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Information Behavior Patterns: A New Theoretical Perspective from an Empirical Study of Naturalistic Information Acquisition

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Abstract

This empirical study offers a new theoretical perspective in information behavior research by identifying interrelationships between certain information behaviors. While previous work recognizes the iterative nature of information acquisition, information behavior research has so far been dominated by the identification and conceptual elaboration of discrete behaviors. We introduce the theoretical concept of 'information behavior patterns' to characterize the intricate connectedness of information interaction in an arts and crafts context. A qualitative study comprising naturalistic observation and semi-structured interviews with 20 arts and crafts hobbyists was conducted in two 'browse-first' information environments that support various forms of active and passive information acquisition: Pinterest and a brick-and-mortar crafts store. Findings revealed a variety of information behavior patterns across both environments. We illustrate several of these through in-depth discussions of two specific information acquisition sessions. We visualize observed patterns from these sessions to illustrate the interweaving of active, passive acquisition, and personal goals. Our findings demonstrate the complex interconnectedness of human information behavior, highlighting the importance of going beyond compartmentalizing behaviors into 'buckets' when trying to understand the complex, dynamic and evolving nature of information interaction.

Keywords: information behavior patterns, information behavior, information acquisition, arts and crafts, hobbyists

Introduction

Information behavior has been a theoretical mainstay of Information Science for decades. Pervasive across work and everyday life, information behavior is a research area that has undergone multiple terminological shifts, covering information needs, sources, seeking, use, and others. One primary change of the area lies in the 1970s, during which researchers have turned their attention away from understanding specific systems, such as library catalogs, bringing human needs and behaviors to the fore to provide better information services (Case & Given, 2016). In accomplishing this, several scholars have examined information acquisition in various discipline contexts (e.g., social science research, Ellis, 1989, and legal research, Makri et al., 2008) and represented it through linear models comprising a general order of recognized actions, often a broad sequence of information seeking and use. While these researchers have acknowledged these models are not strictly linear, they tend to portray information behavior as a discrete set of 'behaviors.' However, segmenting human actions may lead to an oversimplification of the complex and intricate connectedness of information behaviors. Accordingly, examining information behaviors from a broader perspective is essential in understanding and communicating their dynamics. It can help inform the design of digital information environments that support human actions as fully as possible in a way as fulfilling as possible for people.

Grounded upon a qualitative study, we ask the research question 'how do specific information behaviors relate to one another?' We do this in a highly exploratory browse-first context: physical and digital arts and crafts stores, where information acquisition can take many potential different directions. Consider, for example, browsing without a particular aim in mind triggering a serendipitous information encounter or an encounter sparking an active search for a related item. Our goal, therefore, is to identify connections between information behaviors that have traditionally been discussed as discrete.

The rest of this paper is structured as follows. We first clarify a new concept, 'information behavior patterns,' to lay the theoretical foundation of this research, moving on to review literature about how prior researchers approached the concept of linearity in information acquisition. Next, we describe our qualitative research methods, presenting the findings to illustrate participants' interactions with arts and crafts materials. Research limitations and future work are then discussed. This work demonstrates the importance of understanding the complexity and interconnectedness of information behaviors to provide a richer and more nuanced understanding of how seemingly discrete behaviors are interrelated. This, in turn, can shift the emphasis of observing information behaviors away from a 'compartmentalized' view and towards a more holistic view based on appreciations of how the behaviors identified contribute to a broader episode of information acquisition, interpretation, and use.

Clarification of Concept

We coin the term 'information behavior patterns' as a means of regarding information behaviors as more than a set of discrete activities; as a set of interconnected activities that follow, feed, and facilitate each other. Our choice of the word 'pattern' can be traced back to its meanings in English. A pattern is "something designed or used as a model for making things" ("Pattern," 2021), such as a knitting pattern that guides crafters' work. A pattern is also "a reliable sample of traits, acts, tendencies, or other observable characteristics of a

person, group, or institution," which helps information behavior researchers gain a basic understanding of information seeking (Case & Given, 2016). This article uses 'patterns' as per the Case and Given definition. Always including more than one behavior, patterns are flexible, idiosyncratic, and can show the evolutions of information goals across information acquisition episodes. Our empirical data demonstrate a variety of complex patterns comprising various behaviors.

Literature Review

Empirical research on information acquisition has provided considerable evidence to support theories of information behavior. These theories have proven highly valuable in helping to describe and explain aspects of information behavior, including complex and nuanced aspects of information seeking and use, as well as passive acquisition. We formulate the patterns concept not to challenge or replace any existing theories of information behavior but to provide a new theoretical level to examine information behavior—a level above the individual activities people undertake that takes how these activities form sequences into greater account. This section reviews several models of information behavior, including models that incorporate aspects of behavior rather than being exclusively behavioral. This literature review focuses on how these existing models capture and portray sequences in behavior. Its scope focuses on highly cited information-seeking and use models that provide some insight on patterns or sequences of behavior. Many of these models have had an enduring presence in the information behavior literature for the past four decades.

Krikelas' Model of Information-Seeking Behavior

Before Dervin and Nilan (1986) published their seminal article, Krikelas (1983) proposed an information-seeking model that contained multiple crucial elements. The Krikelas model begins with the bracket identifying the creation of need when people perceive their current knowledge is insufficient to address an issue or task. This uncertain perception can result in either a deferred need, followed by information gathering, or an immediate need, which motivates information seeking. The model then drills down to specify source preferences, ranging from internal memory to stored literature, that people may use when engaging in information seeking. The Krikelas model is structured as a simple top-down flowchart where all arrows mark one direction, depicting a variety of intrapersonal and interpersonal sources. Nevertheless, the Krikelas model is often criticized for being oversimplified and keeping "the flavor of a 'library search model'" that may limit its application beyond work-related contexts (Case & Given, 2016, p. 150). This concise model has prompted us to turn our attention to the connectedness between information needs, seeking, and other types of information acquisition. For example, when explaining a deferred need, Krikelas discussed the concept of information gathering, whose definition encapsulates much of the nature of passive acquisition. This model highlights the potential to examine how such behavior can interweave with other (e.g., more active) types of information behavior.

Kuhlthau's Information Search Process Model

Kuhlthau's (2004) Information Search Process (ISP) model pioneered the integration of physical, cognitive, and affective aspects of the search process. The model was constructed based on longitudinal research conducted in the 1980s and 90s, where Kuhlthau examined high schoolers conducting library searches across multiple search sessions. Underpinned by a constructivist approach, the ISP model stresses the constructive process of information seeking and use, where people create meaning as they engage with information. With a clear beginning and end, six stages are presented: Initiation, Selection, Exploration, Formulation, Collection, and Presentation. While these are framed as 'tasks' rather than 'behaviors,'

Kuhlthau did present various ‘actions,’ such as seeking, exploring, and documenting that can be regarded as information behaviors in their own right. The ISP model provides a holistic view of the information-seeking process and recognizes the information tasks involved at each stage. For each broad task, such as when narrowing down searches, one can pose the question: what is the behavioral composition of this task? Specifically, how might multiple information behaviors combine to facilitate these broad tasks?

Ellis’ Model of Information-Seeking Behavior

Ellis’ (1989) model presents a broad framework of information-seeking behavior derived from an empirical study of social science researchers, comprising six activities: Starting, Chaining, Browsing, Differentiating, Monitoring, and Extracting. The model was subsequently validated and refined by examining it in several academic and professional settings, resulting in the addition of two behaviors: Verifying and Ending (Ellis et al., 1993; Ellis & Haugan, 1997). A key property of Ellis’ behavioral model lies in its emphasis on the flexible nature of information seeking. Unlike Kuhlthau, Ellis did not use the term ‘stage’ to characterize the model. Instead, he described components as ‘features’ and ‘characteristics.’ Although presented linearly for the sake of clarity, with some behaviors, like Starting and Ending, that imply a linear sequency, Ellis made it clear that the behaviors in the model did not entirely conform to fixed sequences and vary across information-seeking sessions. This model is therefore pseudolinear, recognizing the iterative and interlined nature of information seeking. Wilson (1999) briefly touched on connectedness when discussing Ellis’ model, suggesting “‘verifying’ is a penultimate stage in a process and that ‘extracting’ must follow on from a behaviour such as ‘browsing’” (p. 254). Here, Wilson associated Browsing with Extracting by expressing their close interrelationship, reflecting our concept of information behavior patterns.

Bates’ Berrypicking Model

Compared with the above three models of information seeking and use, Bates’ (1989) berrypicking model pays close attention to how an information search process progresses, especially looking at the role of browsing. In this model, Bates inferred that people perform multiple behavioral transitions by framing berrypicking as a dynamic form of information seeking. To explain the iterative character of seeking, Bates illustrated the berrypicking model with a diagram depicting the progression of an information search episode. Bates’ original model uses a line of the arrow to represent an evolving search, where interesting information may be found throughout the process. When approaching a search task, a person usually carries out a series of actions, such as formulating and editing queries, that usually lead to the subsequent behavior of browsing search results. The end of the arrow in the model marks the moment that the person is happy with their research. Bates’ model emphasizes the unfolding nature of information acquisition, where people consume information bit by bit as they navigate digital information environments. Moreover, since the model offers a micro view on an information-seeking episode, it is useful as a theoretical lens to understand how browsing manifests in information acquisition. The berrypicking model demonstrates the strong interconnectedness between searching and browsing, which are not regarded as discrete ‘modes’ of information acquisition but are highly related to each other. In the discussion section, we present diagrams inspired by the berrypicking model to visualize the complexity of information behavior patterns.

Foster's Nonlinear Model of Information Seeking

Foster (2004) developed a conceptual model to highlight the nonlinear nature of information behaviors. According to Foster, information seeking is dynamic and flowing, centering on core processes comprising Opening (exploring or revealing information), Orientation ("finding which way was up," p. 234), and Consolidation (judging or interpreting information). Foster's model illustrates that these core processes fall within a cognitive approach, which refers to how people utilize information to solve problems. Foster emphasized the nuanced nature of information behaviors, reporting that their relationships were "concurrent, continuous, cumulative, and looped" (p. 232). With some irony, models like Foster's (and Ellis's (Ellis, 1989)) present their models as though they are linear, despite explicitly acknowledging them not to be so. This demonstrates a quirk of information behavior research, that models are, by definition, an abstraction of reality designed to meaningfully simplify some aspects of complexity for the sake of clarity. Therefore, it may be considered most beneficial to present information behavior linearly to simplify complexity. However, in doing so, information behavior researchers run the risk of oversimplifying reality by glossing over some of the useful intricate detail.

Other than the models presented above, it is worthwhile to briefly cover a conceptual framework developed by Xie (2000), who examined peoples' information-seeking goals rather than behaviors per se. Xie's research serves as a representative example that depicts the prevalence of shifts in intentions and information-seeking strategies. According to Xie, when people approach seeking tasks, their goals can gradually change at a micro level, affecting their adoption of different techniques to accomplish their overarching goals. This type of change in sublevel goals and techniques is considered a shift within a seeking episode. Xie defined various goals, subgoals, interactive intentions, and seeking strategies that people used to achieve these intentions. For instance, a person uses a strategy of 'comparing' specific information to fulfill her interactive intention of 'evaluating' the usefulness of a sought item. Xie concluded that shifts in seeking episodes are worth considering when developing adaptive information retrieval systems. In this research, we expand on Xie's concept of goals by conducting a study that focuses on identifying sequences in information behaviors. We shun the library setting due to its considerable discussions in the literature (e.g., Kleiner et al., 2013; Makri et al., 2007; McKay et al., 2019). Instead, we examine information seeking, which can be framed as a process of goal evolution, in non-traditional information environments where people navigate with an open and lively mind (Dörk et al., 2011; White & Roth, 2009).

While we have presented selected information behavior models and theories that help demonstrate the need to understand patterns of information behavior, it is certainly not possible to be exhaustive; much prior work can be leveraged to motivate the importance of a patterns approach. There are also several widely cited models of information seeking that we do not cover, such as Dervin's (2015) Sense-Making, Williamson's (1998) ecological model of information use, and Wilson's (1999) model of information-seeking behavior. These models work in counterpoint to our study; while they do not specifically highlight the potential of a patterns-based approach to probing information behavior, they do demonstrate the importance of understanding the complexity surrounding information seeking and use, something a patterns-based approach can help achieve. Overall, we contend information behavior patterns are a pragmatic approach to representing the interconnectedness of

information behaviors without resorting to using a linear or pseudolinear model that may oversimplify the complexity of these connections. The patterns concept allows researchers to take a step back when examining information behaviors, by combining discrete behaviors into a coherent set to help explain how people interact with information more holistically than at the level of the individual behaviors they undertake. Furthermore, the patterns concept avoids the tendency to simplify and abstract away complex behaviors, echoing Wilson's (2006) argument that the essence of information behavior research "is not to 'model' information-seeking behaviour, but to draw attention to the interrelationships among concepts used in the field" (p. 659). We argue that the new theoretical perspective of information behavior patterns allows, and indeed encourages, researchers to re-embrace the complexity of information acquisition, advancing the understanding of its nuances.

Methodology

To identify information behavior patterns in an arts and crafts context, we conducted a naturalistic qualitative observation study with recruited participants in digital and physical information environments: Pinterest (pinterest.com) and a brick-and-mortar crafts store located in a U.S. Midwest college town. The selected store is characterized by its donated items and unique approach to shelving products, akin to the bookshop designed for serendipity in prior research (Makri et al., 2019). Rather than organizing items by their object types, the staff focuses on sizes and quantities of items, tending to re-shelve everything in the store frequently. Both Pinterest and the crafts store represent browse-first environments that promote a variety of active and passive forms of information acquisition. These creative spaces support both searching and browsing, active information seeking and passive information encountering. These qualities of these environments make them highly suitable for identifying a broad range of interconnected information behaviors.

A total of 20 participants were observed across two information environments: 10 used Pinterest (2 males and 8 females) and 10 visited the crafts store (1 male and 9 females). Eligible participants had to be over 18 and self-identified as an arts and crafts hobbyist, which was confirmed in pre-interviews. We recruited participants using the weekly university newsletter, personal contact, and flyer. Flyers were placed on bulletin boards in campus buildings, cafes, and community centers across town. To safeguard participant privacy, Pinterest participants could choose to use either their laptops or a public one offered by the University. All participants who used Pinterest agreed to sign into their personal accounts to fully access the website. Although all participants provided informed consent, explicit observation permission was not required from management of the crafts store, as it was considered a semi-public space. To protect participant confidentiality, we have removed all participants' names and identifiable information. Using the random name generator based on U.S. census data, we assigned pseudonyms to each participant by gender (see Table 1).

Table 1
List of Participants in Each Information Environment

Information Environment	Participants
Pinterest	Derick, Karl, Savina, Sophia, Iris, Mia, Nikki, Ruth, Lorene, and Elisa
Physical crafts store	Min, Hila, Tracy, Tamia, Julie, Amanda, Erika, Rong, Yating, and Don

Data Collection

We used two qualitative research methods: interviews and observation, comprising four phases: pre-interview, naturalistic observation, first post-interview, and second post-interview. Each interview and observation session were audio-recorded. Table 2 presents detailed information about the time each phase took. We attempted to keep the pre- and post-interviews short, approximately 5 minutes, and the observation to around 30 minutes in each environment.

Table 2

Time Length of Each Phase in Each Information Environment

Information Environment	Phase	Minimum	Maximum	Average
Pinterest	Pre-interview	4 mins	14 mins	7 mins
	Observation	30 mins	30 mins	30 mins
	First post-interview	2 mins	12 mins	5 mins
	Second post-interview	3 mins	10 mins	6 mins
Physical crafts store	Pre-interview	3 mins	10 mins	6 mins
	Observation	21 mins	30 mins	28 mins
	First post-interview	2 mins	5 mins	3 mins
	Second post-interview	4 mins	10 mins	7 mins

In the pre-interview session, we asked each participant to share their experiences of and current interest in arts and crafts. We considered this phase critical to building rapport. Pre-interviews of Pinterest participants were conducted at spaces chosen by themselves, while physical store participants had their pre-interviews on a bench outside the store. Immediately after the pre-interviews, we did naturalistic observation with each participant. Naturalistic observation has previously been used for generating findings with both theoretical and practical implications in information behavior research (e.g., Hinze et al., 2012; Makri et al., 2008; Waugh et al., 2017). In the naturalistic observation session, we asked participants in both information environments to engage in an *explore* task, asking them to:

"Spend 15 minutes exploring without looking for anything in particular. It doesn't matter if you find anything interesting or not. The most important thing is for you to behave as naturally as possible by doing what you normally would."

This wording emphasized it was exploration, rather than finding something useful, that was important. This aimed to avoid participants feeling pressured to find something specific due to their exploration being observed. After participants finished the first task, we asked them to undertake a *find* task:

"Spend another 15 minutes here and look for something in particular. It can be something broad, specific or anything in between. It doesn't matter if you find it or not and you can stick to or change your task at any time. Again, the most important thing is for you to do what you normally would."

We did not specify a narrow scope for participants' target items to allow them to choose information-seeking tasks ('find' tasks) that, in theory, fell anywhere across the spectrum of

goal-directedness. Moreover, we told the participants that they could freely change between tasks to given them license to pursue information passively encountered during the active seeking tasks, without feeling as though this somehow 'went against the rules' of the study. We did not counterbalance the task order and acknowledged that participants may get more familiar with products during the first task. However, what they found in the first task did not appear to influence their information behavior in the subsequent task. Participants were asked to think aloud—to verbalize what they were *doing*, *thinking* and how they *felt* throughout the observation session (i.e., their behavioral actions, cognitive thoughts and affective feelings). Although the researcher refrained from intervening, she did remind participants to continue to think aloud if they stopped. The researcher also asked questions when noticing interesting behaviors that participants had not explained, following an approach discussed further by Makri and colleagues (2011). To avoid being intrusive and to protect customer privacy in the crafts store, we audio recorded and took notes rather than video recording.

After the observation, we ran our first post-interview, which involved asking participants to reflect on their experiences of undertaking the exploration and find tasks. For instance, they could reflect on the success of browsing and searching experiences or how the environments may either support or hamper their exploration and find tasks. Later post-interviews were held after our data analysis began, serving as member check to validate our preliminary analysis. As the second post-interviews were relatively informal compared to previous phases, they were conducted either by phone or face-to-face, depending on participants' preferences.

Data Analysis

All interviews were transcribed and identifying details anonymized from the outset. Notes served to supplement the transcripts, ensuring we captured participants' actions accurately. We performed an inductive Thematic Analysis, during which we iteratively coded the interview transcripts and field notes using the qualitative research software ATLAS.ti. (Braun & Clarke, 2006). Memos were created during this process to document our initial thoughts and insights related to information behavior patterns. Although we used a broad Thematic Analysis approach, we did not generate traditional 'themes' from the data. First, we generated codes sensitized by concepts from a variety of previous information behavior literature, listed in Table 3. We took care, however, to allow our findings to be primarily data-driven, rather than driven by existing literature. That said, the code labels we chose all echoed prior literature and none of the behaviors we identified were 'unique.' This allowed us to focus on illustrating how existing information behaviors follow, feed, and facilitate each other over time by 'stitching together' individual codes that represented discrete behaviors to identify 'base patterns:' patterns consisting of a commonly observed transition between two specific information behaviors. After that, we examined evidence of behaviors beyond those already captured in the base patterns to identify more elaborate and intricate patterns. Compared with base patterns common in two information environments, elaborate patterns composed of at least three behaviors were rare. Rather than assuming the patterns most frequently presented in the data were necessarily the most interesting and essential to report, we remained alert to complex 'strings' of behaviors embedded within a rich informational context. These were often more interesting than the most prevalent patterns. The output of this analysis was a temporal representation of each information acquisition episode, comprising multiple behaviors that might traditionally be described in their own right rather

than in the context of each other and how they contribute to a broader information task or goal. These can be seen in Tables 4 and 5.

Findings

Participants across both physical and digital environments demonstrated a wide variety of information behavior patterns. For instance, one pattern observed was semi-defined browsing → encountering (with awareness). This was a pattern of information acquisition where a participant, Elisa, browsed Pinterest with a general goal. While browsing, she came across an intriguing image serendipitously, which led her to demonstrate awareness related to the encountered image by recalling her understanding of an e-commerce website, Etsy. Another example observed in the current study was searching → ill-defined browsing → encountering → searching. This pattern was where a participant, Hila, sought a specific product in the arts and crafts store. While searching, she looked over items on nearby shelves of potential interest and accidentally ran into an item that met her another need. After having this encounter, Hila changed her initial searching goal to her second searching goal, attempting to find particular products in the same category as the encountered item.

We provide definitions of each form of information acquisition before delving into the information behavior patterns, which comprise several of these types. We identified patterns consisting of active and passive information acquisition, i.e., conscious and intentional information behaviors versus informal and unplanned information behaviors (Case & Given, 2016). We define each information behavior based on previous literature. Table 3 presents definitions covering all types of information acquisition we observed and examples from the observation data.

Table 3
Information Acquisition Episodes

Information Acquisition Episode	Definition	Example
Search (Bates, 2002; Case & Given, 2016)	An information acquisition episode where a person actively attempts to achieve an explicit goal	Tracy sought a knitting needle with a specific size from a particular brand.
Monitor (Bates, 2002)	An information acquisition episode where a person sustains alertness for something that intrigues him or her yet has no immediate urgency to acquire	Mia subscribed to receive email updates on blog posts.
Browse (Case & Given, 2016; Chang & Rice, 1993; Rice et al., 2001)		
• No goal	An information acquisition episode where a person perceptually examines the information environment without a conscious goal	Iris wandered around the website with no conscious idea of what was being sought.

• Ill-defined goal	An information acquisition episode where a person has a vague or loosely specified goal	Nikki browsed anything of potential interest on the website.
• Semi-defined goal	An information acquisition episode where a person has a general purpose to fulfill, but is not looking for anything specific	Erika sought possible items to use in a student activity on stress relief.
Encounter (Erdelez & Makri, 2020)	An information acquisition episode where a person unexpectedly finds interesting or useful information relevant to their interests	Savina stumbled upon an online tutorial of personal interest.
Awareness (Bates, 2002; McKenzie, 2003)	An information acquisition episode where a person draws upon an understanding (of a topic area or information source availability) gained as a byproduct of engaging in work and everyday life activities, which can but do not necessarily have to include information acquisition	Tamia drew on previous experience in doing paper crafts to anticipate the correct use of an unfamiliar tool.

A total of 36 instances where participants displayed information behavior patterns were identified across the entire dataset, with 17 and 19 cases in the Pinterest and physical store environments, respectively. Table 4 lists the base patterns, i.e., commonly observed connections of two information behaviors (e.g., no goal browsing → encountering). All these base patterns included encountering, a passive information behavior, which we posit may be due to the browse-first nature of the information spaces that can be more prone to serendipity. Table 5 lists more elaborate patterns, involving multiple behaviors found to incorporate the base patterns. A breakdown of each observed information behavior pattern is provided in Table 5.

Table 4
Observed Base Patterns

Base Pattern	Information Environment
No goal browsing → encountering	Pinterest and the crafts store
Ill-defined goal browsing → encountering	Crafts store
Semi-defined goal browsing → encountering	Pinterest and the crafts store

Table 5
Observed Elaborate Patterns

Information Environment	Pattern	Participant(s)

Pinterest	No goal browsing → encountering	Iris, Mia, Nikki, Ruth, Elisa
	No goal browsing → encountering → semi-defined goal browsing	Mia, Nikki
	No goal browsing → encountering → semi-defined goal browsing → no goal browsing	Iris, Elisa
	No goal browsing → encountering → semi-defined goal browsing → encountering	Nikki
	No goal browsing → encountering → monitoring → no goal browsing → encountering → monitoring	Mia
	Semi-defined goal browsing → encountering	Savina, Iris, Mia, Elisa
	Semi-defined goal browsing → monitoring → semi-defined goal browsing → encountering → semi-defined goal browsing → monitoring → semi-defined goal browsing →encountering	Mia
	Semi-defined goal browsing → ill-defined goal browsing → encountering → semi-defined goal browsing → encountering → semi-defined goal browsing → encountering (with awareness)	Elisa
Physical crafts store	No goal browsing → encountering	Hila, Tamia, Julie, Erika, Rong, Don
	No goal browsing → encountering → no goal browsing → encountering	Hila, Tamia
	No goal browsing → encountering → ill-defined browsing → encountering	Yating
	Semi-defined goal browsing → no goal browsing → encountering → semi-defined browsing	Erika
	Ill-defined goal browsing → encountering	Hila, Min, Yating, Amanda
	Searching → ill-defined browsing → encountering → searching	Hila
	No goal browsing → ill-defined browsing → encountering → searching	Don

	Semi-defined goal browsing → ill-defined browsing → encountering → semi-defined browsing → ill-defined browsing → encountering	Min
	Semi-defined goal browsing → encountering → semi-defined browsing → ill-defined goal browsing → encountering	Amanda
	Semi-defined goal browsing → searching	Don

Drawing on the 36 cases observed from 15 participants, we investigated two examples in detail, Don and Mia. We decided to present a small number of detailed examples not only for the sake of brevity, but also because it allowed us to fully convey the complexity and intricateness of information behavior patterns, which we did not think would be possible if we examined more examples in less detail. These particular two examples were selected because each demonstrate an elaborate pattern comprising complex information acquisition episodes beyond those entailed in base patterns. Moreover, we focused on Don's explore task (the first part of his observation) and Mia's find task (the second part of her observation) to illustrate behavioral variety over two tasks. We suggest the less prevalent patterns found in this research are likely to be more unique and context-laden than common patterns, thereby intrinsically interesting for later discussion (see discussion section).

Don and His Interest in Photography

Don was observed at the crafts store. As a graduate student, Don is interested in photography and enjoys playing with electronics and new media art, in particular films. Before the observation, Don had never visited the craft store and mentioned that everything about the store contents and layout was new to him. To accurately present how Don navigated the information environment, we drew on the field notes and audio recording to provide the following narrative description. Each paragraph relates to an individual information behavior and together they comprise the following information behavior pattern: no goal browsing → ill-defined browsing → encountering → searching.

> *No goal browsing:* The participant and researcher walk into the store. Don starts by casually browsing items in the front part of the store without picking up anything. Walking deeper into the store, Don looks at a colorful necklace and tells the researcher he gave a necklace to the person next to him when he joined a parade in Chicago this summer. The participant then moves to another aisle and looks at a box of trophy toppers, saying that he is unsure what they are. He leaves this area, walks to the shelf next to the current aisle, and sees several items relevant to photography, such as cameras and films.
>
> *Ill-defined browsing:* The participant stops at this shelf for a while and takes a close look at products on the shelf. Don tells the researcher "*I kind of want to stop at here for a moment to see what they have.*" The first item he picks up, according to Don, is an air blower used for cameras: "*This looks good! I probably will buy it if it is smaller.*" After putting it back, Don flips through papers and envelopes put on the same shelf, picking up one big yellow envelope, explaining to the researcher this is a

Kodak photographic paper, and puts it back. Don then looks at an upper level of this shelf and finds out a machine titled 'Photo Print Color Enlarger with Stand,' saying, "*This is so cool! Do you see that? The paper attached by it shows it costs more than $400 on eBay!*" The participant squats down and looks over secondhand cameras placed at the bottom level of the shelf.

Encountering: When rummaging through cameras, the participant picks up a traditional camera and tells the researcher that this brand, Olympus, is famous. Nonetheless, he adds the camera may not work as it looks old and puts it back. Don then picks up a camera light diffuser and a few other cameras, such as those sold by Polaroid and Samsung, telling the researcher he knows all these cameras and where they are manufactured. After putting all these items back, Don examines a camera that looks cleaner than the other ones and flips it to see its bottom. He pays close attention to it, saying, "*I am looking at it since I notice this one is made in Japan, and I think it is not that easy to find, you know, based on my experience. I am surprised to see it here, in a crafts store!*"

Searching: Don spends another minute playing with the camera, stating he is going to search for some information on it. Don then takes out his smartphone and begins Googling the item. He tells the researcher he wants to find out how much the same camera costs online. After a while, Don says he thinks the store has the lowest price. However, he says that although tempted to purchase it, he does not know if he can find someone to fix it. Don concludes by stating he needs more time to think before making this purchase.

In summary, Don first *browsed* the store with *no goal*. He then stopped in front of the shelf displaying photographic products with a vague, *ill-defined goal* of *browsing* items related to his personal interest in photography. During this process, Don accidentally stumbled upon a camera that he did not expect to see in the crafts store. After making this *encounter*, he started *searching* for information on this item on his phone.

Mia and Her Sweater Ideas

The second example is from Pinterest participant, Mia. Mia pursues a variety of arts and crafts, including knitting and jewelry making, enjoying using mixed media to create artistic work. She likes visiting thrift stores to find and repurpose old clothing, by making something modern, such as a blanket or a pillow. In general, Mia tends to give what she makes as gifts. During the second part of her observation, Mia said she wanted to seek inspiration for sweater patterns because she planned to knit a sweater for her friend's grandchild. To reconstruct the context where Mia's information behavior patterns were observed, we relate each paragraph below to information acquisition episodes, following the pattern: semi-defined goal browsing → monitoring → semi-defined goal browsing → encountering → semi-defined goal browsing → monitoring → semi-defined goal browsing → encountering.

Semi-defined goal browsing: At the start of the find task, Mia says she is going to look for baby sweater patterns as she plans to knit a sweater for her friend's grandchild. She types in 'baby sweater patterns' on Pinterest and browses the results. When examining the results, Mia points out a picture of a green sweater, telling the

researcher it is cute, and she used to knit some similar ones about a year ago for her friends' grandchildren. Mia adds that many of her friends are having grandchildren recently, so she is busy making new clothes for them. When scrolling down the page, she clicks on a picture of a baby sweater mixing with blue and gray. Mia expresses this is so cute and clicks on the picture to go to the website. While entering the website, Mia notices that there are free patterns to download, so she downloads them and stores them on her laptop. After leaving the website and returning to Pinterest, Mia clicks on a picture of a navy sweater, saying, "*This is another cute one! Let me check the website.*" Mia bookmarks the page detailing the knitting instructions for the sweater to print later and returns to Pinterest. Afterwards, Mia clicks on several pictures of baby sweaters and examines their design. She bookmarks a couple of webpages to save their knitting instructions and downloads the corresponding free patterns.

Monitoring: Mia continues browsing different images of baby sweaters and clicks on a green Celtic braid sweater. She says she likes Celtic braid, but it takes a long time to make, and she does not have the patience. However, she still clicks on the image again, which takes her to the original website, a blog. Mia looks around the blog but cannot find where the image of the green sweater is located within it. Before returning to Pinterest, Mia decides to click on 'Follow' to receive email alerts of new posts on the blog.

Semi-defined goal browsing, encountering: When scrolling down the screen to see more sweater images, Mia runs into an ad irrelevant to her query, which is about selling baby toys. Mia looks surprised when noticing this ad, stating "*Oh look at this! Actually, I also like making toys, so I would like to look for some ideas.*" Mia clicks on the ad, which takes her to the online shopping site. She spends a minute or two scanning the content and tells the researcher the teddy bear is adorable.

Semi-defined goal browsing, monitoring: Mia leaves the teddy bear website and returns to Pinterest to proceed with her original search for baby sweater pictures. She clicks on an image of a light green-blue sweater in Icelandic style. She says it looks attractive and she really likes Icelandic sweaters. She remarks that her friend brought her some wool from Iceland that she has never used and does not want to waste. Mia clicks on the image again, which takes her to a blog. As with the previous blog, she clicks on 'Follow' before returning to Pinterest.

Semi-defined goal browsing, encountering: Mia keeps browsing sweater pictures, which eventually become similar and repetitive. Near the end of the find task, Mia surprisingly encounters an image of different cats' costumes. Although she says this is a distraction, she still clicks on this picture and visits the host website, skimming through each page and laughing every time she sees a cat dressed in a costume. She states the cat costume site was fun to visit.

In summary, Mia first *browsed* Pinterest with a *semi-defined goal* to seek inspiration for baby sweater patterns. While browsing, she *monitored* information by following a blogger and returned to her *semi-defined browsing*. Mia then *encountered* an ad for toys, reflecting

one of her personal interests, while browsing more pictures. She then returned to her search results, *browsed* more images, and did *monitoring* again, by following another blogger. Finally, after more *semi-defined browsing* to get baby sweater ideas, Mia *encountered* an image of cutely dressed cats, which was a positive distraction for her.

Discussion

In this section, we first discuss how Don and Mia's information acquisition episodes can be understood through the theoretical lens of information behavior patterns. We then discuss the importance of the patterns concept. Visualizing the examples in the style of Bates' (1989) berrypicking diagram provides a useful way of depicting information acquisition by preserving the complexity of observed patterns. Without abstracting away details to simplify complexity, we 'muddy the water' by examining relationships between discrete behaviors. Moreover, we incorporate the evolution of goals and illustrate holistically how these behaviors shape and are shaped by the goals. This view highlights that information acquisition sessions comprise disparate information behaviors undertaken piecemeal and information behavior *patterns* involving multiple behaviors. It illuminates that information behaviors are not merely initiated sequentially but potentially in parallel (e.g., methodical browsing as a means of facilitating searching). Therefore, information behaviors can follow, feed, or facilitate each other.

Don's Patterns

The information behavior patterns observed in Don's observation (shown in Figure 1) were no goal browsing → ill-defined goal browsing → encountering → searching.

Figure 1

Visual Representation of the Information Behavior Patterns in Don's Information Acquisition Session

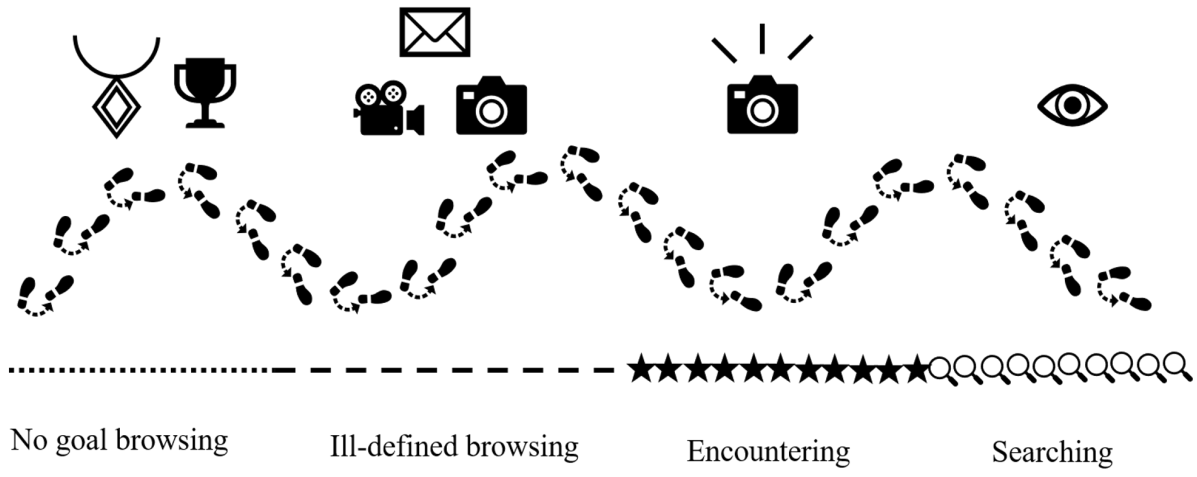

Figure 1 shows Don started his 15-minute explore task by browsing and that his browsing became more goal-oriented as the information acquisition session progressed. He then encountered a camera of interest, which triggered a mobile search for the price. In Figure 1, document icons in the berrypicking model (Bates, 1989) are replaced with icons emulating different items Don saw in the store (e.g., the necklace and the camera). The footstep icons are utilized to illustrate Don physically meandering through the crafts store. The line under the footstep route represents how Don's information behavior episodes are

interleaved as an information behavior pattern. A dotted line represents no goal browsing, a dashed line ill-defined browsing, a starred line encountering, and a magnifying glass line searching.

Don started his task with *no goal browsing*, as he was not looking for anything in particular when exploring. Although Don stopped to check a few items, such as a necklace and trophy, he did not, based on his think-aloud verbalizations, express particular interest in knowing more. He formed more of a focus, transitioning to ill-defined browsing for photographic products when he noticed a shelf displaying such items reflecting his photography hobby. He stopped in front of this shelf for most of the remainder of the task to find something of interest. Here, Don's ill-defined goal browsing was characterized by selecting and sampling (Bates, 2007), as he picked up and down several items. While doing so, he serendipitously *encountered* a camera he did not expect to find in a crafts store, triggering a mobile *search* to find the price from other retailers.

Mia's Patterns

Information behavior patterns observed in Mia's observation are shown in Figure 2: semi-defined browsing → monitoring → semi-defined browsing → encountering → semi-defined browsing → monitoring → semi-defined browsing → encountering.

Figure 2

Visual Representation of the Information Behavior Patterns in Mia's Information Acquisition Session

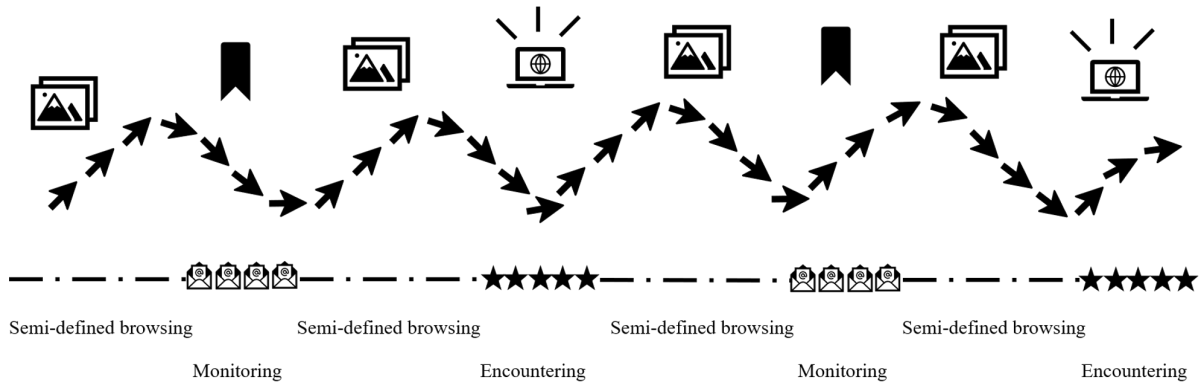

Figure 2 shows Mia alternated between three primary information behaviors: semi-defined browsing, monitoring, and encountering, during her 15-minute find task. We use the same image icon throughout Figure 2 to emulate different images Mia saw on Pinterest, and bookmark icons to signal her monitoring behavior. The cursor icons represent Mia's wandering path through Pinterest, where she often clicked through images of interest to view them in the context of the original website they appeared in. As in Figure 1, the line below the path illustrates the information behavior pattern she displayed. A dash-dotted line indicates semi-defined browsing, an envelope line monitoring, and a starred line encountering. Mia began her find task with *semi-defined browsing*, verbalizing her need to seek inspiration for sweater design. Mia transitioned into a *monitoring* episode when she followed a blogger, returning to *semi-defined browsing*. As she scrolled down the screen, she *encountered* an interesting ad for toys, reflecting her toy-making hobby. She then displayed the same pattern of semi-defined browsing → monitoring → semi-defined browsing → encountering.

Importance of the Information Behavior Patterns Concept

Information behavior patterns, defined as a set of interconnected activities that follow, feed, and facilitate each other, is a theoretical concept that can help better understand the dynamic nature of information interaction. This article contributes a means for unpacking the evolving, nonlinear character of information acquisition. It does so by considering acquisition comprising several information behaviors that can form patterns, reflecting this changing nature. Although information behavior cannot always be presented accurately in a linear manner, information acquisition does occur over time and, as such, presenting information behavior temporally, as in Figures 1 and 2, can be useful. Analyzing and communicating information behaviors in the sequence in which they happened in time allows us to reason about the relationship between them, like do they occur concurrently or in parallel, or do they feed, facilitate, or subsume each other. The patterns concept enables researchers to focus on some of the complexity of information behavior by stepping back to take more of a holistic view without sacrificing gaining a deep understanding of behavior in the process. While Figures 1 and 2 may seem more 'linear' than Bates' (1989) model, this 'linearity' reflects multiple information behaviors occurring over time during a single information acquisition session rather than a generalization of how multiple behaviors relate to one another. They are, therefore, not models but linear temporal illustrations of how information behavior patterns arise during information acquisition. Dervin (2015) also implied temporality in her Sense-Making metaphor graphic, where M. Squiggly sets out a journey through time and space, identifies a gap, and bridges it to reach an outcome. Indeed, information behavior patterns are linear to illustrate information acquisition, and potentially use, episodes, and it is this 'linearity' that supports recognizing patterns.

Moreover, information behavior patterns capture the evolution of information-related tasks or goals across an entire acquisition session and potentially across multiple sessions. It reveals how these goals are cultivated, become more or less concrete and change in response to information found. These are all important features of information acquisition, especially of an exploratory nature (Bates, 1989; White & Roth, 2009). Representing information acquisition sessions as a series of information behavior patterns can illustrate and explain how and why information-related goals change and evolve, building on existing work in that has broken down goals into smaller units in order to better understand them (e.g., Xie, 2000).

Based on the perspective of changing goals, we argue that people also undergo role transitions, transforming from explorers traversing often unknown or little-known information landscapes with an open and creative mindset into purposeful searchers (Dörk et al., 2011; White & Roth, 2009). In the exploratory information environments of our study, rather than experiencing mixed emotions, such as moving from anxiety to relief, as depicted in Kuhlthau's (2004) ISP model, our participant, Don, experienced only positive emotions like curiosity and delight. In fact, many participants mentioned without prompting that they had particularly enjoyed the explore task, which suggests finding information in exploratory environments can be fun. Furthermore, it demonstrates analyzing exploratory information acquisition at the broader level of information behavior patterns, as opposed to the narrower level of individual information behaviors, can draw out and stress some of the pleasurable aspects of information acquisition. This can include serendipitously encountering something interesting, either when exploring and when looking for something specific, or following

one's nose by engaging in curiosity-driven exploration, regardless of whether something useful is found in the process. Our research highlights the critical role of exploration and discovery not as a type of distraction, positive as it may often be, but as an essential approach to information acquisition in its own right.

The concept of information behavior patterns also brings the interrelationship between active and passive information acquisition to the fore. Information behavior patterns are inherently complex, involving many varied actions, multiple types of information acquisition, and countless possible variations, incorporating base patterns and discrete behaviors. Patterns are characterized by their intricate connectedness that can be challenging to discover. They are more like natural flows that often cannot be conveniently labeled in the same way as behaviors. However, they compensate for what they lack in straightforwardness by illuminating the complex and diverse nature of human information interaction. Based on our findings, it is evident that information behavior patterns can comprise a mix of active and passive information acquisition. Even though passive forms of information acquisition are described in some models (e.g., Williamson, 1998; Wilson, 1999), information behavior patterns can help articulate how active and passive information behaviors interrelate. For instance, Don's example illustrates how a delightful passive encounter motivates active searching, demonstrating encounter-driven seeking. Furthermore, Mia's example delineates transitions across semi-defined browsing, monitoring, and encountering, highlighting her varied behavior in response to the find task. Here, Mia's general goal: seeking inspiration for baby sweater design, is fulfilled by a combination of monitoring (following bloggers), semi-defined browsing (collecting relevant images and design patterns), and encountering (e.g., the Icelandic style pattern she could use to knit a sweater with the Icelandic wool she already had). It is a mixture of active and passive information behavior. Although it is possible to roughly label aspects of these behaviors (e.g., semi-defined browsing) as active, and others (e.g., encountering) as passive, their interconnectedness makes this problematic: is an alert of a new blog post truly passively acquired if it has been requested through active monitoring? Is an information encounter truly passive if it occurs during active seeking for something conceptually similar to the information found serendipitously? How active is non-goal browsing if it evolves mostly in response to stimuli in the environment? While the concept of information behavior patterns does not directly answer these questions, it does highlight the potential for a more holistic view of information behavior to help convey some of its nuances, which may differ across different information acquisition sessions, people, and environments.

Our primary research contribution is theoretical. By reorienting information behavior as patterns rather than as discrete or part of a linear or pseudolinear process, we focus on relating behaviors to each other as part of a broader information acquisition session or multiple sessions. Our findings highlight that patterns are most usefully regarded as idiosyncratic and highly context-dependent. Attempting to identify 'stereotypical' or 'archetypical' patterns risks reductionism through oversimplifying complexity, which has been flagged as dangerous in Information Science (Jones, 2008). However, as this was an exploratory study, we cannot yet say more about how patterns unfold in different information settings, where diverse contextual factors are at play. Understanding the role information behavior patterns play in different information contexts is a future research challenge. Furthermore, and perhaps most importantly, the concept of patterns is useful as it promotes a

multilayered understanding of information behavior, where it is possible to zoom in and out to focus on particular layers of behavioral abstraction. For example, we might focus on a broad type of information behavior (e.g., 'seeking' or 'use'), narrower constituent behaviors (e.g., searching, browsing), those that are even more focused (e.g., search query reformulation, goal-directed browsing), and their constituent actions (e.g., engaging with search suggestions, clicking on recommendations). Together, and when complemented by an understanding of how behaviors follow, feed, and facilitate each other, this can encourage a more holistic view of information behavior. While information behavior patterns do not provide a theoretical framework to support all aspects of 'zooming,' they do encourage examining information behavior at a different level of abstraction than usual, which is fundamental to enhancing a holistic and integrated understanding of information behavior.

This work also makes a, albeit lesser, practical contribution. By examining information behavior at a more holistic pattern level, we have illustrated the cultivation, evolution, and change of information-related goals. This is not novel in and of itself but has rarely been examined in browse-first information environments, despite their strong affordances for shaping goals through exploration. We have highlighted the interconnectedness of active and passive acquisition in the context of a dynamic, evolving information acquisition session. While it has already been noted that these forms of acquisition are interconnected (Erdelez & Makri, 2020), our research elucidates the disposition of this connectedness. Additionally, this study's enriched understanding of information behavior has practical implications for designing information literacy instruction and information environments, physical and digital. Both could shift their focus on supporting patterns of behavior rather than individual behaviors. The concept of information behavior patterns may be notably beneficial for motivating the design of information environments that promote smooth, less effortful transitions between different types of information acquisition. In particular, blended support for active and passive forms of information acquisition might be encouraged.

Limitations and Future Work

This was a study with a self-selected sample that happened to comprise mostly females, and most were either staff or students at the University. Nevertheless, to the best of our knowledge, there is not much evidence of markedly different information behavior across genders. Hence, we do not expect this, or our academic sample, to influence the findings' generalizability. This is particularly true since we did not set out to exhaustively identify all possible combinations of information behavior patterns, which would be difficult if not impossible. Similarly, there is no evidence showing that our sample engaged in different information behaviors than those reported in other populations. While previous literature identifies some information behaviors specific to particular work tasks or disciplines (e.g., Ellis, 1989; Ellis et al., 1993; Makri et al., 2008), the information behaviors noted in our study, like searching, browsing, and encountering, have been identified across disciplines and in everyday information acquisition (Ocepek, 2016).

Future research might further explore the relationships between information behaviors when forming patterns. There is potential, for example, to identify a range of different types of relationships to create a structure and syntax (i.e., 'language') of information behavior patterns. In this way, greater understanding can be increased of how behaviors may be nested

within or subsumed by each other to form patterns and how turning points (e.g., from active to passive forms of acquisition) are triggered. Future work might also empirically investigate how best to design information environments for smooth, efficient, and effective transitioning between information behaviors to provide a seamless experience when moving between active and passive acquisition. This is a cyclic research opportunity, as novel information environments are likely to facilitate different and perhaps even more complex patterns of behavior which, in turn, will drive further innovative design efforts. A first step towards achieving this may be to examine patterns in more traditional structured search settings to complement the current research, which was conducted in browse-first environments.

Conclusion

This study offers a new theoretical perspective in information behavior research by empirically identifying interrelationships between information behaviors. To articulate these relationships, we coin a new term: 'information behavior patterns,' conducting a naturalistic qualitative observation of 20 arts and crafts hobbyists in two browse-first information environments. The concept of information behavior patterns avoids oversimplifying our understanding of information interaction, reconsidering it as strongly interconnected. It encourages researchers to comprehend information acquisition not only as piecemeal sets of actions but as a broader, more nuanced activity that can be usefully understood in terms of patterns. The idea of patterns thus re-embraces the intricacy of information acquisition by illustrating possible sequences of information behaviors. It creates additional insight on information behavior theories by elucidating and unpacking the diverse nature of information interaction. This research demonstrates the conceptual value of 'zooming out' and refocusing to better understand this new, more inclusive landscape of information acquisition beyond seeking. Information behavior patterns also highlight the blurred boundaries between active and passive acquisition, informing information literacy and design efforts by underscoring the need to blend transitions between active and passive information acquisition. We hope this work will spur further discussion among information behavior researchers to adopt a wider perspective, seeing how patterns can be used as a theoretical lens for probing human information behavior holistically. This will result in a richer field that can itself evolve in sync with changes to human behavior and digital information environments.

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