports including using a fixed-location overview in the diary keeping study are a smaller proportion. And when the distribution of individual participants' reporting this behaviour is compared (in figures 3.5c and 3.7l), in the diary keeping, a larger number of participants include this behaviour in smaller proportions of their reports. Using a contents list is the activity that predominantly comprises this behaviour, and it is hard to explain why it is included in a smaller proportion of reports in the diary keeping than in the task observation. This difference is all the more puzzling given that the proportions of reports including following fixed-location instructions (which predominantly is made up of index use) are relatively comparable across the two studies. In the task observation, the contents list was used in a larger number of reports than the index (see 5.13), and so it is curious that this should be so different in the diary keeping.

In the task observation, sequencing emerges as the most used semantic behaviour. The same is true of the reports from paper documents in the diary keeping, but it is considerably less ubiquitous. Nonetheless, it is the only semantic behaviour that all participants report using in paper documents in the diary keeping (with the exception of Tanveer, who does not use paper documents at all).

5.12.5 / Comparing semantic behaviours in environmental space

Both the wayfinding survey and the diary keeping include data for semantic behaviours in environmental space. The wayfinding survey data shown in figure 3.6b is comparable with that part of the diary keeping from environmental space shown in figure 3.7f. In the wayfinding survey, semantic

210 See 5.8 and 5.9 for more discussion of these behaviours, particularly in relation to the extent to which paper documents support them and the extent to which the questionnaire supports their reporting.

behaviours are included in 79% of reports, whereas 90% of reports from environmental space in the diary keeping include semantic behaviours. The latter's reports are from a more diverse mix of tasks, and suggests that the higher figure may be more generalisable.

The wayfinding survey and the diary keeping use the same questions to gather data, and this allows us to compare not only the categories of semantic behaviour across the two studies but also the individual tactics used within each category of behaviour. This is shown in figure 5.12j.

Figure 5.12j: *comparison of proportions of reports including individual semantic tactics in the wayfinding survey and the diary keeping studies (all quantities are expressed as percentages of the total number of reports in that study, wayfinding survey: n=43; diary keeping: n=299)*

	Wayfinding survey	Diary keeping
Following fixed-location instructions	**49**	**54**
Direction signs	47	47
Spoken announcements on public transport	2	15
Following portable instructions	**23**	**56**
Line marked on wall, floor, or similar	2	12
Spoken announcements from satnav or similar	2	20
Set of written-down directions	14	19
Map on paper that I carried with me with the route marked	7	4
Map on my phone (or similar) digital device) with the route marked	5	24
Using a portable overview	**51**	**23**
Map on paper that I carried with me with no route marked	40	5
Map on my phone (or similar digital device) with no route marked	19	19
Using a fixed-location overview	**14**	**5**
Map that was fixed to a wall or similar with no route marked	14	5
Sequencing	**9**	**23**
House or room numbers	9	23

Following fixed-location instructions

Across the two studies, this is the only category of semantic behaviour that is included in (relatively) equal proportions in both studies. Of the tactics within this category, the use of direction signs is consistently reported in 47% of instances across both studies, and is the most reported semantic tactic in both. Wayfinding practice literature is dominated by the subject of sign design,[211] and it is possible that the frequent reporting of this tactic in the user research is related to the ubiquity of the subject in practice literature. If the ubiquity of sign design in practice literature is reflected in practice, this suggests that direction signs are the most widely supplied source of seeking-finding information, and hence widely available. But causality cannot be established from this data: is the ubiquity of direction signs the cause of their domination of wayfinding practice literature, or the effect of it? Are direction signs used because (i) they are optimally suited to the purpose of seeking-finding, or (ii) because that is what designers give us?

The other tactic classed as following fixed-location instructions – following spoken announcements on public transport – varies substantially in how often it is reported between the two studies. That it is more frequently reported in the diary keeping suggests that the task in the wayfinding survey did not afford the use of this tactic as readily as the more diverse range of tasks reported in the diary keeping.

Following portable instructions

The proportion of reports that include this behaviour in the diary keeping is double that in the wayfinding survey, and the proportion of reports that include using a portable overview in the wayfinding survey is double that in the diary keeping – it is as if these behaviours – both using portable information –have switched between the studies.

The tactics that make up following portable instructions are generally included in larger proportions of reports in the diary keeping than in the wayfinding survey. Of these, the reasons for following a line marked on the wall, floor, or similar being more reported in the diary keeping are not clear, and the reports themselves give little further insight into the decisions about when to follow (or not follow) a line while seeking-finding in environmental space. The occasions for using such a line are diverse within the diary keeping: they include the obvious instances such as following a line on the floor within a train station or airport, and driving in which lines marked on the road to direct traffic are used for seeking-finding purposes, but there are others, such as finding a bank within a high street, in which the way that line-following is employed is unclear from the report.

211 E.g. Roefs and Mijksenaar (2017: 528); Gibson (2009); Smitshuijzen (2007: 103).

In the diary keeping, using spoken announcements from a satnav or similar is included in a larger proportion of reports than in the wayfinding survey. This is overwhelmingly due to a single participant, Mary: of the 20 reports of satnav use, 13 are hers.[212] A further 4 of these 20 reports come from Tanveer. This leaves only 3 reports between the other 10 participants. This means that excluding the heavy use of Mary and Tanveer, the other participants include using spoken announcements from a satnav in the same proportion of their reports as in the wayfinding survey.

Of the other tactics included as following portable instructions, reports of either using written-down directions or using portable paper maps are both low and they vary by only a few percent between the two studies. The relative ubiquity of smartphones and satnav devices in everyday life may go some way to explaining the minimal use of these tactics; although some may be surprised that the use of written-down directions is as high as 14%, and that using smartphones and satnav devices are not even higher proportions than reported.

Using a portable overview

Within tactics in this category, the exceptional figure in the wayfinding survey of 40% using a map on paper with no route marked is largely explained by the participants being given a map of the area as part of their invitation.[213] That this tactic occurs in only 5% of reports in the diary keeping perhaps illustrates the opportunistic nature of much seeking-finding behaviour: choice of information sources may be based on parsimony: which of the available resources cost least to access and use, in physical and cognitive terms?[214] A further example can be found in Fendley (2009: 92), which shows people using the Tube map in London as means of navigating the city even though it is a schematic map and not topographically accurate. People may use available resources even if they know that they are poorly suited to their task. On the other hand, using a map on a phone or similar digital device occurs in 19% of reports in both studies. It is the presence of the readily available paper map in the wayfinding survey that is the most likely cause of the difference in the proportion of reports that include using a portable overview between the studies.

Using a fixed-location overview

The single tactic in this category – using a map fixed to a wall or similar with no route marked – is included in a greater proportion of reports in the wayfinding survey than the diary keeping. This difference may be in part

212 Mary is the subject of a case study – see 6.11.
213 See 3.3 and 3.6 for further discussion of this.
214 See 1.3.6 and 5.5.

due to the wayfinding survey reporting a task to find a destination in central London. Central London is well-populated with fixed-location maps as part of the Legible London project (Fendley 2009; Davies 2007). In contrast, the tasks reported in the diary keeping extend well beyond central London and encompass areas where such fixed-location maps are less readily available.

This category of behaviour is less reported than other forms of instruction or overview in both studies, although there is variation between them (14% in the wayfinding survey and 5% in the diary keeping). This minimal use potentially supports the suggestion in 5.5 that this behaviour has the greatest cognitive load of the four instruction-following and overview-using behaviours and is hence the most taxing to use.

Sequencing

This is reported relatively infrequently in both studies. In the wayfinding survey, this may be partly accounted for by it being relatively unhelpful in reaching the destination (building numbers are sufficiently sparse in this short street to offer little help in finding this destination). The large banner on the outside of the building (affording aiming over short distances) serves the purpose of confirming both destination and the location of the entrance. It is likely that the diary keeping, with its more diverse assortment of tasks in a range of situations in environmental space, includes some for which sequencing is better suited.

5.12.6 / Comparing semantic behaviours across contexts

The diary keeping allows us to examine the semantic behaviours of the same group of individuals across all 3 contexts (figures 3.7f and 3.7l). However, we must bear in mind the influence of other factors such as task.

In figure 3.7f, we can see that semantic behaviours as a group (the pink bars) are included in a smaller proportion of reports in paper documents than in environmental space or on-screen. The proportions of reports including individual categories of behaviour show greater variation between contexts too: the predominance of following fixed-location instructions (which appears so clearly when all contexts are consolidated, as in figure 3.7c) is only present in on-screen. In this context it is even more predominant: it occurs in 95% of all reports (which is considerably more than the next largest proportion: following portable instructions in 36% of reports). This is not the case in either environmental space or in paper documents. In environmental space, this behaviour occurs in a slightly smaller proportion of reports than following portable instructions (54% and 56% respectively), and other semantic behaviours all included in smaller proportions of reports (in the 5–23%

range). In paper documents, sequencing changes from being one of the most infrequently reported semantic behaviours to being included in the largest proportion of reports (61%). Following fixed-location instructions is the next most frequently reported semantic behaviour, only just ahead of using a fixed-location overview: the large proportion of reports including these two behaviours that use *fixed-location* sources of information, in contrast with the very few reports of using *portable* sources of information, has much to do with the general affordances of printed documents. The case study in 5.13 discusses this further.

It is clear that there is a great deal of variation between categories of behaviour, contexts, and individuals. Figure 3.7f shows us that within a single context, different categories of semantic behaviour vary in the proportion of reports that include them; and the same category of behaviour differs in the proportion of reports that include it across different contexts. Figure 3.7l shows the considerable inter-individual variation that exists for many categories of behaviour in each context.[215] The data presented in these figures offer no immediately discernible pattern.

5.13 / Case study: contents list and index use

The use of contents lists and indexes in paper documents has received only limited research. The task observation study offers the opportunity to examine these activities within a study of seeking-finding using a single paper document: twelve participants each perform the same 6 seeking-finding tasks.[216] This case study looks specifically at the data regarding use of the contents list (using a fixed-location overview) and the index (following fixed-location instructions) within that user study.

Contents lists and indexes are regarded by Waller (1979) as widely understood access structures in conventional book organisation. Practice literature in the main unhesitatingly regards a contents list as useful for seeking-finding.[217] It is described as an 'overview' of the book by both Haslam (2006: 109) and Mitchell and Wightman (2005: 183); the latter also refer to it as 'an aid to navigation for the reader' (p.184), and Martin (1989: 139) characterises it as 'a map of the book'. These all provide tacit support for the notion that

215 Apart from using a portable overview in paper documents, and this is because the questionnaires used did not readily afford the opportunity to report this behaviour (see 5.9.2).
216 See 3.2 for full description of this study.
217 e.g. Haslam (2006: 109); Mitchell and Wightman (2005: 181–4, 337); Bartram (1999: 65); Hochuli and Kinross (1996: 94); Martin (1989: 139); Williamson (1983: 176); McLean (1980: 154); Lee (1979: 315–316).

seeking-finding in paper documents and environmental space are comparable. Indexes too are positively regarded by practice literature.[218]

Nearly 40 years ago, Waller (1979: 176) wrote that 'to my knowledge, no-one has yet looked at contents lists', and the situation has not changed greatly since; the same is true for index research.[219] This limited body of research often looks at performance measures, but conclusions relevant here are:

- The efficacy of contents lists and indexes for seeking-finding (on-screen as well as in paper documents) is questioned by McKnight, Dillon, and Richardson (1989).
- Contents lists are more readily found and used than indexes (Neville and Pugh 1982; Pugh 1979); but Yussen, Stright, and Payne (1993: 248) find index use to be 'near universal' and 'almost all of the students mentioned using the subject index first'.
- Whether the contents list or the index is more effective depends on the particular task.
- There is lack of user understanding about where to find an index within a book (Coe 2014).
- Users confuse indexes and contents lists (Coe 2014).

Figure 3.5c shows considerable inter-individual variation in the proportion of reports including use of the contents list (using a fixed-location overview) and even more so in index use (following fixed-location instructions). The data reveals a number of dimensions to the relationship of these behaviours; their discussion forms the rest of this case study.

5.13.1 / Frequency of use

Both contents list and index are used often: the contents list in 58 of the 72 reports (81%) and the index in 33 (46%). The difference between these figures is sufficiently marked to invite examination. There are 3 possible factors that must be mentioned here because the data from the study does not allow us to examine their possible influence. First, the location of the contents list at the start of the book (and the index at the end) could mean that participants encounter the contents more readily on browsing through the book starting at the front. Second, there may be a difference between the contents list and index in terms of which is perceived to be optimal for each task, and this is likely to vary between individuals. Third, excluding the first task (which requires neither access structure), the contents list can be used to successfully

218 E.g. Mitchell and Wightman (2005: 337); Bartram (1999: 65).

219 This survey finds Browne (2017); Cevolini (2014); Marshal and Bly (2005); Yussen, Stright, and Payne (1993); McKnight, Dillon, and Richardson (1989); Neville and Pugh (1982); Hartley (1980); Pugh (1979); Burnhill, Hartley, and Davies (1977).

complete tasks 2–6, but the index can be used to successfully complete only tasks 3 and 4 – tasks 2, 5, and 6 *cannot* be successfully completed via the index. It is hard to know how much influence this latter is likely to have, given that the data includes unsuccessful behaviour as well as successful behaviour, and the participants are unlikely to be able to predict reliably beforehand which approach best suits each task (particularly given the idiosyncratic nature of the test materials).

As noted in 5.12.4, in the data from paper documents in the diary keeping, using a fixed-location overview (which comprises predominantly the tactic of using a contents list) is included in a smaller proportion of reports (37%), in comparison with the 81% in the task observation. This might suggest that the high figure for contents list use in the task observation is related to either the particular tasks or the test materials and that we might expect a lower figure when (as in the diary keeping) there is a greater range of tasks and paper documents.

5.13.2 / Finding the contents and the index for the first time

In order to use either the contents list or the index, the participant needs to be aware that the book contains that component. In this study, they are found initially by the participant either (i) encountering them by chance as they leaf through the book (meaning it is found through screening), or (ii) expecting that component to be present and knowing where to look for it (meaning it is found through using your theoretical cognitive model). In the recordings made for this study, it can be problematic to distinguish between these two scenarios unless the participant is being particularly explicit in speaking aloud their thoughts.

All participants initially find the contents list relatively early in their test session (6 of them during task 1, 4 during task 2, and 2 during task 3). Not all participants find the index, and those that do largely do so after they have found the contents list (3 participants never find the index, 1 finds it in task 1, 6 in task 3, and 2 in task 4). One participant finds the index via the contents list.

5.13.3 / Naming the contents and index

While we might not normally talk aloud while seeking-finding, and so would not need to consciously identify by name either the contents list or the index, the participants in this study were asked to do so, and the names that they use to identify these book structures are illuminating. Participants commonly use both the contents list and index without naming them (despite the instruction to speak out loud). The contents list is referred to by name only 14 times despite being used in 58 reports (4 participants never refer to it by name). It is identified by location ('the front' or similar) 6 times. It is also referred to as 'index' 6 times, 'an index of sections' once, and 'introduction' twice.

The index is referred to by name 15 times in the 33 reports it is used in (5 participants never refer to it by name, and 1 of these also never names the contents). The index is never referred to as 'contents', and it is referred to by location ('the back' or similar) 11 times.

This misapplication of names suggests that some participants are unclear about the difference between a contents list and an index – a similar finding to that in Coe (2014). However, participants seem largely confident that there will be an access structure either at the front of the book or the back or both (even if their understanding of the functionality of the particular access structure is less clear).

The use of terms such as *front* or *back* of the book are evidence of using an allocentric frame.

5.13.4 / Choosing whether to use contents or index

On starting a task, the participant has to decide their approach. As widely understood access structures, the index and contents list both afford purposeful access into the main body of the book. In this study, the first task is the only one that can be optimally resolved without using either contents list or index: opening the book and scanning page numbers is sufficient. Nonetheless on starting this task, 3 participants head directly for the contents list ('I assume the first point of reference is the contents' Theresa/task 1).

Throughout the 72 reports in this study, the contents list is a first choice in 43 instances (60%), and the index in 22 (31%). The small proportion choosing the index is striking given that Yussen, Stright, and Payne (1993: 248) find index use to be 'near universal'.

Figure 5.13a shows each participant's first choice of access structure in each task (the 'possible approaches' shown here are those that can lead to finding the information). There is no task for which all participants make the same first choice of access structure: the greatest proportion of participants to approach a task by the same access structure is two-thirds. There is no clear relation between individual task and first choice of access structure.

Figure 5.13b shows the same data as 5.13a, but sorted to make overall preferences explicit: 4 participants use the contents list as their first choice for each task, 1 participant always chooses the index as first choice, and the other 7 participants vary in the proportion of their first choices between the contents list and the index.

Participants divide into 3 groups over their first choice of contents list or index: (i) those with a preference for using the contents list, (ii) those with a

Figure 5.13a: *the first choice of access structure made by each participant in each task*

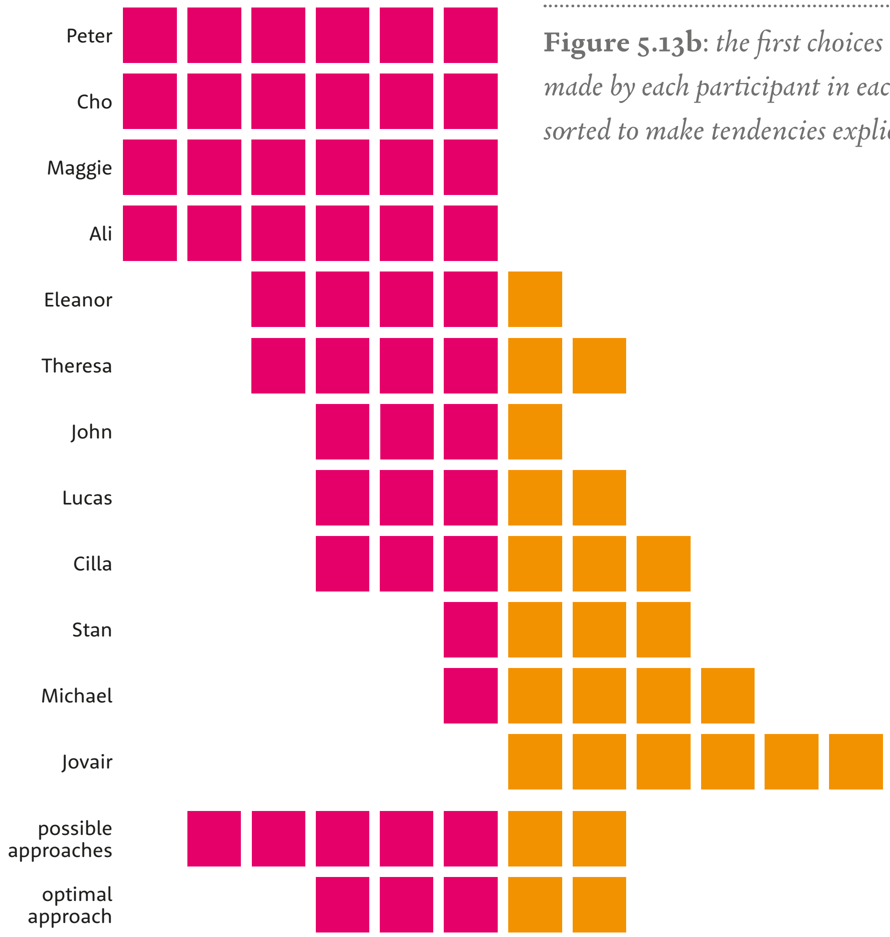


Figure 5.13b: *the first choices of access structure made by each participant in each task, grouped and sorted to make tendencies explicit*

preference for using the index, and (iii) those who show no overall preference for contents list or index. The participants' utterances also make clear that, principally for participants in (iii), decisions about whether to use the index or the contents list are based on either what worked last time or what they think is best suited to the task in hand.

- What worked last time:
  'as the contents worked last time I'll have another go' (Lucas/task 3)
  'I'm not going to the subject index: if it didn't list Beethoven in the back, why would it list Barack Obama?' (Lucas/task 6)
- What is best suited to the task in hand (in these instances, how broad or narrow the particular search needs to be):
  'maybe I should have gone to the index at the back to get precisely to Norse mythology' (Cilla/task 3)
  'Again first of all I would have thought it would have been easier to find him in the index' (Theresa/task 6)

When *all* choices of access structure in this study are examined, rather than just first choices, the picture is less clear – as shown in figure 5.13c. Preferences for contents list use and particularly index use, become less explicit: they are partially subsumed within the category of using both. This question of whether there are patterns in the choices that individuals make in either following instructions or using overviews is returned to in 7.4.3.

Other than the first choices that participants make, further qualitative aspects of behaviour around choosing to use the contents list or index are illustrated by the behaviour of participants in tackling task 5 ('find out how many symphonies Beethoven wrote after the *Eroica* symphony'). Several exhibit strikingly comparable behaviour: Cilla, Theresa, Michael, Eleanor, and Ali all hesitate over whether to use the contents or the index. Each of them has already encountered both contents list and index, and a previous task has taken them to the section on music where the answer to this current task is likely to be – should they go the contents and look up the section on music, or should they go to the index and look up Beethoven?

Cilla turns to contents list, but changes her mind before consulting it, and turns to index: 'I think I'm going to go to the index and look for Beethoven; even though I know there's a section on music, this will probably be the quicker route.' Likewise Eleanor.

Theresa consults the contents list: 'Now I know that I've got a contents section and an index, and I know that Beethoven is bound to be in "The world of music", but I might try finding Beethoven under B [in the index], unless actually if I go to "The world of music" because that did have a mini-contents,

Figure 5.13c: *all choices of access structure made by each participant in each task, grouped and sorted to match 5.13b*

will it just have Beethoven on his own – okay, Beethoven's got his own section here'. Likewise Michael and Ali.

This task can only be completed by starting at the contents list (or by referring to one's memory that chapter 13 deals with musical matters) because Beethoven is not listed in the index.[220] Several of the chapters in the book, including the chapter about music, have their own contents lists ('mini-contents'). This is a less commonplace feature within book organisation, nonetheless 7 participants make use of the mini-contents in task 5 (Beethoven is an item listed in this mini-contents), and 2 also use a mini-contents in task 4.

5.13.5 / Fixed-location or portable?

Several of the participants 'bookmark' the contents list with a finger, allowing them readily to re-access it after looking in the main body of the book. In

220 The index is titled 'Subject index', which typically means that it does not include the names of people (which would be in an index of names). This is why 'Beethoven' will not be found in it, nor 'Obama', although 'Obama administration' is included.

so doing they provide the closest approximation within the user studies to using a portable overview in a paper document. As discussed in 5.8 and 5.9, instructions and overviews that are portable are not commonplace in paper documents, and this 'bookmarking' work-around affords the benefits of portability. Several participants use this behaviour, but it is particularly notable in Peter and Cho who use this strategy to work around not understanding the page numbering system – this is discussed in the case study in 5.14. The use of a 'bookmark' means that this strategy combines aiming with using a fixed-location overview. And the same behaviour has been observed in other studies: a participant, in a study by Marshall and Bly (2005), says: '"The very first thing I always do is find the Table of Contents. ... And so normally I can find it in just a couple of pages. And then what I do is turn down the corner. Because I constantly will flip back to the Table of Contents."'

5.14 / Case study: using page numbers

Using page numbers in order to find the location of a particular page in a book is one of the most commonplace examples of sequencing in paper documents. See 5.11 for a discussion of sequencing in all contexts. This case study looks at understanding page numbering systems in a paper document as demonstrated in the task observation study (see 3.2 for a description of the study and the page numbering system the test materials use).

5.14.1 / Understanding the page numbering

In the task observation study, 8 of the 12 participants demonstrate a functional understanding of the idiosyncratic page numbering system used in the book by the end of the first task. Of the other participants, a further 2 understand it by the end of task 3, Cho understands it by the end of task 4, leaving Peter who never demonstrates full understanding of the page numbering system. Despite this, Peter employs sequencing in 5 of the 6 tasks, but this comprises either other forms of sequencing (e.g. in alphabetical dictionary-type sections) or using page numbers in a localised way that gives no evidence of understanding the alphabetic prefixes in the page numbers or even that these numbers on the page form a comprehensive system.

Michael expresses coming to understand the two-step page numbering system most pithily: 'I followed the alphabet, and then the numbers.' Several participants demonstrate this sort of unhesitating understanding of the system.

Maggie gives the most discursive insight into exploring the page numbers as she starts the first task (finding page Q15) and comes to understand how they work: ‘Right, I’ve never handled this before – so Q15’, *looks at the contents list* ‘which I presume, from the index, I will find – no, it says 14, so is that the section I wonder’, *turns to about halfway through the book, flips backwards,* ‘or is it easier to go just like this’, *still leafing backwards through the book,* ‘now this is where my information – now this is strange’, *leafing backwards and forwards,* ‘because it changes’, *flipping more slowly,* ‘well well well – now what do I do about that, if that’s –’, *flipping backwards again,* ‘it doesn’t go through in a straightforward manner, right okay, well let’s –’, *leafing more purposefully, then pausing,* ‘so – Q15 – I wonder what that means’, *leafing again* ‘Q15, let’s have a look – oh here we are we’ve got some Ps – right – I hope – aha’, *turns pages slowly, arrives at page Q15,* ‘well, just by flipping through I’ve arrived at Q15’. Note also Maggie refers to the contents list as an index (see 5.13.3).

5.14.2 / Peter and Cho

Although Peter never demonstrates a functional understanding of the page numbering system, he completes 5 of the 6 tasks, and his time spent on each task is comparable with other participants who *do* demonstrate such understanding. So, how is he managing to work just as effectively without using the page numbers?

Almost from the outset, Peter uses a tactic that makes intensive use of the contents list and allows it to act as if portable. He uses it to triangulate the relationship between his current location in the book and his objective, allowing him to know whether to move forwards or backwards through the book in order to head towards his objective. The following description of the start of task 3 (find the start of the article on Norse mythology) illustrates this: *Turning to contents,* ‘right, back to the contents page again’, *scanning list,* ‘the essay on Norse mythology – will be under “Myths and legends” I presume – which again is* [letter] “I” – reasonably near the beginning, number seven – so quick flip’, *keeps one finger in contents list and turns about one sixth of the way through the book, checks the running head,* ‘“Britain today”’, *marks place with one finger and turns back to contents list, scans swiftly,* ‘a bit further than that’, *turns back to his place in the book, leafs forwards a bit further, checks running head,* ‘“The historical world”’, *turns back to contents list, scans it,* ‘more than that’, *turns back to his place in the main text, leafs a bit further,* ‘“General compendium”’, *turns back to contents, scans it,* ‘“Myths and legends” will be next’, *returns to main text, leafs a bit further, while scanning running heads, reads running head,* ‘“Myths and legends”’, *starts paging backwards and reaches section start*.

Repeated referring back to the contents (much as if it is a portable overview) allows Peter to monitor his location within the book and his progress relative to his objective. This iterative process is used for each task, and demonstrates itself to be an effective alternative to conventional use of page numbers.

Cho, who also struggles with the page numbering system, employs the same triangulation system using a bookmarked contents list. It is intriguing that 2 of the 12 participants employ this same work-around. The research literature discussing sequencing in general or page number use in particular is too scanty to shed light on the question of comprehension of page numbers or other approaches to detailed navigation of multi-page printed documents. Although Fyfe and Mitchell (1985) do not address page numbering directly, their studies of seeking-finding in paper documents address other forms of sequencing: they find numerous instances of participants who struggle due to not understanding the conventions of the sequencing system they are using, and, in particular, note difficulties with alphabetic sequencing as the cause of more problems than one might anticipate.

5.14.3 / Comparing sequencing in the three studies

The other user studies conducted for this thesis do not include direct observation of behaviour, and so do not permit the same fine-grain examination of process as is possible in the task observation. In terms of quantitative data, in the task observation (in paper documents), sequencing is used in 94% of reports. In the wayfinding survey (in environmental space), sequencing is used in 9% of reports. And in the diary keeping, sequencing is used in the different contexts as follows:

- 23% of reports in environmental space
- 61% of reports in paper documents
- 2% of reports on-screen

The proportion of reports that include sequencing in paper documents in the two studies – the task observation (94%) and the diary keeping (61%) – differ greatly. And the two figures for sequencing in environmental space – the wayfinding survey (9%) and the diary keeping (23%) – also differ rather a lot. This variation suggests that although context may play a part in choosing this tactic, other behaviour-influencing factors are involved. Potential factors are legion, including individual preference and aptitude, and differences in the affordances of particular environments (for example, see 5.12.5 for a discussion of how particular environments in the wayfinding survey may not readily afford sequencing).

5.15 / Case study: Alison

Alison is a participant in the diary keeping study. At the time of the research, she is 42 years old, cohabiting with her partner, educated to degree level, and self-employed as a designer.

Alison includes semantic behaviours in a smaller proportion of her reports than any other participant, but this is relatively typical of her somewhat minimal reporting. Even more striking is the very small proportion of reports including social behaviours.

5.15.1 / Overview of Alison's data

Figure 5.15a shows Alison relative to other participants in terms of the proportion of each participant's reports that come from each context (based on figure 3.7a, with Alison highlighted and all other data greyed out).

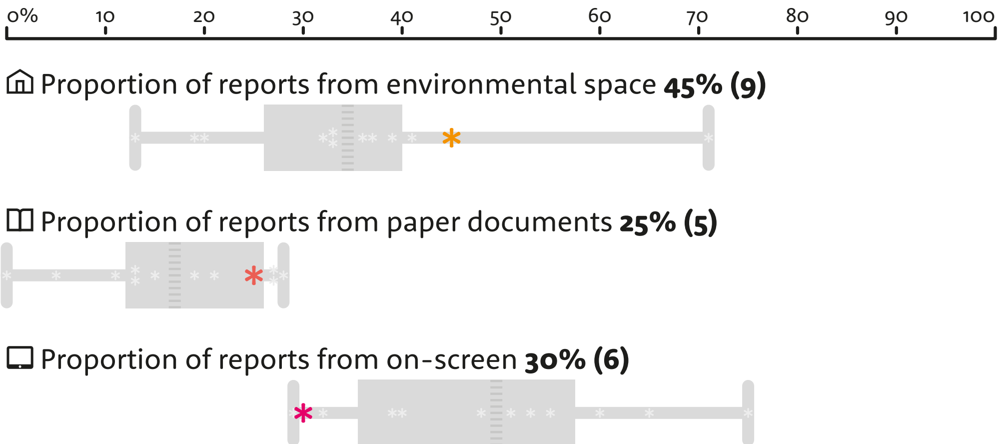


Figure 5.15a (based on 3.7a): *breakdown of Alison's reports by context, in relation to other participants*

The greatest proportion of Alison's reports is from environmental space: Alison is one of 3 participants who make the largest proportion of reports from environmental space, all the others make their largest proportion from on-screen (see 8.3.1). Alison emerges as spending a greater proportion of time than is usual for this group of participants seeking-finding in environmental space; and unlike many participants her seeking-finding on-screen is not substantially greater than her seeking-finding in paper documents.

Figure 5.15b shows Alison relative to other participants in terms of the proportion of each participant's reports that include semantic behaviours across all three contexts (this is based on figure 3.7i, with Alison highlighted and all other data greyed out). Semantic behaviours occur in 70% of Alison's reports (shown by the pink star): the smallest proportion of any participant's

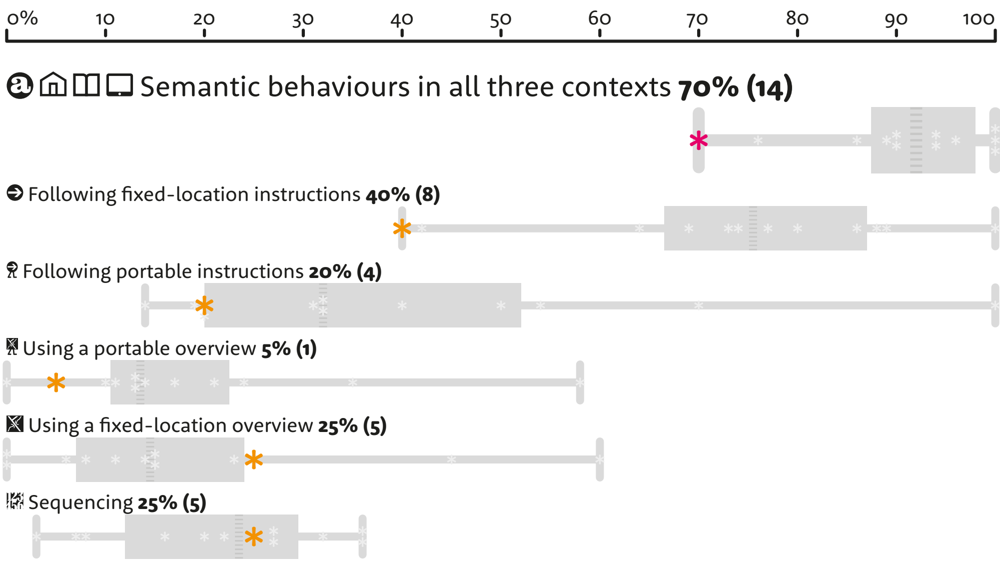


Figure 5.15b (based on figure 3.7i): *the proportion of Alison's reports that include semantic behaviours across all contexts, in relation to other participants*

reports. She is a considerable outlier because most other participants include semantic behaviours in considerably larger proportions of their reports. Before becoming too preoccupied with Alison including semantic behaviours in a smaller percentage of her reports than any other participant, it is worth noting that her reporting of social and spatial behaviours is equally minimal. It is possible that this means that Alison's repertoire of seeking-finding tactics is somewhat constrained, or it could equally mean that her reports were more cursory, or that she was more selective in what she included. The data as it stands cannot clarify this.

The orange stars in figure 5.15b separate the percentages of Alison's reports that include each of the 5 categories of semantic behaviour (with contexts consolidated). Despite her minimal overall reporting of semantic behaviour, she is above the median for 2 categories but below it for the other 3. The semantic behaviour that she reports most frequently – following fixed-location instructions – is the one for which she is an outlier at the bottom of the range: she includes it in a considerably smaller proportion of her reports than any other participant, despite it being her most frequently reported semantic behaviour.

Figure 5.15c shows Alison relative to the other participants in terms of the proportion of each participant's reports that include semantic behaviours with the data broken down by context (this is based on figure 3.7l, with Alison highlighted and all other data greyed out). The pink stars show the percentages of Alison's reports that contain semantic behaviours when separated out into the 3 contexts. The percentages of her reports broken down by category of semantic behaviour and by context are shown as the orange stars.

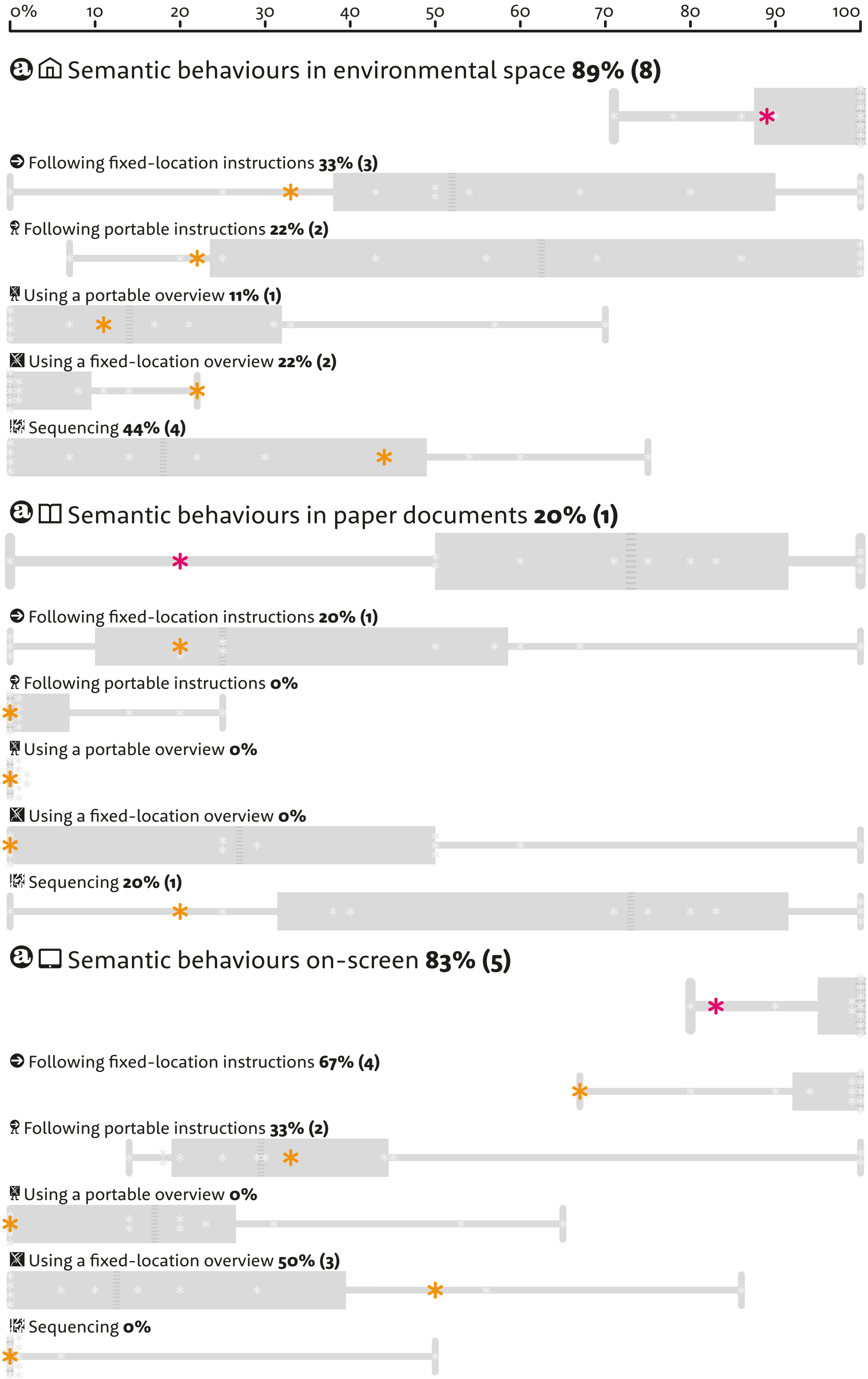


Figure 5.15c (based on figure 3.7l): *the proportions of Alison's reports that include semantic behaviours, broken down by context, in relation to other participants*

When the contexts are separated out but semantic behaviours are still grouped together (the pink stars in figure 5.15c), Alison is below the median in each context. But, interestingly she is not at the bottom of the range in any context – despite reporting the smallest proportion of semantic behaviours when data for contexts is consolidated (figure 5.15b). The proportion of her reports including semantic behaviour in paper documents is considerably lower than that in the other contexts.

When individual categories of semantic behaviour are separated for the different contexts (shown in figure 5.15c by the orange stars), Alison includes most semantic behaviours in a smaller proportion of reports than is typical (below the median in the majority of instances). She is above the median in only 4 categories of behaviour: following portable instructions on-screen, using a fixed-location overview in environmental space and in on-screen; and sequencing in environmental space. For 2 of these, using a fixed-location overview in environmental space and in on-screen, she includes this behaviour in a greater proportion of her reports than almost any other participant. These patterns suggest heavy use of artefacts like you-are-here maps and site maps; and greater than usual use of the back arrow on-screen, and house or room numbers in environmental space

Figure 5.15d presents a different view of Alison's behaviour: without the comparison of other participants. Each row shows a single report: detailing the task, context, and particular combination of behaviours used. This allows us to examine the various combinations of behaviour in each report. The rows are ordered so that categories of semantic behaviour are grouped (as far as is possible) in order to give the best possible overview of groupings within semantic behaviours, and to see if groupings also emerge elsewhere in the table.

The issues emerging from Alison's data form the rest of this case study.

5.15.2 / Semantic behaviours in relation to each other

Following fixed-location instructions occurs in more of Alison's reports than any other semantic behaviour, but she includes it in a smaller proportion of her reports than any other participant. It is also the only semantic behaviour that she reports in all contexts. Others are reported in only 1–2 contexts.

All co-occurrences of categories of semantic behaviours include following fixed-location instructions. Co-occurrences also include following portable instructions (this behaviour only occurs in conjunction with following fixed-location instructions), using a fixed-location overview, and sequencing. Of Alison's reports, 6 contain no semantic behaviours; 7 each contain a single semantic behaviour; 5 contain pairs of semantic behaviours; and 2 both contain 3 semantic behaviours.

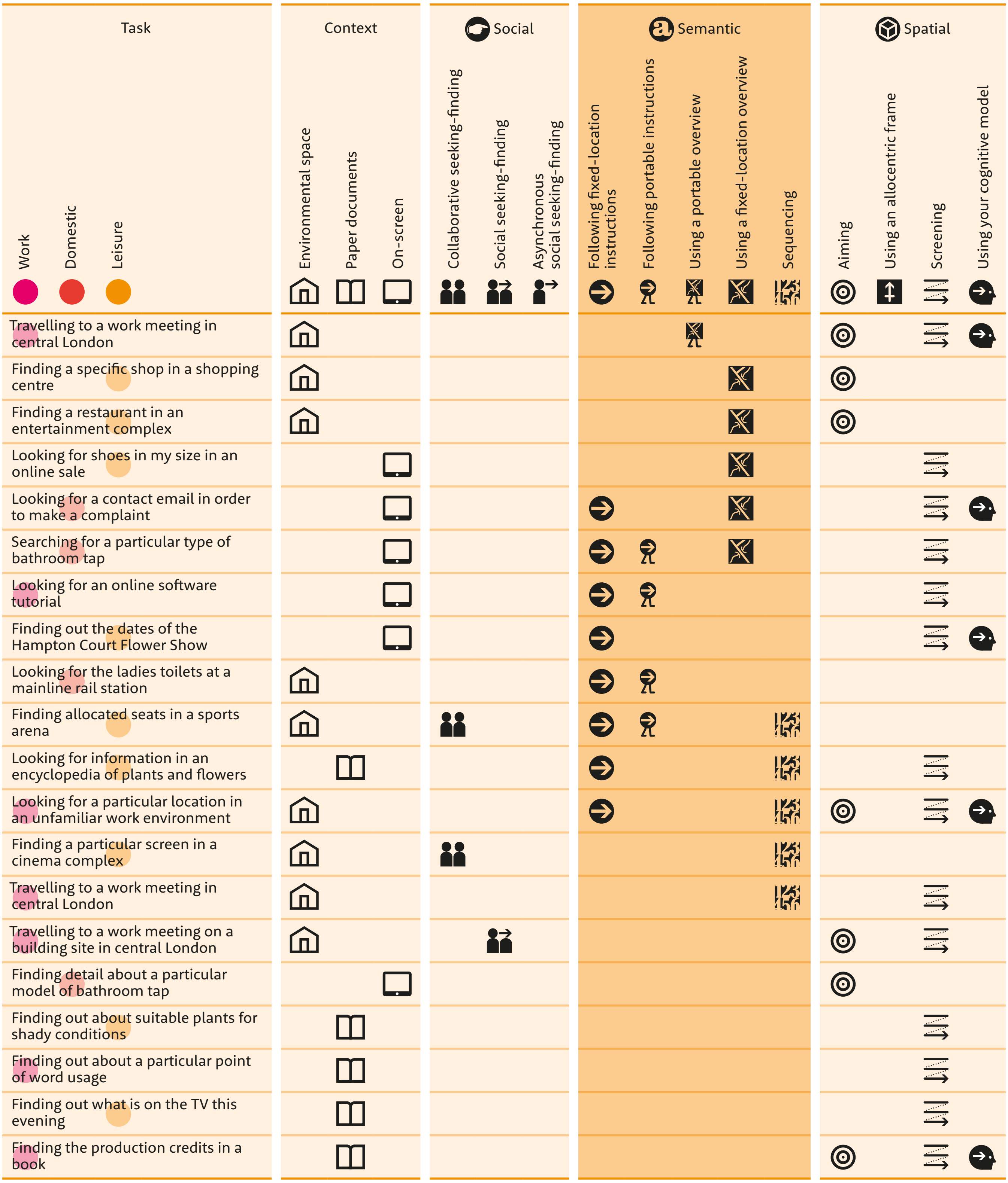


Figure 5.15d: *each row shows the combination of behaviours in one of Alison's reports*

5.15.3 / Semantic behaviours in relation to social and spatial behaviours

One of the noticeable things about the overview in fig. 5.15d is the variety of permutations of behaviours: there are few immediately apparent patterns of co-occurrence across social, semantic, and spatial behaviours that build on the possible patterns among semantic behaviours observed above.

Social behaviours occur strikingly infrequently in Alison's reports. Only 3 (15%) of Alison's 20 reports include social behaviour; this is the lowest proportion for any participant.

Alison's reports include a high proportion (25%) that report spatial behaviours only: this is considerably higher than the proportion for any other participant in the study (median: 5.5%). Of Alison's 5 reports including only spatial behaviours, 4 are from paper documents.

Alison's 3 reports that do *not* include spatial behaviours are all from environmental space. Although environmental space might intuitively seem the most compellingly spatial of the three contexts, it provides Alison's only reports excluding spatial behaviours.

5.15.4 / Comparison of semantic behaviours across contexts

When one sorts Alison's reports by context, the proportion including semantic behaviour in paper documents is unusually low. Figure 5.15c shows that there is only 1 participant who includes semantic behaviours in a smaller proportion of their reports from paper documents. And when individual categories of semantic behaviour in paper documents are examined, Alison is on or below the median for all semantic behaviours, meaning that she reports all of these behaviours less than is usual. Alison's reports of semantic behaviour in environmental space and in on-screen are also infrequent but less extremely so.

Alison makes 5 reports of seeking-finding in paper documents, but only 1 of these involves semantic behaviours – a finding somewhat at odds with the frequent reporting of semantic behaviour in paper documents in the task observation (see 5.12.1). Alison's single instance of using semantic behaviours for seeking-finding in a paper document is a 'classic' type of information seeking task: 'looking up details about a variety of birch tree in the RHS Encyclopedia of Plants and Flowers'. This report includes following fixed-location instructions (using the index) and sequencing (using the page numbers), both of which emerge in the task observation as frequently used tactics (see case studies in 5.13 and 5.14).

Her other reports of seeking-finding in paper documents are more diverse: they include open-ended tasks, and looking for information outside of the main content structure of a document.

As noted in 5.15.3, some of Alison's reports of seeking-finding in environmental space exclude spatial behaviours. The majority of Alison's reports of seeking-finding in paper documents exclude semantic behaviours. One might expect semantic behaviours to be a good fit with seeking-finding in paper documents, and likewise for spatial behaviours and environmental space (a suggestion also put forward by Morville 2005: 4), but these findings suggest a relationship of behaviour to context that is the opposite of this. This is discussed further in 8.3.2.

5.15.5 / Following portable instructions

This behaviour occurs in 4 of Alison's reports: 2 from on-screen space and 2 from environmental space. This puts her just above the median for how frequently she reports this behaviour. All instances co-occur with other semantic behaviours: all also report following fixed-location instructions, and 1 on-screen also reports using a fixed-location overview, and 1 in environmental space also reports sequencing. Both from on-screen also include a single spatial behaviour: screening. And both from environmental space include no spatial behaviours (and the 1 that includes sequencing also includes collaborative seeking-finding).

In the instances from environmental space, the actual tactic Alison uses is following a line marked on a wall, floor, or similar and in both it is in a large public building. The on-screen tactic is using the back arrow, both times in large websites with search functions.

5.15.6 / Using a portable overview

This behaviour occurs only once in Alison's reports, in environmental space. Although infrequent this puts Alison close to the median for this behaviour in this context. It is also the only semantic behaviour in Alison's reports that is never combined with other semantic behaviours. It is combined with spatial behaviours (aiming, screening, and using her cognitive model) but no social behaviours (this is not unusual, as already noted, Alison's reporting of social behaviours is particularly low). This is the only occasion on which Alison uses a map on her phone while she is seeking-finding in environmental space. The only other occasion when she reports using a map on her phone is part of her preparation before setting out. The additional qualitative information from Alison's reports and interviews sheds no light on her infrequent use of the map on her phone. However, it emerges from other participants in the diary keeping and from comments in the wayfinding survey that some people prefer not to use maps in public because they think this makes them appear vulnerable. In cities such as London, people may also be concerned about being seen using their phone in public lest it is grabbed and stolen. Both of these behaviour-influencing factors may be stronger for women on their own. This is discussed further in 8.2.2.

There is one other report that Alison makes of a task that is comparable to this one in which she uses a portable overview – both concern finding a work-related address in central London. However despite the tasks having similar goals, the behaviours employed have little in common: the other instance employs only sequencing and screening. That both instances involve screening is hardly noteworthy given that it occurs in 83% of all reports. Other than this they have no behaviours in common. We can only speculate but it is likely that the particular environments afforded the use of different seeking-finding tactics.

5.15.7 / Sequencing

This behaviour occurs in 5 (25%) of Alison's reports, which puts her slightly above the median. As already noted, only 1 of her 5 reports of seeking-finding in paper documents includes sequencing. The other 4 reports of this tactic are all from environmental space. It is intriguing that, on the one hand, Alison includes sequencing in a greater proportion of her reports from environmental space than most other participants (there are only 3 participants who include it in higher proportions of their reports); but on the other hand, there is only 1 participant who includes sequencing in a smaller proportion of reports from paper documents. Quite why Alison should rely so heavily on house or room numbers and not page numbers is hard to explain, but her open responses suggest that other factors such as task and the affordances of particular spaces may have as much of a bearing as any particular context-driven bias in her choices.

Of the 5 reports including sequencing, 2 have several other factors in common:

- They are the only reports including collaborative seeking-finding
- They are the only instances of sequencing that *exclude* screening
- Both are in environmental space
- Both are leisure tasks, part of being an audience member: finding the right screen in a cinema complex, and finding numbered seats in a sports arena

Other than this, there is little visible pattern in the relationship of sequencing with other factors.

5.16 / Case study: Tanveer

Tanveer is another participant in the diary study. At the time of the research, he is 46 years old, cohabiting with a partner, educated to degree level, and working as an extra for film and television.

Tanveer is notable for never seeking-finding in paper documents, and for the homogeneity of the behaviours included in his reports.

5.16.1 / Overview of Tanveer's data

Figure 5.16a shows Tanveer relative to other participants in terms of the proportion of each participant's reports that come from each context (based on figure 3.7a, with Tanveer highlighted and all other data greyed out). Tanveer is

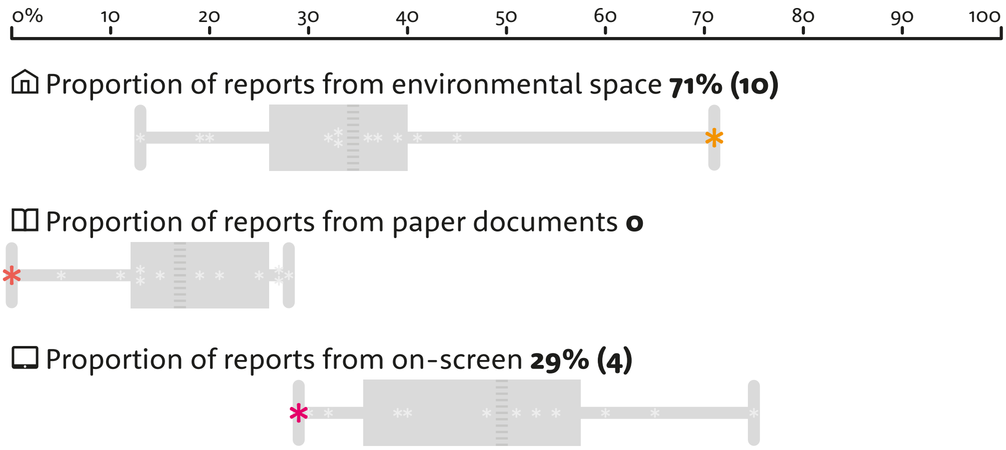


Figure 5.16a (based on 3.7a): *breakdown of Tanveer's reports by context, in relation to other participants*

exceptional in reporting no seeking-finding in paper documents. In his initial briefing meeting, he stated that he no longer uses paper documents for seeking-finding tasks – he even identifies the year (2007) in which he stopped because it is when he built his first computer. Despite having built his own computer, and conducting no seeking-finding in paper documents, his reports include a smaller proportion from on-screen than any other participant. On the other hand, he includes a greater proportion of reports from environmental space than any other participant – possibly this is in part a consequence of his work which frequently requires him to travel to unfamiliar locations.

Figure 5.16b shows Tanveer relative to other participants in terms of the proportion of each participant's reports that include semantic behaviours across all three contexts (this is based on figure 3.7i, with Tanveer highlighted and all other data greyed out). Semantic behaviours occur in all of Tanveer's reports (shown by the pink star). He is 1 of 3 participants to include semantic

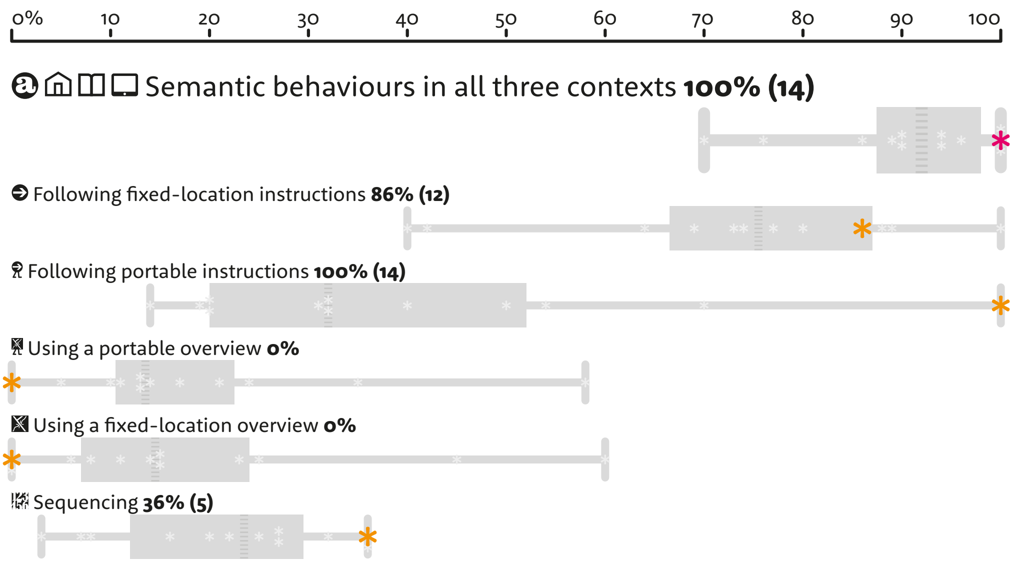


Figure 5.16b (based on figure 3.7i): *the proportion of Tanveer's reports that include semantic behaviours across all contexts, in relation to other participants*

behaviours in all of their reports, and 10 of the 12 participants include semantic behaviours in over 85% of their reports. So although Tanveer is at the top of the range for the proportion of reports including semantic behaviours, he is not unduly exceptional in this respect.

The orange stars in figure 5.16b separate the percentages of Tanveer's reports that include each of the 5 categories of semantic behaviour (with contexts consolidated). Tanveer's behaviour emerges as somewhat extreme: he never reports using a portable overview or using a fixed-location overview (the only participant to do so), but he includes following portable instructions and sequencing in a larger proportion of his reports than the others (for the former, he is an extreme outlier), and for following fixed-location instructions, he is still above the median but not as extreme.

Figure 5.16c shows Tanveer relative to the other participants in terms of the proportion of each participant's reports that include semantic behaviours with the data broken down by context (this is based on figure 3.7l, with Tanveer highlighted and all other data greyed out). The pink stars show the percentages of Tanveer's reports that contain semantic behaviours when separated into the 3 contexts. The percentages of his reports broken down by category of semantic behaviour and by context are shown as orange stars.

Tanveer's behaviour is relatively consistent between environmental space and on-screen. As one would expect after seeing 5.16b, Tanveer reports no instances of using a portable overview or using a fixed-location overview in either environmental space or on-screen. For the rest of the behaviours on-screen, Tanveer is at the other end of the range: making the largest proportion of reports that include them in this context. In environmental

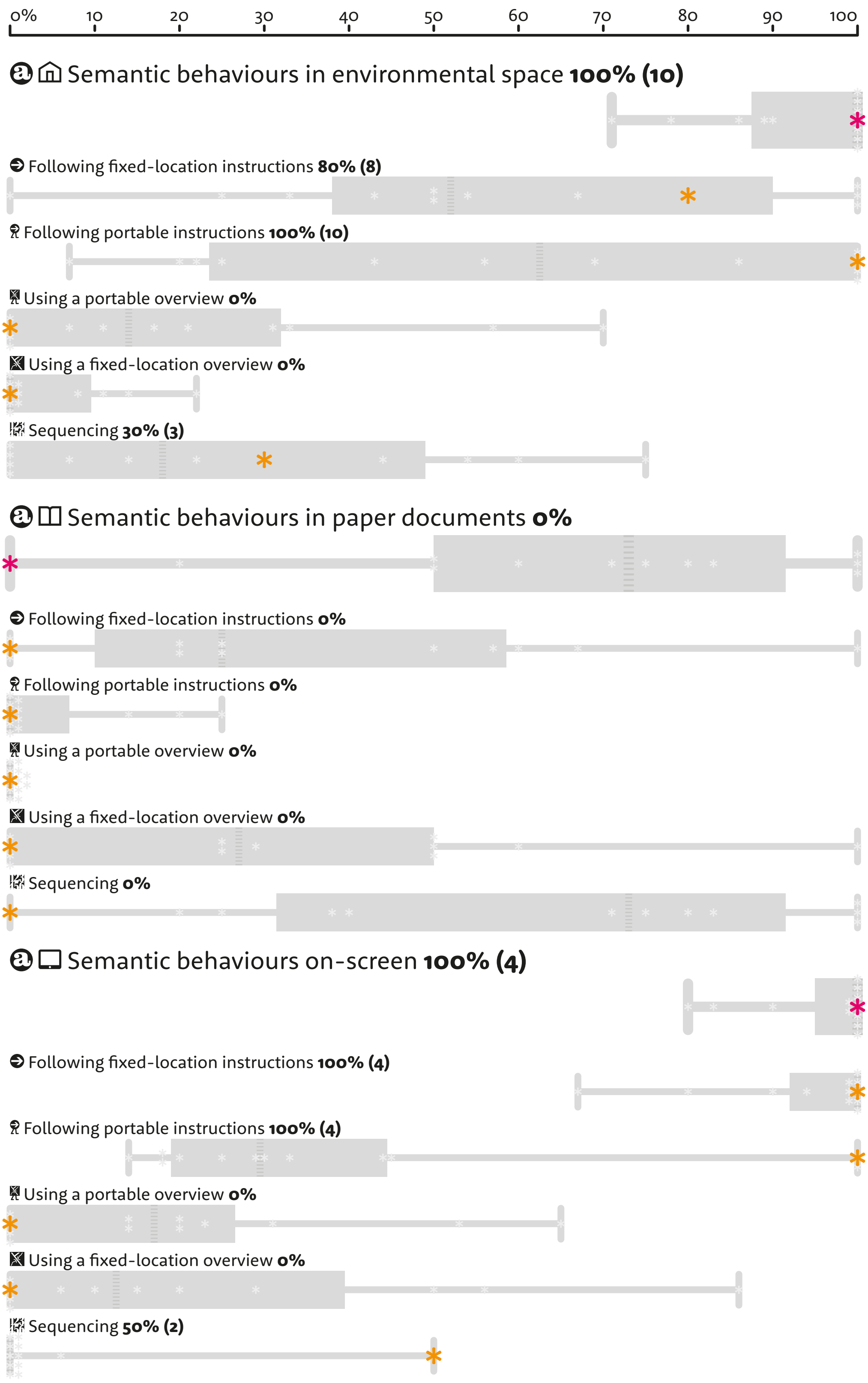


Figure 5.16c (based on figure 3.7l): *the proportions of Tanveer's reports that include semantic behaviours, broken down by context, in relation to other participants*

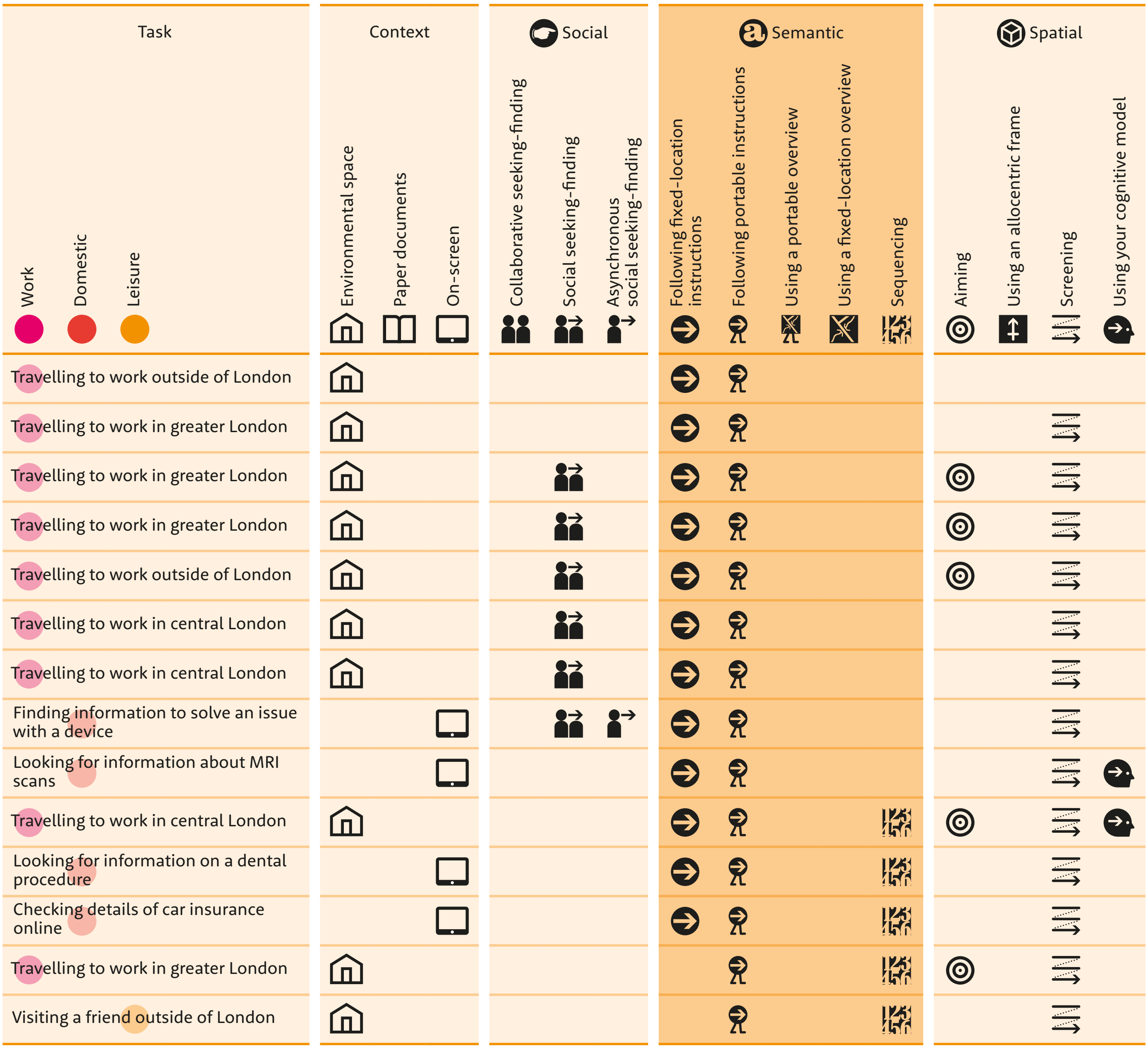


Figure 5.16d: *each row shows the combination of behaviours in one of Tanveer's reports*

space, he remains above the median for these 3 behaviours, but he is not in the top quartile for either following fixed-location instructions or sequencing. Nonetheless, it is striking that his reporting of different semantic behaviours is consistent between the 2 contexts that he uses.

Figure 5.16d presents a different view of Tanveer's behaviour: without the comparison of other participants. Each row shows a single report: detailing the task, context, and particular combination of behaviours used. This allows us to examine the various combinations of behaviour used in each report. The rows are ordered so that categories of semantic behaviour are grouped (as far as is possible) in order to give the best possible overview of groupings within semantic behaviours, and to see if groupings also emerge elsewhere in the table.

The issues emerging from Tanveer's data form the rest of this case study.

5.16.2 / Semantic behaviours in relation to each other

Tanveer demonstrates a tendency to use semantic behaviours together: his repertoire appears limited and when used they are either paired or in threes. Such strong co-occurrence is not the case within either social or spatial behaviours.

Tanveer includes following portable instructions in each of his reports (irrespective of context). It is frequently paired with following fixed-location instructions, and less frequently combined with sequencing. Some reports include all three of these semantic behaviours. Tanveer makes no reports of using a portable overview or using a fixed-location overview.

The ubiquity of following fixed-location instructions and following portable instructions and the absence of using a portable overview and using a fixed-location overview suggest that Tanveer has strong preferences in his choice of semantic behaviours.

5.16.3 / Semantic behaviours in relation to social and spatial behaviours

As figure 5.16d shows, there are no strong patterns of co-occurrence for Tanveer beyond the fact that the majority of reports contain following fixed-location instructions, following portable instructions, and screening. There may be a negative relationship between social behaviours and both sequencing and using his cognitive model, but the data sheds little further light on this and the quantities of reports are too small to be conclusive.

5.17 / Case study: Mike

Mike is another participant in the diary study. At the time of the research, he is 32 years old, cohabiting with a partner, educated to degree level, and employed in recruitment for asset management.

Mike's reports include all 5 semantic behaviours, but they predominantly report following fixed-location instructions and using a portable overview.

5.17.1 / Overview of Mike's data

Figure 5.17a shows Mike relative to other participants in terms of the proportion of each participant's reports that come from each context (based on figure 3.7a, with Mike highlighted and all other data greyed out). The proportions of Mike's reports from each context never stray far from the

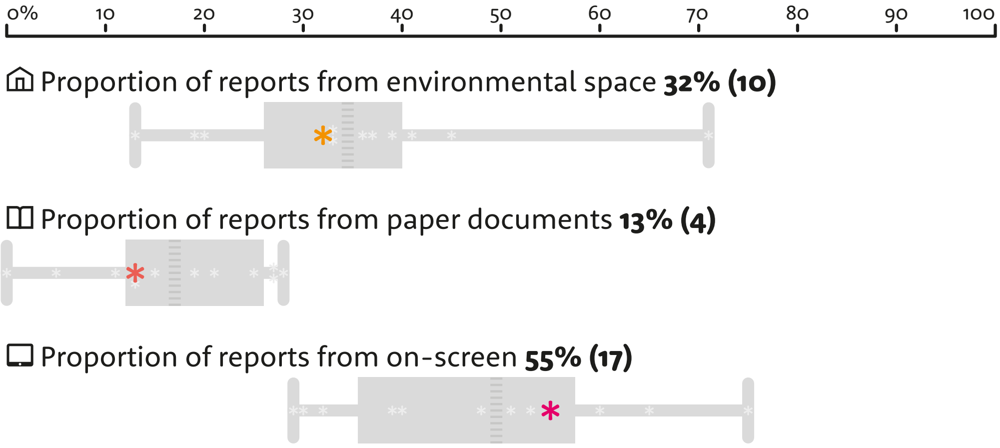


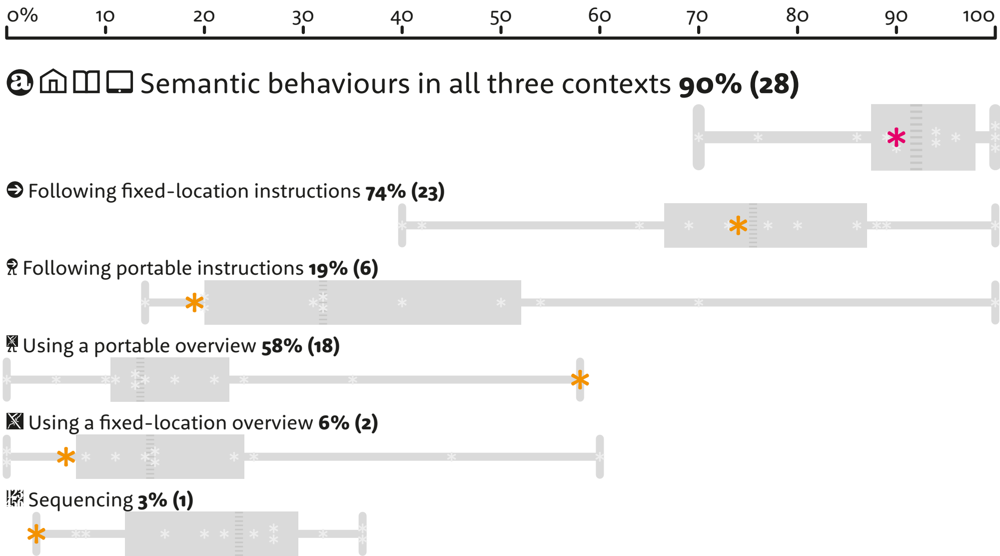
Figure 5.17a (based on 3.7a): *breakdown of Mike's reports by context, in relation to other participants*

median: he is just below the median for the proportions of his reports from environmental space and paper documents, and slightly above for on-screen.

Figure 5.17b shows Mike relative to other participants in terms of the proportion of each participant's reports that include semantic behaviours across all 3 contexts (this is based on figure 3.7i, with Mike highlighted and all other data greyed out). Semantic behaviours occur in 90% of Mike's reports (shown by the pink star); this is just below the median. Mike includes semantic behaviours in a greater proportion of his reports than Alison, but not as many as Tanveer.

The orange stars in figure 5.17b separate the percentages of Mike's reports that include each of the 5 categories of semantic behaviour (with contexts

Figure 5.17b (based on figure 3.7i): *the proportion of Mike's reports that include semantic behaviours across all contexts, in relation to other participants*



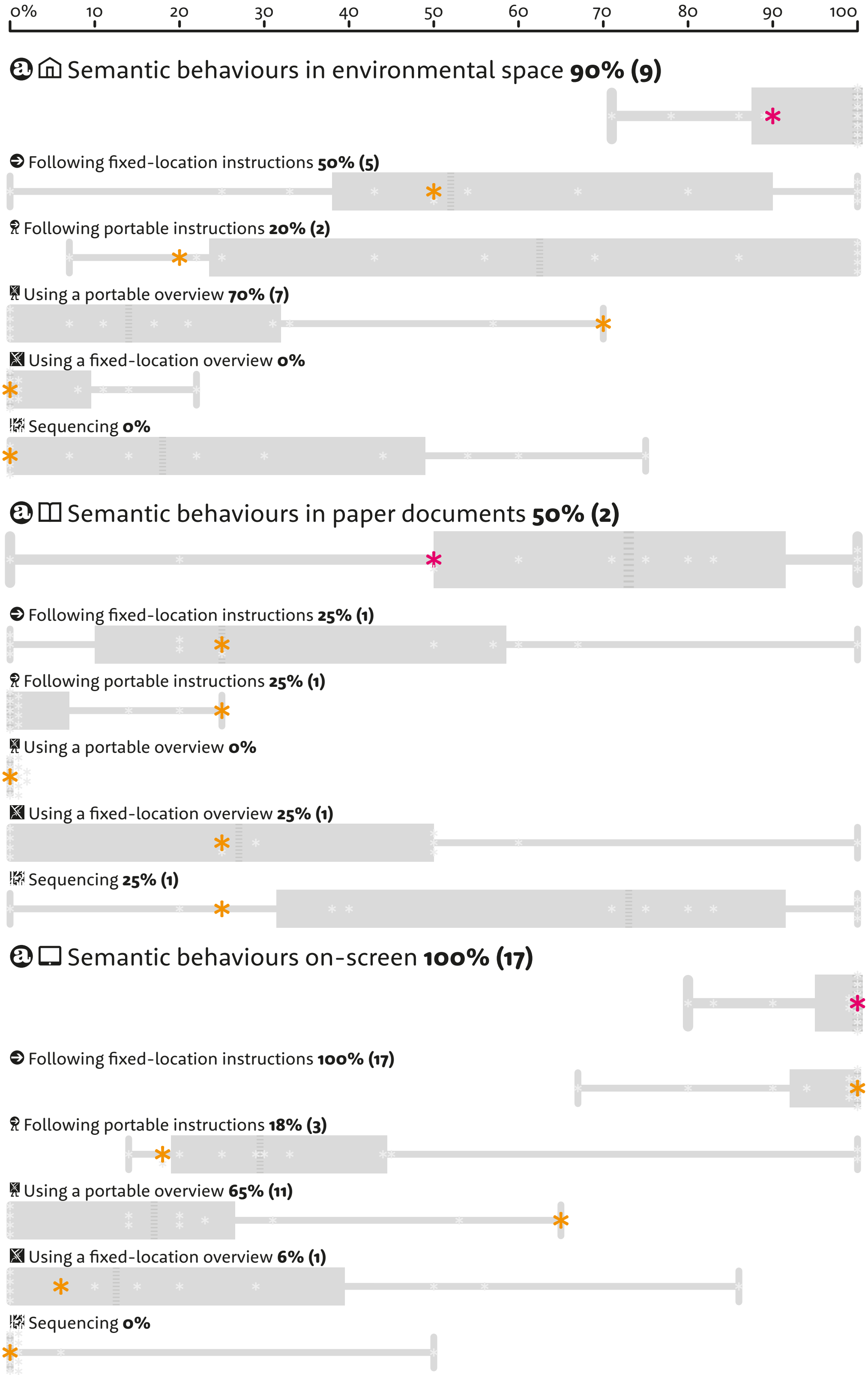
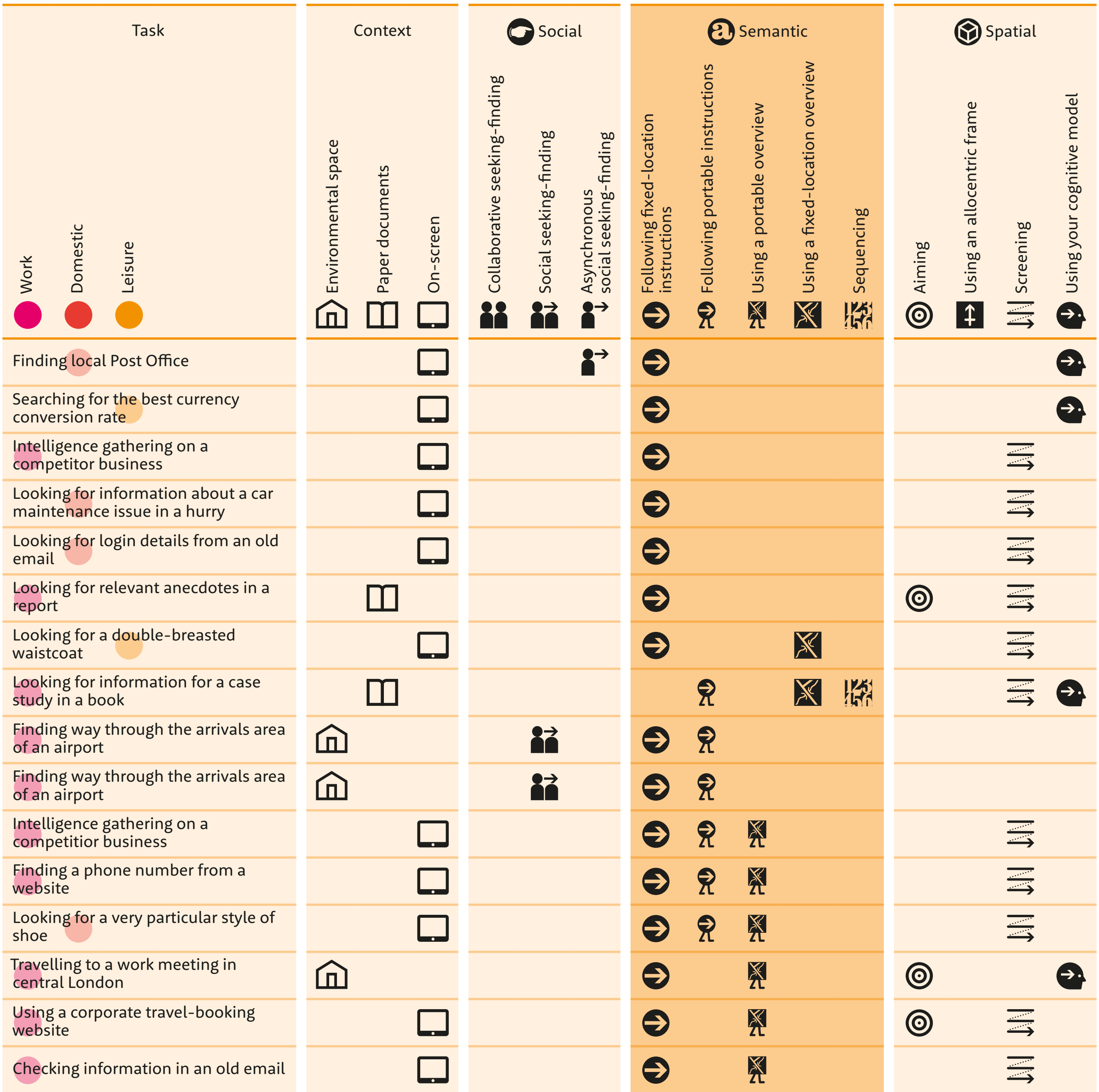


Figure 5.17c (based on figure 3.7l): *the proportions of Mike's reports that include semantic behaviours, broken down by context, in relation to other participants*



consolidated). Despite being close to the median for semantic behaviour as a whole, the reporting of individual categories of semantic behaviour tends to the upper or lower limits of the range. The exception is following fixed-location instructions, where he is in the quartile below the median. For following portable instructions, using a fixed-location overview, and sequencing, he is in the lowest quartile (although they are relatively compressed quartiles). He includes sequencing in a smaller proportion of reports than any other participant, but using a portable overview is included in a greater proportion of reports than any other participant – and this last is a considerable outlier.

Figure 5.17c shows Mike relative to the other participants in terms of the proportion of each participant's reports that include semantic behaviours

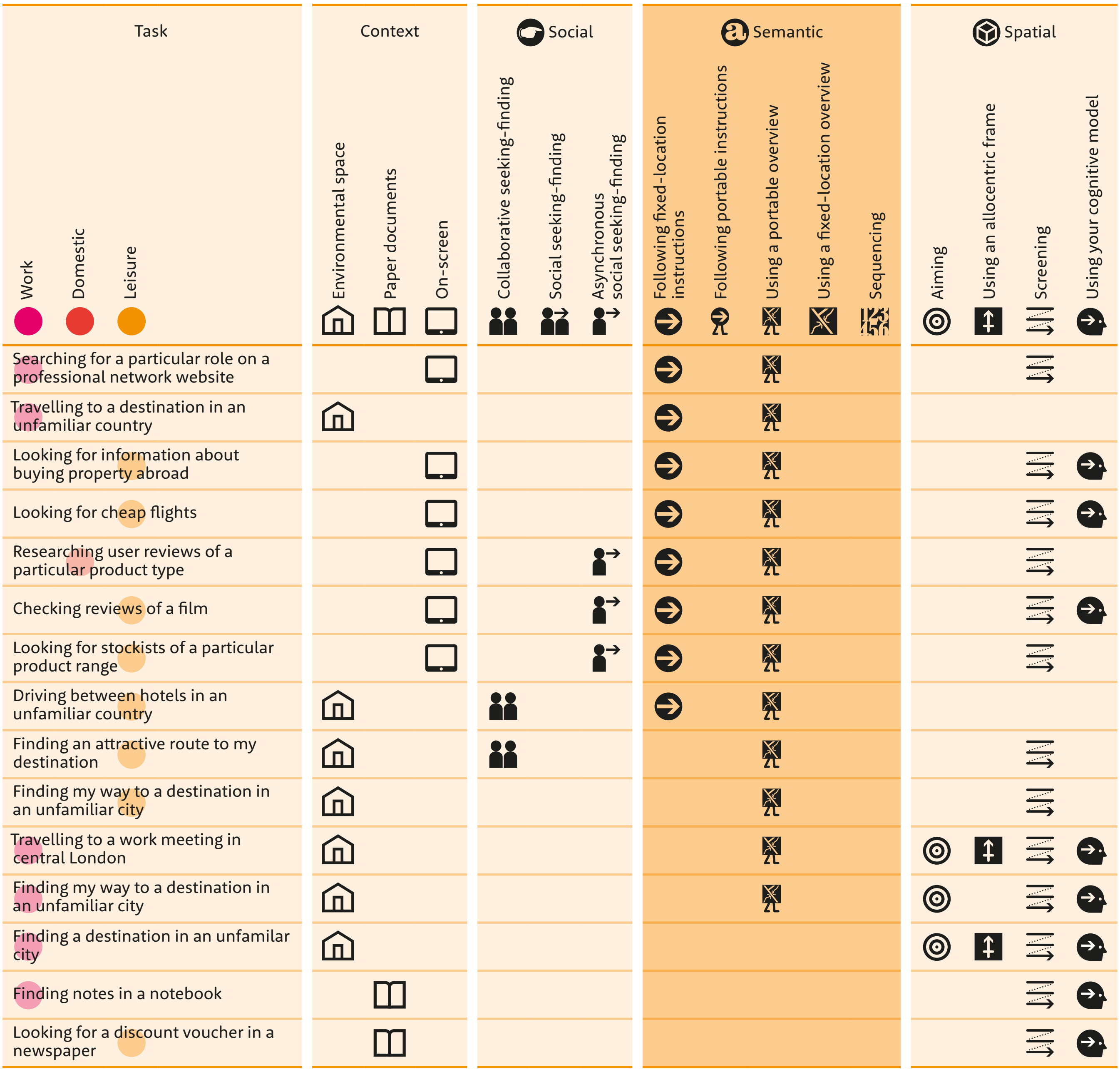


Figure 5.17d (above and facing): *each row shows the combination of behaviours in one of Mike's reports*

with the data broken down by context (this is based on figure 3.7l, with Mike highlighted and all other data greyed out). The pink stars show the percentages of Mike's reports that contain semantic behaviours when separated into the 3 contexts. The percentages of his reports broken down by category of semantic behaviour and by context are shown as orange stars.

When semantic behaviours are viewed as a whole but broken into separate contexts (the pink stars in figure 5.17c), Mike's reporting of this group hovers around the boundary between the bottom two quartiles for environmental space and paper documents, meaning that there are only three or four participants who include this behaviour group in smaller proportions of their reports in each context. But, along with 8 other participants, he includes semantic behaviours in *all* of his reports of seeking-finding on-screen.

In general, across all contexts, the proportions of Mike's reports including each category of behaviour tend to be on or below the median (the orange stars in figure 5.17c). This means that for most behaviours in most contexts, 6 or more of the 12 participants include that behaviour in greater proportions of their reports. The exceptions to this are: following fixed-location instructions on-screen (which, along with 7 other participants, he includes in all of this reports);[221] and using a portable overview in environmental space and in on-screen (in both contexts he is a considerable outlier at the top of the range).

Figure 5.17d presents a different view of Mike's behaviour, without the comparison of other participants. Each row shows a single report: detailing the task, context, and particular combination of behaviours used. This allows us to examine the various combinations of behaviour in each report. The rows are ordered so that categories of semantic behaviour are grouped (as far as is possible) in order to give the best possible overview of groupings within semantic behaviours, and to see if groupings also emerge elsewhere in the table.

The issues emerging from Mike's data form the rest of this case study.

5.17.2 / Semantic behaviours in relation to each other

Figure 5.17d shows us that Mike reports all 5 semantic behaviours, and that following fixed-location instructions and using a portable overview are by far the most reported; they are also the only semantic behaviours that appear in reports without other semantic behaviours. Other categories of semantic behaviour are reported considerably less and never without the presence of at least one other category of semantic behaviour.

Of Mike's reports including semantic behaviour, the small number that exclude following fixed-location instructions predominantly report using a portable overview (in environmental space). There is one report of following fixed-location instructions, using a fixed-location overview, and sequencing (in a paper document); this includes neither following fixed-location instructions nor using a portable overview. It is the only instance of sequencing and one of only two instances of using a fixed-location overview – possibly these rarely used behaviours act as alternatives to fixed-location instructions and portable overviews. This is one of only 4 reports from paper documents, 2 of which include no semantic behaviours at all.

221 This category of behaviour in this context includes using search facilities and clicking on links in text, which everyday experience of on-screen seeking-finding suggests are extremely widespread, and thus it is not surprising that this category of behaviour is so widely reported.

5.17.3 / Semantic behaviours in relation to social and spatial behaviours

Mike's 2 reports including social seeking-finding are strikingly comparable: both relate to the same task ('finding my way through the arrivals area of an airport'), and both are linked with the same semantic behaviours – they include both types of following instructions and exclude both types of using overviews – and neither report includes spatial behaviours. The similarity of these reports is as likely to be a reflection of the homogeneity of airport design as it is of any predisposition on Mike's part.

In addition to these reports of seeking-finding in airports, Mike makes 2 further reports that do not include any spatial behaviours. These are also in environmental space – all 4 reports that exclude spatial behaviours are in environmental space. This negative relationship between spatial behaviours and environmental space, and between semantic behaviours and paper documents, also emerges in the case study of Alison (5.15) and is discussed further in 8.3.2.

Other than these factors, there are no conspicuous patterns of combination of semantic behaviours with social or spatial behaviours: the mixtures are diverse.

6 / Spatial behaviours

6.1 / Introduction

This section introduces the group of seeking-finding behaviours that are identified as spatial. It is one of 3 groups that together encompass all types of seeking-finding behaviour, and are introduced in section 3 (the social and semantic groups are discussed in sections 4 and 5).

This section starts by describing the factors that identify behaviours as spatial. It is followed by discussions of each category of spatial behaviour: definition and examples, how the behaviour is coded from the user research conducted, and the current taxonomy in relation to comparable taxonomies. This is followed by a presentation of spatial behaviour data from the user studies.

This section ends with three case studies. The first examines a single category of spatial behaviour: using your cognitive model. The other 2 each examines an individual participant from the diary keeping study, selected because of the contrasts they offer: Frances typically includes spatial behaviours in a large proportion of her reports, and Mary does the opposite but provides an illustration of how using a satnav device affects seeking-finding behaviour. The picture that emerges from the spatial behaviour data from the user studies is similar to that for social and semantic behaviours in that there is considerable inter-individual difference, and variation between contexts in the use of spatial behaviours in seeking-finding.

The relationship between social, semantic, and spatial behaviours is discussed in section 7. And spatial behaviours in relation to other factors involved in seeking-finding behaviour are discussed in section 8.

6.2 / What distinguishes spatial behaviours?

This taxonomy differentiates between types of seeking-finding behaviour depending on the information that informs the behaviour. Spatial behaviours rely on information integral to the space they take place in, and access to

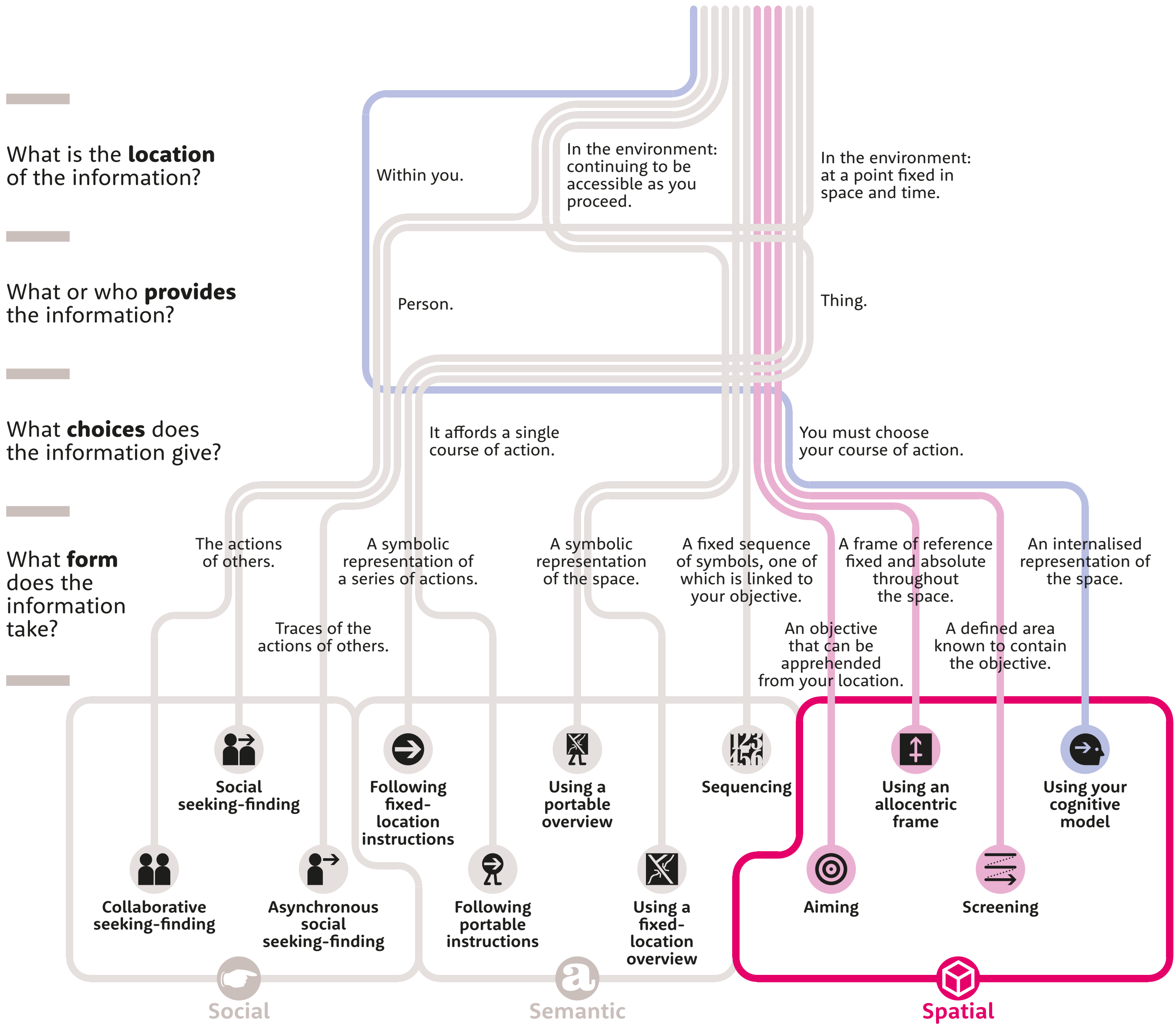


Figure 6.3a: *the place of spatial behaviours within the taxonomy*

which is distributed throughout the space. This sort of information includes such things as landmarks and the points of the compass. As noted in 2.7, all seeking-finding behaviours have social, semantic, and spatial aspects, but each behaviour is put into one group depending on which aspect predominates.

All 4 of the categories of spatial behaviour are the same in requiring the individual to choose their course of action (they do not present a single course of action), but all are dissimilar in the form that their information takes. Three categories are similar to each other in that the information they use is (i) at a point fixed in space and time in the environment, and (ii) provided by a thing and not a person. The fourth category of behaviour is different to the other three in that it uses information that is within you (and hence also provided by a person – yourself).

6.3 / Behaviours in the spatial group

The group of spatial behaviours comprises 4 categories:

- Aiming
- Using an allocentric frame
- Screening
- Using your cognitive model

The place of these behaviours within the taxonomy is shown in figure 6.3a.

6.4 / Aiming

6.4.1 / Definition and examples

The carrier of the information is a thing rather than a person; it takes the form of a marker that is distinct from its surroundings, and that can be apprehended from your location and used as an objective. This objective is at a point fixed in space within the environment, and can be relied upon to remain there for long enough to be useful. The information affords multiple possible courses of action and you must choose which to take. There are two subcategories to aiming. With direct aiming, the perceptible marker is your objective. With indirect aiming, you know that the perceptible marker is proximal to your objective (which cannot be apprehended from your location).

'The perception of distant cues simplifies a great many wayfinding tasks' (Arthur and Passini 1992: 35).

Examples:

- Reaching a destination by being able to see it and so you can simply head for it.
- Finding a particular page in a book because you previously folded down the corner of the page.
- Finding a particular page on the web by using a bookmark that you created in a web browser.

6.4.2 / How this behaviour is captured in the user research

In the **task observation**, this behaviour is coded in response to observing the participant move from one place in the book to another guided by a bookmark that they have previously placed at particular location in the book (in all instances observed here, a finger or thumb is used as the bookmark).

In the questionnaires used in the **wayfinding survey** and the **diary**

keeping, this behaviour is coded from the following responses to the questions on pages 2–3.

In environmental space:

- 'I used landmarks'

In paper documents:

- 'I used bookmarks (or Post-it notes, or fingers) to mark particular places in the document'

On-screen:

- 'I used bookmarks'

6.4.3 / Aiming in other taxonomies

Within taxonomies surveyed from practice literature, in **environmental space** this category of behaviour is derived from 'aiming', the sixth strategy for seeking-finding in environmental space proposed by Mollerup (2005: 60–61), including the 2 subcategories. Mollerup describes aiming as 'the simplest wayfinding strategy' and defines it as 'going in the direction of something perceptible'.

It is also comparable with the first of 4 strategies of Weisman (1987: 443–444), which involves using 'a landmark or goal to guide your trip'; he also describes it as 'the simplest strategy'.

In research literature on environmental space, this behaviour category covers part of the area defined by the 'direct access' tactic in the spatial style of Passini (1981).[222] This cell in Passini's matrix also includes following fixed-location instructions, following portable instructions, using a portable overview, using a fixed-location overview, and using an allocentric frame.

The survey of research and practice literature finds no comparable taxonomies dealing with **paper documents**. And of those from **on-screen**, none includes behaviours comparable with aiming.

6.5 / Using an allocentric frame

6.5.1 / Definition and examples

The carrier of the information is a thing rather than a person; it takes the form of a frame of reference that is fixed and absolute throughout the space in which you are seeking-finding (it is fixed in space within the environment and can be relied upon to remain constant for long enough to be useful). The

222 See 2.4 and 2.10 for more detail of Passini's taxonomy and how it corresponds to mine.

information affords multiple possible courses of action and you must choose which to take.

Examples:

- Finding your destination because you know it is *to the north* of your current location, and you know which direction that is because of the sun's position at this time of day.
- Finding the audio department in John Lewis because it is *on the top* floor.
- Finding the contents list in a book because it is *at the front* of the book.
- 'I scrolled down *to the bottom* of the page where I expected to find the sitemap and the "contact" link' (Alison in the diary keeping study, my italics identify the exact part that provides evidence of using an allocentric frame).

Allocentric frames are also often used for orientation. This thesis does not discuss orientation,[223] but it can be problematic to disentangle orienting behaviour from seeking-finding behaviour – particularly when considering allocentric frames – and so orienting behaviour is unavoidably included in parts of the discussions about using an allocentric frame. Furthermore, because the user research was being conducted while the position of the thesis on these issues was emerging, it is likely that the data collected includes some orientation data among the seeking-finding data. While not ideal, this situation has been allowed to remain because the data as collected does not allow orientation and seeking-finding behaviours to be differentiated.

The term *allocentric* is likely to be familiar to people studying spatial cognition but less so to others. The key point is that the frame of reference is not egocentric. It is not contingent on your spatial location or orientation: you can stand on your head or change the direction you are facing but north remains north in relation to the rest of the space. The same applies to a location description such as the front of a book, or the top of a web page.[224]

Allocentric frames are often used in conjunction with a theoretical cognitive model (see 6.7.1), as is illustrated by these two comments from Alison in the diary keeping:

'knowing [*cognitive model*] the copyright page to be either at the front or back [*allocentric frame*] of the book ...'

'I scrolled down to the bottom [*allocentric frame*] of the page where I expected to find [*cognitive model*] the sitemap and the "contact" link.'

223 See 1.2.6.
224 In relation to the book, the front of the book or the top of the page retain the same spatial relationship to other parts of the book irrespective of the position of the individual in relation to the book.

6.5.2 / How this behaviour is captured in the user research

In the **task observation**, this behaviour is coded in response to the participant speaking of finding their objective by aiming for a location within the book based on its position in relation to the fixed frame of reference provided by the book having a 'front' and 'back'.

In the questionnaires used in the **wayfinding survey** and the **diary keeping**, this behaviour is coded from the following responses to the questions on pages 2–3.

In environmental space:

- 'I orientated myself using the points of the compass'

In paper documents and on-screen, the questionnaires do not contain questions directly addressing this behaviour – in part a consequence of the studies being undertaken in parallel with the development of the taxonomy. Which is not to say that this behaviour does not occur, as illustrated by these two comments from Alison above. Such data has been excluded from the quantitative analyses because it was collected only incidentally and thereby unlikely to be representative of the full extent of this behaviour.

6.5.3 / Using an allocentric frame in other taxonomies

Within taxonomies surveyed from practice literature, in **environmental space**, this category of behaviour is derived from 'compassing', the eighth strategy for seeking-finding in environmental space proposed by Mollerup (2005: 64–65).

The wayfinding strategies identified by Weisman (1987) do not include anything that falls into this category of using an allocentric frame.

In research literature on environmental space, this behaviour category covers part of the area defined by the 'direct access' tactic in the spatial style of Passini (1981).[225] This cell in Passini's matrix also includes following fixed-location instructions, following portable instructions, using a portable overview, using a fixed-location overview, and aiming.

The survey of research and practice literature finds no comparable taxonomies dealing with **paper documents**. And of those from **on-screen**, none includes behaviours comparable with using an allocentric frame.

225 See 2.4 and 2.10 for more detail of Passini's taxonomy and how it corresponds to mine.

6.6 / Screening

6.6.1 / Definition and examples

The carrier of the information is a thing rather than a person; it takes the form of a defined area believed to contain your objective (the defined area is fixed in space within the environment and can be relied upon to remain constant for long enough to be useful): you search this defined area according to a system. The information affords multiple possible courses of action and you must choose which to take.

There are three subcategories of screening: targeting, satisficing, and optimising. With targeting screening, the search ends when the predefined objective is found, even if the defined area has not been completely searched. With satisficing screening, the search ends when a 'good enough' solution is found. With optimising screening, the search is comprehensive, and it ends when the defined area has been entirely searched; only then is the best solution selected from among those available.

Examples:

- Checking the street-name signs for the turnings off the road that you are walking along until you reach the side street with the name you seek (targeting screening).
- Scanning the results from a web search and choosing the result that looks the most promising on the first page (satisficing screening).
- Checking the entire contents list of a book before deciding which section is most likely to contain the information you seek (optimising screening).

6.6.2 / How this behaviour is captured in the user research

In the **task observation**, this behaviour is coded in response to observing the participant reading or scanning written content, on a single page or sequences of pages.

In the questionnaires used in the **wayfinding survey** and the **diary keeping**, this behaviour is coded from the following responses to the questions on pages 2–3.

In environmental space:

- 'I used street name signs'
- 'I made a systematic search of the area in order to find what I was looking for'

In paper documents:

- 'I used the headings in the document to find what I was looking for'
- 'I oriented myself using the running heads'
- 'I made a systematic search of the page/section/section'
- 'I read text carefully'
- 'I scanned text rapidly'
- 'I turned pages rapidly to move forwards/backwards through the document'

On-screen:

- 'I made a systematic search of the page or site'
- 'I scrolled up/down/sideways'
- 'I read text carefully'
- 'I scanned text rapidly'

As with using an allocentric frame, the information sources used in screening, can be used for orientation as well as seeking-finding. For instance, street-name signs and running heads can be used to confirm orientation as readily as they can be used for seeking-finding. And as with the data gathered for using an allocentric frame, that for screening is likely to include some orientation data among the seeking-finding data that likewise it has not been possible to exclude.

Street-name signs can be used in screening only when they are present in sufficient density. This means that this tactic is largely confined to urban areas where the granularity of the street network is sufficiently small.

In constructing the questionnaires, I considered whether the word 'systematic' might discourage participants from choosing behaviours including this word in that it could suggest a more rational, rigorous, and possibly even scientific approach to seeking-finding which is perhaps at odds with the contingent and bounded rationality under which people generally make decisions.[226] On examining the data collected in the wayfinding survey and the diary keeping, I was surprised by how frequently 'I made a systematic search …' *was* selected. Figure 6.6a summarises the data from the diary keeping: it shows the tactics classed as screening and the percentages of reports including it. Despite being used more often than I might have anticipated, systematic searches (the bold rows in figure 6.6a) were included in smaller proportions of reports than other screening tactics.

226 See e.g. Kahneman (2011).

Context	Behaviour description	%
Environmental space (n=103)	**I made a systematic search of the area in order to find what I was looking for**	**19**
	I used street-name signs	*53*
Paper documents (n=51)	**I made a systematic search of the page/section/section**	**10**
	I oriented myself using the running heads	*19*
	I turned pages rapidly	*45*
	I read text carefully	*47*
	I used the headings in the document to find what I was looking for	*49*
	I scanned text rapidly	*51*
On-screen (n=145)	**I made a systematic search of the page or site**	**23**
	I read text carefully	*48*
	I scanned text rapidly	*52*
	I scrolled up/down/sideways	*68*

Figure 6.6a: *breakdown of the screening tactics reported in the diary keeping study*

6.6.3 / Screening in other taxonomies

Within taxonomies surveyed from practice literature, in **environmental space** this category of behaviour, including the three subcategories, is derived from 'screening', the fifth strategy for seeking-finding in environmental space proposed by Mollerup (2005: 58–59).

The wayfinding strategies identified by Weisman (1987) do not include anything that falls into this category of screening.

In research literature on environmental space, this behaviour category covers the area defined by the 'search' tactic in both the linear and spatial styles of Passini (1981).[227] These cells in Passini's matrix do not overlap into any other categories of behaviour in the current taxonomy.

The survey of research and practice literature finds no comparable taxonomies dealing with **paper documents**.

Within taxonomies surveyed from research literature, **on-screen** screening is comparable with 2 of the 11 search moves that Cromley and Azevedo (2008: 289–299) identify: 'free search (scrolling up and down using the scroll bar arrows or slider)', and 'scanning the list of article titles after using the find in

227 See 2.4 and 2.10 for more detail of Passini's taxonomy and how it corresponds to mine.

encyclopedia feature'. And within practice literature, none of the 'mechanisms of navigation' by Kalbach (2007: 54–82) counts as screening.

The term 'satisficing' used here to describe one of the forms of screening, was originally proposed by Simon (1956), although the concept is present in earlier works, as discussed by Brown (2004). Although not named as satisficing, Redish (1993) makes much the same point in observing that people read as much as they think they need to and no more. However, Arthur and Passini (1992: 29) cite Wright (1985) in support of the idea that while some people satisfice, others make a more thorough search of available information before taking action (optimising). Satisficing as a larger-scale pattern or strategy is discussed widely in literature regarding on-screen contexts.[228]

6.7 / Using your cognitive model

6.7.1 / Definition and examples

The carrier of the information is you yourself: the information is within you and takes the form of an internal representation based on knowledge gained from previous actions within the world: a model of how the world is, and how it can be predicted to operate. The information affords multiple possible courses of action and you must choose which to take.

There are three subcategories of using your cognitive model: direct, indirect, and theoretical. When you are using your direct cognitive model, your information comes from direct experience of the space. When you are using your indirect cognitive model, your information has been acquired without direct experience of the space – for instance, from a picture, map, or description of the space. When you are using your theoretical cognitive model, your information derives from experience of other spaces of the same type.

Examples:

- Knowing how to reach your destination because you have made the journey before (using your direct cognitive model).
- Knowing how to reach your destination because you studied the route on a map beforehand (using your indirect cognitive model).
- Knowing how to find the milk in an unfamiliar supermarket because it is usually towards the back (using your theoretical cognitive model).
- Knowing how to find a contents list in a book because they are usually at the front of a book.

228 Such as in Kalbach (2007: 40); Morville (2005).

- ‘I scrolled down to the bottom of the page *where I expected to find* the sitemap and the “contact” link’ (Alison in the diary keeping study, my italics identify the exact part that provides evidence of using her theoretical cognitive model).

This category of behaviour is the subject of a case study, see 6.9.

6.7.2 / How this behaviour is captured in the user research

The general potential for uneven reporting of this category of behaviour is discussed in 6.8.1.

In the **task observation**, this behaviour is coded in response to the participant speaking of either recalling a salient feature of the book from the execution of a previous task (using a direct cognitive model), or from having looked at the contents list (using an indirect cognitive model), or an assumption they are making about how the book is organised based on how other books are organised (using a theoretical cognitive model).

In the questionnaires used in the **wayfinding survey** and the **diary keeping**, this behaviour is coded from the following responses to the questions on pages 2–3.

In environmental space:

- ‘I made a guess because I’ve been somewhere similar before’

In paper documents:

- ‘I made a guess because I’ve used a similar document before’

On-screen:

- ‘I made a guess because I’ve used something similar before’

As discussed in 3.6, this question was not originally formulated to capture the tactic of using your cognitive model, but the open responses make it clear that in each instance of selecting this option, the participant is reporting using their cognitive model. In both studies, the open responses accompanying this question are used to confirm the tactic being employed – and all instances are coded as using your cognitive model.

6.7.3 / Using your cognitive model in other taxonomies

Within taxonomies surveyed from practice literature, in **environmental space**, one subcategory of this behaviour – using your theoretical cognitive model – is derived from ‘educated seeking’, the third strategy for seeking-finding in environmental space proposed by Mollerup (2005: 52–53). He suggests that this tactic ‘works by syllogism, the type of logical method originally described by

Aristotle: if A and B, then C. A and B are the premises. C is the conclusion. The crux of the matter is the validity of the premises.'

Using your cognitive model is comparable with the fourth strategy of Weisman (1987: 445), which involves 'a mental image or cognitive map' to help the individual find their way. Weisman also differentiates between direct and theoretical cognitive models when he says 'within an environment and/or in comparable settings'.

In research literature on environmental space, this behaviour category covers the area defined by the 'indirect access' and 'inference' tactics in both the linear and spatial styles of Passini (1981).[229] These cells in Passini's matrix do not cover any other categories in this taxonomy. Passini's 'indirect access' tactic (in either style) is comparable with using your direct cognitive model and using your indirect cognitive model, in that it relies on accessing memory – whether that memory is of the environment itself or a representation of it. And his 'inference' tactic (in either style) is comparable with using your theoretical cognitive model, in that it requires information derived from manipulating memory through inference.

The survey of research and practice literature finds no comparable taxonomies dealing with **paper documents**. And of those from **on-screen**, none includes behaviours comparable with using your cognitive model.

6.8 / Spatial behaviour in the user research

All three of the user studies conducted for this thesis include evidence of spatial behaviours.

6.8.1 / Data from the task observation

This study gives data for 12 participants each performing the same set of 6 tasks, giving a total of 72 reports of seeking-finding events (n=72).[230] Each report includes the order in which behaviours are deployed. This data is only for a single context – paper documents. An overview of the data from this study is in 3.5, with spatial behaviours shown in figures 3.5b and 3.5d.

Comparisons with the other study that reports seeking-finding in paper documents – the diary keeping – are discussed in 6.8.4.

The task observation recordings provide two data sources: (i) the participant's observable physical actions, and (ii) their spoken commentary

229 See 2.4 and 2.10 for more detail of Passini's taxonomy and how it corresponds to mine.
230 In this study, a report refers to the data from one task executed by one participant: 12 participants each performed 6 tasks, hence 12 × 6 = 72 reports.

about what they are thinking or doing. Between them these sources allow for the data to be triangulated in the sense of whether both the observed physical actions and the spoken utterances agree in the category of behaviour that they suggest is occurring. In comparison with *semantic* behaviours that can be interpreted confidently by the use of contents list or index, *spatial* behaviours can be problematic to interpret from physical actions, and the participants' verbal utterances are not comprehensive, leading to the possibility of under-reporting of these behaviours. To give an example of this: observing the recordings of the task observations sessions, participants often commence a task by purposefully opening the book at either the front or the back, in order to find a particular access structure (the contents list or the index). Thinking about this seeking-finding process, this use of an allocentric frame of reference could be informed by few sources of information other than a cognitive model. So it is perhaps reasonable to conclude that the report of each task should include using your cognitive model and using an allocentric frame.

Notwithstanding this argument, the only instances of using your cognitive model and using an allocentric frame that are included in the data are those when the participant's utterances makes it explicit that they are doing this. For instance when starting task 2, Cilla says, '**I've no idea where that would be, so I think there must be something in a contents listing. So I'm going to the front.**' This gives clear evidence that she is using her cognitive model (she talks of experience of using books in general or this particular book that leads her to believe that the way to access the information she seeks is to use an overview structure of the sort that books typically have – 'a contents listing'), and she is using an allocentric frame (she talks of aiming for 'the front' of the book). Participants do not always explicitly state anything about the frame of reference they use or the knowledge on which they act, and so possibly some instances of these tactics go unreported.

As the top (pink) bar in figure 3.5d shows, 10 of the 12 participants each employ spatial behaviours in all 6 of the tasks. There are only 2 participants who employ spatial behaviours in a smaller proportion of reports: Cilla and Jovair each report 1 task involving no spatial behaviours (Cilla/task 1 and Jovair/task 5). There is only a single task that is optimally completed without spatial behaviours: task 1 can be completed using only sequencing (a semantic behaviour). That 11 of the 12 participants also use spatial behaviours in this task is perhaps indicative of difficulties understanding the idiosyncratic page numbering system in this book. As with many other participants, in completing this task, Cilla also consults the contents list (using a fixed-location overview) but uses no spatial behaviours. And Jovair abandons task 5 (after making no progress by using the index), and this is why he uses no spatial behaviours in this task.

All instances of aiming in this study are coded from the participant using a finger or thumb as a bookmark; this is discussed in 5.13.5 and 5.14 in relation to being able to refer readily to the contents list or index.[231] The two outliers in figure 3.5d using aiming more frequently than other participants are Peter and Cho: they both use aiming as part of a work-round to make up for difficulties in understanding the page numbering system (see 5.14). Of the other participants, 6 also make use of aiming to permit easy re-finding of specific content in the book, and 4 never make use of this tactic.

Using an allocentric frame in this study means using the frame of reference contained within the definite front and back of the book. In this book, the key issues are that it has (i) a contents list at the *front*, (ii) an index at the *back*, and (iii) a fixed number of sequential chapters that allow the user to make an educated guess at where between the front and back any chapter will be. The strength with which the access structures (the contents list and index) are associated with their location within the frame of reference of the book is suggested by how frequently they are referred to by location rather than name (see 5.13.3). There are only 3 participants who *never* make utterances during the study to suggest that they are using to the physical structure of the book as a spatial frame of reference to help them in their seeking-finding; but on the other hand, the most references are by 2 participants who each refer to it in 4 out of 6 tasks.[232]

A page (or double-page spread) in the book also provides a frame of reference (Jabr 2013) for smaller-scale behaviours.[233]

Screening in this study includes instances of the participant rapidly leafing through the book, and being guided by the running heads or text headings, or scanning text within a page. It also includes instances of reading. This category of behaviour is the most ubiquitous spatial behaviour in this study: 7 of the 12 participants provide evidence of screening in all 6 tasks, and the other 5 participants each do so in 5 of their tasks.

Identifying instances of using your cognitive model is dependent on the participant making an utterance that either recalls something relevant or makes an assumption about the book's spatial organisation. Of the spatial behaviours, this is the one with the widest range in terms of the proportion of each participant's reports that include it: Ali refers to his cognitive model in every task, and Michael never does. The rest of the participants are evenly distributed between these points.

231 Bookmark use is also discussed by Thayer, Lee, et al. (2011); Marshall and Bly (2005); Waller (1986).
232 Although, as discussed above, this may be under-reported.
233 See 1.2.4 for a discussion of these terms in relation to scale of behaviour.

6.8.2 / Data from the wayfinding survey

This study gives data for 43 participants performing a single task. This is only in a single context – environmental space. An overview of the data from this study is in 3.6, with spatial behaviours shown in figures 3.6c–d.

Using an allocentric frame is the least reported category of behaviour in figure 3.6c; the other categories of behaviour are all comparable with each other in terms of the percentages of reports that include them.

Comparisons with the other study that reports seeking-finding in environmental space – the diary keeping – are discussed in 6.8.5.

6.8.3 / Data from the diary keeping

This study gives data for 12 participants' seeking-finding activities in their everyday lives over the course of a month. This study covers all 3 contexts. An overview of the data from this study is in 3.7, with spatial behaviours shown in figures 3.7d, 3.7g, 3.7j, and 3.7m.

Across all participants in all contexts, in figure 3.7c screening emerges as the most reported spatial behaviour – it is included in almost 3 times as many reports as any other spatial behaviour. Aiming and using your cognitive model are the next most reported – almost equally frequently (28% and 29% of reports). And using an allocentric frame is reported very infrequently (1%).

The data from the diary keeping allows comparisons of seeking-finding behaviour across contexts (see 6.8.6). And when viewed in conjunction with data from the task observation and the wayfinding survey, it offers the opportunity to compare data sets within the same context (although from different studies); these are discussed in 6.8.4 and 6.8.5.

6.8.4 / Comparing spatial behaviours in paper documents

Both the task observation and the diary keeping include data for spatial behaviours in paper documents. The task observation data is shown in figures 3.5b and 3.5d, and diary keeping in figures 3.7g and 3.7m.

The diary keeping does not collect data for using an allocentric frame in this context, and thus this behaviour is not included in this comparison.

Comparing the data from the studies (figures 3.5b and 3.7g), we can see that both are consistent in the proportion of reports that include spatial behaviours in paper documents (96% and 97%), and reports of individual categories of spatial behaviour are quantitatively consistent between them. Screening is the spatial behaviour included in the greatest proportion of reports in both studies (in 94% and 96% respectively). Using your cognitive model is included in 50% and 37% of reports. Aiming is included in 28% of reports in the task observation, and only 10% of reports in the diary keeping.

When the data for spatial behaviour in paper documents are broken down by participant (figures 3.5d and 3.7m), the 2 studies reveal different patterns. Part of this is down to Tanveer who reports no seeking-finding in paper documents (and so extends the range relating to seeking-finding in paper documents in figure 3.7m down to zero). When Tanveer is discounted, the patterns are less dissimilar (and for this reason the rest of this discussion excludes him, although his data is present in the statistical graphics). In both studies, the majority of participants include some category of spatial behaviour in all their reports. Other than these majorities, 2 of the 12 participants in the task observation use spatial behaviours in only 5 of their 6 tasks, and 1 of the 12 participants in the diary keeping includes spatial behaviours in only half of her reports.

Much the same is true for screening: in the task observation, 7 of the 12 participants include it in all of their reports, and 5 each include it in 5 of their 6 reports; in the diary keeping, 10 participants include screening in all reports, and 1 includes it in half of her reports.

Using your cognitive model has the widest range of inter-individual difference of all categories of spatial behaviour in both studies: in the task observation, participants range between 1 who includes this behaviour in none of his reports to 1 who includes it in all. In the diary keeping (discounting Tanveer), there are 2 participants who do not include using their cognitive model in any of their reports, and 1 who includes it in 75% of his reports. Other participants are distributed between these points.

In the task observation, aiming shows wide inter-individual difference: ranging from 4 participants who never report this behaviour to 2 who include it in 5 of their 6 reports. In the diary keeping, aiming shows considerably less inter-individual difference with 8 never reporting this behaviour and the 3 that do all being outliers including it in 20%, 25%, and 50% of their reports.

6.8.5 / Comparing spatial behaviours in environmental space

Both the wayfinding survey and the diary keeping include data for spatial behaviours in environmental space. The wayfinding survey data shown in figure 3.6c is comparable with that part of the diary keeping from environmental space shown in figure 3.7g. Comparing them, the wayfinding survey has a slightly higher percentage of reports including spatial behaviour than the diary keeping.

Looking at individual categories of behaviour in both studies, using an allocentric frame is included in only small proportions of reports (3% and 5%).

Other than this strong similarity, in the 2 studies, both aiming and screening are each included in 62–77% of reports: but in the wayfinding survey, aiming is included in a slightly larger proportion of reports than screening, and in the diary keeping, the opposite is true. Using your cognitive model is included in 60% of reports in the wayfinding survey, but only 37% in the diary keeping. It is hard to suggest reasons for this difference given that both studies used comparable questionnaires. In the wayfinding survey, the task is to reach an objective in central London: an area full of well-known landmarks, regularly featuring in various media, and arguably the part of London most likely to be familiar to some extent to the largest number of people. The odds are stacked in favour of participants being likely to be able to recruit some sort of cognitive model to help them in their seeking-finding to complete the task in the wayfinding survey. We might speculate that this is what has given rise to the greater proportion of reports including using your cognitive model in that study. The diary keeping reports a more diverse selection of tasks that include a wider range of locations, possibly leading to a smaller proportion of reports including using your cognitive model or aiming.

6.8.6 / Comparing spatial behaviours across contexts

The diary keeping allows us to examine the same group of participants' spatial behaviours across all 3 contexts (figures 3.7g and 3.7m). However, we must bear in mind the influence of other factors such as the type of task.

Spatial behaviours as a group are included in a slightly smaller proportion of reports from environmental space than in paper documents or on-screen (the pink bars in figure 3.7g). The proportion of reports including individual categories of behaviour shows greater variation between contexts too: the predominance of screening (which appears so clearly when the contexts are consolidated in figure 3.7d) remains the case in paper documents and on-screen; but in environmental space, it is reported only as often as aiming (which is conversely included in a greater proportion of reports in environmental space than in paper documents or on-screen). In environmental space and in paper documents, using your cognitive model is reported equally often in 37% of reports, but on-screen it is only included in 21% of reports. Using an allocentric frame is not reported at all in paper documents or on-screen, but this is due to the survey materials offering limited opportunity to report this behaviour (see 6.5.2).

When the behaviour of individual participants is separated (see figure 3.7m), a different picture emerges: there is even less clarity or pattern than in figure 3.7g. The many long bars attest to substantial inter-individual variation, and there is also considerable variation between behaviour categories and between contexts.

In environmental space, the percentage of reports including aiming is quite different to that in paper documents or on-screen. In environmental space, 1 participant includes aiming in all of her reports for this context, and the other participants are relatively evenly distributed down to the participant who reports it in only 33% of her reports. By way of contrast, in both paper documents and on-screen a number of participants never report aiming (9 in paper documents and 5 on-screen), and the majority report it only infrequently (the participant who reports this in the largest proportion – 50% – of her reports in paper documents is a considerable outlier, and on-screen the greatest proportion is only 23% of another participant's reports).

6.9 / Case study: using your cognitive model

This single category of behaviour is given its own case study here for 3 reasons: (i) because it may appear incongruous among the other categories of behaviour in the taxonomy; (ii) the extant research on the subject is extensive and deserves at least an outline survey; and (iii) its difference to other categories of behaviours gives rise to aspects worth exploring.

In 6.7.1, using your cognitive model is defined by using information that is *within* you – it is the only category of behaviour to do so. Knowledge gained from previous actions in the world forms a mental representation: a model of how the world is and how it can be predicted to operate. This information affords multiple possible courses of action and you must choose which to take. There are three subcategories of cognitive model differentiated by the relationship between the information you use and the space you apply it to: (i) a *direct* cognitive model derives from direct experience of the space in question; (ii) an *indirect* cognitive model derives from representations of the space (such as verbal/textual descriptions, visual representations in the form of pictures, diagrams, or maps); and (iii) a *theoretical* cognitive model derives from experience of other spaces that fall into the same category (you have an understanding of the principles that organise this type of space, which relies on understanding of what may be called, for instance, genres, pattern languages, or schemata).

6.9.1 / Does this category of behaviour belong in this taxonomy?

The inclusion of this category in the group of spatial behaviours – and in the taxonomy as a whole – is possibly contentious. Using your cognitive model may be regarded as qualitatively different to the other seeking-finding behaviours in the taxonomy because of the internal origins of the information it uses. It is the only category of behaviour that uses information internal to the individual, and is thus dependent on the individual's previous experience in a way that is different to other behaviours in the taxonomy.

As discussed in 3.6, using your cognitive model was initially not included in this research because it presupposes familiarity with the environment and hence is out of scope of this research that examines seeking-finding in *unfamiliar* environments. However, evidence from the wayfinding survey makes it clear that seeking-finding in unfamiliar spaces can employ cognitive models, and this leads to the inclusion of this category of behaviour in the taxonomy.

Being placed in the group of spatial behaviours does not discount that these behaviours also have social and semantic as well as spatial dimensions. The social and semantic dimensions of using your cognitive model may be stronger than is the case for other categories of spatial behaviour. But, guided by embodied cognition as one of the frames of reference for this thesis, I have chosen to emphasise the physical (embodied) understanding of space within the cognitive model (possibly at the expense of the semantic/symbolic content) and place this behaviour within the spatial group. Supporting this position are studies that conclude that cognitive processing of visual form happens faster than that of semantic content, and that form is prioritised over content (Toms 2001; and Toms and Campbell 1999).[234]

Figure 6.9a shows a diagrammatic representation of the relationships between categories of behaviour in the taxonomy based on how many of the 4 factors (the questions that construct the definitions) are shared by the pairs of behaviours.[235] We might hypothesise that the greater the number of factors that behaviour definitions have in common, the greater the relationship between them. Some things that this figure makes clear are as expected – such as the strength of the grouping of using a fixed-location overview, sequencing, aiming, using an allocentric frame, and screening.[236] Among the other things that are not so readily anticipated is the minimal relationship between using your cognitive model and all other behaviours. It is weakly linked to 8 behaviours, with no stronger links, and this makes it the category of behaviour most unlike the others. While some unrelatedness might have been anticipated, the degree is striking.

234 Spatial memory for textual content in documents is also discussed in O'Hara and Sellen (1997); Dillon (1991); Lovelace and Southall (1983); Rothkopf (1971).
235 See section 2: in particular 2.5 for full discussion of the 4 factors that construct the definitions, and 2.6 for the definitions of categories of behaviour based on these 4 factors.
236 This grouping is discussed in 2.8 and 7.2.

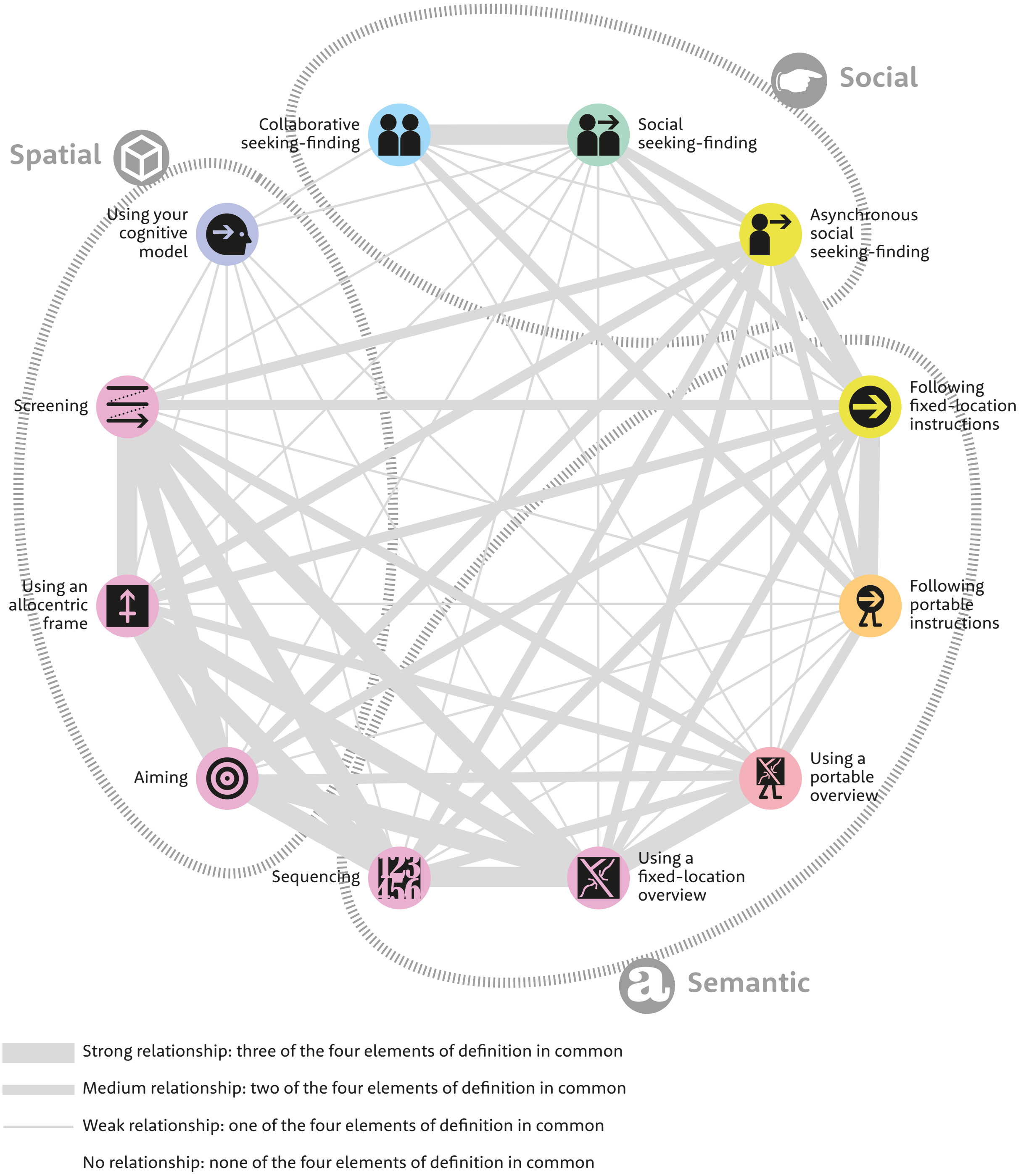


Figure 6.9a: *diagram showing the relationships between categories of behaviour based on how many of the four elements of definition two behaviours share*

6.9.2 / Literature pertaining to using your cognitive model

The notion of a cognitive model in this thesis is based on the concept of the cognitive map developed through research into spatial cognition and spatial behaviour. The foundational exposition of the concept of a cognitive map is generally taken as by Tolman (1948), with Downs and Stea (1977), and Kitchin and Freundschuh (2000) marking further steps in its development.[237] There are differences of opinion among researchers in what they take 'cognitive map' to mean, ranging from those who include only explicitly cartographic representations to those who include more diverse ranges of representations and other sensory inputs. And others propose variants on the term, such as 'cognitive collage' or 'cognitive model'.[238] The concept is now used in other fields of research, such as in seeking-finding in paper documents[239] and on-screen.[240] This thesis uses the term *cognitive model* rather than cognitive map to emphasise that it applies equally to all three contexts without prioritising environmental space, and that it includes elements that are not explicitly map-like.

Of the 3 subcategories of cognitive model in my taxonomy, 2 are identified by Arthur and Passini (1992: 38–39): their 'propositional representations' are comparable with direct cognitive models, and 'analogue representations' are comparable with indirect cognitive models.[241] And they also observe that 'research has shown that both [propositional and analogue] representations can coexist even if they contain contradictory information'.

In *A time in Rome* (Bowen 1959), the author gives an extended first-hand account of using her cognitive model for seeking-finding in environmental space. She discusses revisiting Rome and how her memory of the topography (her cognitive model) proves to be incorrect: 'Simply coming to Rome cannot be half so complex as coming back. This time, I was making anything but a clean start. I was in the hold of memories as positive and obsessive as they were faulty. I was constantly brought up short with, "I could have sworn … !" Ingrained pictures refused to be broken up … What I recollected could not be found again: it had not existed … Memory must be patchy … It succeeded in tying up Rome for me into unnecessary, dismaying knots.' And 'My object was to walk it [Rome] into my head and (this time) keep it there' (pp. 13–15).

237 Downs and Stea (1977: 156) also attribute foundational work to Binet (1894); Claparède (1903); Gulliver (1908); Trowbridge (1913).
238 See Tversky (1993).
239 E.g. Hou, Rashid, and Lee (2017); Jabr (2013).
240 E.g. Thayer, Lee, et al. (2011); Akyel and Erçetin (2009); Ruddle (2009); Vörös, Rouet, and Pléh (2009); Chen (2000); Maglio and Matlock (1998); Dillon, McKnight, and Richardson (1993); Dillon, Richardson, and McKnight (1990); Shum (1990).
241 Arthur and Passini (1992) cite Evans (1980); Gärling and Golledge (1989); Gärling, Book, and Lindberg (1984); Thorndyke and Hayes-Roth (1982) as instrumental in their formulation of this concept.

She also describes the input of other senses into her cognitive model, particularly the importance of smell.[242] Bowen Identifies the customary state of having an incomplete or unevenly detailed cognitive map, in her words 'they solidify in regions and patches only' (p.15). This is confirmed by formal research which finds that cognitive models can be 'fragmented, schematised, inconsistent, incomplete, and multimodal' as a consequence of 'knowledge acquired from different modalities, perspectives, and scales' (Tversky 2005a: 12).[243]

It is widely agreed that the hippocampus is the site of the human cognitive model of environmental space (Dudchenko and Wood 2015; O'Keefe and Nadel 1978). It has also been suggested that the hippocampus may have a role in forming relational memory representations more widely (Olsen, Moses, et al. 2012), and this may point to a neurological basis connecting using your cognitive model across all 3 contexts.

The concept of a *theoretical* cognitive model is identified in both research and practice literature in all 3 contexts, but rarely framed in the terms of a cognitive model. It is expressed in terms of the expectations people may have of a space based on established conventions (often using terms such as schemas, genres, or pattern languages).[244]

Recent research into the use of portable devices (such as smartphones or satnav) to provide seeking-finding assistance in environmental space – largely falling into the category of following portable instructions – suggests that the formation of a cognitive model may be impaired by the use of such devices.[245] Some studies also examine the trade-off between effective portable instructions and cognitive model formation, and the ways in which navigation aids can mitigate the deficit in cognitive model formation.[246] Mary's case study picks up this issue too (see 6.11).

242 'For the closely similar yellow streets were never known to me by name: I had fallen into recognising each by particular window displays and, no less, smells. But now [when the shops are closed for lunch], not only is the eye baffled but the nostrils: sealed completely away from one are the breaths from cheeses, artichokes moist from the garden, marrons moist from the syrup, candied fruits, sawdust, dusty nuts, oranges and apples, perfumed soap together with heated hairdressing, leather, gesso, spiced meats and fishy delicatessen, varnish, fresh flaky pastry and new bread, photographic accessories, freesias and hyacinths and jonquils, bales of textiles whether brocade or calico' Bowen (1959: 38–39).
243 See also Dudchenko and Wood (2015); Downs and Stea (1977: 23 and 212).
244 See, e.g., for environmental space: Birkbeck and Kruczkowski (2015); ACRP (2011: 4); NDA and DoAHG (2011: 56); Waller (2011); Shakespear (2006); Mollerup (2005: 52–53); Passini (1996). For paper documents: Toms (2001); Dillon and Vaughan (1997). And on-screen: Akyel and Erçetin (2009); Kalbach, (2007: 40–44, 205–206); Morville (2005: 145–146); Nielsen (2000: 217); Maglio and Matlock (1999).
245 See e.g. Gardony, Brunyé, and Taylor (2015); Gardony, Brunyé, et al. (2013); Ishikawa and Takahashi (2013); Axon, Speake, and Crawford (2012); Raubal (2011); Ishikawa, Fujiwara, et al. (2008).; Leshed, Velden, et al. (2008); Parush, Ahuvia-Pick, and Erev (2007); Aslan, Schwalm, et al. (2006); Münzer, Zimmer, et al. (2006); Burnett and Lee (2004); Krüger, Aslan, and Zimmer (2004); Jackson (1996); Streeter, Vitello, and Wonsiewicz (1985).
246 E.g. Otterbring, Wästlund, et al. (2014); Münzer, Zimmer, and Baus (2012); Webber, Burnett, and

6.9.3 / Are you ever *not* using your cognitive model?

As discussed in 6.8.1, it is hard to conceive of acting in the world without employing knowledge gained from previous actions in the world: this knowledge is what constitutes a cognitive model. So, arguably, it is impossible to engage in seeking-finding without engaging a cognitive model – the individual must start with some idea of how the space is organised in order to make a plan or at least formulate a starting action for their seeking-finding. Perhaps *all* reports in all three studies should include using your cognitive model.[247]

The studies themselves provide scant evidence for such a hypothesis. Instead of consistent high use, we find infrequent and variable use across all three studies. In the task observation study, only 50% of reports include using your cognitive model (see figure 3.5b); and participants span the entire range in how many of their reports include this behaviour, from none to all (see figure 3.5d). In the wayfinding survey, this behaviour is included in 60% of the reports (see figure 3.6c). And in the diary keeping, across all contexts and participants, the behaviour is included in only 29% of reports (see figure 3.7d), again with variation between contexts and between participants: using your cognitive model typically shows more inter-individual variation than other behaviours (see figures 3.7g and 3.7m). I could argue that, rather than an indication of its frequency of use, these relatively low percentages are indicative of the extent to which using your cognitive model is unreported because it passes unrecognised or unverbalised as we do not identify the source of our knowledge; but this requires further research.

It is also possible that both general and particular aspects of the experimental methods may have a bearing on the low reporting of using your cognitive model. In general terms, the studies were conducted in real-world settings; consequently, the data is noisy and contingent, with the likelihood of some information being lost in 'the blooming buzzing confusion' (James 1890 (1983): 488). This difficult choice between laboratory and natural experimental settings is well expressed by Downs and Stea (1977: 224): 'The laboratory situation gains precision at the expense of realism, while the natural setting represents the reverse …'

Morley (2012); Waters and Winter (2011); Schmid, Richter, and Peters (2010); Baldwin (2009); Oomes, Bojic, and Bazen (2009).

247 One could argue that all categories of seeking-finding behaviour (indeed, all behaviours of every sort) are dependent on previous experience of acting in the world; otherwise how do we know how to make use of a map or a direction sign, or how to ask for directions, or how to use a door. But such philosophical speculations, while possibly of value in enriching the understanding of what a cognitive model is, do not help to move this discussion forward.

And in particular terms, in the task observation study, evidence for using your cognitive model is only taken from explicit utterances and not inferred from actions. And as with all such think-out-loud studies, the utterances give only a partial view of the participant's cognitive processes.[248] In the wayfinding survey and diary keeping studies, participants were asked to self-observe and self-report. This is easier with actions than thoughts. Observing one's thoughts can require a level of metacognition that is challenging at the same time as going about one's everyday business (and in addition to one's customary everyday self-reflection and monitoring), and so 'internal' behaviours such as using your cognitive model may be subject to passing unobserved more frequently than conspicuous actions such as using a portable overview.[249] Even more particularly, as discussed in 3.6, the item in the questionnaires that gathers data about using your cognitive model was not originally formulated for this purpose and only found to work in this way as a result of the responses in the wayfinding survey. Thus it is possible that not all participants understood the question in the same way and this may lead to some of the inter-individual difference.

6.9.4 / Different subcategories of cognitive model in the task observation

The task observation study is the only one conducted for this thesis that affords the opportunity to separate out using your cognitive model into its three subcategories.

Of the 72 reports, 36 include the category using your cognitive model. In 28 reports, participants speak of assumptions they are making about the typical organisation of reference books such as the one they are using. These assumptions or inferences are indicative of using their theoretical cognitive model. These include occasions when a participant uses an *inappropriate* theoretical cognitive model that proves to not match the reality of the book. For instance, Theresa finds a section of the book that starts with a mini-contents list and assumes that all sections will have a mini-contents list, and when she goes to a section that does not have a list, she expresses surprise when her expectations are not met. At this point she has to switch to a different tactic to find the information she seeks within the section. Problems caused by conflicts between a theoretical cognitive model ('preconceptions') and the actual environment can occur in any context: in environmental space, people 'then have to try to generate an alternative mental model of the environment to help them find their way' (Miller and Lewis 1999: 15); and on-screen, 'in

248 See 3.2 for further discussion of issues with verbal protocols.
249 See 3.4 for further discussion of this issue particularly in relation to diary keeping.

usability studies, users complain bitterly whenever they are exposed to sites with overly divergent ways of doing things. In other words, the Web as a whole has become a genre, and each site is interpreted relative to the rules of the genre' (Nielsen 2000: 217).

In 27 reports, participants refer to knowledge about the organisation of the book that they have gained in the course of directly handling the book: this is evidence of using their direct cognitive model. With the 6 tasks that comprise each participant's interaction with the book, it is possible to observe the growth of their direct cognitive model. For instance, having found the section of the book dealing with music in task 2, when asked in task 5 to find out how many symphonies Beethoven wrote after the *Eroica* symphony, some participants make clear in their utterances that they know that there is a section of the book dealing with music and they assume that the answer will be found in this part of the book that they have already visited.

There are no instances of using your indirect cognitive model in the reports from the task observation study. The only structures to afford the formation of an indirect cognitive model are the contents list and mini-contents lists (although, in being found and used less, and giving more constrained overviews, the mini-contents lists afford less opportunity to form a theoretical cognitive model). Participants refer to the contents list on many occasions but none of them subsequently makes an utterance about the organisation of the book based on what they have previously seen in the contents list. That such a process of forming an indirect cognitive model *does* happen is attested to both by evidence from other sources[250] and from the wayfinding survey. In the latter, some participants report looking at a map in advance (meaning that they formed an indirect cognitive model) that they then apply in executing the task.

There are 19 reports that include both using your theoretical cognitive model and using your direct cognitive model. A typical example of this is when the participant knows that this book contains a contents list because they have seen it in a previous task (direct cognitive model), and they know the typical principles of organisation and content for a contents list because they have used other contents lists (theoretical cognitive model), and they use these pieces of understanding together in order to find their objective. This means that reports including both subcategories outnumber reports that include only one. My ad hoc self-observation suggests that (i) the subcategories of cognitive model exist without clear boundaries between them, but (ii) an

250 A famous instance of using his indirect cognitive model is described in Sudjic (2005: 15): Hitler, on his only visit to Paris on 28 June 1940, gives Albert Speer, Herman Giesler, and Arno Breker a tour of the Garnier Opera House based entirely on having made a thorough study of plans of the building years before.

individual's cognitive model is not a single unified entity.[251] Such observations clearly require further research.

6.9.5 / Using your cognitive model in conjunction with planning ahead

There is an intuitive logic in a negative relationship between planning ahead and using your cognitive model: having a cognitive model obviates the need for using external information sources such as maps or other people to plan one's route.

In the diary keeping, planning ahead is included in 68% of reports of seeking-finding in environmental space, but when the sample of reports is narrowed down to those including using your cognitive model, the percentage that includes planning ahead drops to 28%. This suggests that there is a relationship between these factors, but further research is necessary to know more about it.

6.10 / Case study: Frances

Frances is another participant in the diary keeping study. At the time of the research, Frances is 66 years old, married with adult children, educated to degree level, and working part-time although retired.

In overview, Frances includes spatial behaviours in all of her reports, which is more than most other participants. She shows clear patterns in terms of choices of spatial behaviours, and possible relationships with other behaviour groups and contexts.

6.10.1 / Overview of Frances' data

Figure 6.10a shows Frances relative to the other participants in terms of the proportion of each participant's reports that come from each context (based on figure 3.7a with Frances highlighted and all other data greyed out). The greatest proportion of her reports is from environmental space: only 2 participants include greater proportions from this context. Frances is one of only 3 participants who include greater proportions of reports from environmental space than from on-screen (see 8.3.1). And although Frances makes more reports from on-screen than paper documents, there are only 2 participants who have smaller proportions of their reports from on-

251 As also noted by Arthur and Passini (1992: 39), see 6.9.2.

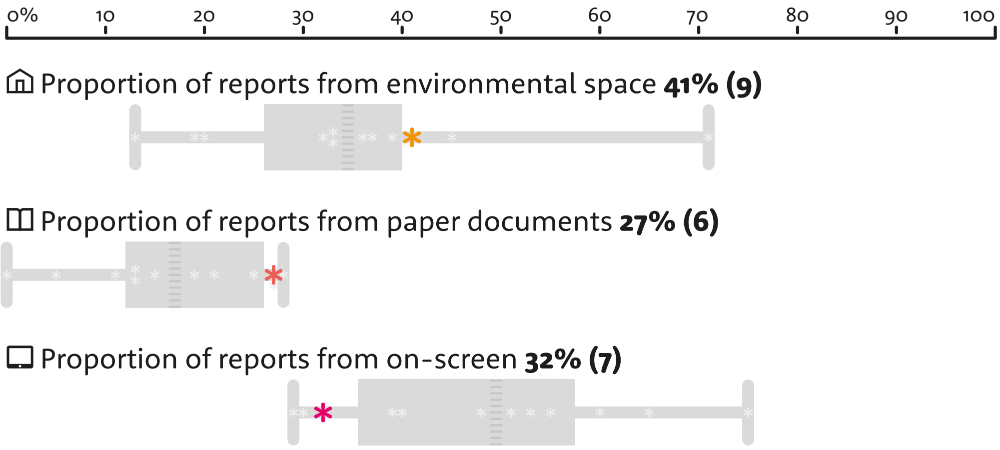


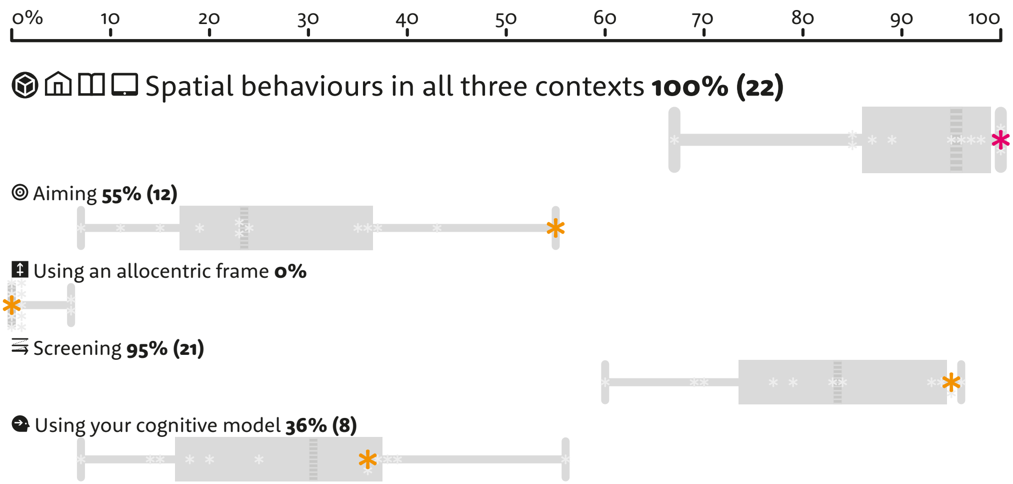
Figure 6.10a (based on 3.7a): *breakdown of Frances' reports by context, in relation to other participants*

screen, and only 1 who includes a larger proportion of reports from paper documents.

Figure 6.10b shows Frances relative to other participants in terms of the proportion of each participant's reports that include spatial behaviours across all contexts (based on figure 3.7j with Frances highlighted and other data greyed out). Spatial behaviours occur in all of her reports (shown by the pink star). She is 1 of 3 participants to include spatial behaviours in all of their reports, while 7 of the 12 participants include spatial behaviours in over 90% of their reports. So although Frances is at the top of the range for the proportion of her reports including spatial behaviours, she is not unduly exceptional in this respect.

The orange stars in figure 6.10b show the percentages of Frances' reports that include each of the 4 categories of spatial behaviour (with contexts

Figure 6.10b (based on figure 3.7j): *the proportions of Frances' reports that include spatial behaviours across all contexts, in relation to other participants*



consolidated) in relation to other participants. Her 55% in aiming is the largest proportion for any participant – she is an outlier by some distance, and at the other end of the range is a participant who includes aiming in only 7% of her reports. None of Frances' reports includes using an allocentric frame, but this is the case with 10 of the 12 participants and hence not unusual.[252] She includes screening in 95% of her reports, and although this is relatively high, she is part of a cluster of 5 participants who include this behaviour in 93–96% , with the other 7 participants including it in 60–84%. Frances includes using her cognitive model in 36% of her reports, and this puts her in the quartile above the median for this category of behaviour, again as part of a cluster of 5 participants who all include this behaviour in 36–39% of their reports.[253] Other than this cluster, another 6 participants are distributed below this point ending with 1 who includes this behaviour in only 7% of her reports. And above the cluster of 5 there is only 1 participant: a considerable outlier who includes using his cognitive model in 56% of his reports.

Figure 6.10c shows Frances relative to the other participants in terms of the proportion of each participant's reports that include spatial behaviours with the data broken down by context. The pink stars show the percentages of her reports that contain spatial behaviours when separated out into the 3 contexts. The percentages of her reports broken down by category of spatial behaviour and by context are shown as orange stars.

As shown in figure 6.10b, Frances is 1 of 3 participants who include some form of spatial behaviour in all reports for all contexts, but figure 6.10c shows that more than 3 participants include spatial behaviours in all of their reports for each individual context. This means that in each context there are participants who include spatial behaviours in all of their reports for that context but do not include spatial behaviours in all of their reports for other contexts.

In environmental space and in paper documents, Frances includes individual categories of spatial behaviour in a greater proportion of reports than is typical. She is in the top quartile for aiming and screening in both contexts, and for using her cognitive model in environmental space, meaning that she includes these behaviours in greater proportions of her reports than practically any other participant. However, Frances' greater than average reporting of spatial behaviours is not the case on-screen: none of her reports from this context includes aiming, and only a small proportion includes using her cognitive model (only 3 participants include this behaviour in smaller

252 The survey materials in this study offer limited opportunity to report using an allocentric frame in paper documents and on-screen – see 6.5.2. This behaviour is not included in any of Frances' reports and, although included in the statistical graphics, is not discussed in this case study because it adds nothing meaningful.

253 Other than Frances, this cluster has only 1 member in common with the cluster of participants who include screening in 93–96% of their reports.

Figure 6.10c (based on figure 3.7m): *the proportions of Frances' reports that include spatial behaviours, broken down by context, in relation to other participants*

proportions of their reports for this context). However, she includes screening in all of her reports from this context.

Figure 6.10d presents a different view of Frances' behaviour: without other participants. Each row shows a single report: detailing the task, context, and particular combination of behaviours used. This allows us to examine the combinations of behaviour in each report. The rows are ordered so that

Task	Task type (Work / Domestic / Leisure)	Context: Environmental space	Context: Paper documents	Context: On-screen	Social: Collaborative seeking-finding	Social: Social seeking-finding	Social: Asynchronous social seeking-finding	Semantic: Following fixed-location instructions	Semantic: Following portable instructions	Semantic: Using a portable overview	Semantic: Using a fixed-location overview	Semantic: Sequencing	Spatial: Aiming	Spatial: Using an allocentric frame	Spatial: Screening	Spatial: Using your cognitive model
Driving from a foreign airport to a holiday destination	Leisure	✓			✓	✓		✓	✓	✓			✓			
Finding a venue in central London	Leisure	✓			✓	✓		✓					✓		✓	
Finding the way through an airport to the departure gate	Leisure	✓			✓	✓		✓				✓	✓		✓	
Finding a friend's house that I have not been to before	Leisure	✓						✓	✓			✓	✓		✓	
Looking for a recipe	Leisure		✓					✓			✓	✓	✓		✓	
Researching a book to suggest for book club to read	Leisure		✓		✓							✓	✓		✓	✓
Looking for the crossword in a newspaper	Leisure		✓										✓		✓	✓
Looking for a particular category of product in a large store	Domestic	✓				✓							✓		✓	✓
Finding a route in an unfamiliar village	Leisure	✓			✓								✓		✓	✓
Looking for a particular product in a large store	Leisure	✓			✓	✓			✓				✓		✓	✓
Finding a destination in central London visited once before	Leisure	✓				✓		✓	✓	✓	✓		✓		✓	✓
Driving to an unfamiliar destination outside of London	Leisure	✓						✓	✓	✓			✓		✓	✓
Looking for a particular section in a professional directory	Work			✓				✓	✓		✓				✓	✓
Looking for information about an online deal	Domestic			✓				✓			✓				✓	
Researching public transport to get to a destination in London	Leisure			✓				✓	✓		✓				✓	
Finding out the weather forecast for the coming month	Leisure			✓				✓			✓				✓	
Finding out the weather forecast for the coming month	Leisure			✓				✓			✓				✓	
Researching a particular category of product	Domestic			✓				✓			✓				✓	
Researching a work-related category of information	Work		✓					✓			✓	✓			✓	
Researching a work-related category of information	Work		✓					✓			✓	✓			✓	
Finding out where a particular film is showing	Leisure		✓					✓				✓			✓	
Researching a work-related topic	Work			✓	✓			✓							✓	

Figure 6.10d: *each row shows the combination of behaviours in one of Frances' reports*

categories of spatial behaviour are each grouped (as far as is possible) in order to give the best possible overview of groupings within spatial behaviours and see if groupings emerge elsewhere in the table.

The issues emerging from Frances' data form the rest of this case study.

6.10.2 / Spatial behaviours in relation to each other

All of Frances' reports include some form of spatial seeking-finding behaviour. Screening occurs in all but 1 (95%) of her reports, and in a substantial portion (41%), it is the only spatial behaviour. Aiming occurs in 12 (55%) of Frances' reports, and among these is the single report that does not include screening. Using her cognitive model occurs in 8 (36%) of her reports; all of these are reports that also include screening, and all bar 1 also include aiming. Frances' choices of spatial behaviours suggest a cumulative heuristic: she commonly uses screening, to which she sometimes adds aiming, and when necessary then adds using her cognitive model. There is also a contextual dimension to this heuristic, discussed in 6.10.4. We can only speculate whether this pattern would continue to be apparent in a sample of reports large enough to be statistically robust.

Aiming and screening each occur in some of Frances' reports as the only spatial behaviour (screening occurs frequently as the only spatial behaviour; aiming occurs infrequently as the only spatial behaviour). Frances reports using her cognitive model only in conjunction with other spatial behaviours.

6.10.3 / Spatial behaviours in relation to social and semantic behaviours

Looking at figure 6.10d, patterns of co-occurrence between spatial behaviours and social and semantic behaviours in Frances' reports are not as clear as the patterns within spatial behaviours. Because spatial behaviours occur in all of Frances' reports, it is not possible to identify any relationships that they have as a group with either of the other behaviour groups or individual categories of behaviour within them. But it is possible to identify relationships between individual categories of spatial behaviour and social and semantic behaviours – these are discussed in 6.10.4.

It is possible that context is a factor in the relationships that spatial behaviours have with categories of social and semantic behaviour in Frances' reports. As discussed in 6.10.4, there are differences in Frances' reporting of categories of spatial behaviour between the contexts, and it is possible that these relationships between context and spatial behaviours involve other categories of behaviour, but the data set is too small to be able to robustly identify such multi-factorial relationships.

In relation to social behaviours

Figure 6.10d suggests that social behaviours have a relationship with specifically aiming among the spatial behaviours: 8 of the 9 instances of social behaviours co-occur with aiming, while only 4 of the 12 instances of aiming do not co-occur with social behaviours. This is discussed further in 6.10.6.

In relation to semantic behaviours

Examining the 5 categories of semantic behaviour one-by-one, the picture that emerges is unclear, but broadly suggests these categories have relationships with aiming or using her cognitive model:

- Following fixed-location instructions tends to occur in reports that do not include using her cognitive model.
- Following portable instructions and using a portable overview both tend to occur alongside aiming (and to a lesser extent alongside using her cognitive model).
- Using a fixed-location overview tends to occur in reports that do not include aiming or using her cognitive model.
- And sequencing tends to occur in reports that do not include using her cognitive model (and less likely that this negative relationship is with aiming).

All of these observations are based on small quantities and so can only be tentative.

6.10.4 / Comparison of spatial behaviours across contexts

All of Frances' reports in all 3 contexts include spatial behaviours, but differences arise in the reporting between individual categories of spatial behaviour. They are:

- Environmental space is the only context in which there is a report from Frances that does not include screening (see 6.10.5).
- Of Frances' reports, all from environmental space, half from paper documents, and *none* from on-screen includes aiming (see 6.10.6).
- Of Frances' reports, just over half from environmental space, one-third from paper documents, and only 1 on-screen include using her cognitive model.

As these last 2 points make clear, the cumulative heuristic discussed in 6.10.2 has a contextual dimension: Frances reports aiming and using her cognitive model most readily in environmental space, less so in paper documents, and barely or not at all on-screen. On-screen, her use of spatial behaviours is limited almost completely to screening. Her use of semantic behaviours on-screen is only slightly less limited: she reports following fixed-location instructions in all instances and using a fixed-location overview in almost all; but she never reports using a portable overview or sequencing and rarely reports following portable instructions. And there is only a single instance of Frances reporting social behaviours on-screen.

This gives a view of Frances' seeking-finding on-screen using a repertoire of tactics more limited than that in environmental space and in paper documents. We can only speculate as to reasons for this but it suggests a relationship between context and choice of seeking-finding behaviour.

6.10.5 / Screening

Frances relies heavily on this behaviour: only 1 of her reports does not include it. But this is not uncommon: she is part of a cluster of 5 participants who include this behaviour in 93–96% of their reports (see figure 6.10b).

If we examine the single report that excludes screening, the data collected goes only so far in illuminating how this instance is different to the others. In this report, Frances is with friends in a hire car finding their way from an airport to a holiday destination. Frances' reports include 2 other instances of driving to unfamiliar destinations and unlike this report, each includes screening: in both in the form of using street-name signs, and 1 also includes systematic searching. Making a systematic search using a car may be a less than ideal means to an end: it may be quicker and less effortful than walking the same route, but dividing attention between driving and screening, and the slow driving speed required may make the activity difficult to accomplish safely. Also, Frances' only report that does not include screening is from environmental space that is not urban: outside of urban areas, street-name signs tend to be unavailable or present in insufficient density for it to be practical to use in screening. We can surmise that this one report may not include screening because the environment (i) does not include street-name signs, and (ii) is unsuited to systematic searching by car.

6.10.6 / Aiming

This behaviour occurs in 55% of Frances' reports, making it her second most frequently reported spatial behaviour: she includes it in a greater proportion of her reports than any other participant. But when Frances' reports are broken down by context, it emerges that she never reports aiming on-screen. There are 4 other participants who do likewise (and those who *do* report it, do so in 23% or less of their reports). However, Frances' reports from environmental space all include aiming, and half of her reports of paper documents include it too, and in both of these contexts she includes aiming in a greater proportion of her reports than any other participant. This absence of aiming on-screen is noted in 6.10.4 as part of Frances' more limited repertoire of seeking-finding tactics on-screen, so it is all the more striking given how much she uses the tactic in other contexts.

In terms of co-occurrence with other spatial behaviours, Frances' reports including aiming always include screening with 1 exception. This is not unusual in that 21 of Frances' total of 22 reports include screening, but the one that does not include screening has aiming as its only spatial behaviour, as is discussed above in 6.10.5. Although this report may have aiming as a single spatial behaviour, it includes both social and semantic behaviours: collaborative seeking-finding, social seeking-finding, following fixed-location instructions, following portable instructions, and using a portable overview. For Frances, this is a large number of categories of behaviour to include in a single report (she includes 2–8 categories of behaviour per report, mean: 4.45, so 6 is towards the top end of her range). I might surmise that the recruitment of so many other categories is perhaps in order to make up for being unable to employ aiming on which she customarily relies.

As noted in 6.10.2, using her cognitive model tends to co-occur with aiming. And as noted in 6.10.3, social behaviours (collaborative seeking-finding and social seeking-finding) tend to co-occur with aiming. Both suggest relationships between these tactics. This particular conjunction of behaviours in environmental space – aiming, using your cognitive model, and social behaviours – all make use of landmarks. Landmarks are integral to aiming in that they form, as my definition in 6.4.1 states, 'a marker that can be apprehended from your location and used as an objective'.[254] Landmarks also constitute a essential structural component in forming and using your cognitive model.[255] And landmarks often form a key component of route directions given as part of social behaviours when seeking-finding in environmental space.[256] So we might surmise that the landmarks in route directions, or a cognitive model are those that then drive aiming.

It is worth looking more closely at Frances' 2 reports of aiming that include neither using her cognitive model nor social behaviours in order to understand the source of their landmark information. One occurs in environmental space: Frances is finding a friend's house. On this occasion, the landmark that Frances knew to look out for was a field next to the house (indirect aiming). While Frances' report does not include the source of this

254 See also Delikostidis, van Elzakker, and Kraak (2015); Delikostidis, Engel, et al. (2013); Mollerup (2013: 40–41 and 54–55); Hansen, Richter, and Klippel (2006); Hunt (1995).

255 Denis, Mores, et al. (2014); Ishikawa and Nakamura (2012); Foo, Warren, et al. (2005); Parush and Berman (2004); Siegel and White (1975); Lynch (1960).

256 Tom and Tversky (2012); Tom and Denis (2004); Tom and Denis (2003); Michon and Denis (2001); Denis, Pazzaglia, et al. (1999).

information, we can speculate that it may have come from previously looking at a map (using her indirect cognitive model) or in instructions from the friend (asynchronous social seeking-finding), and so we may infer that this instance of aiming also employed either a social behaviour or using her cognitive model, although the data collected does not confirm this.

The other report is from a paper document in which Frances looks for a recipe. Here aiming comprises using bookmarks (or Post-it notes or fingers) that she puts in the book to help her re-find pages that she has already looked at. In 5.14.2 we saw how Peter and Cho in the task observation study both use bookmarks. Frances' screening behaviour uses bookmarks (aiming) to structure her search and organise its results, and I could suggest that the bookmarks are landmarks in the cognitive model that Frances forms of the book as she looks through it for a recipe. And so once again we can infer that she is using her cognitive model although the data only suggests this.

As discussed in 6.10.4, Frances' reports of aiming can be interpreted as showing a relation with context: her repertoire of tactics includes aiming most readily in environmental space, less so in paper documents, and not at all on-screen. It might at first seem surprising that Frances does not report aiming on-screen given that using bookmarks could expedite some of her reported tasks (regular tasks such as checking weather forecasts and transport options) and bookmarking facilities are readily available on web browsers and have been widely used for some time.[257] Closer examination reveals that some of these regular tasks are carried out on a tablet or smartphone and using apps in substitution for visiting websites via a browser. Arguably selecting an app from the screen of a device such as a tablet or smartphone could be interpreted as aiming, and so possibly these reports could be construed as including aiming too.[258]

6.10.7 / Using her cognitive model

This behaviour occurs in 8 (36%) of Francis' 22 reports. Of the 3 categories of spatial behaviour that she reports, this is the least frequently reported; and it is the only one that occurs only in conjunction with other spatial behaviours. The possible relationship between using her cognitive model and aiming is discussed in 6.9 and 6.10.6.

As discussed in 6.10.4, there is only one report of Frances using her

257 The survey carried out by *Make tech easier* (https://www.maketecheasier.com/you-still-use-the-bookmarks-browser/ accessed 25/02/2018) into who uses bookmarks, finds that of the 677 respondents, 72% use them 'all the time', and only 1% is not aware of the bookmarks function in browsers. This survey has been carried out among visitors to the relevant page of the *Make tech easier* website and may be not representative of the wider population, but nonetheless it is probably indicative of bookmarking being relatively well-known among users of web browsers.

258 Possibly such inferences could be made from the responses in the questionnaires, but I take the view that such interpretation is too unreliable to be included in my analysis.

cognitive model on-screen, and this may be part of a bigger picture in which her total repertoire of possible tactics for seeking-finding on-screen across social, semantic, and spatial behaviour groups is constrained.

6.11 / Case study: Mary

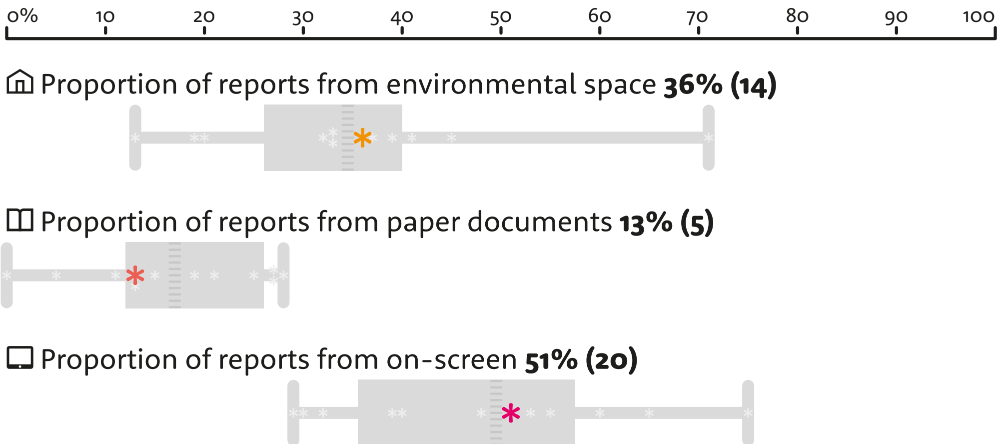
Mary is another of the participants in the diary keeping study. At the time of the research, Mary is 41 years old, married with young children, educated to masters level, and on maternity leave.

In overview, Mary includes spatial behaviours in a smaller proportion of her reports than practically any other participant. Despite this, she reports some categories of spatial behaviour in some contexts in a greater proportion of her reports than any other participant. As with Frances, the picture that emerges is complex and the data only allows us glimpses of the multiplicity of possible behaviour-influencing factors. Mary also gives an insight into satnav use that largely confirms research findings regarding inhibition of formation of a cognitive model, but it is not possible to say from her reports whether this applies to portable instructions more generally.

6.11.1 / Overview of Mary's data

Figure 6.10a shows Mary relative to the other participants in terms of the proportion of each participant's reports that come from each context (based on figure 3.7a with Mary highlighted and all other data greyed out). The proportion of her reports from each context hovers around the median: for environmental space and on-screen, she is just above the median and for paper documents, she is just below. In general she is very close to the middle of the

Figure 6.11a (based on 3.7a): *breakdown of Marys' reports by context, in relation to other participants*



group of participants, but a bit below the average for paper documents.

Figure 6.11b shows Mary relative to other participants in terms of the proportion of each participant's reports that include spatial behaviours across all 3 contexts (based on figure 3.7j with Mary highlighted and other data greyed out). Spatial behaviours occur in 85% of her reports (shown by the pink star). While this is a large percentage, 9 of the 12 participants include spatial behaviours in greater proportions of their reports. Mary is at the opposite end of the range in comparison with Frances and notable for the relative infrequency with which she uses spatial behaviours.

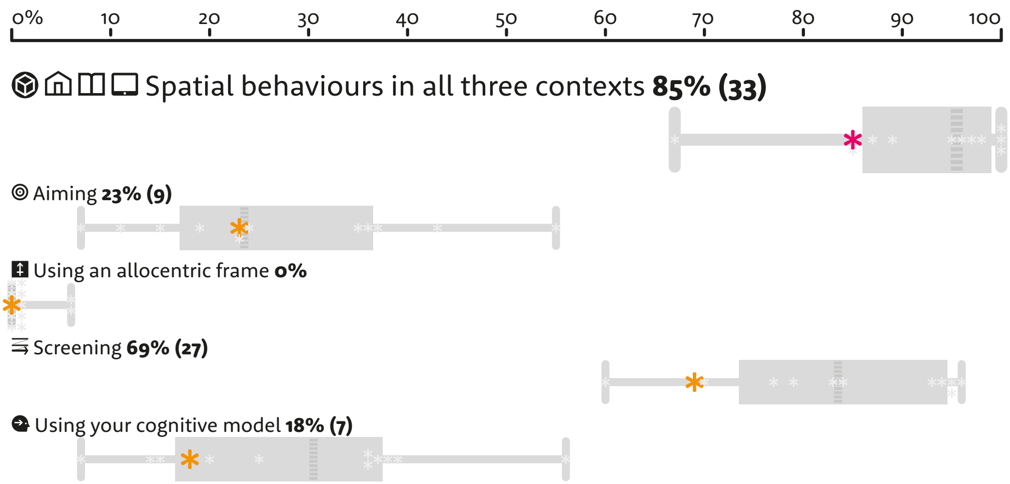


Figure 6.11b (based on figure 3.7j): *the proportions of Mary's reports that include spatial behaviours across all contexts, in relation to other participants*

The orange stars in figure 6.11b show the percentages of Mary's reports that include each of the 4 categories of spatial behaviour (with contexts consolidated) in relation to other participants. She includes aiming in 23% of her reports: this is just below the median for this group of participants, putting her very close to the middle. None of Mary's reports includes using an allocentric frame, but this is the case with 10 of the 12 participants (including Frances, above) and hence not unusual.[259] She includes screening in 69% of her reports, and although this is her most frequently reported spatial behaviour, there is only 1 participant who includes screening in a smaller proportion of their reports. Mary includes using her cognitive model in 18% of her reports, and this puts her in the quartile below the median: there are only 3 participants who include this behaviour in smaller proportions of their reports.

Figure 6.11c shows Mary relative to the other participants in terms of the

259 The survey materials in this study offer limited opportunity to report using an allocentric frame in paper documents and on-screen – see 6.5.2. This behaviour is not included in any of Mary's reports, and, although included in the statistical graphics, is not discussed in this case study because it adds nothing meaningful.

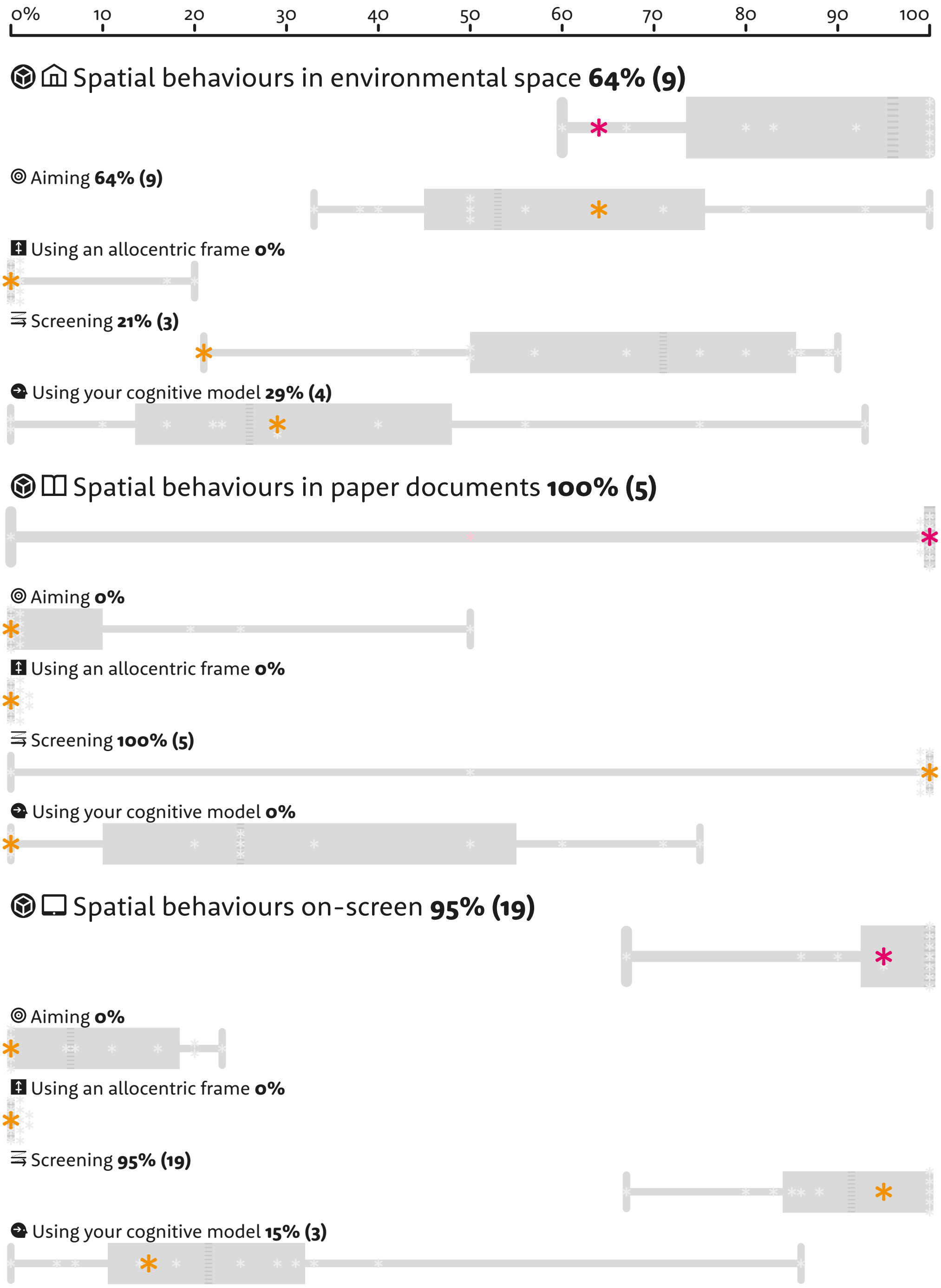


Figure 6.11c (based on figure 3.7m): *the proportions of Mary's reports that include spatial behaviours, broken down by context, in relation to other participants*

proportion of each participant's reports that include spatial behaviours with the data broken down by context. The pink stars show the percentages of her reports that contain spatial behaviours when separated out into the 3 contexts. The percentages of her reports broken down by category of spatial behaviour and by context are shown as orange stars.

Mary is one of the participants who, although they do not include spatial behaviours in all reports in all contexts, do include them in all of the reports in a single context. In Mary's case this is in paper documents, although this is unexceptional as she shares it with all other participants (except for Tanveer who makes no reports at all in this context). For both environmental space and on-screen, Mary emerges as below the median for the proportion of her reports that include spatial behaviours. In environmental space, there is only 1 participant who includes spatial behaviours in a smaller percentage of their reports; nonetheless, Mary includes spatial behaviours in 64% of her reports for this context. On-screen, although Mary includes spatial behaviours in 95% of her reports, there are 7 other participants who include spatial behaviours in greater proportions – all 100%.

The orange stars in 6.11c show that Mary reports considerable use of a few individual categories of spatial behaviour in some contexts and little or no use of most other categories of spatial behaviour.

In environmental space, Mary includes aiming in 64% of her reports, there are only 4 participants who include this behaviour in greater proportions of their reports in this context. Mary's reports of other behaviours in this context are rather more minimal, to the extent of including screening in a smaller proportion of reports than anyone else. But she is above the median for the percentage of her reports that include using her cognitive model (as well as for aiming) in environmental space.

In paper documents, screening is the *only* spatial behaviour that Mary reports and she includes this in all of her reports. However, this extreme difference between categories of spatial behaviour in paper documents is not uncommon among this group of participants: Mary is among 10 of the 12 participants who include screening in all reports for paper documents, and she is among 9 who do not include aiming in any of their reports in this context. However, she is unusual in not reporting any instances of using her cognitive model in this context: there are only 3 participants who do not report this behaviour in this context, while others include it in up to 75% of their reports.

On-screen, Mary's reports of categories of spatial behaviour are quantitatively similar to her reports from paper documents – this is broadly so with all participants.

Figure 6.11d presents a different view of Mary's behaviour: without the comparison of other participants. Each row shows a single report: detailing the task, context, and particular combination of behaviours used. This allows us to examine the combinations of behaviour in each report. The rows are ordered so that categories of spatial behaviour are each grouped (as far as is possible) in order to give the best possible overview of groupings within spatial behaviours and see if groupings emerge elsewhere in the table.

The issues emerging from Mary's data form the rest of this case study.

6.11.2 / Spatial behaviours in relation to each other

As noted above, Mary's reports contain a higher proportion *without* spatial behaviours than almost any other participant. But it is only a small portion – 6 out of 39 (15%). Where Mary reports spatial behaviours, it is usual for her to include only a single category: only 8 (21%) include multiple categories of spatial behaviour.

Screening and aiming each occur as the only spatial behaviour in Mary's reports. Screening is the only spatial behaviour in 21 (54%) reports, and aiming in 4 (10%).

Using her cognitive model occurs in 7 (18%) of Mary's reports, and it is the only category of spatial behaviour that she reports *only* in conjunction with other categories of spatial behaviour. This is the case with 10 of the 12 participants (Mike and Annabelle are the only 2 participants to whom this does not apply) – see 7.4.3.

Of Mary's 8 reports that include more than one category of spatial behaviour, they show every possible permutation of the 3 behaviours, but they are differentiated by context:

- Aiming + screening + using her cognitive model: *2 instances, in environmental space*.
- Aiming + using her cognitive model: *2 instances, in environmental space*.
- Aiming + screening: *1 instance, in environmental space*.
- Screening + using her cognitive model: *3 instances, on-screen*.

These quantities are sufficiently small (out of 39 reports) for it to be inadvisable to draw anything more than the most tentative conclusions about either co-occurrence of spatial behaviours or the relationships with context.

The cumulative heuristic in spatial behaviour that emerges in Frances' case study (see 6.10.2) is present but less so in Mary's reports. However, unlike Frances, Mary's reports of co-occurrences of spatial behaviour are only from environmental space and on-screen whereas Frances' are from all 3 contexts.

6.11.3 / Spatial behaviours in relation to social and semantic behaviours

Apart from following fixed-location instructions and following portable instructions, other categories of social and semantic behaviour are used only infrequently (1–5 instances), so identifying patterns of relationship between spatial behaviours and social and semantic behaviours can only be tentative – as with identifying patterns of relationship between categories of spatial behaviour.

Task	Work	Domestic	Leisure	Context: Environmental space	Context: Paper documents	Context: On-screen	Social: Collaborative seeking-finding	Social: Social seeking-finding	Social: Asynchronous social seeking-finding	Semantic: Following fixed-location instructions	Semantic: Following portable instructions	Semantic: Using a portable overview	Semantic: Using a fixed-location overview	Semantic: Sequencing	Spatial: Aiming	Spatial: Using an allocentric frame	Spatial: Screening	Spatial: Using your cognitive model
Going to a pub			●	●			●				●				●			
Going to a public library			●	●			●				●				●			
Going to a retail park		●		●			●			●	●				●			
Going to an out of town store		●		●			●			●	●				●			
Going to a new school		●		●			●			●	●				●			●
Going to a supermarket		●		●			●				●				●			●
Going to a department store		●		●			●								●		●	●
Finding a public toilet		●		●			●	●							●		●	●
Visiting new GP practice		●		●							●	●		●	●		●	
Finding out train times		●				●				●		●					●	●
Finding a new dentist		●				●				●							●	●
Finding a new GP		●				●				●							●	●
Finding out uniform requirements for a new school		●				●				●							●	
Finding out about regulations regarding to train tickets for children		●				●				●							●	
Finding information about local school places		●	●			●				●							●	
Finding a local TV-aerial repair firm		●				●				●							●	
Finding information about a local church			●			●				●							●	
Researching children's furniture		●				●				●							●	
Researching a tourist attraction			●			●				●		●					●	
Researching household products		●				●				●	●	●					●	
Researching information about a local school		●				●				●	●	●					●	
Finding a local electrician		●				●				●	●						●	
Researching how to stop a cat scratching furniture		●				●			●	●	●						●	
Researching household products		●				●			●	●	●						●	
Researching local decorators		●				●				●	●						●	
Researching reviews for household products		●				●				●	●						●	
Researching local churches			●			●				●	●						●	

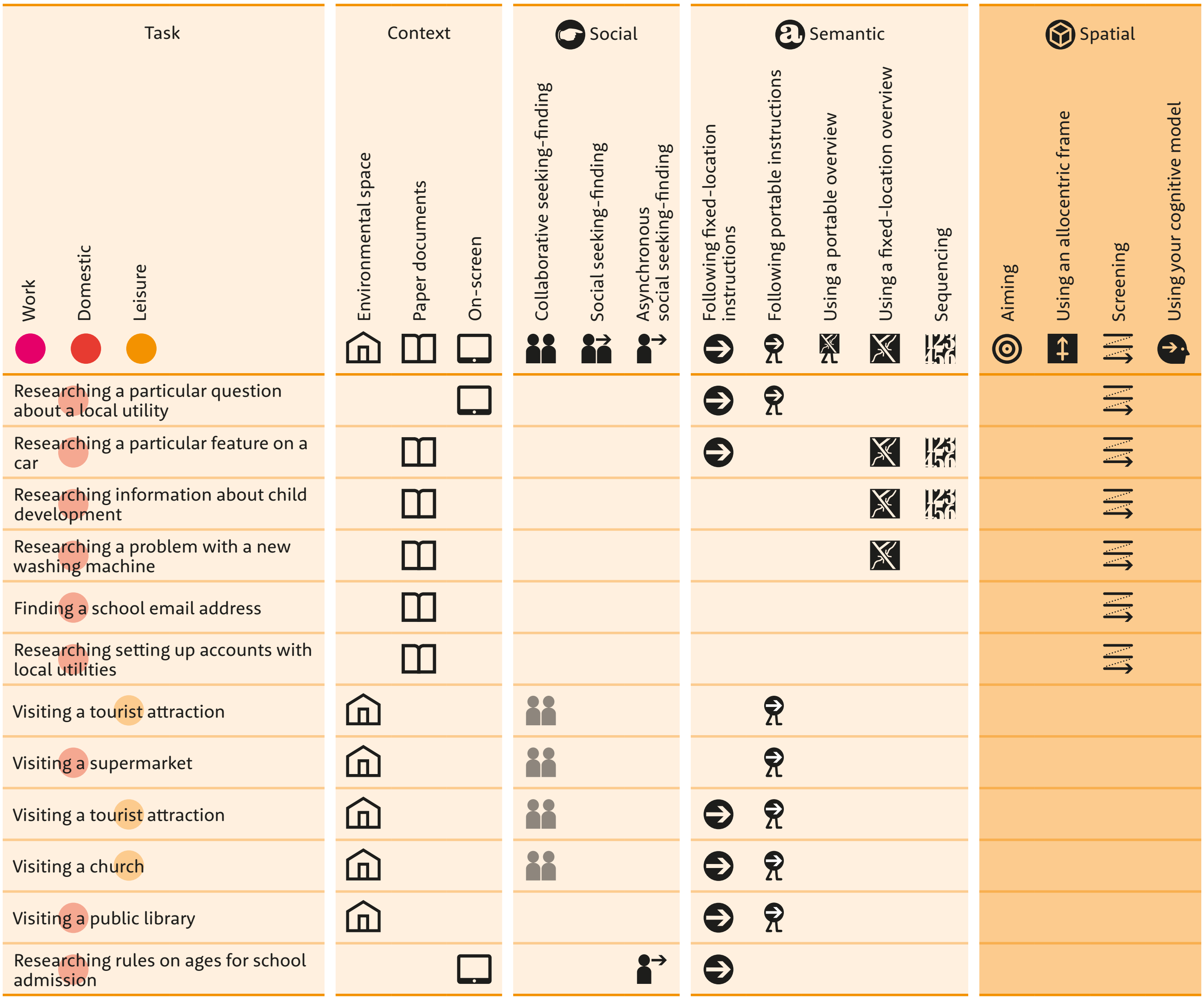


Figure 6.11d (above and facing): *each row shows the combination of behaviours in one of Mary's reports (reports of collaborative seeking-finding are greyed out and not included because of their possible unreliability – see 3.7)*

In relation to social behaviours

Mary's reports of collaborative seeking-finding have been excluded due to problems with her reporting of this behaviour – see 3.7. As a consequence, Mary's social behaviour is somewhat sparse in figure 6.11d: 1 report of social seeking-finding in environmental space, and 3 of asynchronous social seeking-finding on-screen.

The single report of social seeking-finding in environmental space, is 1 of only 4 that do not include semantic behaviours, on which more below. Of the 3 instances of asynchronous social seeking-finding (all on-screen), 2 include screening and 1 no spatial behaviours. All 3 have semantic behaviours: all include following fixed-location instructions, and 2 following portable instructions.

Although these are small samples, they suggest that for Mary, perhaps, social seeking-finding is associated with spatial behaviours or with environmental space, and that asynchronous social seeking-finding is associated with semantic behaviours or with on-screen contexts.

In relation to semantic behaviours

All of Mary's reports include semantic behaviours, except for 4 which all include spatial behaviours. Of them, 2 are from environmental space; and they are the only instances that include 3 categories of spatial behaviour (all other reports include fewer). The other 2 reports are from paper documents, and both include only a single category of behaviour (across all three groups): screening. This suggests that when semantic behaviours are not employed, there is a relation between spatial behaviours and context. In environmental space multiple spatial behaviours are used but in paper documents only screening is used.

Following fixed-location instructions and following portable instructions, occur in large proportions of Mary's reports (69% and 54%). There are only 3 participants who include the former in smaller proportions; but for the latter there are only 2 who include it in *larger* proportions. Both behaviours are largely absent in reports from paper documents: 2 of Mary's reports from paper documents include no semantic behaviours, and 3 include categories of semantic behaviour that she reports much less frequently. This suggests that Mary's use of semantic behaviours in paper documents is qualitatively different to that in environmental space or on-screen. The data also suggests a negative relationship between following portable instructions and screening (or less likely, using her cognitive model) and possibly this may involve context.

6.11.4 / Comparison of spatial behaviours across contexts

Mary reports spatial behaviours in all 3 contexts. All of her reports from paper documents include spatial behaviours, but 5 (of 14) reports from environmental space and 1 (of 20) from on-screen do not include spatial behaviours.

In terms of differences between seeking-finding in paper documents and on-screen, in her briefing interview Mary, makes a clear statement about why she might choose to interact with a paper document rather than on-screen: '… if I have to do actions … I find it easier from a printed document, then I can highlight or mark it where I need to do things and refer back to it. If it's online it's convenient if you just want to do one thing and then you can do it straight away but if you need to do something at a later time, I find it quite helpful to have something I can refer to.' In her debriefing after the test period, Mary observes that she uses paper documents less than she expected, but notes that this may be partly to do with not having a printer at home: she was not always able to print documents when she might have preferred to do so – further demonstrating the diversity of behaviour-influencing factors.

As noted in 6.11.2, Mary's reports include multiple categories of spatial behaviour only in environmental space and on-screen, and these contexts differ in the permutations of spatial behaviour reported therein. They are very small sample sizes but suggest a relation between permutations of spatial behaviours and context: on-screen reports predominantly report only screening, but where they involve other categories of spatial behaviour, it is using her cognitive model. Reports from environmental space are equally likely to include either no spatial behaviour, or only aiming, or aiming + screening +/or using her cognitive model.

Individual categories of spatial behaviour show emergent relationships with context in Mary's reports. These are treated in detail in the discussion of individual categories of spatial behaviour below, but briefly they are as follows:

- Reports that do not include screening are predominantly from environmental space (see 6.11.5).
- Aiming is only reported in environmental space (see 6.11.6).
- Mary reports using her cognitive model in environmental space and on-screen but never in paper documents (see 6.11.7).

In common with all but 1 of the other participants, the semantic behaviour Mary reports most often is following fixed-location instructions. She is like Frances in reporting aiming and using her cognitive model most readily in environmental space; but she also reports using her cognitive model on-screen and not in paper documents – the opposite of Frances. Unlike Frances, Mary includes a large proportion of reports from on-screen, and her repertoire of tactics is not diminished in this context.

Mary's reports from environmental space include an unusually high proportion of following portable instructions, predominantly from her satnav while she is driving. During the study, Mary moved house to a new area and, being unfamiliar with it, was often reliant on her satnav for seeking-finding in environmental space. In the debriefing session at the end of the test period, Mary notes her dependence on her satnav and suspects that it is hindering her forming a cognitive model of the area: 'you get where you're going but you don't really learn'. Mary's suspicion is largely confirmed by research (see 6.9.2).

6.11.5 / Screening

Screening is Mary's most frequently reported spatial behaviour (as is the case with all participants), occurring in 27 (69%) of her reports, and in a substantial portion of these – 21 (54%) – it is the only spatial behaviour. Although screening gives the impression of ubiquity in Mary's reports, there is only 1 other participant who includes this behaviour in a smaller proportion of their reports (see figure 6.11b). Mary's reporting of screening in environmental space is particularly low: of her 14 reports, only 3 include screening. This is striking given how often it is included in her reports from other contexts. Not only does Mary include this behaviour in all of her reports from paper documents, it is the *only* spatial behaviour that she reports from this context (unlike Frances whose reports for this context include aiming, screening, and using her cognitive model). The situation is similar for Mary's reports from on-screen: all except 1 include screening, and for most of them it is the only spatial behaviour (the only other spatial behaviour that Mary reports on-screen is using her cognitive model, in only 3 of her 20 reports).

Mary's minimal reporting of screening in environmental space may be explained by the circumstances of her life. The other participants in this study live in urban areas, but she lives in a rural village. Consequently, she is more reliant on her car than most other participants (public transport is less available and the places she needs to get to are farther apart than in urban environments). As discussed in 6.6.2 and 6.10.5, screening is not well suited to non-urban environments, and cars are not well suited to screening; so her greater proportion of car use (resulting from her non-urban environment) may explain why Mary's reports include so little screening in environmental space. Another factor that may be influencing the amount of screening in Mary's reports from environmental space is her reliance on her satnav (a form of following portable instructions) as discussed in 6.11.4. These reports all include either screening or following portable instructions (there is a single report from this context that includes both; all other reports include only one of these behaviours). So, for Mary there is a negative relation between these behaviours: it may be that her satnav replaces the need for screening.

6.11.6 / Aiming

Aiming occurs in 9 (23%) of Mary's reports, and in 4 of these it is the sole spatial behaviour. Mary reports this tactic only in environmental space, but she also makes 5 reports from environmental space that do not include it (and indeed include no spatial behaviours). Frances includes aiming in *all* of her reports from environmental space, but also reports it in half of her reports from paper documents (see figure 6.10d). The possibility of a relationship between aiming and environmental space is discussed further in 8.3.3.

In her exit debriefing, Mary notes that 'I think [using] landmarks is probably my preferred way of navigating.' She goes on to comment that the landmarks may be minor features such as 'a railway bridge, a bend in the road, maybe a signpost'. Research into landmark use is extensive and largely confirms the efficacy of features that are visually salient (but not necessarily significant in any other way) to support seeking-finding in environmental space.[260]

When Mary's reports from environmental space that do not include aiming are compared with those that do, it is hard to find any consistent difference between them. As already observed, those that do not include aiming do not include any other category of spatial behaviour at all, but it is not possible to distinguish any other characteristic that differentiates the groups. None of the factors recorded in the questionnaires – categories of social or semantic behaviour, task characteristics, planning ahead, and mode of transport – demonstrates identifiable relationships with aiming in environmental space. It is of course possible that the non-reporting of aiming in these environments is simply because they are deficient in visually salient features suitable for use as landmarks.

6.11.7 / Using her cognitive model

As discussed above, the data suggests that following portable instructions may have a negative relationship with either screening and/or using her cognitive model (although the case for a negative relationship with the latter is weaker) in that they tend not to occur in the same reports.

Mary reports using her cognitive model in environmental space and on-screen but not in paper documents. The participants in the task observation provide evidence of using both theoretical and direct cognitive models in a paper document (see 6.9.4), and practitioners writing about the design of paper documents often assume that the users of these documents have theoretical cognitive models of exactly the sort that the participants in the task observation demonstrate.[261] Mary's not reporting this behaviour in this context may be because only 1 of her 5 reports uses a conventional book; the others use documents (such as a set of information sheets from a child's school, or a washing machine manual) whose structure is less subject to the conventions of book organisation and hence may not support the engagement of this theoretical cognitive model.

260 E.g. Denis, Mores, et al. (2014); Ishikawa and Nakamura (2012); Tom and Tversky (2012); Ruddle, Volkova, et al. (2011); Hurlbaeus, Basten, et al. (2008); Etchamendy and Bohbot (2007); May and Ross (2006); Foo, Warren, et al. (2005); Tom and Denis (2004); Denis, Pazzaglia, et al. (1999); Siegel and White (1975).

261 See e.g. Caldwell and Zappaterra (2014: 78–86); Hendel (1998: 9, 51–59); Hochuli and Kinross (1996: 94); Wilson (1993: 60–66); Williamson (1983: 170–183)

7 / Relationships among behaviours

7.1 / Introduction

This section discusses relationships among categories of seeking-finding behaviour. It starts with a brief overview of how the topic is treated in the literature surveyed. This is followed by an examination of the insights offered by comparing definitions of behaviours: first, among the categories in the current taxonomy, and then between it and other taxonomies. After this, the different ways in which behaviours can be related are explored, based on the data from the user studies. And finally, there are discussions of general points emerging from the user studies regarding relationships among behaviours. Following on from this examination of relationships among behaviours, relationships between behaviours and other factors – individual, context, and task – are explored in section 8.

Relationships among categories of behaviour are examined here on the premise that doing so can enrich our understanding both of individual behaviours and the overall systems of seeking-finding behaviour. Much of the literature surveyed does not directly address relationships among behaviours: many studies focus on individual behaviours, or small numbers of behaviours.[262] These allow a specific individual behaviour to be examined closely but do not afford consideration of how it may be situated among the full range of possible seeking-finding behaviours. Such studies might be taken to suggest that a certain task is achieved by using a particular behaviour, but they do not necessarily examine whether a task could require multiple behaviours during its execution, or could be undertaken using different behaviours by different individuals, or using different behaviours by the same individual in different circumstances. The user studies conducted for this thesis provide few examples of a task executed using a single category of behaviour (see 7.5.2).

Moreover, experience suggests that most seeking-finding tasks in everyday life can be approached in a variety of ways by using different combinations of behaviour; and sometimes circumstances may drive the adoption of one

262 E.g. Lukas, Mittelstaedt, et al. (2014); Ishikawa and Takahashi (2013); Wen, Helton, and Billinghurst (2013); Andre (1991).

tactic rather than another. For example, in environmental space, RSSB (2006: 35) suggests that if you-are-here maps (using a fixed-location overview) are unavailable in a railway station, then people are more likely to ask staff (social seeking-finding), which suggests that in certain circumstances these behaviours are interchangeable.

Many studies also examine or compare behaviours in order to measure performance or outcome.[263] They may provide insight that contributes to answering the research questions here, but their conclusions regarding performance do not contribute directly. Studies that compare preferences are more pertinent.[264]

7.2 / Relationships suggested by the taxonomy definitions

Section 6.9.1 introduces the idea of using the 4 questions that shape the definitions in the taxonomy as a means of identifying degrees of connectedness between categories of behaviour. This approach suggests that using your cognitive model is the category of behaviour that has least in common with other categories.

This same approach also identifies three further points. First, the social, semantic, and spatial groups do not separate out along visible breaks in figure 6.9a. These groups arose from a thought process separate to that which generated the questions that structure the definitions,[265] and possibly this is what is reflected here. Second, the 4 'map-based' behaviours – following fixed-location instructions, following portable instructions, using a portable overview, and using a fixed-location overview – are not as strongly related as one might expect given that all include map use. This perhaps supports their identification as separate categories in this taxonomy. The third point is that using a fixed-location overview, sequencing, aiming, using an allocentric frame, and screening emerge as strongly connected. This is not entirely surprising: it returns to the issue raised in 2.8 regarding the similarity of the definitions of these categories. Reflecting on this cluster of categories, it is possible to argue for particular connections among them. For instance, sequencing can be seen as a particular semantic type of aiming or screening. Like indirect aiming, you can direct your progress towards an objective that you cannot directly apprehend from your present location; in this instance through the agency of a

263 E.g. Chu, Paul, and Ruel (2009); Spyridakis, Mobrand, et al. (2007); González de Cossío and Dyson (2002).
264 E.g. Wen, Helton, and Billinghurst (2013); Nielsen (2000); Andre (1991); McKnight, Dillon, and Richardson (1989).
265 See 10.1 for an account of the development of the taxonomy.

known sequence of symbols. And, like targeting screening, it can be construed as a form of systematic searching, a search that ends when the given symbol (at a given position in the sequence) is reached; in this instance the search is organised in space by the symbol sequence. To give another example, one could argue that using an allocentric frame is a form of indirect aiming that uses a frame of reference to permit you to aim for an objective that you cannot directly apprehend from your present location. It is possible to construct other such connections between behaviours in this group. These arguments rely on similarities in the activities that form the behaviour, but what is undeniable (and critical to the taxonomy as it stands) is that the sources of information that they use are materially different to each other.

7.3 / Relationships suggested by other taxonomies

The other taxonomies discussed in 2.10 contain some categories of behaviour that span multiple categories in my taxonomy. These 'super-categories' are:

- Social seeking-finding + asynchronous social seeking-finding
  = social navigation in environmental space (Mollerup 2005)
- Following fixed-location instructions + following portable instructions
  = browser mechanisms on-screen (Kalbach 2007)
- Following fixed-location instructions + following portable instructions
  + sequencing
  = linear / direct access in environmental space (Passini 1981)
- Using a portable overview + using a fixed-location overview
  = map reading in environmental space (Mollerup 2005)
  = tree navigation, site maps, and directories on-screen (Kalbach 2007)
- Following fixed-location instructions + following portable instructions
  + using a portable overview + using a fixed-location overview + aiming
  + using an allocentric frame
  = spatial / direct access in environmental space (Passini 1981)

These 'super-categories' from other taxonomies are overlaid on my taxonomy in figure 7.3a. Most of the relationships suggested here are straightforward: they are each contained in one of the three behaviour groups in my taxonomy. For example, 'social navigation' (Mollerup 2005) makes the same connection that is implicit in the names of social seeking-finding and asynchronous social

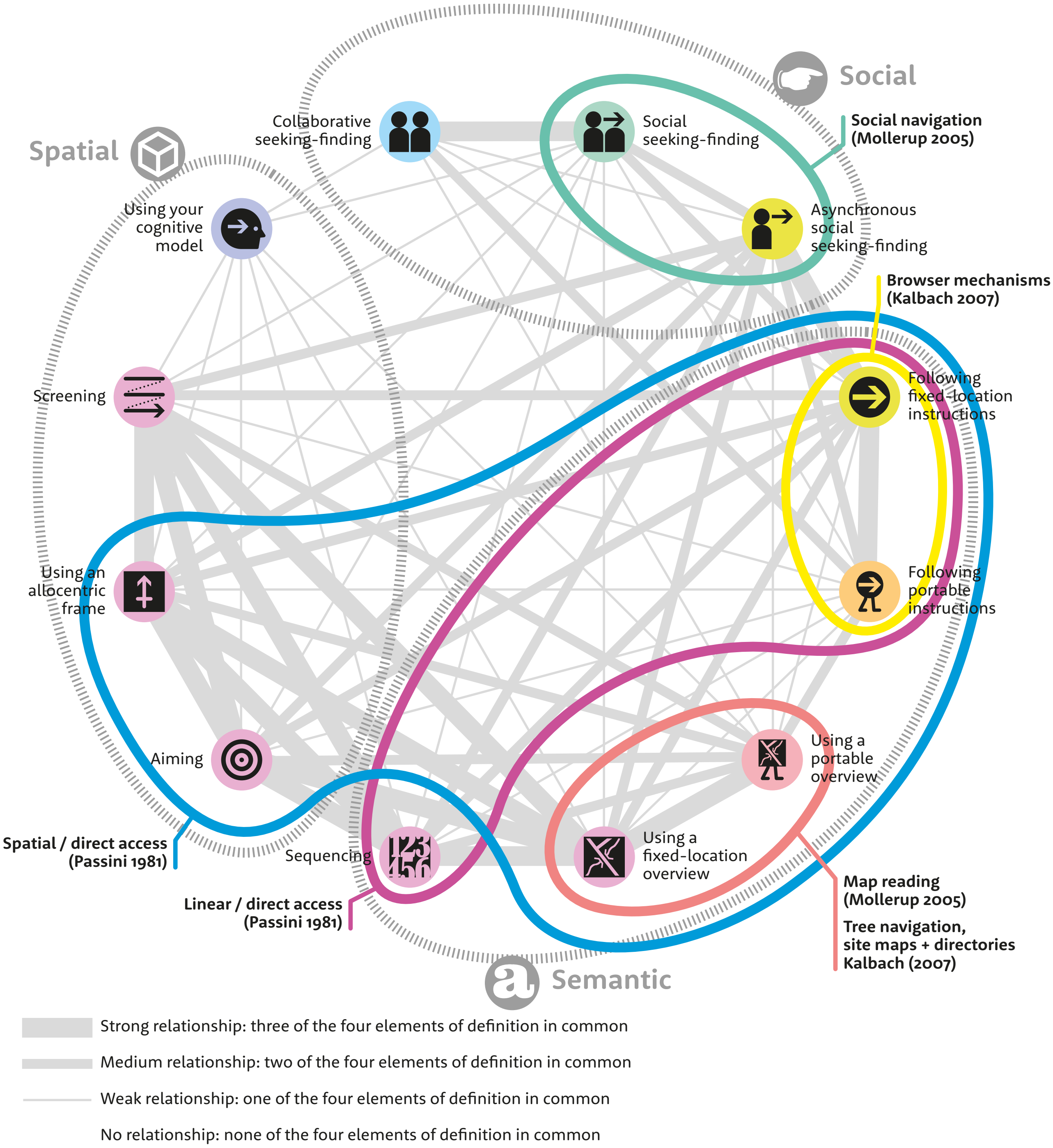


Figure 7.3a: *figure 6.9a with the groupings ('super-categories') from other taxonomies mapped on to it*

seeking-finding, but does not differentiate between whether the other person is present, or has left traces of their presence after their depature. This derives from commonalities in the *origins* of the information they use. These two categories are not strongly related in the current taxonomy due to qualitative differences in the information they use.

The 'spatial / direct access' group of Passini (1981) provokes more thought here. Figure 7.3a does not serve to shed any light on this other than perhaps to remind us that Passini's definitions employ a set of factors strongly different to those in the current taxonomy.[266]

7.4 / Ways in which behaviours can be related

Scrutinising and coding the recordings in the task observation study, in conjunction with reflecting on my personal experience of seeking-finding behaviour in everyday life, suggests 5 ways in which behaviours can be related:

- *Causal*: behaviour A causes behaviour B
- *Nested*: behaviour A contains smaller-scale behaviour B
- *Parallel*: behaviour A and behaviour B occur at the same time
- *Sequential*: behaviour A is followed by behaviour B
- *Co-occurring*: behaviour A is used in the same task as behaviour B (this category subsumes most of the above, as discussed below)

These offer approaches to examining relationships among behaviours in the user studies. The last one – co-occurring – is a somewhat portmanteau term: behaviours that are nested, parallel, or sequential, and in some cases causal, are also co-occurring. Co-occurrence is included here because it also includes behaviours that occur in the same task, but are not causal, nested, parallel, or sequential. All of these types of relationship are discussed below, but the largest part of the analysis is of behaviours that are sequential or co-occurring, because identifying instances of the other ways in which behaviours can be related is more problematic (see below).

Some of the challenges to examining relationships between behaviours in everyday seeking-finding are identified by Albers (2003b: 270): 'In a complex problem-solving environment, attempts to describe step-by-step actions break down because no single route to a solution exists. … A conventional task analysis … doesn't do a good job of capturing the underlying reasons that drive performing the actions or the information relationships used to analyse the problems … The common problem with task analysis is that it captures what the user does but fails to capture what motivated the user to perform the action.'

266 See 2.4 and 2.8 for more detail of Passini's taxonomy and how it corresponds to mine.

7.4.1 / Causal, nested, and parallel relationships among behaviours

Causal relationships

It is likely that behaviours sometimes occur as a consequence of other behaviours. For example, using a fixed-location overview necessitates remembering the information it contains (in the form of a cognitive model), which leads to using your indirect cognitive model when the mental model incorporating information from the overview is accessed and used. Although we might confidently speculate about such causality in principle, there are general problems with being able to confidently assign causality (Holt and Walker 2009: 215). This may be the reason why many studies of seeking-finding behaviour are largely silent on the subject.

Nested and parallel relationships

The task observation is the only 1 of the 3 studies that gives data about the temporal relationships among the behaviours included in a report. Examining the recordings from this study suggests that behaviours are often sequential (see 7.3.2), like the steps in a recipe, but can also overlap, and this may take the form of either being nested or happening in parallel.

Nesting refers to larger-scale behaviours containing smaller-scale behaviours. The behaviour categories used in my taxonomy can contain smaller behaviours, and can themselves be contained by larger behaviours. Of behaviours occurring in parallel, at larger scales we might call this multi-tasking; self-reflection suggests that at smaller scale (such as is used in this thesis), it is often not so consciously deliberate.

Experience of coding the data in the task observation study raises the issue of identifying the boundaries between instances of behaviours. Such boundaries (like the categories of behaviour themselves) are a largely artificial, post hoc construction imposed on messy everyday life in order to render it intelligible. Distinctions as to whether behaviours are nested, parallel, or sequential are equally artificial. Furthermore, the resources available for coding the data in the task observation study do not permit identifying behaviours of less than 1 second duration. In order to code the recordings into manageable data without undue distortion, behaviours are regarded as occurring one after the other; this is discussed in 7.4.2. This means that the data as it stands does not identify instances of behaviours being nested or occurring in parallel. But this is not to deny either that they happen or that they are worth studying, as the brief examples below (from the task observation study, and the literature survey) indicate.

An insight into nesting of behaviours that the task observation study *does* afford looks at behaviours at a scale larger than elsewhere in this thesis. In the case study in 5.14.2, the work-around used by Peter and Cho to mitigate not understanding the page numbering system shows tactics being strung together in repeating patterns to form larger-scale strategies. These are brief multiple alternating episodes of aiming and screening, interspersed by instances of using a fixed-location overview. For instance, in completing task 3, Cho is using a fixed-location overview 10 times, screening 16 times, and aiming 14 times.[267]

Another example of nested behaviours comes from the literature review: 'Some click forward from lists and abstracts to full-text viewing of articles, but as the studies show (Nicholas, Huntington, et al. 2008), two-thirds of article views lasted less than three minutes and 40 percent were completed in a minute or less. This viewing and bouncing behaviour is called "squirreling" — an energetic search for treasures that are downloaded for later consumption' (Hillesund 2010). He also cites Nicholas, Rowlands, et al. (2008) who identify a similar strategy called 'power browsing'. In both instances, the larger behaviour is screening, but nested within it is following fixed-location instructions (clicking on links).

7.4.2 / Sequential relationships among behaviours

As noted above, the task observation is the only user study that gives data about the temporal relationships among behaviours within a report. The coding of the data limits the opportunity to examine behaviours that are nested or in parallel, but offers opportunity to examine sequential relationships among behaviours. This sequentiality may also suggest causality: you have to do A in order to then do B. But as discussed above, causality can be problematic to establish, and the data here is unsuited to doing this.

Experience suggests that in everyday life, some sequences of behaviours are likely to be more commonplace than others. For example, from paper documents: using a cross-reference (following fixed-location instructions) is typically followed by using the page numbers to find the page referred to (sequencing).

Patterns of sequentiality in the task observation data

Each of the 72 reports that make up the data from the task observation study can be broken down into separate sequences: each sequence comprises a different attempt by the participant to complete the task, and reports can contain more than 1 attempt/sequence. The sequences are made up of consecutive steps, each step being an instance of a category of behaviour. In this study, the recorded sequences contain 1–38 steps (mean: 6). A sequence continues until the participant (i) reaches their objective, (ii) abandons the attempt and starts again using a different strategy,[268] or (iii) abandons the task entirely. The data

267 The data showing these sequences is in 10.2.2.

268 Starting again marks the beginning of a new sequence.

for all sequences is in 10.2.1. Sequences can contain multiple instances of the same behaviour, which are usually *not* consecutive, but occasionally, there are instances of consecutive steps of the same behaviour, discussed further below.

Figure 7.4a shows how many times each behaviour is followed by another behaviour in the task observation study. The data is broken down to also show how many times each pair of behaviours occurs at the start and at the end of a sequence. This table shows that some pairs are used more often than others, and different patterns emerge at the starts and ends of sequences. Only 33 of the 49 possible combinations of behaviours are reported: one-third of possible combinations are unreported in this study.

Only 2 behaviours give rise to instances of a behaviour following itself: sequencing and screening. In sequencing following sequencing, the participant completes a sequencing activity (such as using the page numbers to find a particular page), and then embarks on another (such as using the alphabetic ordering of entries to find the right entry). For screening, consecutive instances are recorded either when the participant's utterances and actions make it clear that they change objective in their screening, or when they change between types of screening (such as changing from scanning running heads to find a desired section, to then scanning text within the section). Most other categories of behaviour are less conducive to being followed by a second instance of the same behaviour.

In this study, most combinations of behaviour are unreported or reported in small numbers; very few are reported in large quantities:

- Following fixed-location instructions, then sequencing
  using the index is followed by using the alphabet to find the right item in the sequence of items listed.
- Using a fixed-location overview, then screening
  using the contents list is followed by scanning the overview it provides.
- Sequencing, then sequencing or screening
  sequencing then sequencing is discussed above; sequencing then screening is, e.g., using page numbers to locate a desired page, and then scanning the content on that page to find the desired information.
- Aiming, then using a fixed-location overview
  typically part of the work-around used by Peter or Cho to make up for not understanding the page numbering system, as discussed above under nested behaviours: this part of the process is the participant returning to the bookmarked contents list and using it to check the relative position of the item they seek[269].

269 See 5.14 for full discussion of this strategy.

- Screening, then sequencing or aiming
  both are typically part of the process of scanning the contents list or index (screening), and then using the page numbers to find the right page (sequencing), or using the knowledge of the position of the page number referred to in relation to the whole of the book to know how far through the book to head for (aiming).

  Two further behaviours, while not frequently used, are noteworthy:

- Using an allocentric frame is often followed by following fixed-location instructions or using a fixed-location overview
  the participant expresses an intention to go to either the front of the book to consult the contents list, or to the back of the book to consult the index.
- Using your cognitive model is often followed by following fixed-location instructions, using a fixed-location overview, or using an allocentric frame
  in the first 2 cases, the participant states that they know there is an index or contents list, and then goes straight to that part of the book; for using an allocentric frame, the participant states that they know that there is an index or contents list, and then states that they will go to it at the back or front of the book.

For some of these pairs, the second behaviour could be regarded as nested within the first (as discussed above).

Among the pairs of behaviours that start sequences (see figure 7.4a), using your cognitive model is the most frequently reported starting behaviour, reported in 43 instances; using a fixed-location overview in 29 instances; following fixed-location instructions is reported in 19; other behaviours each start 10 sequences or fewer. The predominance of using your cognitive model is even more striking when compared with the overall totals: using your cognitive model is rarely reported other than as the first behaviour in a sequence. As discussed in sections 3 and 6, it is likely that this category of behaviour is particularly prone to under-reporting. But in terms of the evidence of this study, this finding is striking and supports the suggestion made in 6.9.3 that the individual has to engage their cognitive model in order to decide how best to act.

The only other pairs of opening behaviours that are reported in anything more than a handful of cases are somewhat self-explanatory: following fixed-location instructions, then sequencing; and using a fixed-location overview, then screening. As discussed above, they constitute using the contents list or index: these are the principal access structures in the paper document used in this study, and so it is unsurprising that they should be frequently used as starting behaviours.

The most frequent final behaviours are sequencing and screening. Sequencing is typically the last behaviour when the task requires locating an

First behaviour \ Second behaviour	Following fixed-location instructions	Using a fixed-location overview	Sequencing	Aiming	Using an allocentric frame	Screening	Using your cognitive model
Following fixed-location instructions		1 1	17 47 13			1 4 2	
Using a fixed-location overview			2 8 3	3		27 104 9	
Sequencing	2	8	57	9	2	76 57	
Aiming	3 14	4 35	9 3			2 27 5	
Using an allocentric frame	4 8	5 14	1			5	
Screening	2	3 10	7 73 23	61	4	11	1 1 1
Using your cognitive model	7 7 1	19 19 1	4 4 1	1	12 12	1 1	

Figure 7.4a: *the number of occasions on which each behaviour is followed by another behaviour, in the task observation study. Within each cell, the upper number is the number of instances of that pair of behaviours occurring at the start of a sequence; the middle number is the total number of instances of that pair of behaviours; and the bottom number is the number of instances of that pair occurring at the end of a sequence (zeros have been omitted to minimise clutter in the table). n=120 separate sequences*

item in an alphabetically or numerically ordered list; and screening, when the required information is within prose that has to be scanned to find it.

7.4.3 / Relationships among co-occurring behaviours

Co-occurrence is the most straightforward of the 5 sorts of relationship among categories of behaviour, and subsumes the other sorts of relationship described above. It simply requires that the behaviours occur in the same report. All 3 user studies can be used to examine co-occurrence, and given that the majority of reports in each study include multiple categories of behaviour, there is a great deal of it. However, patterns of co-occurrence are not readily discernible.

The case studies in sections 4–6 that examine individual participants from the diary keeping identify many patterns of co-occurrence within individual participants' reports. These include:

- For Jess, the range of semantic behaviours is constrained when social behaviours also occur (see 4.9.3).
- For Jess and Fergus, collaborative seeking-finding co-occurs with both social seeking-finding and asynchronous social seeking-finding, but the latter two never co-occur (see 4.9.2 and 4.10.2).
- For Alison, instances of semantic behaviours co-occurring always include following fixed-location instructions (see 5.15.2).
- For Mike, following fixed-location instructions and using a portable overview are the only semantic behaviours that occur without the presence of other semantic behaviours; he uses all five semantic behaviours but the other three only occur in permutations of two or more of them (see 5.17.2).

These patterns of co-occurrence are often based on small data sets, and so may be exaggerated. Furthermore, these relationships are rarely evident in the data from other participants. We can tentatively conclude that individuals demonstrate different relationships among behaviours, but that there is little in the way of these relationships that are common across all (or even most) participants. Two areas of relationship among behaviours that emerge from the user studies are discussed below.

Using overviews, or following instructions

This revisits the relationship identified in 5.13.4. In that case study, participants in the task observation are sorted into three groups based on their decisions to use the contents list (using a fixed-location overview), index (following fixed-location instructions), or a mixture of both. These groupings are most apparent when only the *first* choice of either contents list or index is examined

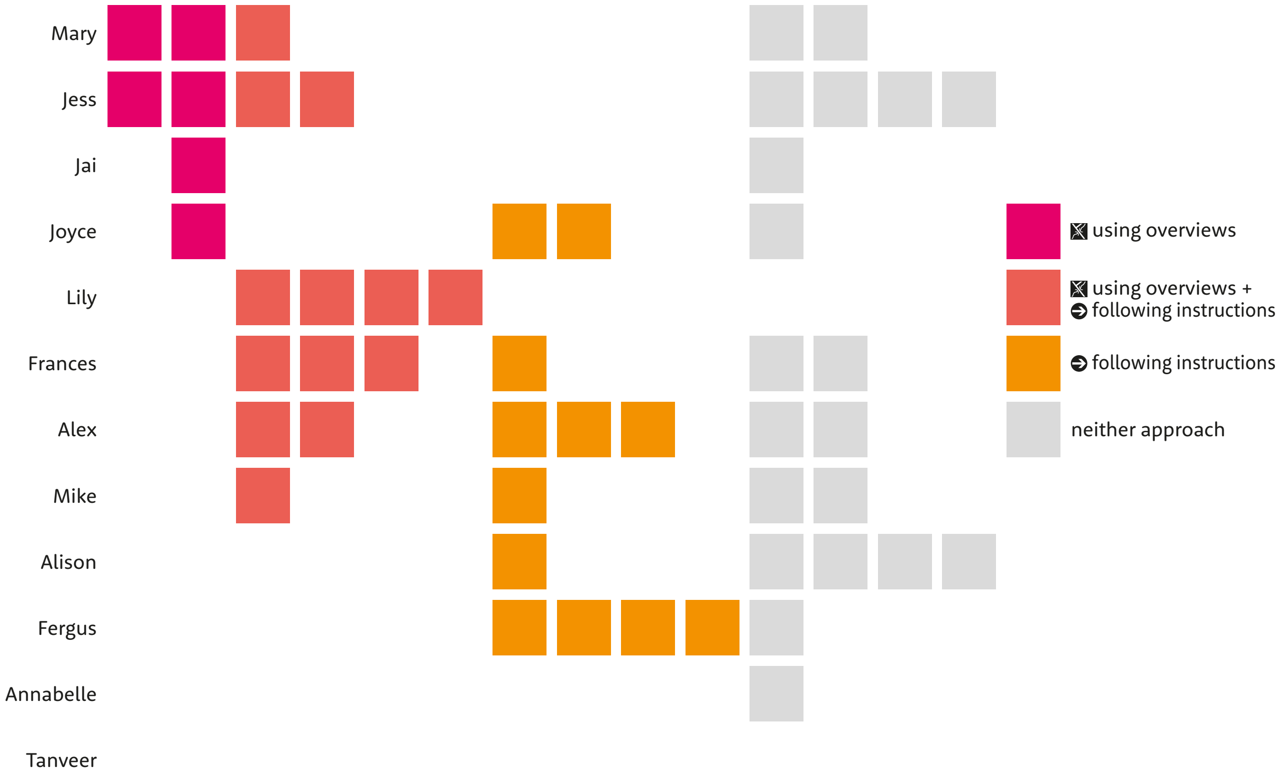


Figure 7.4b: *data from paper documents in the diary keeping study, analysed for instances of using overviews and following instructions. Compare this with figure 5.13c. The values here are absolute quantities rather than percentages due to the small quantities*

(figure 5.13b); when *all* choices are considered, the groupings are still evident but the number of participants using a mixture increases, and the number of participants using 1 or the other decreases (figure 5.13c).

The task observation looks at behaviour in a paper document, and an analysis of the reports from paper documents in the diary keeping study finds similar groupings: see figure 7.4b. The quantities involved are small, though. One difference between the two studies is that the participants in the task observation study use overviews more than following instructions, whereas in the diary keeping study the opposite is true: they follow instructions more than using overviews. [270] When the same analysis is applied to the data in all contexts from the diary keeping study, the balance shifts even further towards following instructions: see figure 7.4c.

It is possible that the decisions individuals make about whether to use

270 One difference between these analyses is that whereas the analysis of data from the task observation study examines only following fixed-location instructions and using a fixed-location overview, that from the diary keeping study includes following portable instructions with following fixed-location instructions, and similarly using a portable overview is included with using a fixed-location overview. This has been done (i) because the paper document used for the task observation did not afford the 'portable' behaviours, and (ii) including them in the analysis of the diary keeping data increases the size of the data sets.

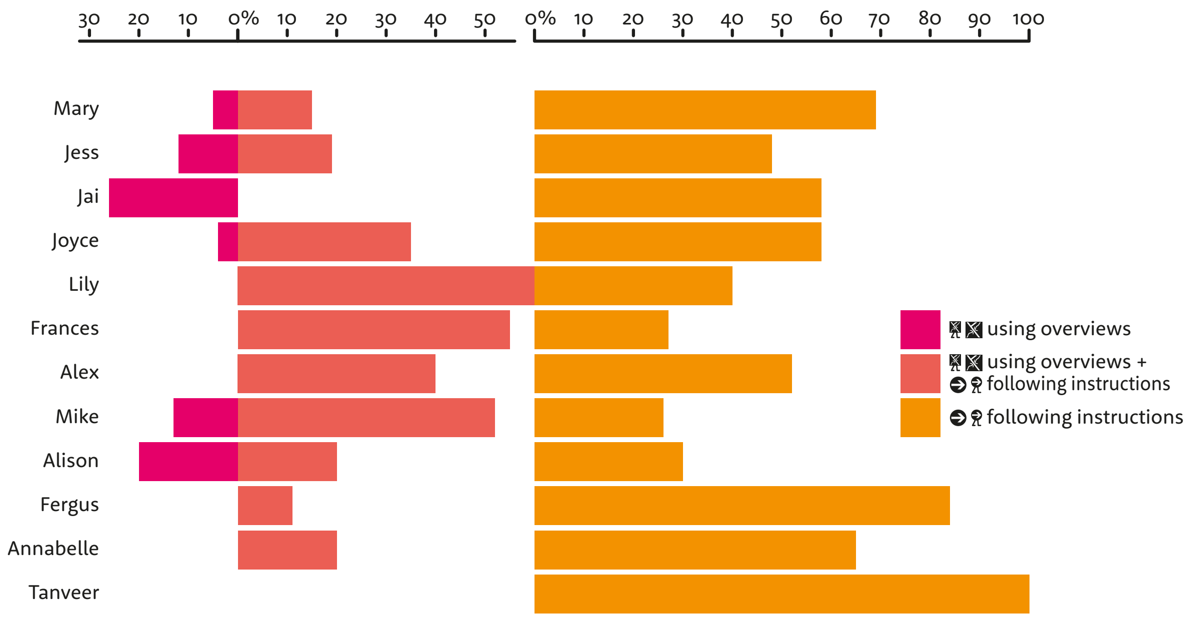


Figure 7.4c: *data from all contexts in the diary keeping study, analysed for instances of using overviews and following instructions. The values are percentages*

overviews or instructions may fall into consistent groups – particularly their first choices, but further research is required.

Using your cognitive model in relation to other categories of behaviour

Using your cognitive model emerges in sections 4–6 as having relationships with a number of other categories of behaviour. As discussed in 4.11.3, there is a relationship between using your cognitive model and social behaviours in paper documents, but the data gives little further insight into this co-occurrence. Using your cognitive model often occurs in conjunction with using an allocentric frame (see 6.5.1). This co-occurrence is noted in both the task observation and the diary keeping. As discussed in 6.8.1, it is possible that in the task observation both behaviours are under-reported. Figure 7.4a shows how minimally these behaviours are reported, but indicates a degree of co-occurrence in the form of sequentiality. In the diary keeping, this co-occurrence is noted in 6.5.1 and 6.7.1.

In 6.10.6 there is a discussion about using your cognitive model in relation to aiming and social seeking-finding: the latter 2 both rely to some extent on landmarks, and landmarks also form a key structural component of cognitive models. Possibly it is reliance on landmarks that underpins the relationships between these behaviours. Finally, in 6.11.2, Mary's case study points out that using her cognitive model is the single category of spatial behaviour that she reports only in conjunction with other spatial behaviours: both aiming and screening occur as the only spatial behaviour within a report, but not using her cognitive model. This is a trait that Mary shares with 9 other participants in the diary keeping study. Mike and Annabelle are the only participants in this study who make reports that include using their cognitive model as the only spatial behaviour: an interesting subject for further research.

7.5 / Three points about relationships among behaviours

Despite limited evidence of relationships among specific behaviours in the three user studies, 3 general findings are discussed here.

7.5.1 / Individuals typically use multiple behaviours

Individuals typically *do* use multiple tactics in the course of a seeking-finding task in everyday life. Figure 7.5a shows the numbers of categories of behaviour per report for each of the user studies, and the numbers of reports including multiple categories of behaviour. Few reports include single categories of behaviour, as discussed in 7.5.2.

Study	*Mean number of categories of behaviour per report*	*Number of reports including multiple categories of behaviour*
Task observation	4.24	72 of 72 (100%)
Wayfinding survey	4.25	41 of 43 (95%)
Diary keeping	3.51	290 of 299 (97%)

Figure 7.5a: *comparisons of the numbers of categories of behaviour included in each report, across the three studies*

That there are multiple behaviours within each seeking-finding event is likely to be a consequence of examining behaviour at a relatively small scale. It is intuitively logical to expect that an examination of behaviours at a larger scale would find fewer behaviours within each seeking-finding report.

The literature survey finds only limited discussion of mixing or switching tactics within a single seeking-finding event.[271] Among those who mention it, Mollerup (2005: 43) also makes the point that choice of tactic may be influenced by the individual's disposition, previous knowledge, and

271 But it is mentioned in Fidel (2012: 105); Nico and Daprati (2009); Etchamendy and Bohbot (2007); Brown and Laurier (2005a); Mollerup (2005: 43); Albers (2004); Iaria, Petrides, et al. (2003); Carpman and Grant (2002: 431); Danielson (2002); RRSG (2002).

information sources available, highlighting the range of other factors that may have a bearing on choice of tactic – as discussed in section 8.

In everyday life seeking-finding, it is possible that the task may change as the seeking-finding progresses: for instance the goal may become more defined, or altered, as a result of information gathered on the way (Albers 2004; Marchionini 1995), and it would not be surprising if a change of goal or task resulted in a change of tactic(s). For example, in the diary keeping study, while researching online before purchasing a beard trimmer, Mike reports that he changes the filters in his search, in response to what he reads in reviews of beard trimmers. His behaviours are adjusted as a result of information he receives while seeking-finding.

7.5.2 / When do individuals use *single* behaviours?

Within the user studies, there are only a few reports that include a single category of behaviour. Figure 7.5b summarises these.

Screening emerges here as the most reported only behaviour. All of the behaviours included here are among the most frequently reported behaviours in the studies, and so their presence is less surprising. In the wayfinding survey, using your cognitive model is reported only slightly less than screening, and this might raise questions about its absence from this table. But as noted above, it is often found in relation with other behaviours, so perhaps that explains its non-occurrence as the only behaviour.

The questionnaires from the wayfinding survey yield little qualitative insight into the 2 journeys that employ only a single tactic. The reports from the diary keeping that include screening as the only tactic all use paper documents:[272] all of these tasks could have been undertaken on-screen. As discussed in 5.13, the access structures for printed documents are typically the contents list and index (using a fixed-location overview and following fixed-location instructions), but these behaviours are not employed in any of the reports considered here. Rather the participant goes straight into the main body of the document. Perhaps they decide it is unnecessary, or the document does not have these structures: an interaction of task type and document type causes the customary access structures to be bypassed. Instead, these reports include using running heads, headwords, headings in the text, scanning text, and close reading of text to find the information they seek; all of which count as screening.

272 The tasks using paper documents are as follows: Alison is finding plants suitable for shade, checking the plural of a word in a dictionary, and finding out what's on TV in the evening; Mary is looking for an email address, and finding out how to set up utility accounts; Jess is looking for guidance on how to use an online work interface, and researching what to do at the weekend.

	Number of reports including only this behaviour		
Study	Following fixed-location instructions	Aiming	Screening
Wayfinding survey (n=43)	0	1	1
Diary keeping (n=299)	1	1	7

Figure 7.5b: *comparisons of the numbers of reports including a single category of behaviour, across the wayfinding survey and the diary keeping*

The other 2 reports from the diary keeping that include a single category of behaviour both occur on-screen. Of these, 1 reports aiming: Alison is choosing a bathroom fitting: she previously bookmarked web pages to create a short list, and now is finding them again using her bookmarks in order to compare them. The other report including a single category of behaviour is made by Jai: he is planning a journey by bike, and to do so he uses an internet search to get to the web page he requires, and then he enters terms into required fields on the page and clicks on the button to process his request and display the results. All of these count as following fixed-location instructions.

These reports do not shed light on what might be particular about them to require a single tactic. But they do illustrate recurring themes in this thesis: (i) the intertwining of seeking-finding behaviour in different contexts;[273] and (ii) planning ahead before seeking-finding in environmental space.[274]

7.5.3 / Different individuals make different choices

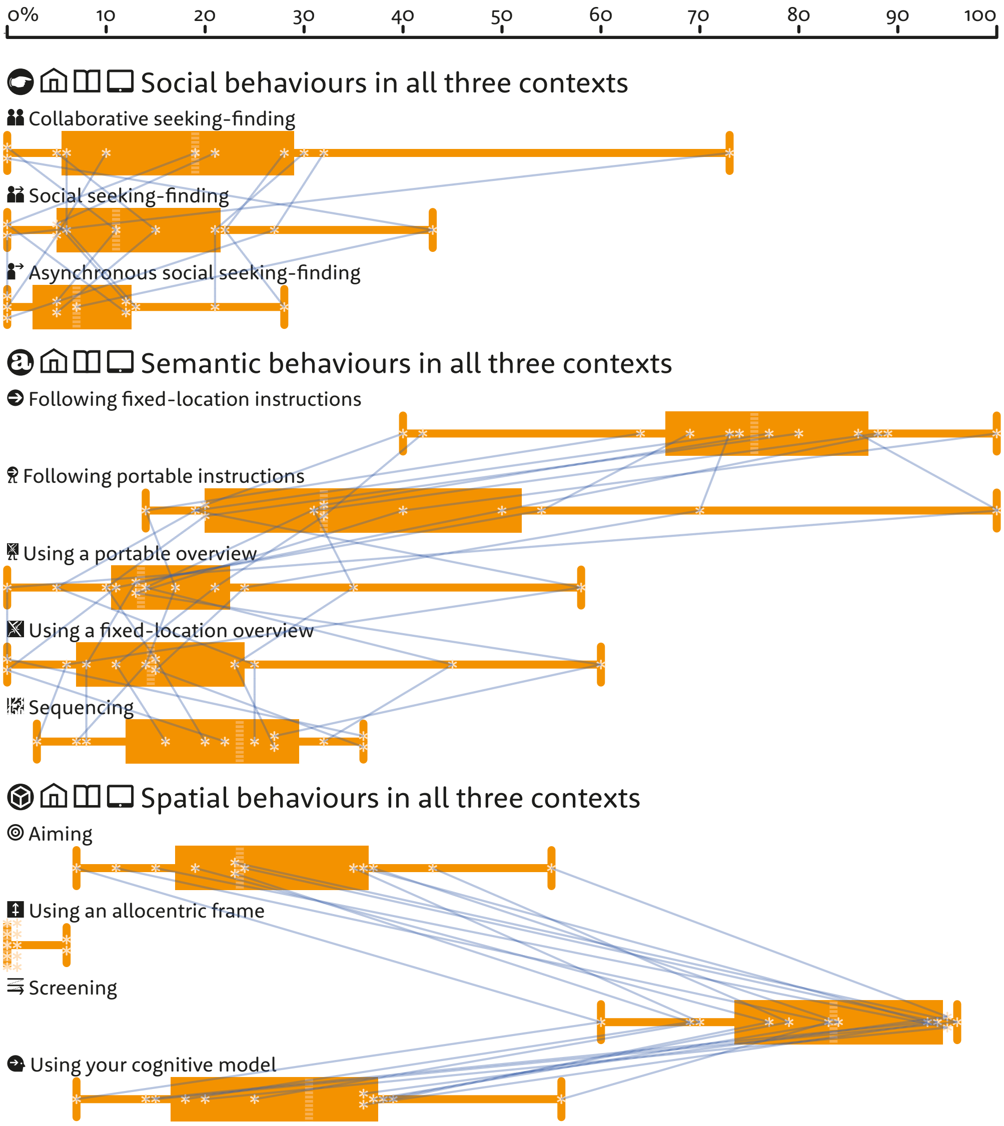
If we ask the question: *Are patterns of seeking-finding behaviour common across different individuals?* The three studies collectively offer the answer: *Not in general*. Taking figures 3.7h–j, and joining together the points for each individual, as shown in figure 7.5c, show no clear pattern across individuals. This lack of comparability may be influenced as much by the diversity of task and affordances of particular environments as it is by differences between individuals.

That individuals have different preferences or aptitudes is a given for Sylvia Harris in ACRP (2011: 18). She advises that optimally navigable spaces should give the choice of maps (using overviews), landmarks (aiming), and staff to ask (social seeking-finding), so that individuals can choose the tactic(s) that suit

273 Mary looks for an email address in a paper document; Jess looks for guidance on using an online work interface in a paper document; Jai researches on-screen to find a route in environmental space and having done so prints out a paper map.
274 Jai researching on-screen to plan a route in environmental space.

them best. A similar point about different individual preferences is made in Arthur and Passini (1992: 49), and in on-screen seeking-finding by Bevirt (1996). This difference between individuals is one of the factors discussed in more detail in section 8.

Figure 7.5c (based on 3.7h–j) *'joining the dots': each blue line represents a different participant in the diary keeping study, and these show no pattern or consistency between*



8 / Individual, context, and task in relation to behaviour choices

8.1 / Introduction

Following on from the previous section examining relationships among the categories of seeking-finding behaviour, this section examines relationships between those behaviours and the factors of individual, context, and task. These are specified by the second research question. As 2.3.1 makes clear, these are far from the only ones potentially influencing choices of seeking-finding behaviour; but as explained in 1.2.6, the number of factors examined in this thesis is limited in order to keep the discussion to a manageable scope. Individual, context, and task are selected as most likely to have influence across a broad range of seeking-finding events.

Choice of behaviour in relation to the individual is examined: covering inter-individual difference, gender, and intra-individual difference. Choice of behaviour is discussed in relation to context, and in relation to context + the individual. Choice of behaviour is explored in relation to task, in relation to task + context, and in relation to task + the individual. Choice of behaviour is not examined in relation to context + task + the individual all together, because the data sets available from the user studies are not sufficiently large to withstand being broken down into so many subcategories without potentially producing unreliable results due to the small numbers involved.

In overview, 2 general, and 2 more specific points emerge from the data of the user studies. The general points are that (i) choice of behaviour is influenced in a variety of ways by individual, context, and task; and (ii) that these influences interact. And the more specific points are that (i) task has less influence than context or the individual on choice of behaviour, but this may be due to the coarse granularity of the analysis of tasks here; and (ii) gender emerges as a particular form of individual difference that influences some choices of behaviour in some contexts.

The interaction of different factors in seeking-finding environmental space is discussed by Li (2006: 739), who concludes that 'there is no definite consistency for a single preferred type of information throughout a series of wayfinding tasks. The change in user preferences during the wayfinding tasks occurs in response to levels of confidence, different spatial layouts, surrounding and wayfinding situations which individuals encounter'. And Hölscher, Tenbrink, and Wiener (2011: 228) point out that 'it remains unclear how the fundamental processes involved in wayfinding and route planning may change according to the situation'.

The *theory of setting* and the concept of *conditional knowledge* – both introduced in 1.2.2 – underpin much of this section. The former proposes that when situation or circumstances vary, the nature of the behaviour is likely to vary (Garner 1990). And the latter identifies the knowledge that guides the individual in knowing when to apply items of procedural or declarative knowledge (Paris, Lipson, and Wixson 1983): here, specifically which categories of behaviour to engage. When considered alongside everyday experience of seeking-finding, these suggest that (i) circumstances (particular task, context, and other factors not considered here) will have an impact on choice of behaviour; and (ii) these differences will not only exist between individuals (inter-individual difference) but may also exist within individuals (intra-individual difference).

8.2 / Behaviour in relation to the individual

8.2.1 / Inter-individual difference

The difference between individuals is widely acknowledged as a factor in seeking-finding behaviour in all contexts, in both research and practice literature.[275] This also emerges repeatedly in discussions of the user studies in sections 3–7. While there are some broad behavioural patterns that emerge across individuals, the differences between individuals stand out more strongly. This is in line with the observation about spatial abilities by Hegarty and Waller (2005: 122): 'differences among individuals on some tasks might be large enough to make the effects of other variables (perhaps those manipulated by an experimentalist) difficult to detect'.

275 E.g. in environmental space: Farr, Kleinschmidt, et al. (2014); Kozhevnikov, Evans, and Kosslyn (2014); Weisberg, Schinazi, et al. (2014); Li (2012); Webber, Burnett, and Morley (2012); Wen, Ishikawa, and Sato (2011); Wolbers and Hegarty (2010); Baldwin (2009); Nico and Daprati (2009); Nori, Grandicelli, and Giusberti (2009); Kelly, McNamara, et al. (2008); Peña, Contreras, et al. (2008); Davies (2007: 28); Smitshuijzen (2007: 13); Hegarty, Montello, et al. (2006); Ishikawa and Montello (2006); Li (2006); Montello and Sas (2006); Münzer, Zimmer, et al. (2006); Blajenkova, Motes, and Kozhevnikov (2005); Hegarty and Waller (2005); Cornell, Sorenson, and Mio (2003); Kato and Takeuchi (2003); Pazzaglia and De Beni (2001); DETR and CABE (2000: 28); Allen (1999a); Montello (1998); Arthur and Passini (1992). In paper documents: Hegarty and Steinhoff (1997); Schriver (1997: 160, 409); Armbruster and Armstrong (1993); O'Donnell (1993); Hegarty, Carpenter, and Just (1991); Lee (1979). On-screen: Vörös, Rouet, and Pléh (2009); Cromley and Azevedo (2008); Juvina and van Oostendorp (2006); Brown (2003); Nielsen (2000); Benyon and Höök (1997); Bevirt (1996). And more widely, Wright (1985).

Differences can also arise not only as a result of differences between individuals, but also as a result of differences in circumstances, which may appear as inter-individual difference. In environmental space, ACRP (2011: 16–17) observe that a pedestrian's decisions will be different to those of a motorist. In on-screen, portable personal digital devices are proving to elicit different choices to desktop machines, because (i) they are portable instead of being fixed-location, and (ii) the smaller touch-sensitive screen demands a different approach to interaction and hence different seeking-finding behaviours (see 1.4.4). For instance, Frances' non-use of aiming on-screen might be due to using a portable digital device rather than a desktop computer (see 6.10.6).

Culture,[276] age,[277] and gender (see below) can also give rise to differences in an individual's choices of seeking-finding behaviour.

8.2.2 / Gender

Gender differences in seeking-finding behaviour are widely studied and discussed.[278] Halpern and Collaer (2005: 171) note that 'The many questions about sex differences in cognitive abilities are socially and politically sensitive because of the potential for misusing scientific results to fuel prejudice and discrimination.' Bearing this and the potential scale of this subject in mind, I approach the issue with caution. It is included because it emerges as influencing the choice of seeking-finding behaviour in the diary keeping. That said, the diary keeping participants comprise 5 men and 7 women: with such a small sample it is not possible to be sure that findings are a reflection of gender difference rather than simply coincidences.

Social seeking-finding often involves the individual asking for help. That men are unwilling to ask for help is a widely held gender stereotype (Devlin 2003; Bennett 1998), covering a much broader range of behaviours than seeking-finding, such as seeking professional help (Addis and Mahalik 2003).[279] Hupfer and Detlor (2006) cite Bakan (1966) who characterises men as independent and autonomous, and women as interdependent and interpersonal: this suggests perhaps that women are more likely than men

276 E.g. Hund, Schmettow, and Noordzij (2012: 1); DETR and CABE (2000: 28).

277 E.g. Rodgers, Sindone, and Moffat (2012); Laberge and Scialfa (2005); Sjölinder, Höök, et al. (2005). Bovy and Stern (1990: 20) cite a study by Benshoof (1970), which finds a relationship between driver's age and route choice: older people more than younger people tend to select a route before starting to drive.

278 Without having explicitly set out to examine this issue, the survey finds it discussed, e.g. in environmental space: Li and Klippel (2014); Münzer, Zimmer, and Baus (2012); Anacta and Schwering (2010); Wolbers and Hegarty (2010); Chen, Chang, and Chang (2009); Peña,Contreras, et al. (2008); Chebat, Gélinas-Chebat, and Therrien (2005); Parsons and Tassinary (2002); Allen (2000); Prestopnik and Roskos-Ewoldsen (2000). In printed documents: Roy, Taylor, and Chi (2003). On-screen: Parush and Berman (2004); Roy and Chi (2003); Roy, Taylor, and Chi (2003); Lawton (1996).

279 Apart from gender differences in *asking* for help, research finds gender differences in *giving or following* directions, e.g. Hund and Padgitt (2010); Hund and Minarik (2006).

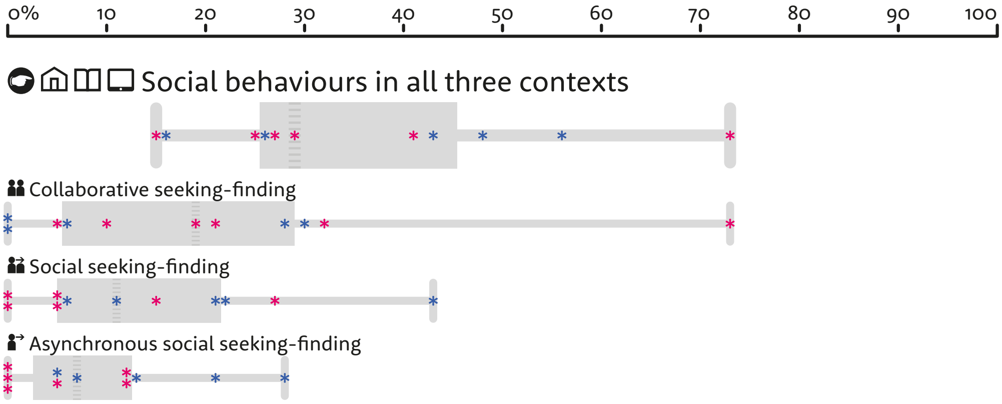


Figure 8.2a: *gender in relation to behaviour: based on figure 3.7h, distribution of the proportions of individual participants' reports that include social behaviours across all contexts in the diary keeping study, and with the gender of the participants identified (pink=women, blue=men) (11 participants shown: 6 women and 5 men, because Mary's social behaviour data is excluded)*

to be more predisposed to engage in social behaviours in seeking-finding. These are, of course, very broad generalisations. But given this gender characterisation, it is perhaps unsurprising that the diary keeping participant who includes social behaviours in the largest proportion of reports is a woman (see figure 8.2a), thus far supporting gender stereotypes and Bakan's gender characterisations. However, the participant who includes them in the smallest proportion is also a woman. In this study, examining the proportions of reports including social behaviours broken down by participant, reveals that in the top 2 quartiles (individuals who include social behaviours in greater than average proportions of their reports) are predominantly men; and the bottom 2 quartiles (who include social behaviours in lesser than average proportions of their reports) are predominantly women. This runs counter to expectations driven by the stereotype; but the differences are marginal and the number of participants too small for anything other than tentative conclusions. When one examines social seeking-finding (the category including interpersonal behaviours such as asking for help), the distribution of men and women is weighted slightly further against the stereotype. This applies to all contexts (see figure 8.2b), and it also emerges that the only social behaviour that women more often include in greater proportions than men is collaborative seeking-finding. As with social seeking-finding, collaborative seeking-finding is interpersonal and interdependent, but unlike social seeking-finding, one is interacting with familiar people rather than with strangers.

One of the female participants in the diary keeping study – Jess – makes it clear that she only asks strangers for directions (social seeking-finding) if she is in company (collaborative seeking-finding) (see 4.9.2); and for her this is an issue

Figure 8.2b: *gender in relation to behaviour: based on figure 3.7k, distribution of the proportions of individual participants' reports that include social behaviours in the diary keeping study, separated out by context, and with the gender of the participants identified (pink=women, blue=men) (11 participants shown: 6 women and 5 men, because Mary's social behaviour data is excluded)*

of personal security as a woman. Gender differences in perceptions of personal security are widely reported: broadly, women are more worried than men about being subject to unwanted attention and less able to defend themselves against it.[280] Examining the data for all participants in the diary keeping reveals that of the 13 reports from environmental space that include both collaborative seeking-finding and social seeking-finding, 6 are by women and 7 are by men. However, of the 17 reports from environmental space of social seeking-finding

280 E.g. Yavuz and Welch (2010); Carter (2004); Dickinson, Kingham, et al. (2003); Atkins (1989).

occurring *without* collaborative seeking-finding, only 5 are by women and 12 are by men: this suggests that men are more predisposed than women to ask directions of strangers when they are out alone.

Looking at semantic and spatial behaviours for gender differences in the proportions of reports that include them for men and women, it emerges that in most cases the gender distribution is broadly even (see figures 8.2c–f).

Figure 8.2c: *gender in relation to behaviour: based on figure 3.7i, distribution of the proportions of individual participants' reports that include semantic behaviours across all contexts in the diary keeping study, and with the gender of the participants identified (pink=women, blue=men)*

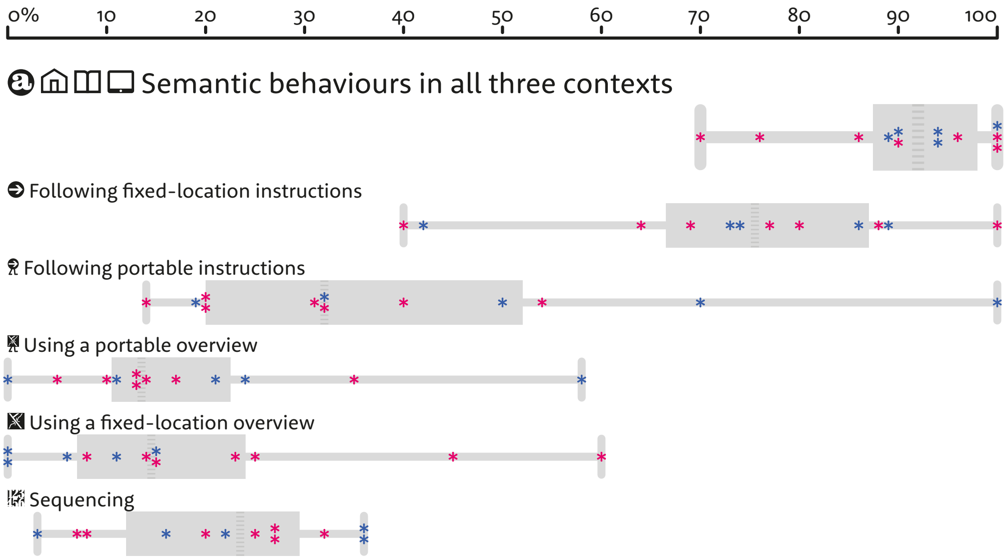
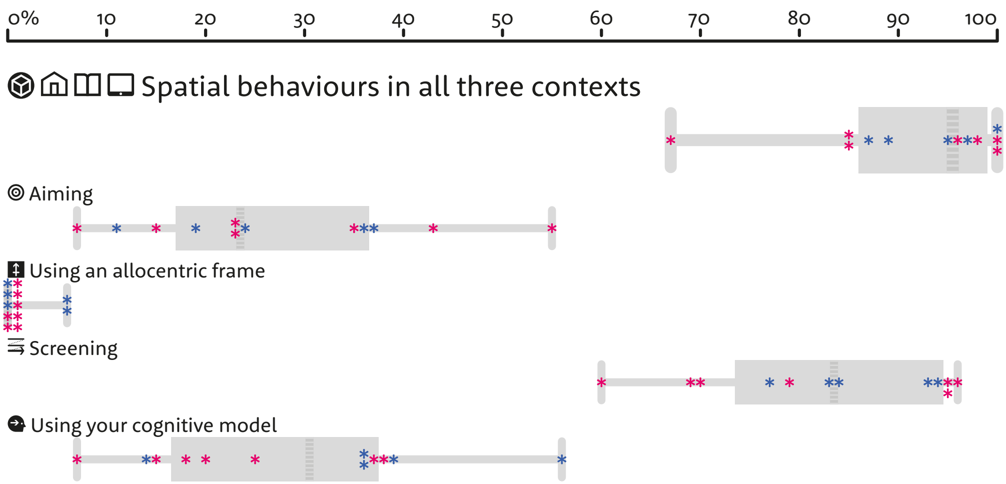


Figure 8.2d: *gender in relation to behaviour: based on figure 3.7j, distributions of the proportions of individual participants' reports that include spatial behaviours across all three contexts in the diary keeping study, and with the gender of the participants identified (pink=women, blue=men)*



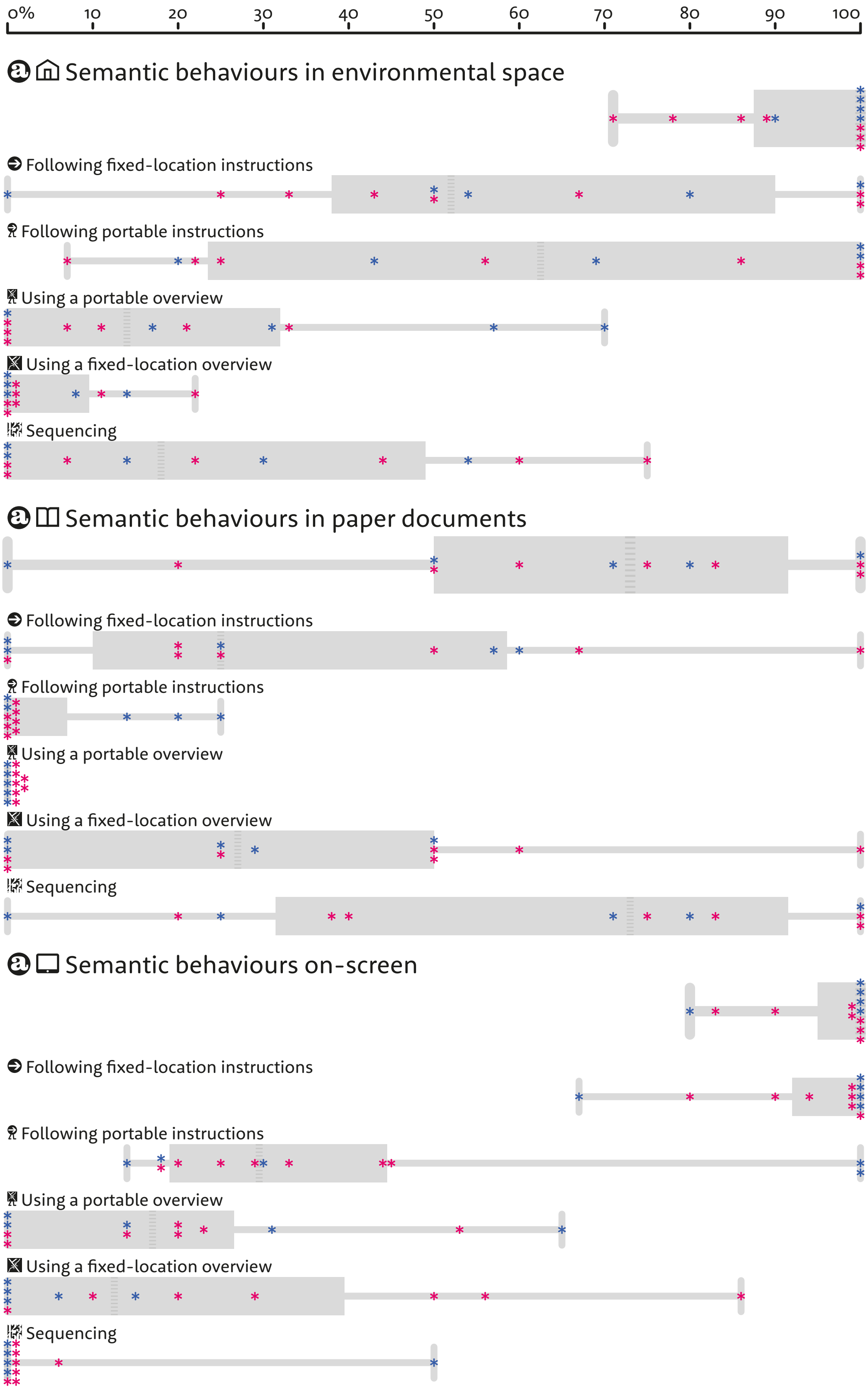


Figure 8.2e: *gender in relation to behaviour: based on figure 3.7l, distribution of the proportions of individual participants' reports that include semantic behaviours in the diary keeping study, separated by context, and with the gender of the participants identified (pink=women, blue=men)*

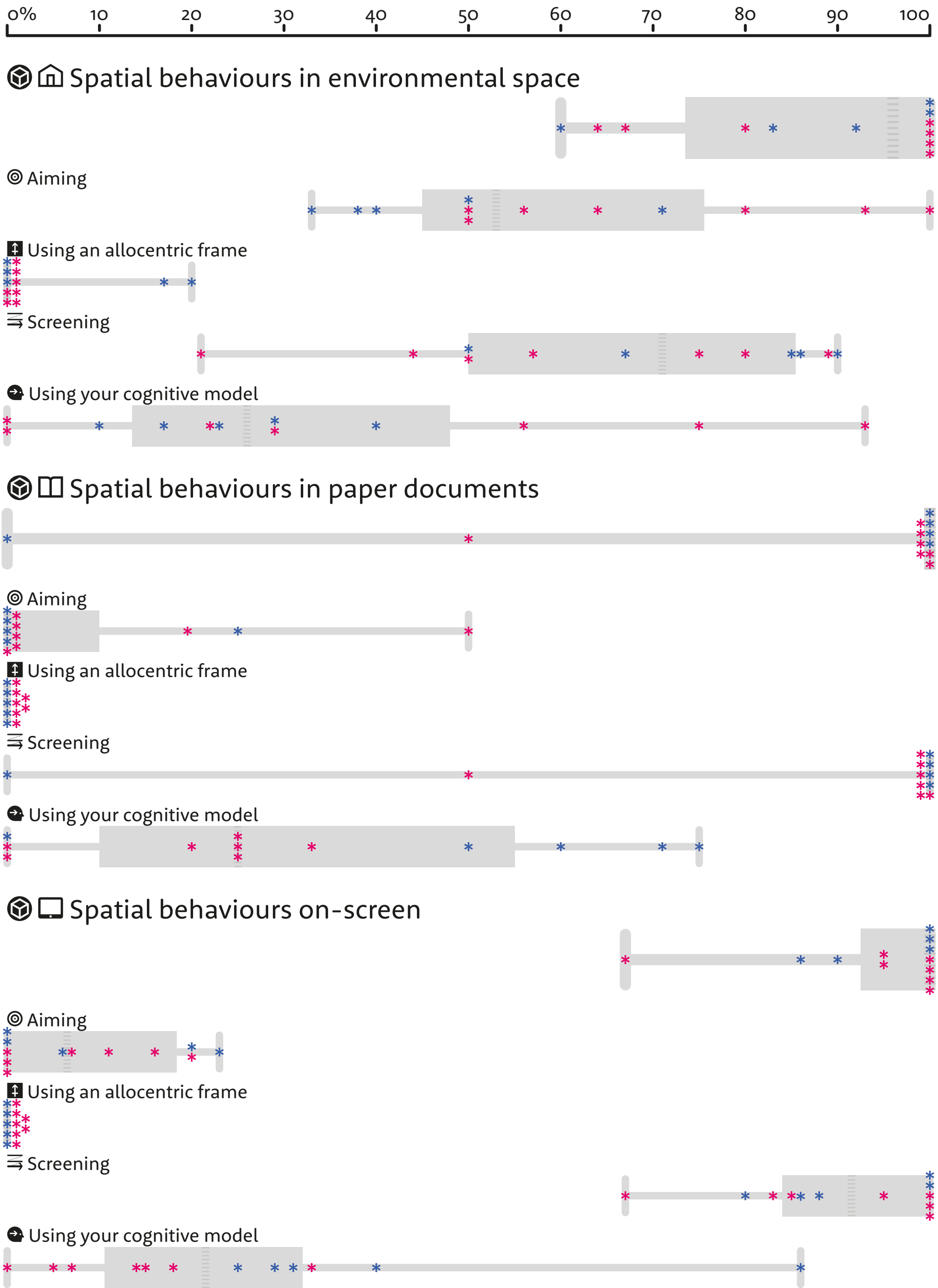


Figure 8.2f: *gender in relation to behaviour: based on figure 3.7m, distribution of the proportions of individual participants' reports that include spatial behaviours in the diary keeping study, separated by context, and with the gender of the participants identified (pink=women, blue=men)*

There are, however, a small number of behaviour/context permutations for which the gender distribution is less even:

Included in greater proportions of reports by more men than women:

- Using a portable overview *in environmental space*
- Using your cognitive model *in paper documents and on-screen*

Included in greater proportions of reports by more women than men:

- Using a fixed location overview *on-screen*
- Aiming *in environmental space*

Using a portable overview in environmental space may again be an issue of personal security. This is largely about using maps in public, as raised in 5.15.6, where it is noted that being seen using a map in public makes you vulnerable (it signals that you do not know where you are, and that you are distracted). Added to this, the desire not to use a mobile phone in public, due to the risk of having it stolen, increases the disincentives to use a map on a mobile phone. As with the personal security issues discussed above, gender plays a part here. In the diary keeping, of the 57 reports from environmental space by women only 8 (14%) involve use of a map on a mobile phone; compared to 19 (41%) of 46 reports by men. Perceived vulnerability to risk is probably not the only factor here but the gender difference is marked.

It is intriguing that of the participants in this study, men are more predisposed than women to use their cognitive model when seeking-finding in documents printed on paper and on-screen, and that women are more predisposed than men to use site maps on-screen, and landmarks in environmental space. The data offers little further insight into the reasons for these differences. And as noted above, with such a small number of participants, it is hard to be sure that this *is* a reflection of gender differences.

8.2.3 / Intra-individual difference

Not only are individuals different to each other, the same individual may vary in their decisions from one moment to the next, perhaps influenced by factors such as the particular circumstances within which they operate at any given time.[281] This picks up the theory of settings (Garner 1990), which makes the point that when the situation or circumstances vary, the nature of strategic activity often varies as well: this suggests that the same individual may use different behaviours when the situation or circumstances vary.

Factors that can influence intra-individual variation include such things

281 E.g. Webber, Burnett, and Morley (2012); Li (2006: 739); Arthur and Passini (1992: 49).

as strong emotions,[282] or having your mobility temporarily constrained (for instance by a heavy load or a pushchair).[283]

An approach to examining intra-individual difference is to minimise other variables. This is somewhat problematic outside of a laboratory, but the user studies do provide some opportunities in which the variables of task and context are relatively consistent. The task observation study examines 12 individuals each performing the same set of tasks, and arguably the 6 tasks are sufficiently similar to afford comparison of the behaviour of an individual between tasks. As discussed in the case studies in 5.13 and 5.14, some participants show less intra-individual difference than others. For instance, Jovair is considerably more inclined to use the index rather than the contents list, unlike Peter and Cho who never use the index and only use the contents list; other participants vary their choices of behaviour based on what they think to be best suited to the task or what worked last time. This latter group show greater intra-individual difference to Jovair, Peter, or Cho.

The diary keeping study provides evidence of both intra-individual difference and perhaps the surprising lack of it. Section 8.4.1 examines occasions when a single participant makes more than one report of the same task: under these conditions Mike shows no intra-individual difference, but Frances and Alison do. As discussed in the case studies, these differences are likely to be due to differences in the particular circumstances (despite the similarity of the tasks). They are also suggestive of the opportunist nature of tactic choice.

In the diary keeping study, most participants show considerable intra-individual variation, but it is not possible to be sure what is driving this, and to what extent each participant would continue to demonstrate this difference if all other variables were controlled. Tanveer is the exception however, showing a striking lack of intra-individual variation despite differences in task and context (see 5.16).

8.3 / Behaviour in relation to context

Much of this thesis is taken up with seeking comparability of seeking-finding behaviours across different contexts, but this does not mean that they are the same across all three contexts. Everyday experience suggests strongly that, in some respects, seeking-finding is *not* the same across the contexts.

The taxonomy provides an effective tool for comparing behaviours in one context with those in another, and earlier sections demonstrate in detail how the same 12 categories of seeking-finding behaviour are applicable

282 E.g. Smitshuijzen (2007: 35); Arthur and Passini (1992: 63 and 67–68).
283 E.g. Arthur and Passini (1992: 63).

across all 3 contexts. But the user studies allow us to see quantitative and qualitative differences in these behaviours in each context. It is principally the diary keeping that informs this discussion of relationships between context and behaviour, because it includes reports from all 3 contexts by the same small group of participants. Broadly, what emerges suggests that (i) for each participant, the behaviour choices made in each context are different; and (ii) among the group of participants, the differences in behaviour choices across contexts show no obvious pattern.

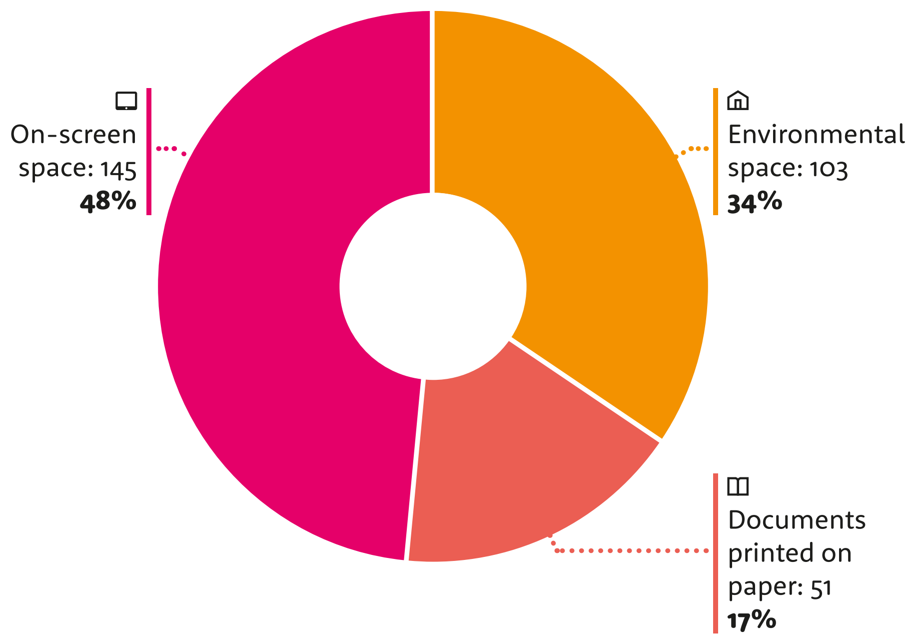
8.3.1 / Different amounts of seeking-finding happen in the different contexts

The diary keeping participants return different quantities of reports for each context, as can be seen in figure 8.3a.

Reports from environmental space comprise almost exactly one-third of the total. That seeking-finding on-screen comprises substantially more than one-third, and in paper documents less, is perhaps a reflection of changes that have happened over the past generation in terms of information supply. The current standing of paper documents is pithily (if dismissively) expressed by a character in *End games* (Dibdin 2007: 275): 'Linear reading! In treeware format! It was just too weird.'

When the reports are broken down by participant as well as by context (as shown in figure 3.7a), there is only 1 participant who does not make reports from all 3 contexts: Tanveer. He explicitly links his non-use of paper

Figure 8.3a: *the returned questionnaires by context, in the diary keeping study*



documents to the availability of on-screen resources for seeking-finding (see 5.16). The other participants all make reports from all contexts. Although the proportions vary, 9 of the participants each make the largest proportion of their reports from on-screen, and the smallest proportion in paper documents. The participants for whom this is not true are Alison, Frances, and Tanveer: each of these 3 makes the largest proportion of their reports from environmental space. Of Alison's reports, 45% are from environmental space, and reports from on-screen (30%) are barely more than those from paper documents (25%) (figure 5.15a). Frances makes 41% of her reports from environmental space, 32% from on-screen, and 27% from paper documents (figure 6.10a). Tanveer's reports from environmental space comprise 71% of his total, and on-screen reports comprise only 29% (figure 5.16a). We can speculate over the reasons for why Alison, Frances, and Tanveer are different to the others in this way: perhaps one of them does a lot of travelling to unfamiliar destinations, or has a dislike of digital media, or more readily notices and recalls their instances of seeking-finding in environmental space than those on-screen. The data as it stands sheds little light on why these participants are different in making the largest proportion of their reports from environmental space rather than on-screen.

As an aside, it is ironic that none of the participants in this study chooses to submit reports on-screen: all submit them on paper (the opposite of what one might predict given the balance of seeking-finding reports in these contexts). From the exit interviews, it emerges that the decision to use paper questionnaires is often driven by convenience: the paper is generally to hand, whereas the on-screen version is too many navigational steps (mouse clicks) away. This illustrates a point from the case study looking at social behaviours in paper documents in 4.11: when paper documents are chosen, it can be because they are readily available, and this can override choosing the optimal tool for the job. This also emerges in 5.12.5, where it is suggested that choice of information source may be based on what costs least to use in terms of physical and cognitive effort.

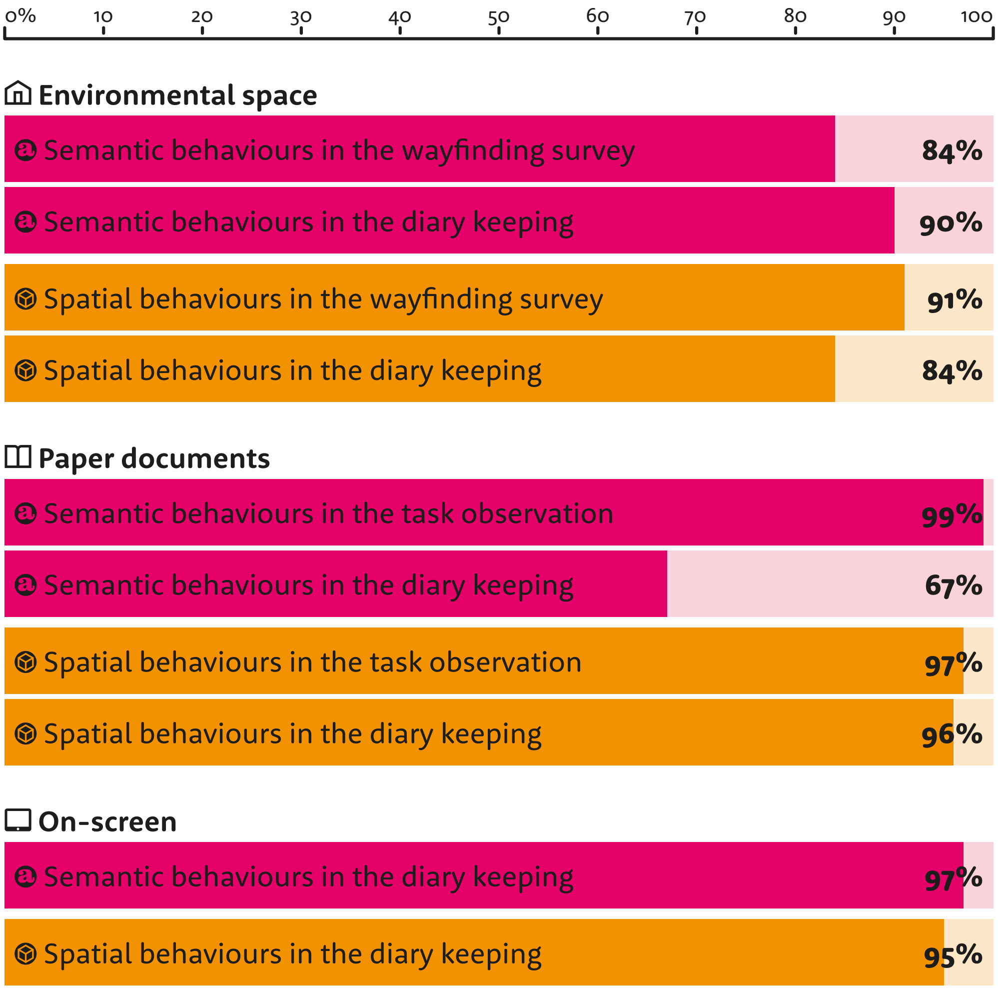
8.3.2 / Relationships among behaviour groups and contexts

The suggestion is made by Morville (2005: 4) that seeking-finding with spatial characteristics will arise most readily in environmental space; and that with semantic characteristics, on-screen. There is an intuitive logic to this. Assuming that the semantic and spatial behaviour groups of the taxonomy broadly match what Morville means by 'semantic' and 'spatial', no such relationship between behaviour group and context emerges in the quantitative data from the user studies.

Figure 8.3b summarises the data from the three user studies in terms of the proportions of reports in each context that include semantic and spatial behaviours. The differences are not great, and no clear pattern emerges of relationship between behaviour group and context. It is striking that the diary keeping includes semantic behaviours in only 67% of reports: one might expect this context to be as 'semantic' as on-screen. We can only speculate as to the reasons for this somewhat exceptional figure.

The data from the user studies shows that, in general, both semantic and spatial behaviour groups are heavily reported in all 3 contexts. As noted in 5.15.3 and 5.17.3, some individual participants in the diary keeping show a tendency that runs contrary to Morville's suggestion more strongly than any tendency in the data as a whole.

Figure 8.3b: *context in relation to behaviour: the proportions of reports including each behaviour group across all three studies (summarised from figures 3.5a, 3.5b, 3.6b, 3.6c, 3.7f, and 3.7g)*



8.3.3 / Individual categories of behaviour vary in the proportion of reports including them in each context

The discussions of individual categories of behaviour that comprise sections 4–6, identify some behaviour/context permutations for which data is not collected by the user studies. The reasons for this are discussed in earlier sections. Briefly, it is a consequence of the taxonomy being developed at the same time as the user studies were being conducted, and not through any deliberate policy of omission. In the task observation, there are some categories of behaviour that the test materials do not afford: social behaviours, following portable instructions, and using a portable overview. In the wayfinding survey and diary keeping, some behaviour/context permutations are not supported by the questionnaires: social seeking-finding, using a portable overview, and using an allocentric frame in paper documents; using an allocentric frame on-screen. There are 2 causes for this: (i) difficulties formulating concise and concrete examples of all categories of behaviour, in all contexts, in order to include them as prompts in the questionnaires; and (ii) at this stage, the taxonomy was still work-in-progress and that made it difficult to ensure that all behaviours were supported by the questionnaires because there was no definitive list of categories of behaviour.

These limitations might suggest that, perhaps, some behaviours are not so readily supported by some contexts. While this is a useful pointer to identifying differences in behaviour across contexts, it is far from definitive. For instance, although the diary keeping questionnaires did not offer participants an opportunity to report using an allocentric frame in paper documents, this behaviour is included in 23 of the 72 reports in the task observation (and there is the possibility that this is under-reported: see 6.8.1). Furthermore, although the test materials in the task observation did not afford following portable instructions, this behaviour is included in 3 of the reports from paper documents in the diary keeping.[284]

When the diary keeping data are examined for the proportions of reports including each category of behaviour, broken down by context, they show that it is rare for categories of behaviour to be included in the same proportions of reports across all 3 contexts (see figure 8.3c). This suggests that although all categories of behaviour are possible in all contexts, perhaps contexts differ in how readily each affords each category of behaviour. Uncovering the reason(s) for this variation requires further research.

284 The tactic coded in each of these instances is following a line on a page, and the tasks are (i) finding out about holiday options in a travel brochure, (ii) checking football scores in a newspaper, and (iii) looking for things to do over the weekend in a listings magazine.

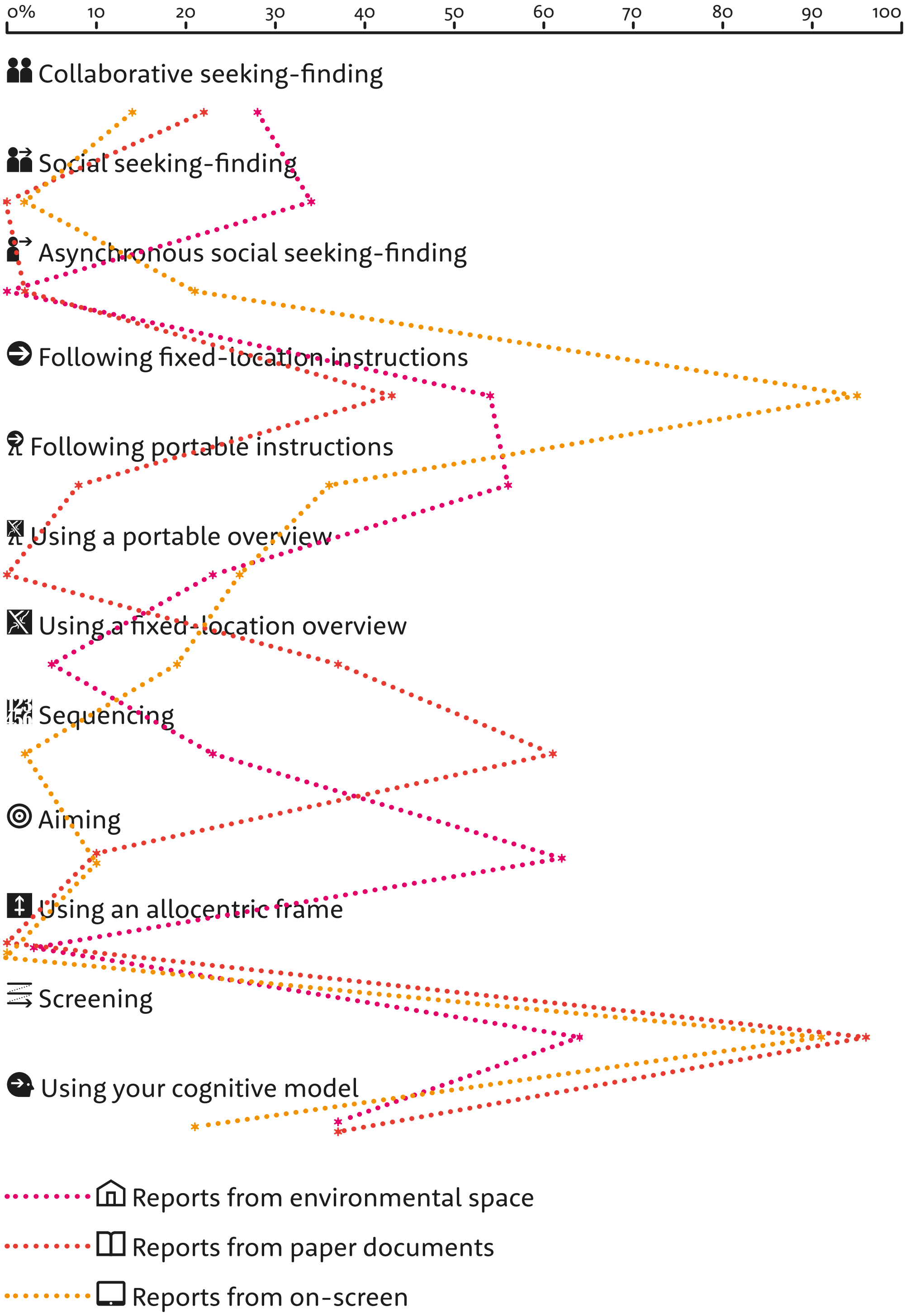


Figure 8.3c: *context in relation to behaviour: the proportion of reports containing each category of behaviour in each context in the diary keeping study*

As discussed in 4.8.4, individual categories of behaviour within the social group show strong differences between contexts in the proportion of reports that include them. These may be the consequence of particular affordances of the contexts. Collaborative seeking-finding is included in 14–28% of reports from each context, but in paper documents it is almost the only social behaviour reported: social seeking-finding is not reported in this context, and asynchronous social seeking-finding is included in only 2% of reports. Social seeking-finding is reported almost exclusively in environmental space – the context in which strangers are most reliably co-present. And asynchronous social seeking-finding occurs almost entirely on-screen – a context that offers extensive opportunities to leave information and opinions to guide the decisions of other people in places where they can be readily accessed.

In the case study examining social behaviours in paper documents (in 4.11), it emerges that collaborative seeking-finding in paper documents tends to occur in the same reports as using your cognitive model. The data as it stands is unable, however, to shed any further light on the nature of this relationship.

In section 6.10.6 and 6.11.6, it is noted that, in the reports from Frances and Mary, aiming is included in a far larger proportion of reports from environmental space than any other context. This relationship is more widely applicable: across all participants in this study, aiming is included in 28% of reports across all contexts; but in environmental space this increases to 62%. Looking at figure 8.3c, this is one of the categories of behaviour with the greatest difference between one context and the others in terms of the proportion of reports that include it. A key component of aiming is the use of landmarks, and although questions have been raised about the sequential process of environmental knowledge through the landmark, route, and survey stages proposed by Siegel and White (1975),[285] the fundamental role of landmarks in the development of environmental knowledge is still largely accepted. It is intriguing that a landmark-using behaviour, such as aiming, is so little used in other contexts, particularly on-screen where metaphors from environmental space are widely applied (see 1.5). If we examine the other behaviours that use landmarks – social seeking-finding and using your cognitive model – both of these are also included in smaller proportions of reports from on-screen than other contexts (see 6.10.6). We can only speculate but perhaps on-screen seeking-finding has not been able to incorporate landmarks as effectively as environmental space, or perhaps the studies did not capture this aspect of behaviour sufficiently effectively. Whichever is the case, landmark use in different contexts may be worth further investigation, particularly given that Lugli, Ragni, et al. (2017) find that an individual's style

285 E.g. Blajenkova, Motes, and Kozhevnikov (2005).

of seeking-finding in environmental space can predict their style of seeking-finding on-screen.[286]

Three other behaviours show substantial differences between contexts in the proportions of reports including them: following fixed-location instructions, following portable instructions, and sequencing. The first of these ranges from 95% on-screen to 54% in environmental space, and 43% in paper documents: its prevalence on-screen attests to the ubiquity of clicking on links in text; and the proportion of reports in paper documents is comparable to the data from the task observation study (46%). Following portable instructions ranges from 56% in environmental space, and 37% on-screen, down to 8% in paper documents: although there are concerns about being seen consulting a map, the same does not apply to using a satnav; and as discussed earlier, it is rare but not unknown for paper documents to afford this behaviour. Sequencing ranges from 61% in paper documents, down to 24% in environmental space and 2% on-screen: using page numbers is a heavily reported activity in paper documents, but almost unknown on-screen – perhaps the ability to skip from place to place at the click of a link obviates the need for flicking through swathes of pages.

8.3.4 / Behaviour in relation to context and the individual

As discussed above, the diary keeping study shows differences between one context and another in terms of the proportion of reports including each category of behaviour. It also shows that different contexts elicit different patterns of reporting particular categories of behaviour across individuals. For instance, collaborative seeking-finding in paper documents elicits 3 quantitatively different clusters of reports among participants. As already noted, this is practically the only social behaviour reported for paper documents; and the participants fall into distinct groups based on the proportion of their reports that include it. It is never reported by 5 participants, 2 include it in all of their reports, and 4 occupy the middle ground including it in 13–29% of their reports.

In another example, in 4.10.3, Fergus never includes asynchronous social seeking-finding and following portable instructions in the same report (of his 18 reports, 5 include the former, 9 the latter, and 4 neither). However, rather than there being negative relationship between these behaviours, it is possible that choice of these behaviours is related to context. Asynchronous social seeking-finding is only reported on-screen, while following portable

286 While Lugli, Rani, et al. (2017) may appear at first to make the sorts of connections between seeking-finding behaviour in different contexts that this thesis seeks, it remains largely undiscussed here because it considers behaviour at a scale so much greater than that used in this thesis that there is little common ground.

instructions is almost never reported on-screen. The relationship between these behaviours and context is shown by some other participants, but not all of them; and none of them as strongly as Fergus.

And for Mary, as reported in 6.11.3, context has a bearing on what she does when semantic behaviours are not employed: in environmental space, she includes multiple spatial behaviours in each report, but in paper documents, her reports include only screening. This pattern emerges across all participants, but not as strongly as in Mary's reports.

8.4 / Behaviour in relation to task

The likelihood of a relationship between choice of behaviour and task is perhaps common-sensical: it is reasonable to assume that *means* (choice of behaviour) and *ends* (task or goal) will be related. The diversity of possible tasks in everyday life is so great that their analysis is worthy of research itself; I can do little more than acknowledge that range.

Task – either the immediate task or the larger-scale goal – as a driver of behaviour emerges as a research topic in all three contexts.[287] Key points are: (i) the complexity of many tasks in everyday life (Albers 2004); (ii) tasks or their objectives may not be clearly defined before the individual takes action, indeed some tasks require that seeking-finding start in order to clarify the goal or task (Mollerup 2005: 27); and (iii) the same piece of information can be used in many different tasks and may be recruited by different categories of behaviour (Horn 1985).

Despite the attention paid to both task/goal and behaviour in seeking-finding, the literature survey finds little discussion of the relationship between these two factors (other than observing that they are related). They are connected by Lorch, Lorch, and Klusewitz (1993) in seeking-finding in paper documents, which further identifies a relationship with individuals; and by Zhang and Duke (2008) in seeking-finding on-screen and in paper documents. Task complexity as a factor in seeking-finding behaviour emerges in studies by Zhang (2012); Chae and Kim (2004); and Wright and Reid (1973); the last also identifies the characteristics of the user as a factor.

287 E.g. Zhang, Wang, et al. (2012); Chen, Chang, and Chang (2009); Mallot and Basten (2009); Wiener, Bücher, and Hölscher (2009); Zhang and Duke (2008); van den Broek, Lorch, et al. (2001); Allen (1999a); Freksa (1999); Taylor, Naylor, and Chechile (1999); Raubal and Egenhofer (1998); Schriver (1997: 384–388); Marchionini (1995); Lorch, Lorch, and Klusewitz (1993); Arthur and Passini (1992); Guthrie and Mosenthal (1987); Fyfe and Mitchell (1985); Pugh (1979); Waller (1979); Downs and Stea (1977).

8.4.1 / Task has only limited influence on choice of behaviour

Despite the reasonable expectation that task and choice of behaviour will be related, the user studies suggest that this is not the case: differences in task have only limited impact on choice of behaviour.

Tasks in the task observation

This study observes 12 participants performing the same set of 6 tasks. Figure 8.4a shows the behaviours included in each report of each task by each participant, and they are grouped by task in order to compare how the participants execute the same task. Overall, 2 observations emerge: (i) participants choose different permutations of behaviour to execute the same task; and (ii) for tasks 2–6, one task looks much like another in terms of the sorts of permutations of behaviour that participants are using. In most tasks, individual participants use a variety of combinations of behaviour. Different tasks do not elicit discernibly different behaviour patterns that are common across multiple participants. The lack of difference between the reports of one task and another may be because the tasks are all too similar to readily show differences between them; or it may be that in this study, task has less bearing on choice of behaviour than either the affordances of the particular environment or individual aptitude and preference. It suggests that the observation by Freksa (1999: 26) about behaviour in environmental space also applies to paper documents: 'different individuals may employ different strategies to solve the same problem'. In this study, different individuals given the same problem solve it using different permutations of tactics.

Tasks in the wayfinding survey

This study examines how a number of different participants achieve the same goal: to arrive at a particular destination at more or less the same time. Although the goal is the same, the tasks are somewhat less similar because the participants all have different starting points. As with the task observation, the participants in this study report a variety of permutations of behaviour (see figure 3.6d). Also like the task observation, some behaviours are included in greater proportions of reports than others. This leads to the same tentative conclusion as in the task observation: there is no clear pattern in the behaviours included in the reports to suggest that choice of behaviour was shaped by the particular task.

Tasks in the diary keeping

This study examines a wide range of tasks conducted by a small sample of participants across all 3 contexts. Unlike the other studies, the range of tasks is wide and there is little comparability among them. However, tasks can be separated into 3 broad categories: work, domestic, and leisure. When the

Task	Participant	Semantic			Spatial			
		Following fixed-location instructions	Using a fixed-location overview	Sequencing	Aiming	Using an allocentric frame	Screening	Using your cognitive model
1	Cilla		●	●				
1	John			●			●	
1	Peter		●	●	●	●	●	●
1	Theresa		●	●				●
1	Michael			●			●	
1	Stan			●			●	
1	Eleanor			●			●	
1	Ali		●	●			●	●
1	Cho		●	●	●		●	
1	Jovair	●	●	●		●	●	●
1	Lucas			●			●	
1	Maggie		●	●			●	
2	Cilla		●	●		●	●	●
2	John						●	
2	Peter		●	●	●	●	●	●
2	Theresa		●	●		●	●	●
2	Michael		●	●	●	●	●	
2	Stan			●			●	●
2	Eleanor		●	●		●	●	
2	Ali		●	●			●	●
2	Cho		●		●		●	
2	Jovair	●	●	●	●		●	
2	Lucas		●	●		●	●	
2	Maggie		●	●			●	
3	Cilla	●	●	●		●	●	●
3	John	●	●	●		●	●	●
3	Peter		●	●	●	●	●	●
3	Theresa		●	●		●	●	●
3	Michael	●		●	●			
3	Stan	●	●	●			●	●
3	Eleanor		●	●			●	●
3	Ali	●	●	●	●	●	●	●
3	Cho		●		●		●	
3	Jovair	●	●	●	●		●	
3	Lucas	●	●	●			●	●
3	Maggie		●	●	●		●	
4	Cilla	●		●			●	●
4	John	●		●			●	
4	Peter		●	●	●		●	●
4	Theresa	●	●	●		●	●	
4	Michael	●		●	●		●	
4	Stan	●	●	●			●	
4	Eleanor	●	●	●	●		●	
4	Ali	●	●	●			●	●
4	Cho		●	●			●	
4	Jovair	●		●			●	
4	Lucas	●		●		●	●	●
4	Maggie	●	●	●	●		●	●

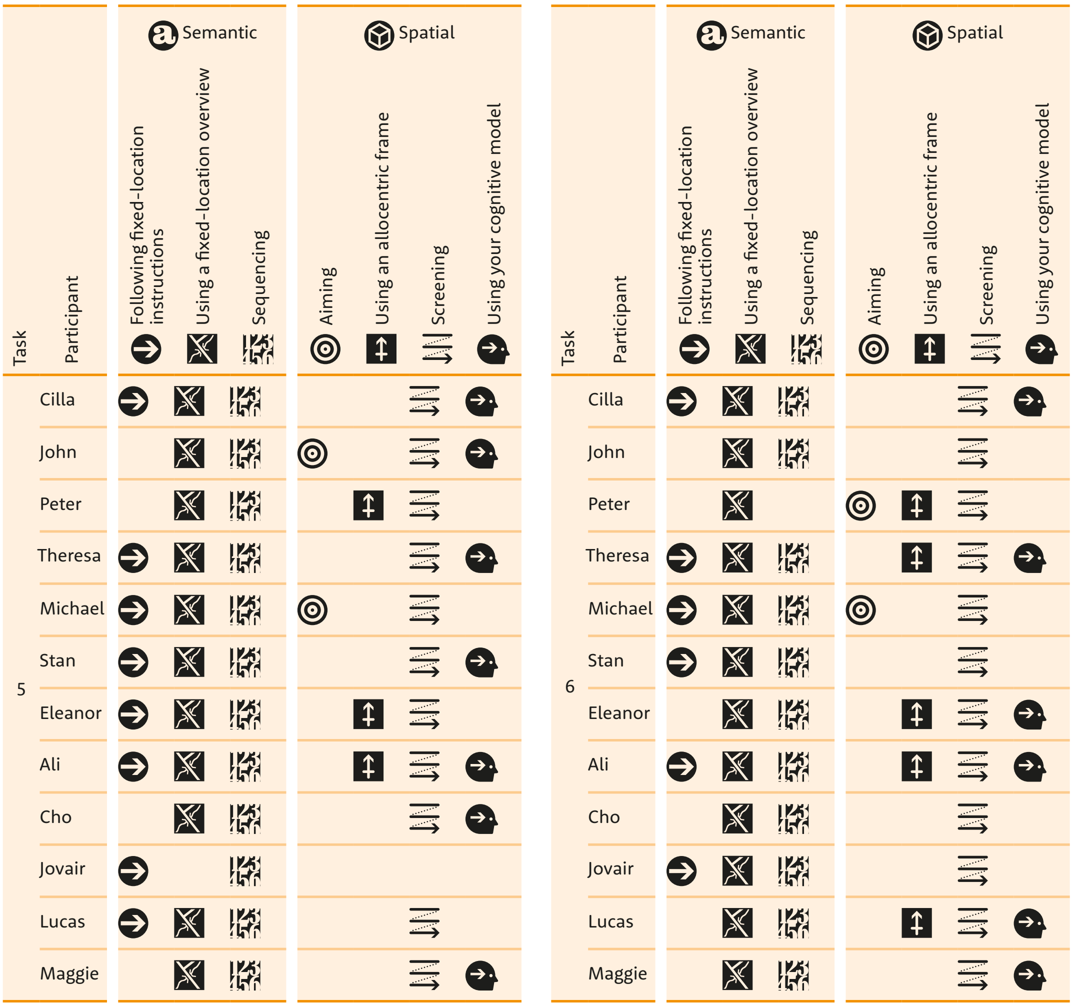


Figure 8.4a (above and facing): *task + the individual in relation to behaviour: reports from the task observation study, grouped by task; each row shows the combination of behaviours used in one task by one participant (figure 10.2a shows the same data grouped by participant)*

reports are divided into these task groups, work and domestic tasks each comprise just over one-quarter, and leisure tasks make up just under half of the reports. The proportions of reports from each task category in the consolidated data mask considerable inter-individual variation (see figure 8.4b). This variation in breakdown of task type is assumed to be indicative of the diversity of circumstances in the lives of the individual participants rather than of anything to do with choices of seeking-finding behaviour. Nonetheless, simply in terms of giving this discussion some background, it is useful to see this view of the data.

In general, each category of seeking-finding behaviour is used in relatively similar proportions across the three task groups (see figure 8.4c). Some of the greatest variation between task groups is shown in social behaviours. It is perhaps not surprising that collaborative seeking-finding is included in the largest proportion of reports of leisure tasks (on the premise that leisure

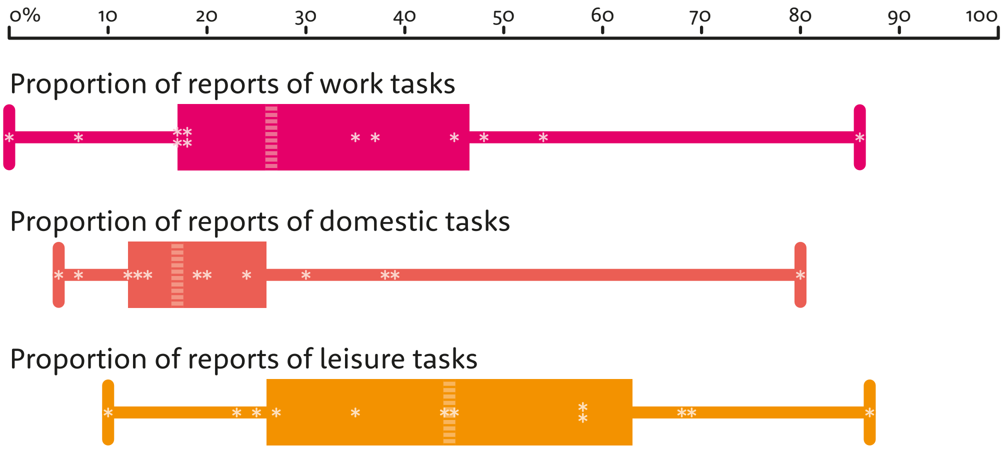


Figure 8.4b: *distribution of proportions of individual participants' reports from each task category in the diary keeping study*

activities are more fun with other people), and the smallest proportion of work tasks.[288] Social seeking-finding is included in the greatest proportion of reports of work tasks and the smallest proportion of reports of domestic tasks, suggesting that asking co-workers for assistance is more common than collaborating with them. This concurs with the findings in numerous studies that co-workers are one of the most frequently used sources of information in the workplace.[289] We might surmise that social seeking-finding is least common in domestic tasks because these may take place in the home, where it is less likely there will be strangers to ask (social seeking-finding); but in the home there are more likely to be other household members to involve in the task (collaborative seeking-finding), or resources such as Facebook, Pinterest, or Mumsnet that afford asynchronous social seeking-finding slanted at domestic and leisure interests rather than work-related ones. Other than social behaviours, using your cognitive model is the only behaviour to show much variation between task groups. This behaviour is included in 29–30% of reports of domestic and leisure tasks, but only 2% of reports of work tasks. Quite why work tasks should engage cognitive models to such a small extent in comparison with other types of task is not readily explicable (unless it is a consequence of possible unevenness in the reporting of this behaviour, see 3.6).

Within most categories of behaviour, the variation between task groups (in figure 8.4c) is generally smaller than the variation between contexts (in figure 8.3c). This suggests that task may be less instrumental than context in choice of seeking-finding behaviour – certainly when task is viewed at this somewhat coarse level of granularity.

288 Notwithstanding what this may suggest about teamwork and collaboration in the workplace.
289 E.g. Fidel and Green (2004); Byström and Järvelin (1995); Allen (1984).

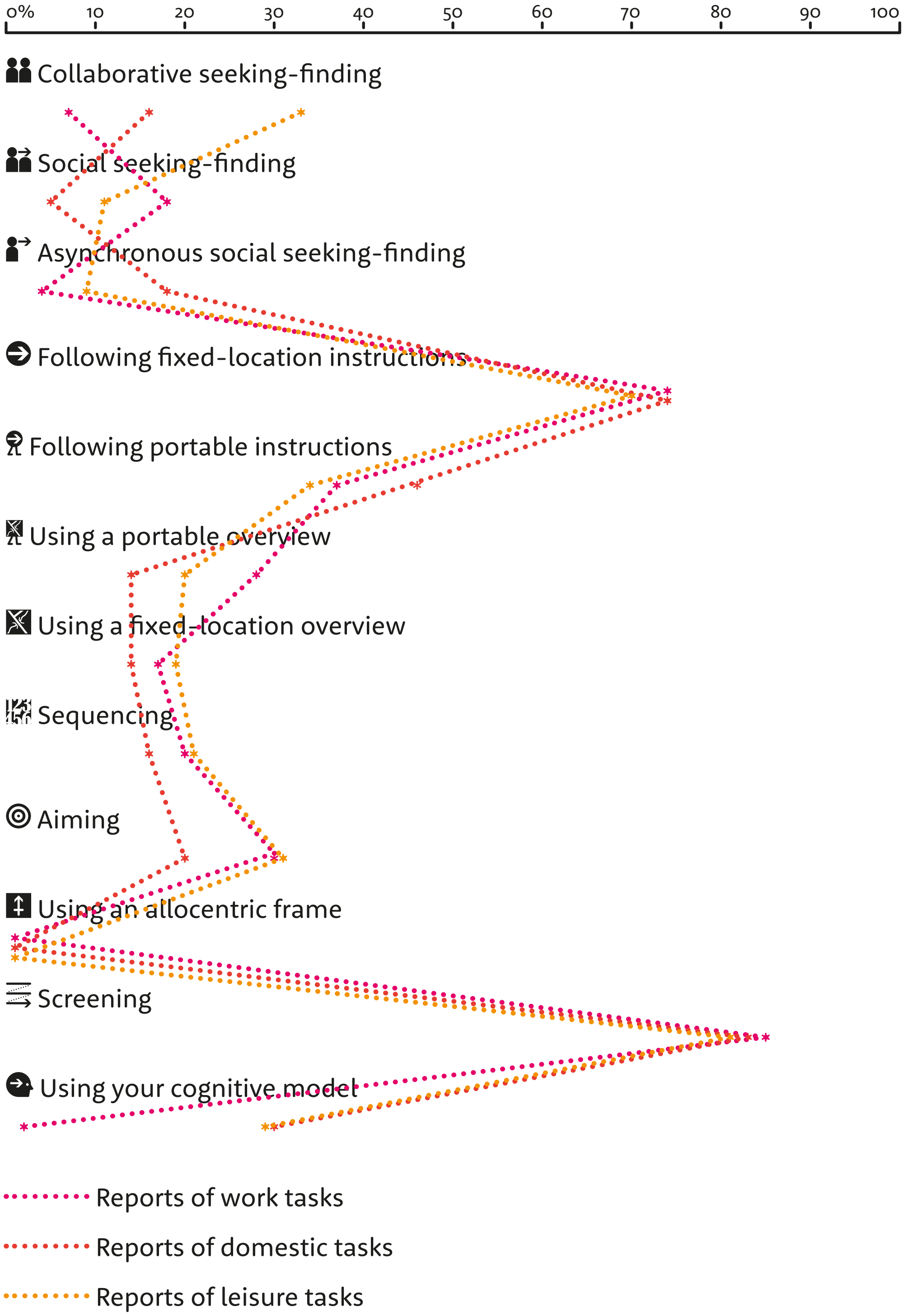


Figure 8.4c: *task in relation to behaviour: the proportion of reports containing each category of behaviour in each task group in the diary keeping study*

It is worth looking at individual tasks in more detail, where we have more than 1 report of comparable tasks. In 5.17.3, Mike reports 2 instances of making his way through the arrivals area of an airport. This task elicits similar behaviours across reports. Both reports comprise social seeking-finding, following fixed-location instructions, and following portable instructions. Mike's reports come from different airports. We have no comparable reports from other participants to know if different people would execute the same task using the same behaviours, but airport design is sufficiently similar the world over for a theoretical cognitive model (not that this is reported in these instances) to be engaged in terms of the expectations of process and likely stages, and most other passengers will be doing the same thing and so following other people (social seeking-finding) is a relatively reliable strategy.

Section 5.15.6 discusses 2 comparable tasks that Alison reports. Both concern finding a work-related address in central London, but despite having similar goals, they have little in common in terms of choice of behaviours. This is also the case in 6.10.5: Frances' reports of similar tasks have little in common in terms of choice of behaviours.

While task may have an undeniable influence on choice of behaviours in seeking-finding, the particular affordances of the environment and the particular aptitudes or preferences of the individual may be stronger. Even if a behaviour is optimal per se for achieving a particular task, it is not chosen if (i) the particular environment does not support it, or (ii) the individual has other preferences or aptitudes.

8.4.2 / Behaviour in relation to both task and context

If the reports from the diary keeping study are separated by both task group and context, it allows us to examine whether some behaviours are more prevalent in some context/task permutations than others: in figure 8.4d, the height of each bar represents the proportion of reports that include that behaviour in a particular task/context permutation. This figure reinforces the suggestion that task has less bearing on the choice of behaviour than context: in each category of behaviour for each context, the 3 bars (pink, red, and orange) that show the 3 task groups are more similar in height to each other than they are to the bars directly above and below them (for the same task group in the same behaviour category, but in different contexts).

Social behaviours show some of the greatest differences between task groups in the same context (as expected from the discussion above about task and behaviour in the diary keeping). As already noted, collaborative seeking-finding is rarely reported in work tasks in any context, but is reported substantially more in both domestic and leisure tasks in environmental space.

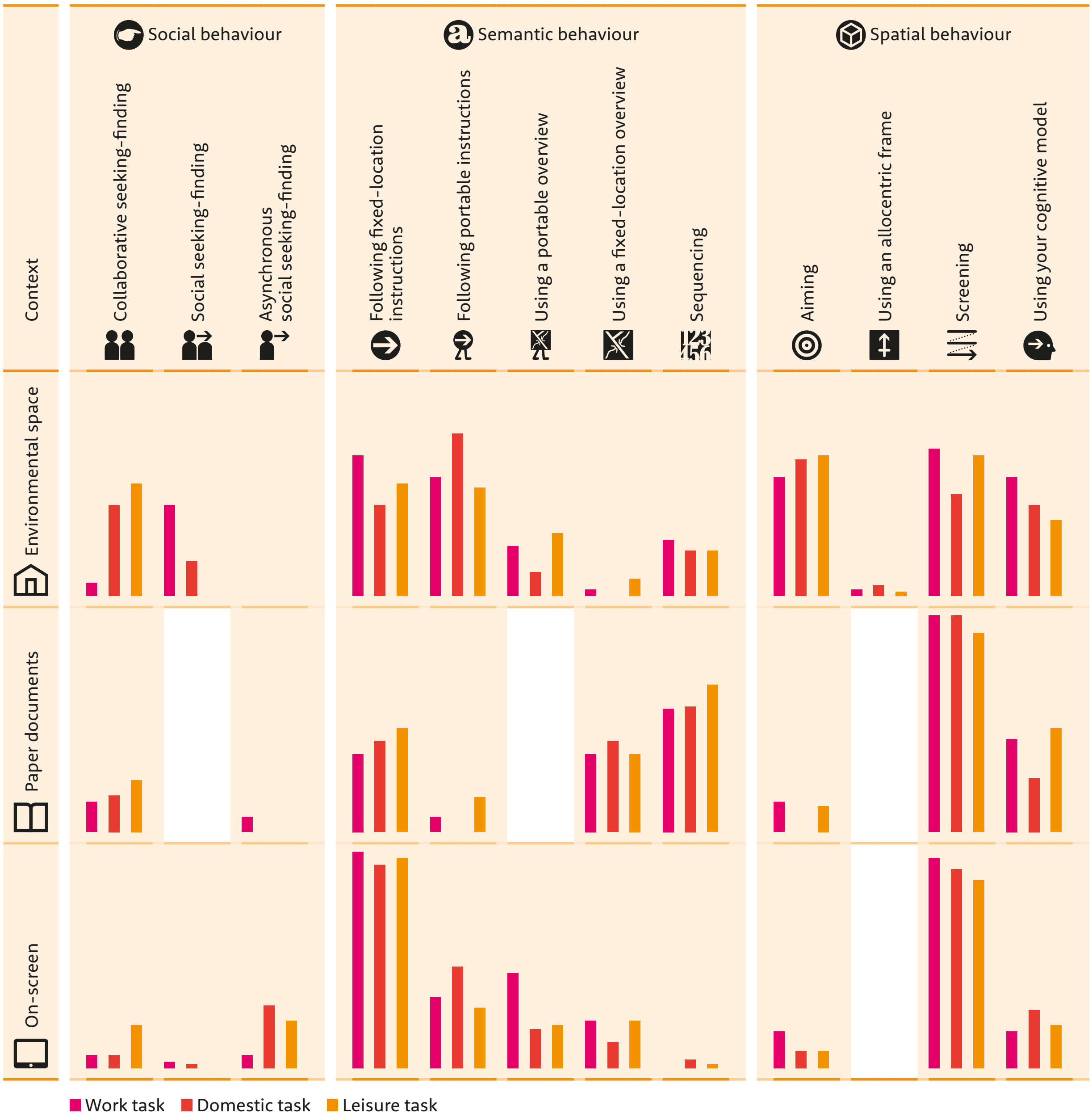


Figure 8.4d: *task + context in relation to behaviour: proportions of reports including each behaviour for each task/context permutation. Quantities are as percentages of the total number of reports for that behaviour in that task/context permutation. White spaces are where data was not collected for a particular behaviour/context permutation*

On the other hand, social seeking-finding is predominantly reported in work tasks in environmental space, and asynchronous social seeking-finding is predominantly reported in domestic and leisure tasks on-screen. At this level of granularity the absolute quantitites are small, and while the data suggests tendencies, any attempt to draw conclusions must be cautious.

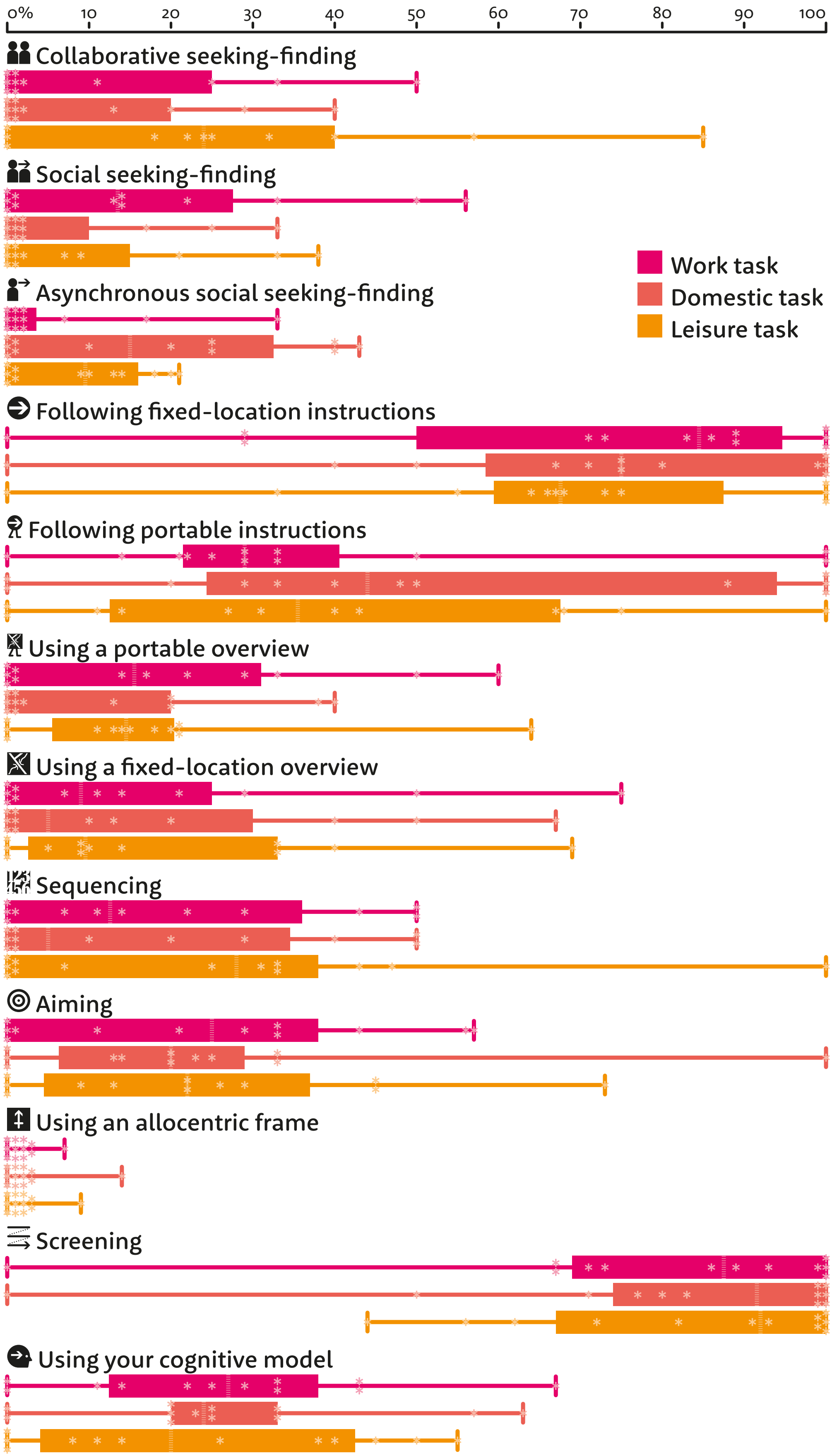


Figure 8.4e: *task + the individual in relation to behaviour: distribution of the proportions of individual participants' reports that include each behaviour, when broken down by task category*

8.4.3 / Behaviour in relation to both task and the individual

If the reports from the diary keeping study are separated by both task group and the individual, it allows us to examine the variation between the proportions of each participant's reports that include each category of data. This is shown in figure 8.4e, which suggests, much as 8.4c and 8.4d do, that task has less influence on choice of behaviour than other factors. Within each category of behaviour, each box-and-whisker plot is more similar to other box-and-whisker plots for different task groups within the same category of behaviour than it is to the same task group in other categories of behaviour. For instance, the proportions of reports of work tasks including following fixed-location instructions are more similar to the proportions of reports of domestic or leisure tasks for the same category of behaviour than to reports of work tasks from any other category of behaviour.

What is not revealed by figure 8.4e is that individuals do not occupy consistent positions within the box-and-whisker plots for different task groups within the same behaviour. For instance, Alison includes following fixed-location instructions in 29% of her reports of work tasks, 75% of domestic tasks, and 33% of leisure tasks. Frances includes the same behaviour in 100% of her reports of work tasks, but 67% of domestic tasks, and 73% of leisure tasks. There are no overall trends within any category of behaviour. The 3 task groups elicit quantitatively similar proportions of reports within each category of behaviour even when broken down by individual, but individuals show considerable variation in reporting a category of behaviour between one task group and another

It is possible that some of this variation may be due to the small sample sizes resulting from breaking down each participant's reports into the separate task categories: the small sample size may lead to less reliable results.

This investigation into task in relation to context, the individual, and choice of behaviour in the user studies uses relatively coarse categories of task. This undoubtedly has a bearing on the findings. A more nuanced approach to task types is beyond the capacity of this thesis, but likely to be productive, particularly given the finding here that participants include categories of behaviour in different proportions of reports in different task categories.

9 / Conclusion

In this thesis, I set out to answer a principal question:

In what ways are seeking-finding behaviours comparable across the contexts of environmental space, documents printed on paper, and on-screen?

And a secondary question:

What are the relationships between choice of seeking-finding behaviour, and the variables of individual, context, and task?

The motivation for this research comes from my practice as an information designer. Having worked on projects in all three contexts, I observed that the types of elements I could include in a design to support users in their seeking-finding were similar across the contexts. Having noticed this, I was frustrated at the lack of discussion I could find regarding this similarity. And so, in addition to contributing to (academic) knowledge, in this research I am also driven by the wish to (i) satisfy my own curiosity, (ii) provoke designers to think widely and systematically about how their designed output supports its users, and (iii) provide evidence of user behaviour to inform design decisions for myself and other designers.

Overview

This thesis begins by defining key terms and frames of reference, starting with *seeking-finding*. The need to constuct this term is symptomatic of the lack of discussion comparing this behaviour across the three contexts. Leading out of this is a summary of the literature review, further elements of which are woven throughout the thesis, where relevant to the discussion. Next, the context-agnostic taxonomy of seeking-finding behaviours is introduced: the questions that drive it are explained, and the twelve categories of behaviour that it constructs are each defined (a description of the development of the taxonomy is in 10.1). This taxonomy is the principal tool used to permit comparisons of behaviour across contexts. The three user research studies conducted for this thesis are then described in detail: the task observation, the wayfinding survey, and the diary keeping. This includes an overview of the data from these studies. The next three sections form the core of the thesis: each of the twelve categories of behaviour is covered in detail. These discussions include the data relating to each category of behaviour from the user studies, as well as case studies that illuminate particular aspects of behaviour, that point to observations about seeking-finding behaviour across the contexts. Following on are discussions based on the data from the user studies that specifically examine how categories of behaviour relate to each other, and to the other factors of individual, context, and task. Finally, this section states general conclusions.

The literature survey

Reference to practice literature in the setting of a PhD thesis may be unusual, but its contribution here is undeniable. One issue that it makes quite apparent is the disjunction between research and practice literature: there is little that spans the two camps. Assessing practice literature can be problematic because authors rarely provide evidence to support their assertions: that can only be deduced – if at all – from the (unstated) history of practice of the designer authors. Researchers vary in the credence they give to practice literature: from Fidel (2012), who is confident of the value of including practitioners in her debate (see 1.4.1); to Carpman and Grant (2002), who are sceptical of the reliability of practitioners writing about their own practice (see 1.4.2). As a practitioner, I may be biased in favour of insight based on the tacit knowledge that comes with extended experience of the discipline: to mitigate this I have tried to err on the side of caution in terms of (i) selecting which practice literature to include, and (ii) choosing when and how much to rely on their evidence.

The literature surveyed (from both research and practice) has not only been used to identify the knowledge gap that this thesis seeks to fill; it has also been used in the formulation of the taxonomy. I have examined approaches to discussing the variety of seeking-finding behaviour, including other taxonomies. And it has been used to inform the discussions of individual categories of behaviour.

The quantity of literature surveyed for this thesis is substantial, due to covering three contexts, and due to the cross-disciplinary nature of this research. The literature is unevenly distributed over this extensive domain: some aspects are studied more intensively than others. The breadth of this survey has allowed connections (some unexpected) to be made across contexts, between research and practice, and among what might have been regarded as disparate behaviours. There are abundant studies of seeking-finding behaviour within each context, but because they are only about a single context, their contributions here are limited. There are small bodies of literature comparing seeking-finding behaviour in one context with another, but discussions of seeking-finding behaviour encompassing all three contexts are strikingly absent. This lack, from both research and practice, of examination of seeking-finding behaviour across all three contexts, is the knowledge gap that this thesis identifies and addresses.

The taxonomy

My approach to the research questions is principally through creating a taxonomy of seeking-finding behaviours that is equally applicable to all three contexts. It serves as a tool to permit behaviour in one context to be compared with that in another.

In line with the aim of creating an outcome useful to information design practitioners, the individual categories of behaviour in the taxonomy are defined by material differences in the information sources employed. The definitions are constructed from the answers to four simple questions:

- What is the **location** of the information?
  – Within you
  – In the environment: continuing to be accessible as you proceed
  – In the environment: at a point fixed in space and time

- What or who **provides** the information?
  – A person
  – A thing

- What **choices** does the information give?
  – It affords a single course of action
  – You must choose your course of action

- What **form** does the information take?
  – The actions of others
  – Traces of the actions of others
  – A symbolic representation of a series of actions
  – A symbolic representation of the space
  – A fixed sequence of symbols, one of which is linked to your objective
  – An objective that can be apprehended from your location
  – A frame of reference fixed and absolute throughout the space
  – A defined area known to contain the objective
  – An internalised representation of the space

Different permutations of answers give rise to the twelve categories of behaviour in the taxonomy.

The twelve categories of behaviour are divided into three groups: social, semantic, and spatial. All categories have these three characteristics, but each category is put into one of these groups depending on what characteristic predominates.

One challenge I find in using the taxonomy is that of keeping in mind all twelve categories of behaviour: it can be difficult to retain them and still have sufficient capacity in working memory to think usefully about behaviour. In answer to the question: *Then why not make fewer categories?,* I concluded that fewer categories would be too simplistic to serve my purposes, particularly given the small scale at which behaviours are examined in this thesis.[290]

The taxonomy as a tool for information designers

The categories of behaviour, and the four questions (given above) that drive them, can be used by information designers as a prompt to thinking widely and systematically about how users will interact with the information that the designer is tasked with communicating. This is facilitated by the definitions being structured around material differences in the information that drives the behaviour; and these questions are such that they can be used in thought experiments to suggest possible approaches to solving information design challenges. For example, the questions can prompt speculative thinking such as: *What if the information was portable? What if the information was communicated by a person rather than a thing? Does the information offer multiple courses of action, or just one?* They can act as reminders of the full range of possibilities open to the designer. Also one might use the questions to structure an analysis of extant solutions to a seeking-finding problem in order to identify possible limitations.

That the taxonomy can function in this way is as yet untested by any designer other than myself.

The taxonomy as a tool for research

Creating the taxonomy also contributes to knowledge through providing a framework to situate (current and future) studies of individual behaviours in order to better understand their place within the gamut of seeking-finding behaviour. The taxonomy also serves to highlight differences that superficial similiarities might obscure, such as the differences between various types of map-like artefacts: *Do these maps offer a single course of action, or multiple possibilities? Are they fixed-location, or portable?* Using the same sort of approach, the taxonomy can highlight similarities that superficial differences might obscure: such as the comparability of a line marked on the floor with a portable set of spoken instructions. It is possible (and my hope) that such distinctions and similarities may serve to clarify seemingly contradictory results in studies; but this is for subsequent research to reveal.

290 This is a situation where extended cognition can come into play: the full range of categories of behaviour can be kept to hand outside of the human brain (i.e. on paper, or on-screen), leaving more working memory available to consider behaviour in the categories.

The user research studies

The user research reported in this thesis took place for two principal reasons. First, to test and inform the taxonomy during its creation. And secondly, to provide a body of data, across all three contexts, for analysis using the taxonomy in order to answer the research questions. In these two roles, the user studies had the potential to inform the taxonomy itself, and to test and demonstrate its utility. Expressed in these terms, the approach may seem self-fulfilling: such possible risk is acceptable in the context of exploratory research, and given the scope of the research, it would have been difficult for it to be otherwise and still be contained within a single doctoral research project. Perhaps, it may be regarded as getting maximum value out of the user studies.

The three user studies – the task observation, the wayfinding survey, and the diary keeping – each have a different place within the arc of this research process. The task observation was conducted at an early stage and was highly exploratory. It served to inform the taxonomy inasmuch as it shed light on the problems of creating categories of behaviour that look beyond superficial context-led descriptors to uncover context-agnostic ones. It also revealed issues around artificial task formulation, and drove the subsequent adoption of approaches intended to avoid this. This first study also provides a body of data about seeking-finding behaviour in the single context of paper documents. It offers the opportunity to study issues around the sequence of behaviours, and to compare several participants performing the same set of tasks. The second study – the wayfinding survey – came about because an opportunity arose to collect data about seeking-finding in environmental space from a larger sample of participants. This study served to test approaches to collecting data that were used in the diary keeping study that followed. It also provides a body of data about seeking-finding in environmental space. The third study – the diary keeping – collects data about seeking-finding behaviour across all contexts. The data comes from twelve participants, recorded over the course of a month, and collects data about activities in everyday life.

The data from these studies is organised and analysed using the taxonomy's twelve categories of behaviour, in their three groups. In so doing, it demonstrates the utility of the taxonomy for research into seeking-finding behaviour, and the possibilities that it offers to other researchers to organise the behaviours they wish to study. Analysing the studies using the taxonomy provides the opportunity to examine individual categories of behaviour, and for these examinations to span all three contexts. It also affords comparisons between categories of behaviour, and examination of relationships between them. And finally it affords examination of how the categories are influenced by the variables of individual, context, and task. Using the taxonomy in this way demonstrates its utility asthe comparisons of behaviour across the three contexts would have been problematic without it.

One disadvantage of conducting the studies before the taxonomy was complete, as arose in all three studies, is that none of the studies collects data covering all categories of behaviour. This is not ideal, but the need to fit the entire scope into a doctoral research project necessitated some such compromises. The individual user studies each have limitations, as noted in section 3: that these are different in each study helps in mitigating their influence.

Diary keeping is possibly the least well known of the three study approaches. It demonstrates its value in the breadth and richness of the reports it collects from everyday life. With hindsight, it would have been better if the taxonomy had been complete before this final study commenced, as this could have made it possible to capture data about all twelve categories of behaviour in all three contexts. It might have also been better to conduct a preliminary analysis of the data from the questionnaires before the exit interviews. Such are the lessons that may be difficult to anticipate but become clear afterwards. Nonetheless, as a tool for collecting data about behaviour in everyday life, the diary keeping demonstrates its value.

The findings of the user research

One point that emerges repeatedly in the analyses of data from the user studies is the difference between individuals. There is not a single dimension in which the participants in the studies all behave consistently; in fact, the only consistent factor is difference: differences in patterns of behaviour within individuals, between individuals, between contexts. For every participant who always reports a particular behaviour in a particular context, there is another who never reports that behaviour in that context, and yet another handful who include that behaviour in that context in a range of different proportions of their reports. And when that particular pattern of differences is compared with same participants' reporting the same behaviour in another context, yet another different pattern emerges.

This extraordinary diversity is probably, in part, the consequence of having conducted the studies in the real world and not in a laboratory setting: behaviour-influencing factors are legion, and disentangling their various influences problematic in the data captured by these studies. However, this research is exploratory and the somewhat inscrutable complexity of the data is only to be expected when investigating behaviour in everyday life in a real world setting.

Another point that emerges clearly is that although the taxonomy may be applicable to all three contexts equally, seeking-finding tends to be quite different in each context: individuals vary in how they differ in their choices of seeking-finding tactics from one context to another, but in general individuals employ different tactics in different contexts.

Task emerges as having surprisingly little influence on choice of seeking-finding tactic, although this may be a consequence of the coarse granularity with which tasks are differentiated in this thesis.

In terms of information design practice, a global finding from the user studies is how different individuals are in their preferences and aptitudes. Solutions to information design problems often assume that all users will do the same thing in the same way. The headline from this user research, for information designers, is that they should start from the premise that they need to support as many *different* approaches as possible to executing seeking-finding tasks.

Findings from within the process of conducting the research

A point that has emerged strongly for me through conducting this research is the role of designing as a tool for thinking. Just as Clark (2011 and 1997) points out that writing can be part of thinking (extended cognition), I have found that designing the information and giving visual form to concepts have contributed to developing the discussions presented here. This is particularly the case in the taxonomy diagram shown in figure 2.6a. In the course of over forty iterations, figuring out how to visually represent the four questions and their relationship to the categories of behaviour, creating the diagram, and resolving problems in its visual organisation, have helped me to identify weaknesses and gaps in my thinking, and driven forward my understanding of aspects of the taxonomy. This is described more fully in 10.1. As an example of this, while reflecting on the categories of behaviour generated by the four questions, I realised that the taxonomy made a place for collaborative seeking-finding: it was through an interrogation of the diagram that I came to understand that this behaviour was a separate category rather than an unresolved aspect of social seeking-finding.

Future research

Throughout this thesis, there are several notes about potential directions for future research. In itself, the possibility to compare behaviours across contexts offers extensive scope for further study. The other behaviour-influencing factors of task and the individual, not to mention the much larger number of factors that are not discussed here, all offer considerable scope for research in relation to choices of wayfinding behaviour, and in relation to each other.

At present there is little research that examines seeking-finding qualitatively: how to conduct and report such research are large challenges. The taxonomy presented here can further that endeavour.

The distinction between semantic and spatial behaviours is also worthy of further examination. This thesis tentatively demonstrates the utility of the distinction between these groups, but there is considerable scope for more study.

I regard the taxonomy itself as work-in-progress, and this offers scope for further research. Can the definitions be improved? Can the names of the behaviours be improved? Can the definitions of the three groups be improved? I am sure that there are also applications of the taxonomy that I have not yet realised.

10 / Appendices

10.1 / Development of the taxonomy

The taxonomy presented in this thesis is the outcome of long development in several phases, so briefly explaining that process may be useful. However, the single linear narrative here is somewhat more straightforward than was actually the case because several activities were often progressing in parallel.

Origins

Creating and using a taxonomy of seeking-finding behaviours that can be applied equally to all three contexts is key to the approach taken to answering the research questions. The decision to employ this approach is a consequence of the origins of the project. Previously in my design practice I had made use of the set of strategies formulated by Mollerup (2005) to describe seeking-finding behaviour in environmental space;[291] specifically, these had proved useful when designing wayfinding systems and discussing them with clients. This engagement with Mollerup's strategies interacted with my observations (also in the course of my design practice) about the comparability of seeking-finding behaviours in the three contexts, and this led me to speculate as to whether Mollerup's strategies could be applied to all three contexts. Out of this grew the idea that seeking-finding behaviour might be rendered comparable across contexts through the lens of a taxonomy of behaviours.

Starting the literature survey

Conscious of how instrumental Mollerup (2005) had been in the origins of the research questions, I took the deliberate decision to set aside his strategies as I undertook the first stages of literature survey and research, lest his influence became too pronounced. I wanted other points of view to be equally available for consideration without interposing Mollerup's ideas between them and myself.

The first user study – the task observation

The initial analysis of data from the first user study describes categories of behaviour in language tied strongly to their context of paper documents.[292] This context-specificity is not surprising given that these categories emerge from a bottom-up, inductive process that forms categories by observing actual instances of behaviour. Identifying this issue of context-specificity in these emergent categories sharpened my awareness of this issue in the literature survey.[293] And it focussed attention on the challenge of writing behaviour descriptions for my taxonomy that apply equally to all three contexts.

291 See 2.4.2 for a description of Mollerup's wayfinding strategies.
292 This analysis is not included in this thesis – see 3.2.4 for further explanation.
293 Context-specificity is discussed in 1.4 and 2.3–2.4.

Conclusions from the literature survey

The literature survey reveals many descriptions of types of seeking-finding behaviour: individual categories of behaviour, small groups of categories of behaviour, and complete taxonomies in (typically) one or (occasionally) across two contexts. I could find no taxonomy to describe behaviour across all three contexts. The diverse approaches to sorting seeking-finding behaviour in the literature do not 'add up' to a coherent taxonomy due not only to issues of context-specificity but also to variation in scale, scope, and abstraction between studies.[294] Thus I was barely any further ahead with making a taxonomy applicable to all three contexts, but had identified key dimensions of the knowledge gap.

The second and third user studies – the wayfinding survey and the diary keeping studies

The wayfinding survey and the diary keeping both collect data via questionnaires that use deliberately context-specific descriptions of behaviour. This was done – despite aiming to use this data to compare behaviours across contexts – because it affords behaviour descriptions that are concise and readily intelligible to non-experts (the participants in the study).[295] Also, the at-the-time unfinished state of the taxonomy made it problematic to match questionnaires to it. While there is a process advantage to aligning the descriptions of behaviour used in the questionnaires and the taxonomy (coding of the data from the questionnaires to render it ready for analysis using the behaviour categories in the taxonomy becomes more straightforward), this was neither possible (due to the unfinished state of the taxonomy) nor appropriate (due to the need for the questionnaires to be written in language accessible to non-experts) in this instance.

The diary keeping required three related questionnaires – one for each context – and composing them presented another opportunity to compare behaviours in different contexts. The first to be written was for environmental space, because it was closely based on that in the wayfinding survey. The questionnaires for paper documents and on-screen in the diary keeping were based on the one for environmental space: replacing the behaviour descriptions from environmental space with those from paper documents or on-screen offered an opportunity – in the form of a thought experiment – to compare behaviour in one context with another.

Beginning to formulate the taxonomy

At this point I returned to the categories of behaviour in Mollerup (2005) with the intention of re-examining them (i) in the light of the literature

294 Scale is discussed in 1.2.4, abstraction is discussed in 1.2.5, and scope is discussed in 2.4.1.
295 This is discussed in 3.3.2.

survey, and (ii) to explore how they might be applicable to contexts other than environmental space.

I found that, to a large extent, Mollerup's strategies make a productive starting point in formulating a set of behaviour categories applicable to all three contexts, particularly in conjunction with the other taxonomies identified in the literature survey. Nonetheless, constructing definitions equally applicable to all three contexts was a slow process and went through many iterations. This process was both bottom-up and top-down. It was bottom-up in that I examined data from the user studies to see what groupings and configurations emerged. And the process was top-down in that I constructed category definitions to apply to the data.

In wrestling with definitions for this set of categories of seeking-finding behaviour, it soon became apparent that I needed not only a set of category definitions but also a system that articulated how these categories related to each other.

Identifying systemic factors

In the course of forming a system to structure the categories of behaviour, I identified *information* as the key factor driving the definitions of all the categories. Structuring the taxonomy around this also affords a direct connection to information designers – one of the intended audiences for this work – in that it focuses on the relationship between information artefacts (produced by information designers) and their users.

Having established this key factor, further analysis and reflection revealed that the categories of behaviour are largely differentiated by three dimensions of it. These readily became the three of the four questions that drive the taxonomy:

- What is the **location** of the information?
- What or who **provides** the information?
- What **choices** does the information give?

These questions were subject to numerous iterations, clarifications, and refinements before reaching their current form.

These three top-down questions serve to differentiate between many (but not all) of the categories of behaviour that the bottom-up process identifies. At this point my objective was to see if a fourth question could be constructed to readily disaggregate the categories of behaviour that the first three questions did not. Several were identified and considered, from among them a question about *form* proved the most productive:

- What **form** does the information take?

Unlike the previous three questions, this one requires more possible answers, many relating to only a single category of behaviour. Possible differences between behaviours identified by, on the one hand, the first three questions and, on the other, the fourth question are discussed in 2.11.

It was only at a late stage, rereading Mollerup (2005: 27), that I discovered that, although he does not apply the structure of questions to differentiate between his set of strategies, he observes the differences that they articulate: 'Seeking information includes looking for and reading – taking in – external information to combine it with internal information. External information includes off-route and on-route information. Off-route information covers maps, verbal descriptions, and other forms of advance information. On-route information covers cues given by the environment itself and by all kinds of signs. Internal information is the traveller's relevant knowledge. By combining external and internal information, the traveller identifies a number of eligible routes.'

Thinking by information design

Iterating and refining the taxonomy happened not only through thinking and writing, but also through designing it. In my practice as an information designer, a key objective is to present information as clearly, directly, and unambiguously as possible. I have noticed that a by-product of this process is that logical errors, flaws, and problems with content or structure can become visually apparent as the information is given graphical form. Knowing this, I deliberately applied myself to 'designing' the taxonomy as part of developing and testing my thinking. I regard this as in the category of activity that Clark (1997: 191–218) discusses as a looping of cognitive processes out of the mind to include external supports that enable a person to think ideas that are bigger than his or her mind could possibly hold. To paraphrase Clark (1997: 198): the thinking *is* the designing. This is not the same as designing something to make it formally beautiful (although designers may find it hard to resist doing this as well).

This process of thinking by designing took place in two broad stages. The first involved pen and paper and trying to sketch possible ways that the taxonomy might be organised.[296] It was in doing this that the first three questions that drive the taxonomy emerged. While this initial stage required swift sketching in order to capture ideas about the bigger structures of the taxonomy, the second stage moved from pen and paper onto the computer screen and design software. This stage examined details of how the elements fitted together and how to visually explain this. This working out of detail

296 There is little evidence to present of this pen and paper process: these sketches went into the recycling bin immediately their usefulness had ended – when they had been replaced by a subsequent generation of sketches. At the time I saw no value in keeping them (and considerable potential to confuse myself by referring to out-of-date material).

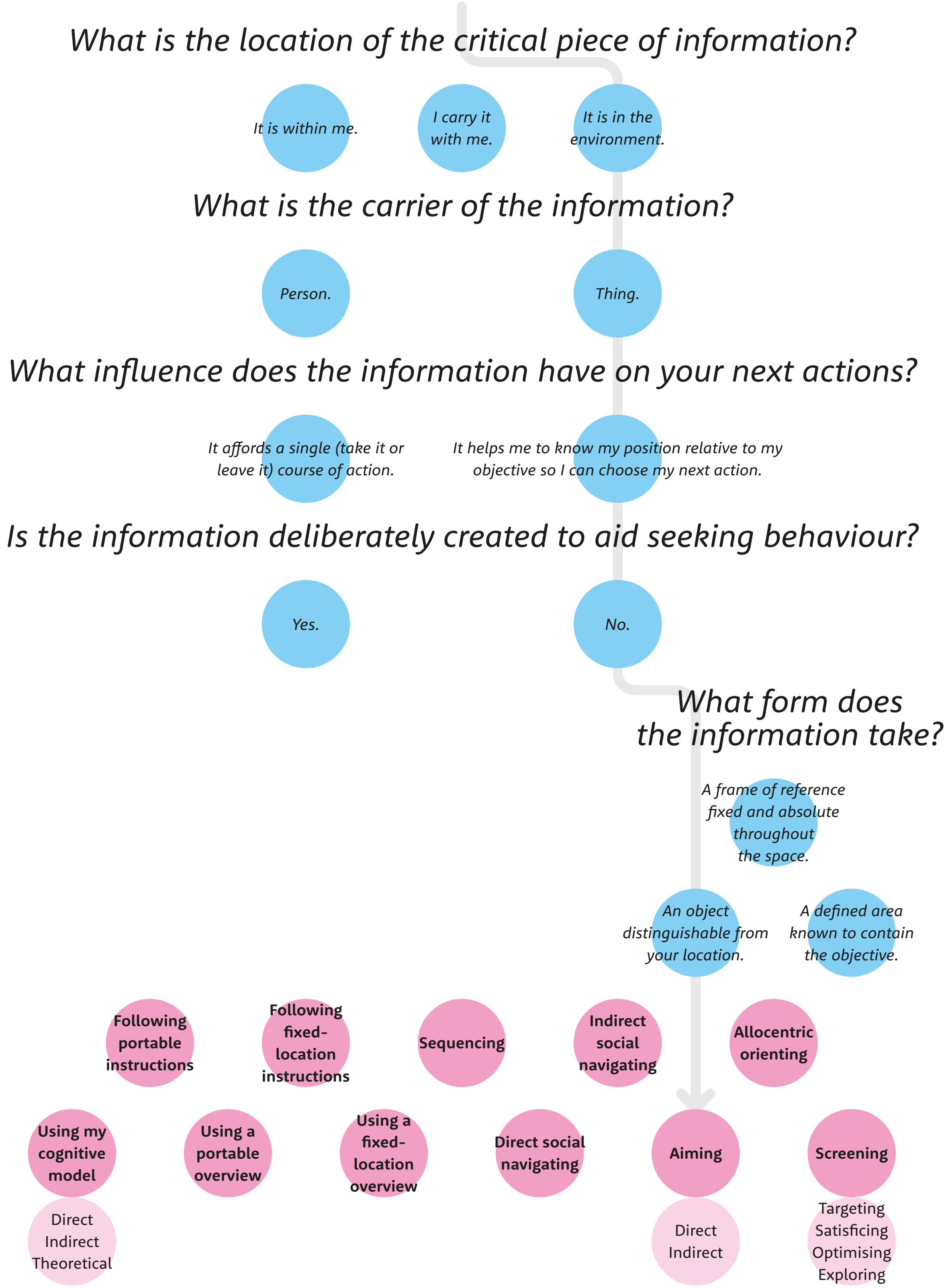


Figure 10.1a: *an early point in the second stage of thinking about the taxonomy by designing it, here showing the route through the questions for aiming*

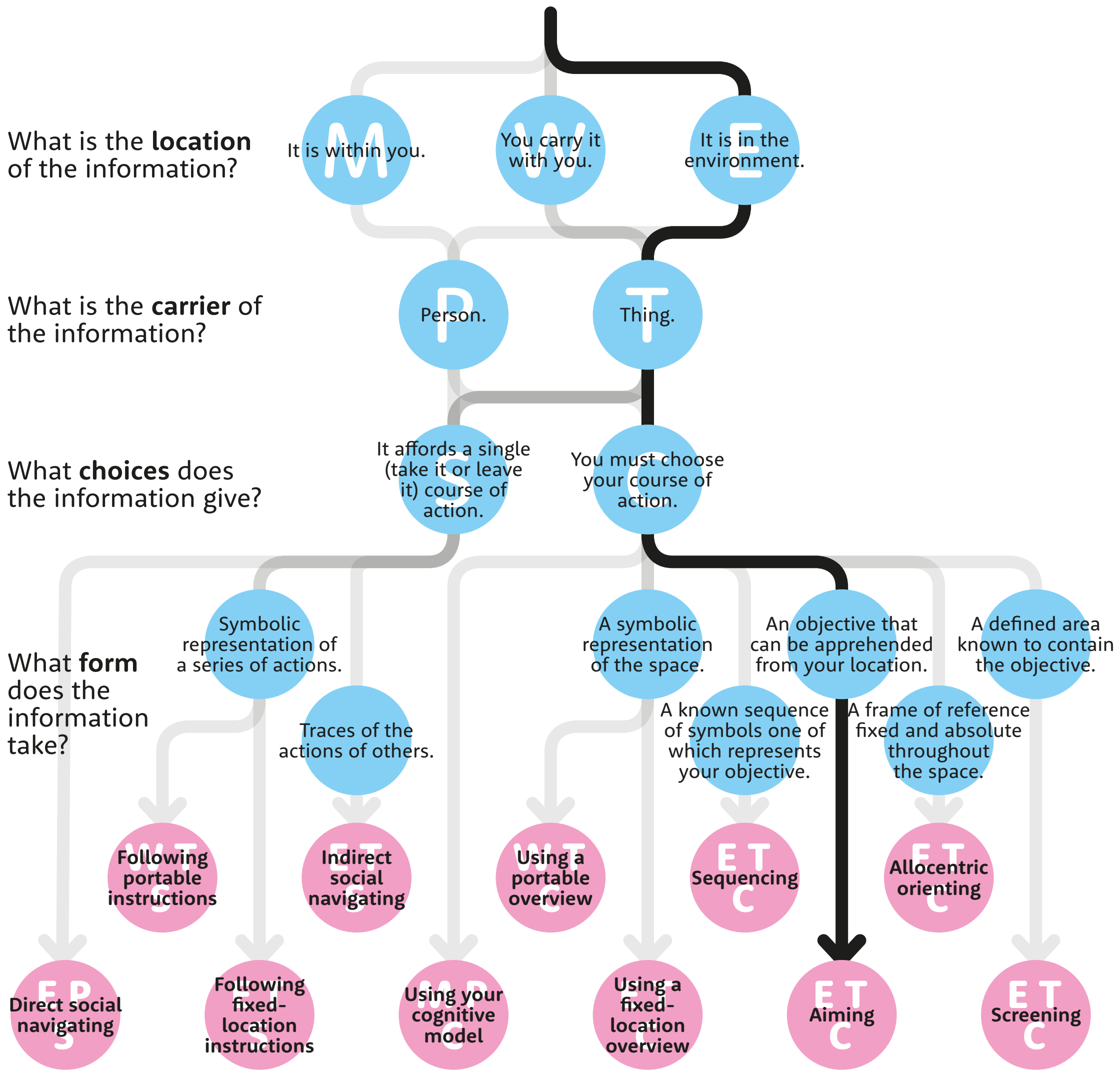


Figure 10.1b: *a later point in the second stage of thinking about the taxonomy by designing it, here again showing the route through the questions for aiming, and also identifying the question of the unused permutations of answers ('unoccupied positions'). Collaborative seeking-finding is still absent from the taxonomy*

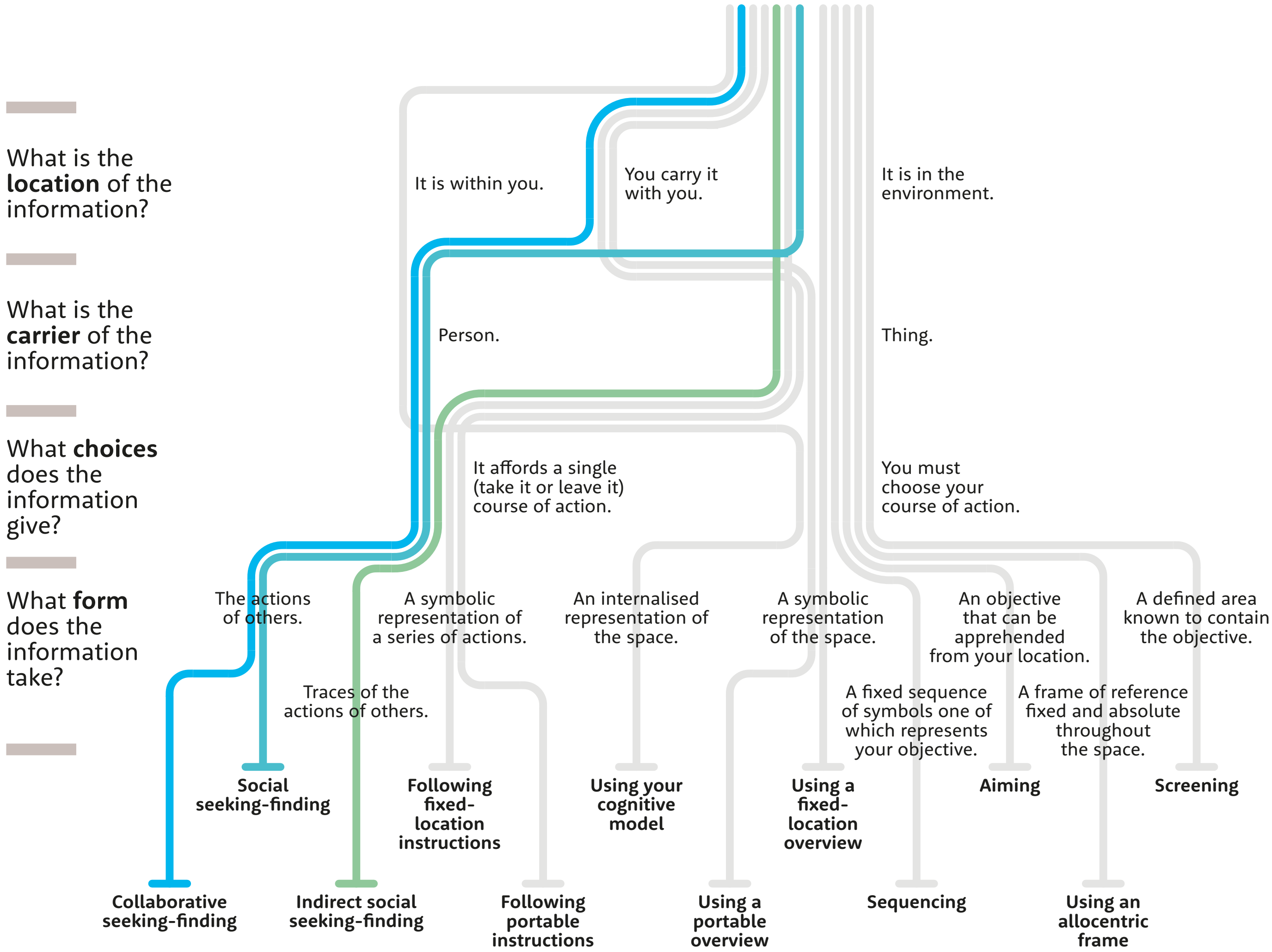


Figure 10.1c: *a much later point in the second stage of thinking about the taxonomy by designing it, here showing the route through the questions for social behaviours. Much of the organisation of the taxonomy has reached its current form, but some of the wording, the order of categories at the bottom of the diagram, the pictograms for individual categories, and the indication of groupings are still not final*

dealt with issues such as the adjacency of individual categories of behaviour, or how the questions relate to each other, and how the sequence of their answers are articulated to define each category of behaviour (see figures 10.1a–c for examples of points in this process). It was during this detail stage that, for instance, the question of the 'empty' categories became more apparent.[297]

Definition workshops

A further way in which the user studies contributed to the development of the taxonomy was through the process of coding data into the categories. This particularly applied to the wayfinding survey and the diary keeping studies: the process of assigning the behaviour descriptions in the questionnaires to behaviour categories in the taxonomy tested the effectiveness of the category definitions. As discussed in 3.3, there are issues of inter-rater reliability raised by the indirect relationship between the behaviour descriptions in the questionnaires and the behaviour categories in the taxonomy. In order to resolve these issues, a series of workshops were held: participants assigned the behaviours described in the questionnaires to categories in the taxonomy, and explained their reasoning. In addition to serving to stabilise the coding of behaviours into the taxonomy, the questions raised by the workshop participants highlighted areas needing further work in the category definitions and overall taxonomy.

The groups

The social, semantic, and spatial groupings are one aspect of the taxonomy that arrived relatively late in the process. Early iterations have a single category of social behaviour, based on 'social navigation' in Mollerup (2005: 66–67). The question in the taxonomy of whether the information is provided by a person or a thing, and some suggestions in the literature, prompted this single category to be disaggregated into social seeking-finding (information provided by a person) and asynchronous social seeking-finding (information provided by a thing, that carries the traces of a person's actions).[298] Further thought experiments based on the questions driving the taxonomy raised the issue: *What if the person who provides the information continues with you rather than staying at a fixed point?* Such a category could accommodate the behaviour of people such as tour guides, and friends or colleagues with whom one collaborates in seeking-finding in any one of the three contexts. Out of this arose the category of collaborative seeking-finding.

A further consequence of this was the exploration of the extensive literature discussing on-screen collaborative activities, which revealed the

297 See 2.9.

298 Some of the essays in Munro, Höök, and Benyon (1999b) use the terms 'direct' and 'indirect' to describe comparable differentiation in types of social navigation.

coining of the term ‘social navigation’ by Dourish and Chalmers (1994) with the allied groups of semantic and spatial navigation.[299] This led to further thought experiments around the applicability of these groupings to the taxonomy. Although originally formulated for on-screen seeking-finding, these groupings prove readily applicable to other contexts (many of the essays about on-screen behaviour in Munro, Höök, and Benyon (1999b) explicitly reference seeking-finding in environmental space). Furthermore, the process of analysing the data from the user studies demonstrates the utility of these groupings in articulating qualitative differences and similarities between categories of behaviours.[300] As is discussed in 2.7, all categories of behaviour include social, semantic, and spatial dimensions, but behaviours are placed in one group or another depending on which aspect predominates. And as Rosch (1975) notes, not all members of a grouping are equally good examples of that group, but that does not affect the validity of their place in the group.

A limitation

This process of developing the taxonomy may be criticised for being informed by a closed and inward-looking feedback loop. The data from the user studies is used on the one hand to inform the structure and organisation of the taxonomy. And on the other hand that taxonomy is used as a lens to reveal insight in the data from the user studies, and the data is used to demonstrate the utility of the taxonomy. The data from the user studies both informs the making of the taxonomy and then tests its validity: making it to be a self-fulfilling prophecy. If this were a formal study devised to test a null hypothesis, this might be a problem, but the exploratory nature of this research means that this issue is not critical. Also, the other sources that inform the taxonomy (e.g. the literature review, common sense) serve to moderate the influence of the data from the user studies on the taxonomy.

299 See 2.7 for further discussion of the three groups.

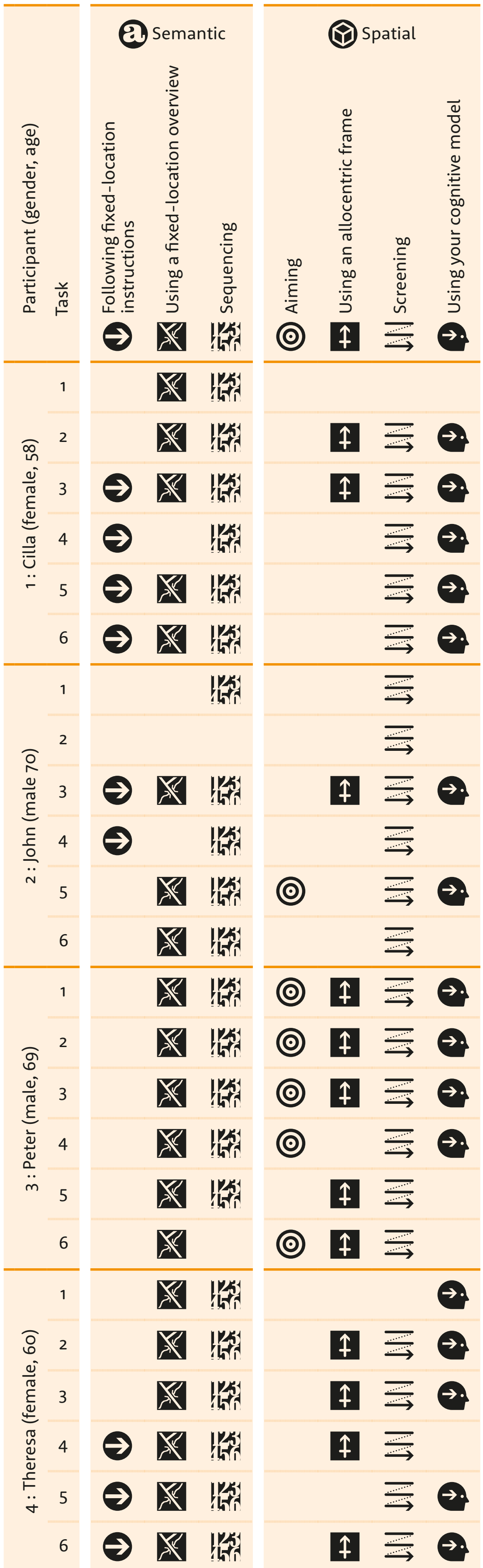
300 These groupings are used to structure sections 4–6 of this thesis. This and the analysis of data from the user studies contained within these and sections 7 and 8 constitutes a large part of the demonstration of the utility of these categories.

10.2 / Data from the task observation study

The task observation study is described in 3.2, including an overview of the data collected. The data is then discussed and analysed throughout sections 4–8, particularly in 5.12.1, 5.13, 5.14, 6.8.1, and 6.9. The data presented below is in two formats. First, in 10.2.1 each row shows a single report made by one participant detailing the particular combination of behaviours used in that report. This format is used for presenting the data from all three user studies and allows for ready visual comparison between them. And second, section 10.2.2 describes each report as a chronological sequence of behaviours, affording different insights.

10.2.1 / Data tabulated

Figure 10.2a (above and facing): *reports from the task observation study, sorted by participant; each row shows the behaviours used in one task by one participant. This is the same data as in figure 8.4a, but there it is grouped by task, here the rows are grouped by participant*



		Semantic			Spatial			
Participant (gender, age)	Task	Following fixed-location instructions	Using a fixed-location overview	Sequencing	Aiming	Using an allocentric frame	Screening	Using your cognitive model
5 : Michael (male, 65)	1			●			●	
	2		●	●	●	●	●	
	3	●		●	●			
	4	●		●	●		●	
	5	●	●	●	●		●	
	6	●	●	●	●		●	
6 : Stan (male, 61)	1			●			●	
	2			●			●	●
	3	●	●	●			●	●
	4	●	●	●			●	
	5	●	●	●			●	●
	6	●	●	●			●	
7 : Eleanor (female, 62)	1			●			●	
	2		●	●		●	●	
	3		●	●			●	●
	4	●	●	●	●		●	
	5	●	●	●		●	●	
	6		●	●		●	●	●
8 : Ali (male 39)	1		●	●			●	●
	2		●	●			●	●
	3	●	●	●	●	●	●	●
	4	●	●	●			●	●
	5	●	●	●		●	●	●
	6	●	●	●		●	●	●
9 : Cho (female, 39)	1		●	●	●		●	
	2		●		●		●	
	3		●		●		●	
	4		●	●			●	
	5		●	●			●	●
	6		●	●			●	●
10 : Jovair (male, 45)	1	●	●	●		●	●	●
	2	●	●	●	●		●	
	3	●	●	●	●		●	
	4	●		●			●	
	5	●		●				
	6	●	●	●			●	
11 : Lucas (male, 58)	1			●			●	
	2		●	●		●	●	
	3	●	●	●			●	●
	4	●		●		●	●	●
	5	●	●	●			●	
	6		●	●		●	●	●
12 : Maggie (female, 75)	1		●	●			●	
	2		●	●			●	
	3		●	●	●		●	
	4	●	●	●	●		●	●
	5		●	●			●	●
	6		●	●			●	●

10.2.2 / Sequences of behaviour, coded

Below are summaries of the sequences of behaviour that each participant used in the course of executing each task, coded according to the categories of the taxonomy. These allow a different sort of insight into behaviour that is not afforded by either the wayfinding survey or the diary keeping.

- Behaviours in regular weight type are behaviours that do not lead to a successful conclusion.
- **Behaviours in bold type are behaviours that lead to a successful conclusion.**
- There are no social behaviours.
- Semantic behaviours are coded in pink.
- Spatial behaviours are coded in green.
- › : closing guillaumet indicates one behaviour leading to the next.
- | : vertical stroke indicates a discontinuity in behaviour (a change of mind). Where behaviours continue on the same line after a vertical stroke, it indicates that the participant took a step or two back; where behaviours start a new line (with space above) after a vertical stroke, it indicates that they started again 'from scratch'.
- # : hash symbol indicates a successful conclusion.
- *P* : moment when page numbering system is understood.
- *C* : moment when contents list is discovered.
- *I* : moment when index is discovered.

Participant 1 : Cilla

Task 1

C **fixed-location overview** > **sequencing** *P* #

Task 2

cognitive model (direct and theoretical) > **allocentric frame** > **fixed-location overview** > **sequencing** > **screening** #

Task 3

cognitive model (direct) > fixed-location overview > screening > sequencing > screening |

allocentric frame > *I* **fixed-location instructions** > **sequencing** > **screening** #

Task 4

cognitive model (direct) > **fixed-location instructions** > **sequencing** > **sequencing** > **screening** #

Task 5

cognitive model (direct and theoretical) > fixed-location instructions > sequencing |

cognitive model (direct) > screening |

cognitive model (direct) > **fixed-location overview** > **screening** > **sequencing** > **screening** > **screening** #

Task 6

cognitive model (direct and theoretical) > fixed-location instructions > sequencing | sequencing > sequencing > screening |

screening > **fixed-location overview** > **screening** > **sequencing** > **sequencing** > **screening** #

Participant 2 : John

Task 1

screening > sequencing #

Task 2

screening #

Task 3

screening > cognitive model (theoretical) > allocentric frame > *C* fixed-location overview > screening *I* > fixed-location instructions > *P* sequencing > screening #

Task 4

fixed-location instructions > sequencing | **fixed-location instructions > sequencing > sequencing > screening #**

Task 5

cognitive model (direct) > sequencing |

aiming > screening |

cognitive model (direct) > fixed-location overview > sequencing > screening |

Task 6

fixed-location overview > sequencing > sequencing > screening |

screening > sequencing #

Participant 3 : Peter

Task 1

cognitive model (theoretical) › allocentric frame › *C* fixed-location overview › sequencing › allocentric frame › screening › aiming › fixed-location overview › screening › aiming › screening › aiming › fixed-location overview › screening › aiming › screening › sequencing #

Task 2

cognitive model (direct) › allocentric frame › fixed-location overview › screening › allocentric frame › screening › aiming › fixed-location overview › screening › aiming › screening › sequencing #

Task 3

cognitive model (direct) › fixed-location overview › screening › allocentric frame › screening › aiming › fixed-location overview › screening › aiming › screening › aiming › fixed-location overview › screening › aiming › screening › aiming › fixed-location overview › aiming › screening › sequencing | **screening #**

Task 4

cognitive model (direct and theoretical) › fixed-location overview › screening › screening › aiming › fixed-location overview › screening › aiming › screening › aiming › fixed-location overview › screening › aiming › screening › fixed-location overview › screening › aiming › screening › fixed-location overview › screening › screening › aiming › fixed-location overview › aiming › screening › sequencing › screening #

Task 5

fixed-location overview › screening › allocentric frame › screening › fixed-location overview › screening › sequencing › screening #

Task 6

fixed-location overview › screening › allocentric frame › screening › aiming › fixed-location overview › screening › aiming › screening |

Participant 4 : Theresa

Task 1

cognitive model (theoretical) > *C* **fixed-location overview** > **sequencing** > *P* **sequencing** #

Task 2

cognitive model (direct and theoretical) > **allocentric frame** > **fixed-location overview** > **screening** > **sequencing** #

Task 3

cognitive model (direct and theoretical) > **allocentric frame** > **fixed-location overview** > **screening** > **sequencing** > **fixed-location overview** > **screening** > sequencing | **screening** #

Task 4

allocentric frame > fixed-location overview > screening |

allocentric frame > *I* **fixed-location instructions** > **sequencing** > **sequencing** > **screening** #

Task 5

cognitive model (direct and theoretical) > fixed-location instructions |

cognitive model (direct and theoretical) > **sequencing** > **fixed-location overview** > **screening** > **sequencing** > **screening** #

Task 6

cognitive model (direct and theoretical) > fixed-location instructions > sequencing > sequencing > screening |

allocentric frame > fixed-location instructions > sequencing | **fixed-location overview** > **screening** > **sequencing** #

Participant 5 : Michael

Task 1

screening > **sequencing** *P* #

Task 2

allocentric frame > *C* **fixed-location overview** > **screening** > sequencing | **aiming** > **fixed-location overview** > **screening** > **aiming** > **sequencing** #

Task 3

I **fixed location instructions** > **sequencing** > sequencing | aiming > fixed-location instructions > sequencing > sequencing | **aiming** > **fixed-location instructions** > **sequencing** > **sequencing** #

Task 4

aiming > **fixed-location instructions** > **sequencing** > **sequencing** > **sequencing** > **screening** #

Task 5

fixed-location instructions > sequencing |

aiming > **fixed-location overview** > **screening** > **sequencing** > **fixed-location overview** > **screening** > **sequencing** > **screening** #

Task 6

fixed-location instructions > sequencing > sequencing > screening | aiming > fixed-location instructions > sequencing > aiming > sequencing > screening | aiming > fixed location instructions > screening > aiming > sequencing > screening |

aiming > fixed location instructions > sequencing > sequencing > screening |

aiming > fixed-location instructions > sequencing |

aiming > screening |

fixed-location overview > **screening** > **sequencing** > **sequencing** #

Participant 6 : Stan

Task 1

screening › **sequencing** *P* #

Task 2

cognitive model (theoretical) › sequencing | **screening** #

Task 3

cognitive model (theoretical) › *I* fixed-location instructions › sequencing | sequencing |

screening |

C fixed-location overview › screening › sequencing › screening | sequencing |

screening |

fixed-location overview › screening |

screening |

Task 4

fixed-location overview › screening › sequencing › screening › sequencing |

fixed-location instructions › sequencing | **sequencing** › **sequencing** › **sequencing** › **screening** #

Task 5

fixed-location instructions › sequencing |

cognitive model (direct) › **sequencing** › **screening** › **fixed-location overview** › **screening** › **sequencing** › **screening** #

Task 6

fixed-location instructions › sequencing | sequencing › sequencing › screening |

fixed-location overview › **screening** › **sequencing** › **sequencing** › **screening** #

Participant 7 : Eleanor

Task 1

screening > *P* **sequencing** #

Task 2

allocentric frame > *C* **fixed-location overview** > **screening** > **sequencing** #

Task 3

cognitive model (direct) > **fixed-location overview** > **screening** > **sequencing** > **screening** #

Task 4

fixed-location overview > screening > sequencing > sequencing > screening | sequencing |

aiming > fixed-location overview > screening > sequencing > sequencing | screening |

aiming > fixed-location overview > screening |

I **fixed-location instructions** > **sequencing** > **sequencing** > **screening** #

Task 5

fixed-location instructions > sequencing |

allocentric frame > **fixed-location overview** > **screening** > **sequencing** > **screening** > **fixed-location overview** > **screening** > **sequencing** > **screening** #

Task 6

cognitive model (direct and theoretical) > allocentric frame > fixed-location overview > screening > sequencing > screening |

allocentric frame > fixed-location instructions > sequencing > sequencing > screening |

cognitive model (direct and theoretical) > fixed-location overview > screening > sequencing > sequencing | sequencing |

Participant 8 : Ali

Task 1

cognitive model (theoretical) › *C* **fixed-location overview** › **screening** › **sequencing** *P* #

Task 2

cognitive model (direct and theoretical) › **fixed-location overview** › **screening** › **sequencing** #

Task 3

fixed-location overview › screening › sequencing › aiming › fixed-location overview › screening › aiming › screening › aiming › fixed-location overview › screening › aiming › sequencing |

cognitive model (theoretical) › **allocentric frame** › *I* **fixed-location instructions** › **sequencing** › **allocentric frame** › **sequencing** › **screening** #

Task 4

cognitive model (direct and theoretical) › fixed-location overview › screening | **fixed-location instructions** › **sequencing** › **sequencing** › **screening** #

Task 5

cognitive model (direct and theoretical) › fixed-location overview › screening |

cognitive model (direct and theoretical) › allocentric frame › fixed-location instructions › sequencing |

cognitive model (direct and theoretical) › **fixed-location overview** › **screening** › **sequencing** › **fixed-location overview** › **screening** › **sequencing** › **screening** #

Task 6

cognitive model (direct and theoretical) › fixed-location overview |

cognitive model (direct and theoretical) › allocentric frame › fixed-location instructions › sequencing |

fixed-location overview › **screening** › **sequencing** › sequencing | **sequencing** › **screening** #

Participant 9 : Cho

Task 1

screening > *C* fixed-location overview > screening > screening > aiming > fixed-location overview > screening > aiming > screening > aiming > fixed-location overview > aiming > sequencing #

Task 2

fixed-location overview > screening > screening > aiming > fixed-location overview > screening > aiming > screening > aiming > fixed-location overview > screening > aiming > screening > aiming > fixed-location overview > screening > aiming > screening > aiming > fixed-location overview > screening > aiming > screening > aiming > fixed-location overview > screening > aiming > screening #

Task 3

fixed-location overview > screening > screening > aiming > fixed-location overview > screening > aiming > screening > aiming > fixed-location overview > screening > aiming > screening > aiming > fixed-location overview > screening > aiming > screening > aiming > fixed-location overview > screening > aiming > screening > aiming > fixed-location overview > screening > aiming > screening > aiming > fixed-location overview > screening > aiming > screening > aiming > fixed-location overview > screening > aiming > screening #

Task 4

fixed-location overview > screening > screening > fixed-location overview > screening > sequencing |

aiming > fixed-location overview > screening > *P* sequencing > fixed-location overview > screening |

Task 5

cognitive model (direct and theoretical) > fixed-location overview > screening > sequencing > fixed-location overview > screening > sequencing > screening #

Task 6

fixed-location overview > screening > sequencing > screening > sequencing > screening |

Participant 10 : Jovair

Task 1

fixed-location overview > screening |

cognitive model (theoretical) > allocentric frame > *I* fixed-location instructions > screening |

screening > sequencing *P* #

Task 2

screening |

fixed-location instructions > sequencing > sequencing > screening | aiming > fixed-location overview > screening |

C **fixed-location overview > screening > sequencing** #

Task 3

fixed-location instructions > screening > fixed-location overview > screening > aiming > fixed-location instructions > sequencing | **sequencing > sequencing > aiming > fixed-location instructions > sequencing > sequencing > screening > aiming > fixed-location instructions > sequencing > sequencing > screening > aiming > fixed-location overview > sequencing > sequencing** #

Task 4

fixed-location instructions > sequencing > sequencing > screening |

fixed-location instructions > sequencing > sequencing > sequencing > screening #

Task 5

fixed-location instructions > sequencing | sequencing |

Task 6

fixed-location instructions > sequencing > sequencing > screening |

fixed-location instructions > sequencing | sequencing | sequencing | sequencing > sequencing > screening |

fixed-location instructions > fixed-location overview > screening | fixed-location instructions > screening |

Participant 11 : Lucas

Task 1

screening > **sequencing** *P* #

Task 2

allocentric frame > *C* **fixed-location overview** > **screening** > **sequencing** #

Task 3

cognitive model (direct and theoretical) > fixed-location overview > screening |

cognitive model (theoretical) > *I* **fixed-location instructions** > **sequencing** > **sequencing** #

Task 4

cognitive model (direct and theoretical) > **allocentric frame** > **fixed-location instructions** > **sequencing** > **sequencing** > **screening** #

Task 5

fixed-location instructions > sequencing |

fixed-location overview > **screening** > **sequencing** > **fixed-location overview** > **screening** > **sequencing** > **screening** #

Task 6

cognitive model (direct and theoretical) > **allocentric frame** > **fixed-location overview** > **screening** > **sequencing** > **sequencing** > **screening** #

Participant 12 : Maggie

Task 1

screening › *C* **fixed-location overview** › **screening** › **sequencing** #

Task 2

fixed-location overview › **screening** › **sequencing** #

Task 3

fixed-location overview › screening › *P* sequencing › aiming › fixed-location overview › aiming › sequencing › screening › sequencing | screening |

fixed-location overview › **screening** › **aiming** › **sequencing** › **screening** #

Task 4

cognitive model (direct and theoretical) › fixed-location overview › screening › screening › sequencing | screening | sequencing | screening | sequencing | sequencing › screening |

fixed-location overview › screening › aiming › sequencing › sequencing › screening |

fixed-location overview › screening › sequencing › sequencing › screening |

fixed-location overview › screening › aiming › sequencing › sequencing | sequencing › fixed-location instruction (*cross-reference not index*) › sequencing › screening |

fixed-location overview › screening › screening › sequencing › sequencing › screening | screening |

fixed-location overview › screening › sequencing › screening |

fixed-location overview › screening › sequencing › screening | sequencing › screening | sequencing › screening | screening |

Task 5

cognitive model (direct and theoretical) › **fixed-location overview** › **screening** › **sequencing** › **screening** #

Task 6

cognitive model (direct and theoretical) › **fixed-location overview** › **screening** › **sequencing** › **screening** #

10.3 / Data from the diary keeping study

The diary keeping study is described in 3.4, which includes an overview of the data from the study. There is substantial discussion and analysis of the data from this study in sections 4–8, including case studies of a number of participants, which show overviews of individual participants' reports (Jess, figure 4.9d; Fergus, figure 4.10d; Alison, figure 5.15d; Tanveer, 5.16d; Mike, 5.17d; Frances 6.10d; and Mary 6.11d). Participants who are not included as case studies have their data shown here, in figures 10.3a–10.3e. In these tables, each row shows a single report made by that participant: detailing the task, context, and particular combination of behaviours used in that report. In each of the figures below, the individual reports have been ordered so that reports of individual categories of semantic behaviour are grouped. This first affords a view of whether there are any patterns of co-occurrence of semantic behaviours, and beyond that whether there are any patterns of co-occurrence with other categories of behaviour.

Task	Work	Domestic	Leisure	Context: Environmental space	Context: Documents printed on paper	Context: On-screen	Social: Collaborative seeking-finding	Social: Social seeking-finding	Social: Asynchronous social seeking-finding	Semantic: Following fixed-location instructions	Semantic: Following portable instructions	Semantic: Using a portable overview	Semantic: Using a fixed-location overview	Semantic: Sequencing	Spatial: Aiming	Spatial: Using an allocentric frame	Spatial: Screening	Spatial: Using your cognitive model
Finding a department in my work place	●			●				●		●	●		●					
Researching takeaway options for dinner		●				●	●		●	●	●		●		●		●	
Locating a client payment (using a different program to usual)	●					●	●	●		●	●		●		●		●	
Finding contact details in a document	●				●					●			●	●			●	
Seeing what's happening over the weekend in a listings magazine			●		●						●		●	●			●	●
Finding a work location in inner London	●			●			●	●						●	●			●
Finding a location in inner London			●	●							●			●	●		●	
Finding a location in central London			●	●							●			●			●	
Finding a location in central London			●	●							●			●	●		●	
Visiting a friend in greater London			●	●			●			●	●			●	●		●	
Finding a shop in inner London			●	●			●	●		●	●			●			●	●
Finding a restaurant in a listings magazine			●		●					●				●			●	
Finding a restaurant in a listings magazine			●		●					●				●			●	●
Finding payment number on a handwritten invoice	●				●		●		●	●				●			●	●
Finding a location in central London			●	●						●		●		●			●	
Finding a location in inner London			●	●			●	●		●		●					●	
Finding a location in inner London			●	●			●	●		●		●			●		●	
Locating customer information for an order	●					●				●	●	●					●	
Online birthday present purchase		●				●			●	●	●	●					●	
Researching restaurant options			●			●			●	●	●	●					●	
Finding an email and downloading attachment		●				●				●	●	●					●	●
Finding a location in greater London		●		●							●	●					●	●
Finding an old contact in my phone		●				●				●	●						●	●
Booking holiday accommodation			●			●			●	●	●				●		●	●

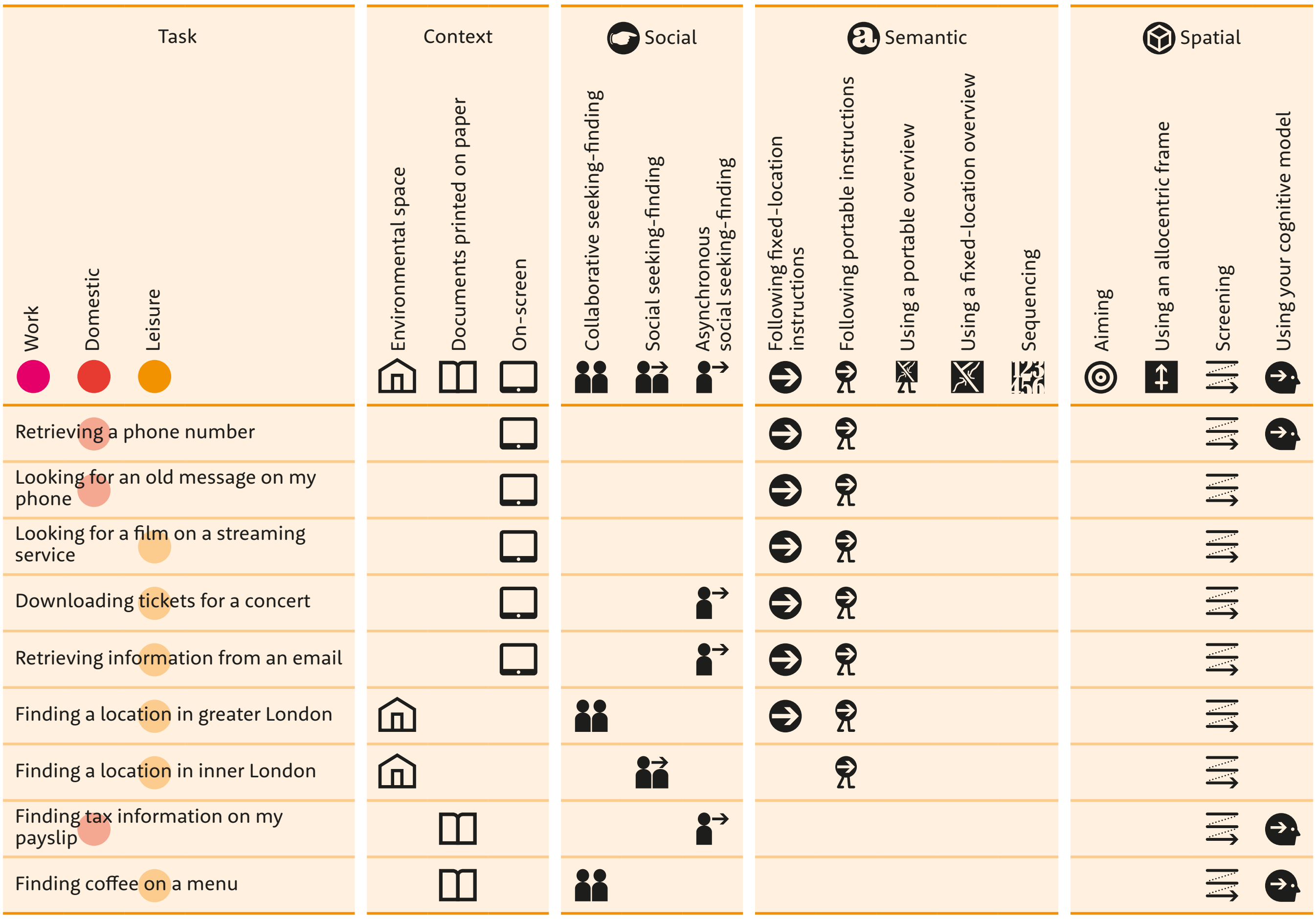


Figure 10.3a (above and facing): *each row shows the combination of behaviours in one of Alex' reports*

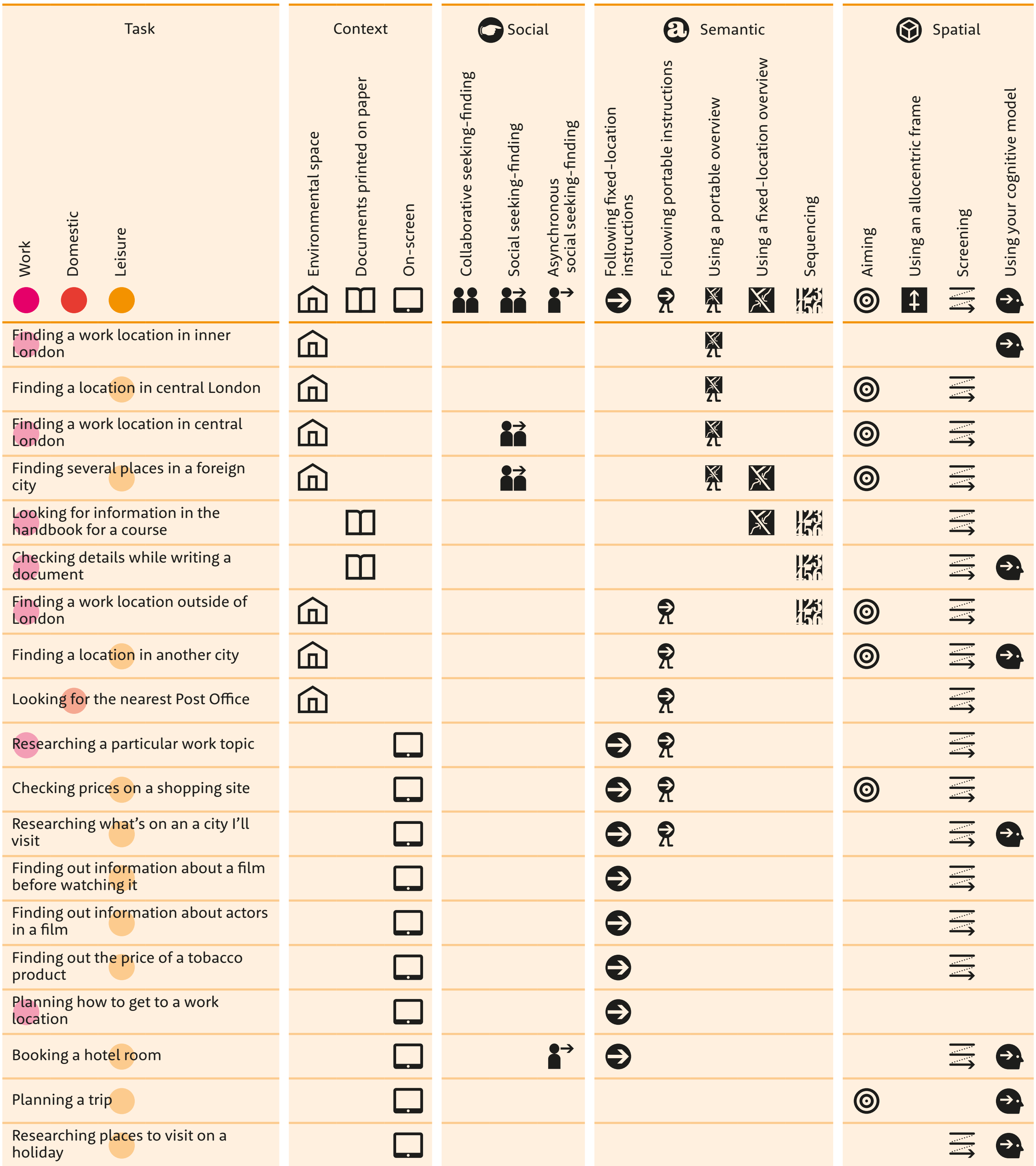


Figure 10.3b: *each row shows the combination of behaviours in one of Jai's reports*

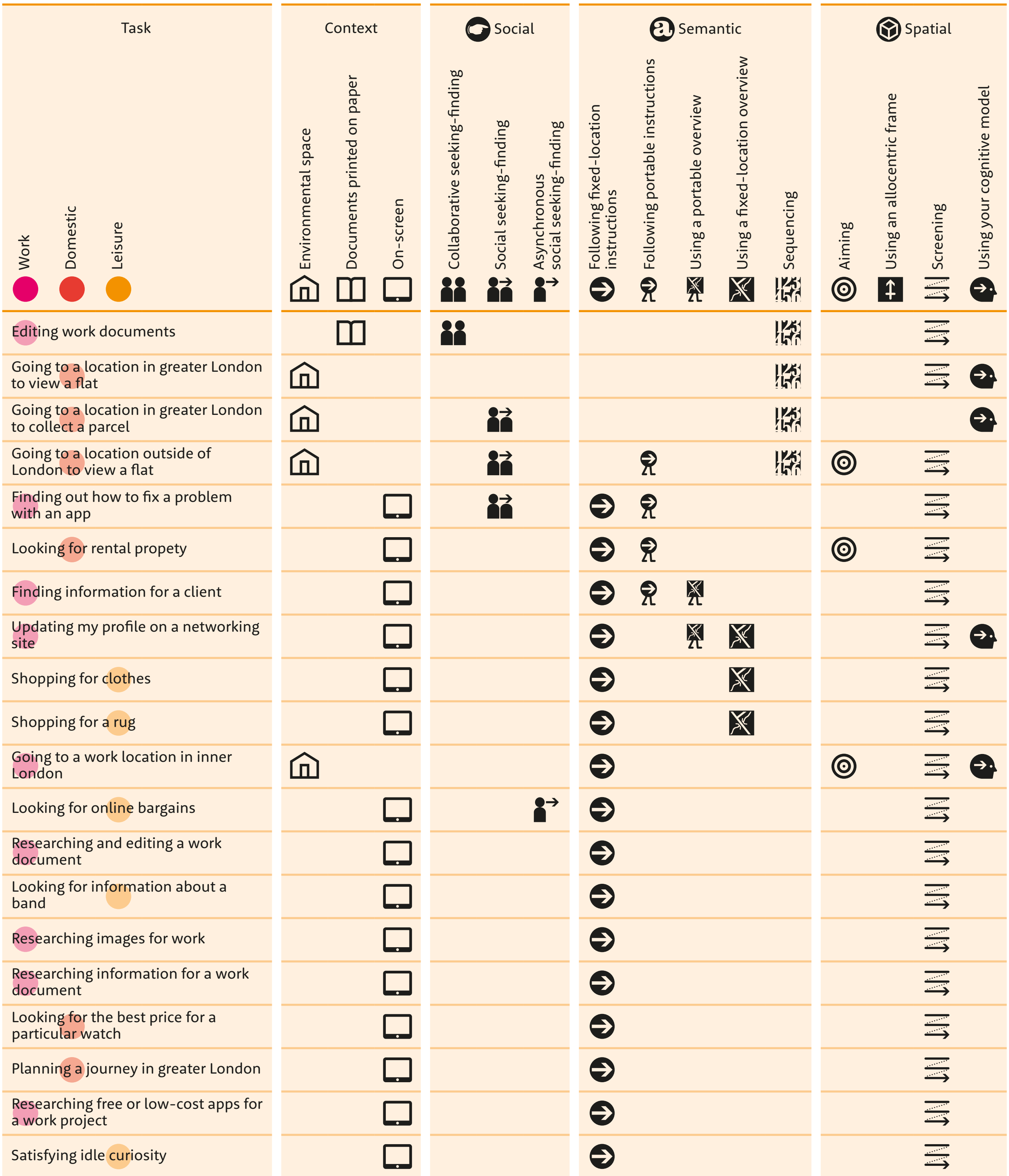


Figure 10.3c: *each row shows the combination of behaviours in one of Annabelle's reports*

Task				Context			Social			Semantic					Spatial			
	Work	Domestic	Leisure	Environmental space	Documents printed on paper	On-screen	Collaborative seeking-finding	Social seeking-finding	Asynchronous social seeking-finding	Following fixed-location instructions	Following portable instructions	Using a portable overview	Using a fixed-location overview	Sequencing	Aiming	Using an allocentric frame	Screening	Using your cognitive model
Planning a route in central London			✓			✓				✓							✓	
Checking which is the correct airport terminal in a foreign city			✓			✓				✓							✓	
Visitng dentist		✓		✓						✓	✓				✓			
Attending a work meeting in central London	✓			✓						✓	✓						✓	
Planning a route in a foreign city			✓			✓	✓			✓	✓						✓	
Planning route to airport terminal in a foreign city			✓			✓	✓			✓	✓						✓	
Planning route in a foreign city			✓			✓	✓			✓	✓		✓					
Researching a particular restaurant in a foreign city			✓			✓	✓			✓	✓		✓					
Researching nightclubs in a particular part of inner London			✓			✓	✓			✓			✓					
Researching bars in a foreign city			✓			✓	✓			✓		✓	✓				✓	
Researching restuarants in a foreign city			✓			✓	✓			✓		✓	✓				✓	
Finding directions to a beach in a foreign country			✓		✓		✓			✓			✓	✓			✓	✓
Finding directions to a historic site in a foreign country			✓		✓		✓			✓			✓	✓			✓	
Finding directions to a historic site in a foreign country			✓		✓		✓			✓			✓	✓				
Finding directions to a beach in a foreign country			✓		✓		✓			✓			✓	✓				

Figure 10.3d: *each row shows the combination of behaviours in one of Lily's reports*

Task		Context			Social			Semantic					Spatial			
	Work / Domestic / Leisure	Environmental space	Documents printed on paper	On-screen	Collaborative seeking-finding	Social seeking-finding	Asynchronous social seeking-finding	Following fixed-location instructions	Following portable instructions	Using a portable overview	Using a fixed-location overview	Sequencing	Aiming	Using an allocentric frame	Screening	Using your cognitive model
Purchasing a birthday gift	Domestic		●					●				●			●	
Planning how to get to a new hairdresser	Leisure		●					●				●			●	
Booking holiday accommodation	Leisure			●				●	●			●			●	
Finding a work location in inner London	Work	●						●	●			●				
Visiting a friend in greater London	Leisure	●			●			●	●			●	●		●	
Finding a work location in central London	Work	●						●	●			●	●		●	
Researching new tvs	Domestic		●								●	●			●	
Research for work	Work			●				●		●	●				●	
Research for work	Work			●				●		●	●				●	
Research for work	Work			●				●		●	●		●		●	
Researching restaurants in another town	Leisure			●	●		●	●		●	●				●	
Planning travel to a work location in inner London	Work			●					●	●	●				●	
Finding information from a child's school	Domestic			●				●	●	●					●	
Taking a family member to a work location	Domestic	●			●			●	●				●		●	
Going to a hotel in another town	Leisure	●			●			●	●				●		●	
Research for work	Work			●			●	●		●					●	
Research for work	Work			●				●		●					●	
Planning travel to a work location in inner London	Work			●				●		●					●	
Shopping for a particular garment	Leisure			●	●			●							●	
Research for work	Work			●				●							●	
Research for work	Work			●				●					●		●	
Research for work	Work			●				●							●	
Researching reading material for my son	Domestic			●			●	●							●	●
Research for work	Work			●				●							●	●
Looking for a particular music video	Leisure			●				●							●	●
Research for work	Work		●												●	●

Figure 10.3e: *each row shows the combination of behaviours in one of Joyce's reports*

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