Historical Reasoning in Authentic Research Tasks: Mapping Cognitive and Document Spaces

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To support historians in their work, we need to understand their work-related needs and propose what is required to support those needs. Although the quantity of digitized historical documents available is increasing, historians' ways of working with the digital documents have not been widely studied, particularly in authentic work settings. To better support the historians' reasoning processes, we investigate history researchers' work tasks as the context of information interaction and examine their cognitive access points into information. The analysis is based on a longitudinal observational research and interviews in a task-based research setting. Based on these findings in the historians' cognitive space, we build bridges into the document space. By studying the information interactions in real task contexts, we facilitate the provision of task-specific handles into documents that can be used in designing digital research tools for historians.

Introduction

Historical research entails creating a coherent story based on historical materials and facts. It is creating new knowledge based on pieces of past information. This method of research is called historical reasoning (Kuhn, Weinstock, & Flaton, 1994). Typically, the relations between the information items that the reasoning is based on, and understanding the context in which the historical documents were created, are of importance. Historians' information environment is currently changing from using original historical information items into using digital surrogates of the originals. Traditionally, the researchers prefer the originals, but historians' preferences began to change as they increasingly started to consult digital formats (Sinn & Soares, 2014).

Studying information interaction in work task context performance has been seen as central in information seeking and retrieval research (Ingwersen & Jarvelin, 2005; Toms, 2011; Vakkari, 2001). Researchers' work tasks include all kinds of research activities triggering information needs that lead to information behavior. Moreover, work tasks are seen as the motivating factor behind the information interaction. The underlying goal in task-based information interaction is to augment the work task performance.

This study focuses on academic historians' information interactions during work task performance processes. Work tasks are conceptualized as historians' perceived tasks while

they analyze the historical digitized documents. The study uses the task as context for studying information interactions and information goals. Information interaction means the processes of how people aim at interacting with the information contents carried by information sources. We focus on *cognitive access points*, which mean the desired way to access the pieces of information (cf. Ingwersen, 1992). These are the kinds of information intents that historians want to examine in the documents.

Just providing digitized content does not make the information content accessible. Optimized access to information is gained with a thorough understanding of user needs and information interaction behaviors. By studying the real-life needs and use contexts of historians, we are able to better gain an understanding of which pieces of the content they should be provided with, and how this content should be provided. By using this task-based information interaction approach, we are able to avoid a data-centered approach, which may ignore the task-specific requirements and therefore provide information that may not be very helpful in task performance processes.

We shall focus on the following research questions:

- RQ1: Information interactions: How do the historians search, select, and work with the primary sources in the context of research work tasks?
- RQ2: Information needs: What are the task-based information needs—in terms of cognitive access points—of the history researchers working with the selected primary sources?
- RQ3: Implications: How can these information needs be supported?

First, we review research in historical reasoning and information interaction in the history domain. Second, we report a longitudinal observational research to examine the history of researchers' information interactions and desired cognitive access points into information. We observed a group of historians during their real-world research work tasks, the cognitive spaces of the participating history researchers, and how to match the document space into their task-specific needs. Third, we discuss the implications derived from the observational research and aim at presenting the items in the cognitive space present in the document space; that is, by how to provide the possible task-relevant handles to support access to the needed information. We propose expression-level solutions related to the cognitive access points collected during the observation.

Related Research

Historical Reasoning

According to Voss, Wiley, and Sandak (1999), *reasoning* is a process in which the individual moves from a given state to another via inference. Reasoning is typically utilized in problem-solving or decision-making, evoked by formal or informal task situations. In formal logic-based reasoning, usually a single "right answer" exists, while in *informal* reasoning an *argument* is formulated, consisting of a claim

supported by a reason, and varying in strength. Informal reasoning may be broken down into various structural elements, such as stating argument, fact, or reason, and comparing or elaborating. In informal reasoning, also counterarguments may need to be taken into account to judge the strength of the argument. In the field of history, arguments are often found in narrative texts (Voss et al., 1999).

Historical reasoning can be characterized as a process entailing the components of (a) asking historical questions (descriptive, causal, comparative, and so forth), (b) contextualization, (c) making arguments to support claims put forward, (d) using sources, (e) organizing information to explain historical phenomena, and (f) using methodological/substantive historical concepts (Van Drie & Van Boxtel, 2008). In this article, we reflect on the user needs from the point of view of historical reasoning and consider the implications of them to system design. The system should support finding documented evidence from digital sources to support or refute claims put forward. In particular, we will consider automatic annotations from the point of view of historical reasoning.

Information Interaction in the History Domain

Information interaction has been defined as cognitive activities and behaviors aiming at both searching and using information during human task performance. The activities in information interaction include (a) task planning, (b) searching information items, (c) selecting them, (d) working with them, and (e) synthesizing and reporting (Järvelin et al., 2015). In a task-based approach, information interactions are embedded in the task requirements and serve the purposes of the task performance. This is different from document or system-based approaches, typically considering the document or system characteristics.

Information interaction in a historical domain has been studied from various viewpoints that can be seen as components in the whole task-based information interaction process. Source selection, which is included in task-planning activity in the task-based model, has been investigated, for instance, by Anderson (2004) and Tibbo (2002). Both studies surveyed historians to understand how they locate primary source materials. They report the variety of sources utilized and point out the need to assess what the users want and need. Duff and Johnson (2002) studied the information-seeking of historians in the context of archives and primary sources. They discuss finding primary sources, searching as known-item search, and, interestingly, building contextual knowledge. The study stresses the importance of the interleaved and simultaneous nature of activities during the research process. Similarly, Sinn and Soares (2014) conducted a survey to understand how historians utilized digital archives during their research. They report a rich set of results, regarding the historians' paths to digital collections, and their motivations and various experiences in using them. In addition to studying the locating and selecting process of the sources, the studies report experiences of

historians who use digital systems in searching, browsing, and manipulating historical documents.

After selecting the suitable sources, searching may take place. The way collections are created and organized affects the searcher's ability to use them. Jarlbrink and Snickars (2017) focused on problems caused by an endangered provenance chain in outsourced large-scale digital preservation of historical newspapers, and how this affects searching. Moreover, retrieving all relevant documents was challenging due to noisy word forms caused by errors during the optical character recognition. From the searcher's point of view, the noise created during preservation affects his/her ability to express the search needs and to home in on relevant documents. Because items found are assessed in the selection phase in the information interaction model (cf. Järvelin et al., 2015), noise also affects this activity. Moreover, noise affects the phase of working with items, because it complicates, for instance, the automatic discovery of relevant text patterns. Furthermore, Buchanan, Cunningham, Blandford, Rimmer, and Warwick (2005) studied the use of digital libraries in the context of humanities research work. Cole (2000) focused in particular on historians' work processes and types of cognitive access points they used during information seeking.

Serendipitous information encountering has been seen as an inherent part of historians' information interactions and work tasks (Martin & Quan-Haase, 2016). However, given the need for serendipitous information encountering, history researchers demand control over their information environments. Seeking for serendipity during information interaction is a selected strategy in historical research work. The way that the collections are arranged and how access to the collections is provided plays a crucial role. For example, lack of context and control over the search results has been seen as reducing the usefulness of existing digital tools in the seeking for serendipitous encounters (Martin & Quan-Haase, 2016).

After retrieving and selecting relevant information items, working with information items activity takes place (Järvelin et al., 2015). This activity, working with information items, typically involves subprocesses such as annotating. According to Boot (2009), annotation means various ways of commenting on texts. The purpose of annotations is to help the process of interpretation, which is at the heart of scholarship. Annotations may differ in many dimensions—purpose, intended audience, types of items annotated, annotation structure and visual appearance, and level of privacy (Boot, 2009). Annotations provide one possible basis for both querying and exploring texts.

Melgar, Koolen, Huurdeman, and Blom (2017) discussed annotation as a process in media scholars' work. Their research does not study historical research per se but it discusses the various stages in digital humanities research work and the meaning of the annotation work. Annotation work is also the focus of Ruvane (2006), who studied historical geographers' process of "becoming informed" and the central role of annotations in this process.

Some of the previous research focuses on the digital information environment. The digitization of the information resources is changing the ways of working (Ingwersen & Jarvelin, 2005), and this is also the case in the historical domain. Historical research has previously been mainly qualitative and descriptive in nature, but nowadays computational methods enable the handling of large historical collections (see, for instance, Petrelli & Clough, 2012; Jarlbrink & Snickars, 2017) and comprehensive quantitative analyses can be built to compare large numbers of historical documents (Jänicke et al., 2015; Kunz, 2007). Humanities scholars find it important that technology should support their ways of working, regardless of the tools used or whether working in print or with digital texts (Given & Willson, 2018).

After found and worked with, the information is synthesized and reported to create the output of the task process. This is an essential part of the knowledge work of history researchers and other academics. Synthesizing requires the writer to integrate the information from multiple information sources into a new structure and, by doing this, creating new knowledge. A study that discusses the impact of information retrieval tools and library catalogs to historians work was conducted by Solberg (2012). It focused on how the tools shape the ways historians make sense of the information available, and therefore may affect the outcomes of the research tasks.

Framework of the Study

The task-based information interaction (TBII) evaluation framework (Järvelin et al., 2015) was used to design our study setting. This helped the researchers to understand the goals of the particular occurrences and to map them as a coherent whole. We conducted a task-based study, during which real-life research work tasks were performed in an authentic work setting. Moreover, by selecting this approach we are able to focus on information interactions, representations of user needs, and matching them to the document space. Furthermore, the working-with items activity became the focus of our research after the historians work process started to unfold. This activity captures actions during the actual use of the information sources. This type of activity is not commonly studied in information science because most of the previous research examined either the activities of searching or selecting information items.

The rationale for using information is to find such pieces of information that help in attaining the goals of work tasks. By studying the goals and actual processes of work tasks, we are able to create an understanding of the information behavior in a larger context. The larger task goal frames the analysis, gives focus in the data collection phase, and helps anchoring the data into meaningful activity processes. Furthermore, it allows conceptualizing the information activities from the viewpoint of academic historians.

This study employs the cognitive approach to information seeking and retrieval (cf. Ingwersen, 1992). In the cognitive approach, both the role of the information space (that is, the document space) and the characteristics of users and information problems are recognized (that is, the cognitive

space; Ingwersen, 1992; Newby, 2001). Traditionally, in information seeking and retrieval documents are assumed in a communication chain, in which an intended message is communicated to the end user. In the present research, the role of the document space is different: the historians are using the information space for their own purposes that may differ from the intended message of the original creator of the information content.

Figure 1 shows the two central conceptual spaces, the *cognitive space* and the *document space*, used in the present study (Newby, 2001). Cognitive space presents the human actor's cognitive activities related to the task performance. It captures the human perception of the task goals related to the task at hand, and cognitive access points to related task goals. Cognitive access points are the historians' assumptions of the information environment and its task-relevant "bits and pieces of evidentiary data" (Cole, 2000, p 87). Cognitive access points reflect the historians' ideas of how primary sources can help in reaching their research goals and answering their research questions. By taking the historians' point of view and their ways of categorizing and labeling the evidence, we can overcome the wrong assumptions possibly built into information systems.

The labeling and categorizing of the primary sources is called annotating. From the actor's point of view (in the cognitive space), annotations are created through the lenses of her/his current understanding of the task. However, the annotation process may be augmented with automatic annotations (in the document space). The automatically created annotations may be purposefully tentative and exploratory, intended to suggest interesting objects or interpretative structures. They may not only argue for support of current research practices—but also argue for different practices. It is important to understand what kind of structures the actor expects to see.
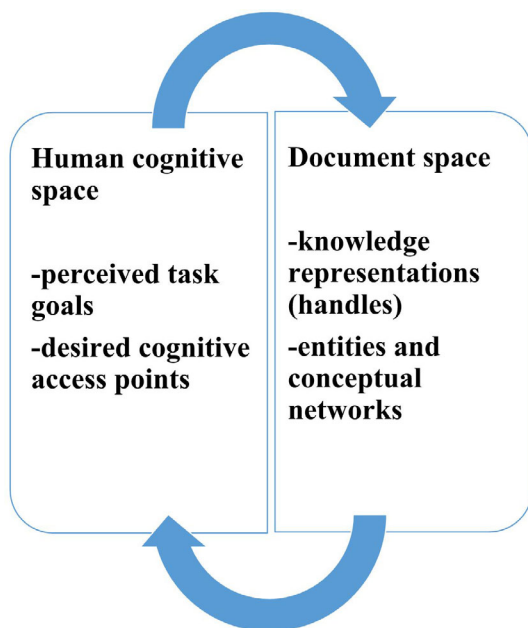

FIG. 1. The cognitive space and the document space.

The document space includes the information sources, that is, the information environment needed in task performance. When aiming at providing potentially relevant information to the users, one way is to organize the information environment by building task-relevant handles to meaningful information and data. Knowledge handles are inbuilt vehicles to grasp the semantically meaningful contents (Ingwersen & Jarvelin, 2005). Handles can be provided, for instance, by building links to particular pieces of task-relevant information or creating structure into the text and data. Structure can be provided by adding meta-data (representations of "aboutness" and/or other content-related features). In the case of historians, this means intellectual or automatic annotation of the primary sources.

Concepts have semantic meaning and similar entities may have different roles in the text that make sense to the historians. The particular meaning, sense, a text string has on a particular occasion is determined by its context (Mitkov, 2003). The context may be derived from the textual context, the context of the collection of the primary sources, or the historical context. The primary sources may be, for instance, annotated by using the meanings each handle bears (in the document space) to help the historians to resegment the texts, select task-relevant pieces of the texts, and build associations between the relevant pieces.

Next, we describe the research setting. We analyze task goals and information interactions during tasks. We aim at understanding the domain and viewing expertise as an active constructive process (cf. Vicente, 1999). Task-based setting enables suggesting how task support systems could be designed to effectively meet the challenges the historians face within the digital information environment.

Research Setting

Data Collection

Information interactions of history researchers were collected by triangulating interviews and observational data. We studied real-life activities; namely, academic historians' working with the primary data sets. First, we conducted critical incident interviews to create an understanding of the information environment the historians worked with and their overall research methods, source collection practices, and research task descriptions. We conducted five interviews during which the participants demonstrated an ongoing or recently completed task. The interviews took place during 1 month (September–October) in 2017. We selected the participants for the interviews from varying stages of their research career and varying subfields of history research. Two of the participants were doctoral students, one postdoctoral, and one was a senior research fellow. The postdoctoral researcher was interviewed twice. The interviewees had been working with their current research topics from 3 to more than 20 years, which indicates a high level of expertise.

In conducting the interviews we used the critical incident technique (CIT; Flanagan, 1954), in which the interviewee

is asked to recall a recent incident related to their current work tasks they are engaged with. This helps the interviewee to anchor their recalled activities. During the interviews, the participants were asked to demonstrate how they used recently needed information sources. Interviews were semistructured with themes that were based on the task-based framework, but the discussions were left open to facilitate possible unexpected viewpoints. Informed consents were collected prior to interviews. Interviews lasted approximately 1 hour and were recorded and transcribed into total of 24 pages of text.

After the interviews, we conducted an observational study, during which we closely followed 12 collaborative meetings in a participatory setting. Meetings were held fortnightly from September 2017 to March 2018, except two longer breaks (~1 month) in December and in February and each meeting lasted from 1 to 2 hours. Collaborative meetings aimed to improve access to historical primary sources from World War II in Finland.

The observational study aimed at closely examining the activities during the use of the selected primary sources. Three of the interviewees from the first stage participated in the observational study. In addition to these, two research assistants and two information scientists participated. Participants were at varying phases of their academic careers. One historian was a doctoral student finalizing his doctoral work, one postdoctoral researcher, and the visual journalist was a senior research fellow. The two research assistants were also involved in the meetings and were actively working with the primary sources. They were advanced masters students. The observer was asking questions during the meetings for clarification of intentions and purposes. During the meetings detailed field notes were collected.

Data Analysis

We used grounded theory in the analysis and coding to create a conceptual model of the cognitive access points (Strauss & Corbin, 1990). During the first round, open coding of the cognitive access points into preliminary categories was conducted. The second round, the axial coding, entailed the analysis and reorganization of the open codes. During axial coding similar characteristics were compared and merged to create categories. In the third phase, the categories were grouped into similar types of classes expressing similar features or attributes of a distinct class.

Transcribed interviews and field data were inductively coded with the Atlas.ti program for qualitative analysis. Research material was collected and analyzed in Finnish and only the quotes and examples used in reporting findings were translated into English.

First, we analyzed the TBII activities. To reveal the whole TBII process, we used the transcribed semistructured interviews. We grouped the participants' answers thematically to create a holistic picture about the ways of working with the existing information environment.

Second, we examined the cognitive access points described by the participants. This analysis was based on the demonstrations during the interviews and the collaborative meetings. The historians were using their own conceptualizations and understanding and utilized their disciplinary background in the reasoning process. In the analysis, we focused on how the historians were trying to make sense of the primary sources to answer their research questions and hypotheses. We were interested in what kinds of cognitive access points are needed to accomplish research tasks in history.

Third, the cognitive access points were extracted for further analysis. These were the units of analysis. This phase was conducted in two rounds; first, 223 cognitive access points were identified; during the second round, 263 mentions about desired cognitive access points were coded. The difference was examined carefully, and was due to the level of granularity in the coding. This means that the historians sometimes discussed several access points with a broader conceptualization, after which the separate, narrower cognitive access points were mentioned. These were identified as one occurrence in the first round, and separated into several occurrences in the second round.

Digitized Primary Sources

In history research, a primary source provides direct or firsthand evidence about an event, object, person, or piece of work. In our case, the digitized primary sources included three subcollections of the Second World War events in Finland: (a) war-time letters: personal letters of soldiers and their relatives (texts of some 7,000 letters); (b) a deceased soldiers database describing individuals (~94,673 textual records); and (c) war-time photographs—images with meta-data, including descriptive caption texts (~140,000 images; see Table 1).

The information items in the collections were of varying types. Letters and images contained nonstructured text, whereas the database of the deceased persons contained finely defined structure with fairly standard contents.

The language of all primary materials was Finnish. As such, the texts share the main retrieval challenges of historical Finnish, entailing (a) morphological variation, (b) historical/dialectical expressions, and (c) corrupted words due to optical character recognition.

Findings

This section discusses the findings from interviews and observational study. First, we studied their information interactions related to work tasks, the task goals, and the information needs. Second, we focused particularly on cognitive access points, which are the results of the historians' reasoning processes involving their understanding about how the primary sources could be utilized to reach the task goals.

Historians' Information Interactions

We used interviews to study the activities according to the task-based information interaction framework, namely (a) task

TABLE 1. Data samples (pseudonymized) of three types of digitized historical primary materials, with loose English translations (selections, in italics).

Primary material type	Sample text
1. Wartime letters (excerpt of text)	Osoite. Kenttäposti.K.no 7. 2/J.R.11. Kirje: Rintamalla 3Y10 38, Hei Anna! SAK/101/3 Terveiseni Sinulle Rakkaani täältä rintamalta. *Address. Military mail.K.no 7. 2/J.R.11. Letter:* *At the front 3Y10 38, Hello Anna! SAK/101/3* *My greetings for You My Love here from the front.*
2. Deceased soldiers database (person entry)	AALTONEN;MATTI OIVA;Y;M;FI;FI; su;0;työmies;1;stm.;2./JR9;1;01.01.1923; 1;1;1923;17;;1554;;A;;;;;;;; ;;;;;07.07.1941;7;7;1941;;Rukajärvi; 0559;1;254;
3. Wartime photographs (metadata and caption text)	47560;Kapteeni A.Suomi;Suomi, A.; 1941:09:07;;Rukajärvi;Rukajärvi, Pismajoki; F117/22; Tykki on avannut tuhoavan tulen.;;;;;; *F117/22; The gun has opened destructive fire.*

planning, (b) searching information items, (c) selecting them, (d) working with them, and (e) synthesizing and reporting (Järvelin et al., 2015). The interviews covered the whole task-based information interaction cycle.

Historians described their task planning activities and the structure of future work outputs (that is, scholarly documents) in detail. Historians were very aware of various stages of their research processes and were analytic about possible "turning-points," during which they made decisions and selections about transitions between subtasks and activities. This refers to task monitoring. Historians' research goals included researching feelings and emotions during the Second World War, and how the phenomena were described in historical documents. The wordings were of interest, particularly when there was no vocabulary during that time that could describe such phenomena.

Historians were doing a lot of manual work and reading of materials, which was time-consuming. One historian described the ways of working:

"The research material was paged through, literally page by page, and this took half a year" [P4].

They were typically interacting with the primary sources by using spreadsheet programs. Another common type was using sources in pictorial form, one item at a time. One of the researchers was using digital methods, such as counting word frequencies, followed by close reading.

Importantly, the intensive and time-consuming way of working helped the historians to create a deep understanding about the primary sources. Historians did not consider the prolonged research process problematic, because they emphasized the quality of the reasoning processes. They were concerned also about the current quality of the digitized primary sources:

"Turn from paper to digital was done in few years. Now the question is, how to do it better" [P4].

Historians were reflecting on their digital skills. Some of them felt that they lacked some statistical and computing skills, and awareness about existing suitable digital tools that could be utilized in their analysis. The undergoing change into the digital information environment also was something that required different types of research skills.

"Traditionally we are reading a lot of archival material. Processes include photographing individual papers, sources, and then starting to create a story. These kinds of large collections are new [...] and how you are supposed to examine these, then?" [P1].

The searching included browsing and at the same time reading large collections; the searching activity was actually realized during the selection phase, and during this phase, the participants already started reading the retrieved documents. Based on the understanding of this initial reading, they selected relevant items. Because their information goals were mostly exploratory, the participants mostly browsed the primary sources instead of querying them. The information items were retrieved as delineable data sets.

Selection criteria of the useful information varied, but in practice they mainly framed their selections via the searching activity; if the items met the search criteria, they were included in the results. One historian mentioned that the selection was not at all difficult because they were aware of suitable primary sources available. The selection was partially due to the constraints of the information environment: "In historical research you cannot really create your data, you just take what is preserved" [P2].

One selection criterion was sufficient topical coverage, which varied based on the research topic and available information items. This activity required much work due to "semi-digital" information environments that do not support this activity. Typically, the selected information items were stored on personal computers and filed systematically. Also, they created meta-data files (as textual documents and spreadsheet files), which they used to locate and manage their personal collections of the information items.

The working with information items activity entailed reading, scanning and browsing, comparing and linking, and annotating information items. The annotations and notes were combined for later use. This activity was strongly coupled with the synthesizing and reporting activity. The participants were reading and comparing different types of information items and making inductive reasoning based on the information. The quality of the information items and the type and amount of information they presented were important variables that affected the ways this activity was conducted. While reading and interpreting the sources, the participants reported that they were annotating, making lists, and taking notes. One of the participants was making interpretations based on quantitative analysis of the texts before

undertaking close reading of the items. As in previous activities, the quality of the information items and their content was central. This activity was mostly interpretative close reading, not linear or selective reading. We focus on this activity more closely in the remaining sections.

The last activity, synthesizing and reporting, encompasses drafting, constructing, reporting, and disseminating processes. This activity was very seamlessly integrated with the working with items activity. In their academic writing practices, they synthesize information about, recreate, and analyze the events discussed in primary sources, and expressed that: "telling a good story is a key component" [P2] of their research work. The management of information items was crucial to this activity. They needed to carefully cite their personal collections of primary sources, and organizing such a large body of material was not a simple task. They used complicated, typically home-grown and practical, systems to manage the masses of material.

Cognitive Access Points

Next, we drill into the cognitive access points as part of historians' information interactions. There were several constructions the historians used in their aims at accessing information.

Persons are of particular interest in historical research (Cole, 2000; Duff & Johnson, 2002). In our case the historians were interested in the varying roles the persons appeared in in the primary sources (see Table 2). The social relationships between people were also important. For example, what kind of letters soldiers sent to the home front and vice versa, and how the letters sent by soldiers to the other soldiers differed from these. The context derived from the varying source types that may change the semantics of a person name. For example, in the caption texts of photographs the role of the person name made a difference; the role of the creator differed from acting as a target person in the photographs. One of the research interests of the history researchers was to examine the geographical paths of certain photographers during the war, and to analyze the content of the photographs in relation to the stages of the war.

The interests of the historians involved studying the gender differences in writing styles; one of the hypotheses assumed that females would use more varied language in describing emotions. In addition, nationality made a difference in the primary sources. Whether the target person was of hostile nationality affected the interpretation, because the stylistic ways that the enemy was described could vary during the different stages of the war. Some other attributes of

persons occurred frequently in the historians' descriptions of their work including occupation, social class, age, and marital status (see Table 3).

Relationships between people and between people and places were important in historians' research work. These relationships may be explicitly depending on the context of the primary source type; for instance, the place of death in the database of the deceased, or implicit, such as relationships between a writer and recipient of a letter. Relationships between persons, such as marital status, may be implicitly indicated and construed from the style of the letter, some topics discussed (for instance, children), or from the use of terms of endearment. Mentions of the enemy were expected to vary across the stages of the war and primary source type. For example, the collection photographs had strong propaganda purposes and there were official directions in which way the enemy should be described. Therefore, there might be contradictory messages in the caption text compared with the subjects of the image itself. Other kinds of relationships included friendship, kinship, relationship between the sender and receiver, and the photographer and target people in the photographs.

History researchers' research topics included the casualties of war, types of casualties, and the number and distribution of casualty types during each stage of the war (see Table 4). In the course of the war, each battle could be studied as processes or as stages in a timeline, and the casualty types could be compared between the battles. Similar to the relationships, the casualty types are explicit in the database of the deceased but not clearly expressed in other types of documents, or mentions about the casualties might even be censored.

The next type of access point is organizations (Table 5). During the war, there were a variety of temporary organizations. Some organizations were moving from a place to another during the war. Field hospitals were one type of moving organizations. Furthermore, field post offices were usually marked with mask numbers in the letters. To study these, a list of mask

TABLE 3. Attributes of person class.

Class	Type	Description
Person	First name	First name or initials
	Last name	
	Gender	
	Military rank	Military rank or civilian
	Marital status	Married, divorced, widowed, or single
	Occupation	
	Social class	
	Age	
	Nationality	

TABLE 2. Actor roles of person class.

Class	Type	Description
Person	Photographer	Photographer in a propaganda troop
	Sender	Sender of a letter
	Receiver	Receiver of a letter
	Target	Person of interest

TABLE 4. Casualty type of person class.

Class	Type	Description
Person	Killed in action	
	Died of wounds	
	Wounded in action	Combatant wounded during a battle
	Missing in action	Lost during a battle

TABLE 5. Types of organization class.

Class	Type	Description
Organization	Military hospital	
	Field hospital	
	Field post office	Usually marked as mask numbers
	Military (organic) unit	
	Defense command	
	Industrial	A factory or related industrial organization

numbers and equivalent places are needed. Routes of the moving access points, such as persons and organizations, were of interest to the historians. However, some missing and inconsistent data makes the routing difficult. For example, for studying the places a photographer had traveled, the name of the photographer was needed and also the place where the picture was taken. However, sometimes the place name was the place of development of the film, not the actual scene of the photograph.

The place names were in some cases ambiguous. There are numerous similar place names in Finland. Some place names were topographical, describing the formations of the landscape, such as "Killing hill." The varying ways of how the places were described in the primary sources caused granularity issues; for instance, when events related to a particular geographical area were studied. Some materials described city districts or parts of towns, but did not mention the town itself. The village names, regions, and topographical place names needed to be mapped into a greater area, and resources to do this were not easy to find or even not existing.

Interestingly, some of the photographs were images of landscapes with captions describing the scenery. The purpose of the photographs was to create detailed maps of the places. Some place names were official names of municipalities or parishes and were described in detail in existing documents, whereas some place names were missing from official documents because they were located in the occupied area, and were never part of the administrative processes. Types of the places the historians described are presented in Table 6.

Historians discussed a variety of temporal expressions (see Table 7). Temporal expressions included exact calendar dates, times of a day, seasonal expressions such as "spring

TABLE 6. Types of place class.

Class	Type	Description
Place	Region	
	Domicile	
	Front line	Line of battle
	Home front	
	Place of death	
	Parish	Municipality or parish
	Location	
	Village	
	County	
	Topographical	Land forms, and so on
	Route	

TABLE 7. Types of temporal expressions.

Class	Type	Description
Temporal expression	Date	Exact date, month or year
	Birth date	
	Death date	
	Period	Has start date and end-date, or described as a period of time or duration
	Event	For instance, a battle
	Season	Seasons of year
	Stage of war	The war can be divided to stages, for instance, Winter war, Interim peace Continuation war

time" or "winter," or, duration, such as periods of hours, days, or months. Temporality was associated also with the understanding of the sources: At the end of the war the data were sparse, and sometimes the timestamps were created afterward. At some points of time there was no activity on the front line, and this may have affected, for instance, the number of letters that were sent from the front line to the home front. Birth dates and death dates were also discussed during the data collection, and these were documented in an organized manner in the database of the deceased.

Supporting Historical Reasoning

In the previous section we described the information interactions (RQ1) and categorized specific types of needs of historians, which were observed during the field study (RQ2). These included studying the roles of persons and their social relationships, the geographical locations of photographers during the war, the gender differences in writing, the distribution of casualties during different stages of the war, and the wartime temporary organizations. To support the historian in finding and observing relevant pieces of information, some structure needs to be created in the data. Next, we will propose how to support historical reasoning from the point of view of system design. Our goal is to help historians locate relevant pieces of evidence in the primary documents to support or refute claims put forward (RQ3). We focus on automatic annotations and discuss how to propose task-relevant handles to information intended to help the historian during the process of interpretation. An overview of our observations and proposals is presented in Table 8.

First, the roles of persons were mentioned as important cognitive access points into the historical data (see Tables 2 and 3). In the letter and photograph collections (see Table 1), identifying roles can be supported by utilizing structural information available in the primary data. The role of a person in the photograph collection can be limited to the photographer by focusing the search on the "photographer" field, or to the target person of the photograph by focusing on the "caption text" field. In the case of unstructured data (letters), the roles may be inferred from the text; for

TABLE 8. Task-specific cognitive access points of historians in the cognitive space and their matching within the document space.

Cognitive space (access points)	Document space (expression level)
Need to observe	Indication of the conceptual handle in text
The role of a person (*letters* data set)	Utilize structural information, or infer the role from the text. *Role annotations* can be added to primary data.
Relationships between persons (*letters*)	Relationships may be defined in terms of the roles of those in relation; relationships may be inferred from text. *Relationship annotations* can be added based on the roles.
Gender differences in expressions (*letters*)	Gender of the author may be inferred based on textual clues, such as the role in the relationship (for instance, "wife"), or based on the name of the recipient or the sender ("Anna") or gender-associated person attributes (for instance, military rank or kinship). *Gender annotations* may be added to primary data.
Variation in the expressions (*letters*, *photographs*)	Study of expressions can be facilitated by utilizing external meta-data of known events and stages of war. *Event annotations* can be added to primary data.
Impact of high death toll events on official propaganda and private communications under censorship (*combined* use of data sets)	Database of the deceased soldiers includes *the date and place of each individual's* death, or when they were wounded, together with descriptive information of the person (for instance, marital status, occupation, or military rank). This descriptive information can be summed up, placed into the timeline, and utilized as *research interest-driven* handles to annotate *other* data collections in case adequate temporal expressions are available in the data, which allows this mapping.

instance, based on textual expressions of military rank, kinship, endearment, or friendship. Accordingly, explicit *role annotations* can be proposed by matching relevant expressions (for instance, term lists of known military ranks or kinship terms) with the target texts.

Second, the relationships between persons were found as important cognitive access points (Table 3). Relationships are often defined in terms of roles of those in relation. In case of unstructured data (letters), the existence of relationships can be argued based on roles observed (see above), or expressions such as romantic salutations. For example, the endearment to "Dear wife" in the beginning of a letter proposes the existence of a relationship "husband–wife" with husband as the sender. The ending salutations may offer additional evidence regarding the relationship; for instance, in the form of gender-dependent first names, military ranks, or kinship terms. Accordingly, finding and observing relationships between persons in the primary data may be supported by annotating the target texts with matching role and relationship terms.

Third, gender differences in writing during the war were mentioned as an interesting research aspect. In the case of unstructured data (letters), gender of the sender or recipient may sometimes be argued based on the textual clues. Examples of these include gender-related first names (for instance, "Dear Anna" implying a female recipient); kinship terms ("Dear brother" implying a male recipient); or other gender-related attributes such as military rank (Table 3). Observing gender-related pieces of evidence in the primary data could be supported by proposing gender annotations. They could be based on matching gender-related expressions (for instance, lists of first names, kinship terms, or military ranks) with texts constituting the beginning or ending salutations of the letters.

Fourth, the variation in expressions during different stages of the war (Table 7), in official propaganda (photograph collection) versus personal writing (letters) was mentioned as an interesting research aspect. To support historical reasoning related to temporal aspects, external meta-data on dates of known war events can be utilized. Subsequently, event annotations can be proposed based on temporal expressions in the meta-data fields (for instance, date of the photograph), or in descriptive texts (for instance, "caption text" field in the photograph collection). In the database of the deceased, the date and place of each individual's death—or when the person was wounded—is recorded, together with personal descriptive information such as marital status, occupation, and military rank (Table 1). Based on these data, selected descriptive information can be summed up and placed into the timeline to create research interest-driven conceptual handles; for instance, of high death-toll events, which can be used to annotate other historical collections belonging to the relevant historical context. Such annotations may facilitate studying, for instance, whether and how major events were reflected in the language of propaganda and in personal communications (letters) under the censorship.

Last, the historians were interested in entities such as organizations (for instance, military hospital, post office, factory) and locations (for instance, domicile, battle, place of death; Tables 5 and 6). These needs can be supported by annotating the texts using existing named entity recognition techniques, for instance, Omorfi tagger (Pirinen, 2015).

Discussion

This research focused on understanding historians' task-based information interactions, namely, their current work practices and their cognitive access points into historical information. By studying them we increase the understanding of the support needs for the academic historians' research work. Our findings help in understanding information interactions in the historical domain, and allow suggesting implications for system design based on empirical observations to help historians locate and work with relevant information.

Our field study indicated that historians' work practices were semidigital in the sense that the primary sources were

digitized, but the information practices, ways of working with the primary sources, were more traditional and similar to practices in paper-based information environments. This was due to the lack of suitable tools that could be used for the historical information needs and documents, partially because of the challenges with the historical Finnish language and optical character recognition (OCR) errors.

The historians' information needs were varied, including several characteristics and roles of person names, and particular contextual information about places, events, and temporal aspect. Names of places, persons, and organizations were important, which corroborates the findings of Cole (2000). In this sense, the historical research goals are similar regardless of the different information environment, for example, Cole's paper-based compared to our digital documents.

Regarding information retrieval system design, our point of departure was that the acquisition and interpretations of historical primary sources, that is, information items, may be required to perform work tasks. Working with information items subsumes active reading to select and gather information while items are examined in the situation framed by the task. The relevance of the items is determined from the viewpoint of the task goals. During this process, eventually some semantic components (for instance, text or image) will be read and interpreted. In our case, the historian may take advantage of various semantic structures, rhetorical organization, and verbal cues in the text (Järvelin et al., 2015). We were interested in supporting historical reasoning automatically, that is, proposing pieces of information likely to be relevant from the point of view of making arguments to support or refute historical claims.

We proposed the implications of some specific needs observed in the field study, regarding the system design. In the case of studying the roles or relationships of persons, or gender-related aspects, we proposed annotating the target texts with matching labels. The presence of relevant conceptual handles could be argued based on relevant expressions. For example, in the case of private letters the expressions of endearment, kinship, or military rank can give clues about the roles, relationships, and gender of the sender and/or recipient of the letter. In particular, the beginning or ending salutations of the letter may help in arguing about these issues. For providing automatic support, lists of known relevant expressions can be collected first and then matched with the target texts.

The matching of historical Finnish texts is challenging due to the fact that Finnish is a morphologically complex language, where suffixes are added to the word stems to express inflection and derivation (for instance, the word "Rintama*lla*" meaning "*at the front*" in Table 1); it is also a compounding language, that is, multiword expressions are written together (for instance, word "isän*maa*han," meaning "to father*land*"), and decompounding compound words may be necessary in matching relevant expressions (see Alkula, 2001). Moreover, due to the dialectical differences in different regions of the country, many alternative spellings and inflections of words may exist in historical texts (for instance, the word "saataksemme," dialectical form of the word "saadaksemme" meaning "*to get*"). Last, when digitized document images are transformed into digital

text by OCR, errors may take place (for instance, the word "js" as an erroneous form of "ja" meaning "*and*"). Due to the potentially large variation in expressions due to these reasons, we propose using fuzzy matching methods during the automatic annotation procedure.

Regarding the need to study the effects of catastrophic events on official propaganda (for instance, in the caption texts of the photographs) versus on the private letters written by the soldiers at the home front or war front under the censorship, we proposed creating support by annotating data collections based on information derived from separate collections. As an example, the database of the deceased Finnish soldiers includes the date and place of each individual's death, or when they were wounded, together with information describing the person in more detail; for instance, his/her marital status, occupation, and military rank. Based on the research interest, selected information (for instance, the age distribution of the deceased at focus) can be summed up and placed into the timeline. These information bits may serve as research interest-driven handles (here: with temporal properties), which can be used to annotate other data sets from relevant historical contexts, as long as temporal expressions are available in them, for example as in the date field of the caption texts of photographs and the date information available in the letters. Our hypothesis is that such research interest-driven annotations may facilitate working with items by helping the historian contextualize pieces of information under inspection (for instance, letters written before/after high death-toll events).

Last, the historians expressed needs to study historical organizations and locations. The issue of named entity recognition is beyond the scope of the present study, but we notify the potential of existing named entity recognition software to propose corresponding annotations to help the historian in finding and observing expressions of organizations and locations in historical primary data.

For the historians, the provenance of the historical documents is of crucial importance (Gunn & Faire, 2012). When designing new tools and organizing the information one should bear in mind, that any changes in the data should be traced back to the first originals. Another issue was the need for control over the data and retrieval. For example, the steps of automation in the information systems should be transparent to the researchers. They need to understand the logic behind the "supports" that are provided. Transparency of the processes in digitization was also an issue in Jarlbrink and Snickars (2017). This affects the provenance of the digital documents.

Limitations and Future Directions

This was a descriptive research about a few historians' information needs with specific information sources in a small language area. We emphasize the fact that our findings are not intended to be generalized, for instance, to include different subfields of history. We did not offer a fully functional information retrieval system, as it does not yet exist. Instead, we suggested how to address the information intents

of a group of historians. Moreover, we provided detailed analysis of historians' desired access points into information, and discussed the implications to system design. We used a task-based approach to bind our findings to real-world use contexts.

In the future, we will implement the ideas into a functional system, and provide a task-based evaluation with realistic use cases and tasks. The evaluation focus will be on the perceived usefulness of the future system in terms of whether the system features support the work task processes.

Conclusion

Supporting the historians' work tasks in digital information environments involves two perspectives. The first is to understand the information practices with the primary sources in the context of work tasks. The second is to provide and categorize the possible task-relevant information handles into the historical primary sources.

Encountered with the expansion of a digital information environment within the historical domain, historians need support to handle and work with large collections of historical primary sources. The goal of this study was to provide task-relevant cognitive access points into information that can be used to inform the design of a task-support information search system.

We conducted a multiple-method study by observing collaborative meetings and semistructured interviews to identify the historians' information needs as cognitive access points and studied the characteristics of their tasks as the context of information access. We presented the information needs as cognitive access points and built a bridge between the users' cognitive space and the document space. To provide better support to historians working with the digital information sources, there is a need for domain-tailored research tools. By addressing historians' task-based information interactions, we reach toward supporting their research work tasks in a user-centered way and thus enabling novel ways for them to work with the unique historical documents.

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