Melting the Affective Poles: A Study of the Interaction of Positive and Negative Affects and their Role in Collaborative Information Seeking

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ABSTRACT
This paper introduces one problem in collaborative information seeking (CIS) concerning with the interaction of positive and negative affects in the information search process of teams. Along with rationale, research questions, and literature review, this proposal describe key aspects under which a dissertation on this research topic will be carried out. This includes an experimental design, instruments, and methods of analyses. Furthermore, expected results and their implications to CIS, human computer interaction, and information retrieval, and also to the general research field of information science are discussed.

Categories and Subject Descriptors
H.3.3 [Information Search and Retrieval]: Query formulation, relevance feedback, search process, selection process.

General Terms
Experimentation, Human Factors, Measurement, Performance.

Keywords
Collaborative Information Seeking, Emotions, Performance.

1. INTRODUCTION
For many years studies in information science have been focused primarily on people as individual entities, this especially when it comes to understand their behaviors in online information search [1][2]. It has been recognized by many, however, that information seeking is not always an individual activity but it often involves interactions as well as collaboration with other people [3][4][5].

During the past two decades scientists from different fields, including information science, computer science, and psychology, have explored the social component of information-related processes in both experimental and natural settings [2][6][7], producing as a result a large research corpus, which includes topics such as collaborative information seeking (CIS). Results derived from such studies have recently become of particular interest for those who investigate and design interactive information retrieval (IIR) systems [7].

This interest has also come with new challenges and problems to investigate. In the context of CIS, one of such problems is the socio-affective dimension and its implications in the information search process (ISP). Even though these issues have been studied in the past decades for the case of individual seekers, little is known about them in collaborative scenarios.

Due to the scope and complexity of this problem to be investigated as a whole, this research will focus in one specific sub-problem, namely, affects interaction and its implications in collaborative information seeking. Although psychologists have studied affects interactions in applied domains including business and family, there are no studies about how such affective processes shape the behaviors, practices, strategies, communication, and performance of teams that engage in information seeking activities.

The organization of this manuscript consists of four sections: Firstly, the rationale of this work and research questions are presented. Secondly, an overview of relevant literature about this research problem is offered. Thirdly, the study design to address the research questions is described. Finally, expected results and their possible implications to the specific problem of system design and also to CIS and information science in a more general sense are discussed.

2. RATIONALE
Collaborative Information Seeking (CIS), a relatively new research topic in information science, presents unique problems that need to be addressed and challenging questions that need to be answered in a field of growing practical importance to society. Recent exploratory studies have shed light on some of these problems while raising new research questions and suggesting new hypotheses for work going forward. One such problems is the role of the affective dimension in CIS. Feelings, emotions, moods, and affects play an active role in the information seeking of individuals, but little is known about the affective dimension in CIS settings

Affective processes in CIS differ from those in solo information seeking and can be derived from two sources: (1) the collaborative process itself, especially as a result of social interactions that are not necessarily related to the task being solved by the group; and (2) information-related processes, which include information seeking, relevance judgments, information use, and sense-making, among others.

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The affective dimension, and even specific affective processes such as affects, mood, emotions, and feelings, as research topics in CIS are too broad to approach directly. The proposed work, therefore, will be focused on the following two specific aspects: (1) collaborative affective load and (2) effects of positive and negative affects in team's performance.

The study of positive and negative affects in team performance has been addressed by some under a positive psychology perspective. Some authors have argued that positive and negative affects in specific proportions (3:1 relation between positive and negative affects - P/N) could contribute positively in contexts where teamwork and decision making take place [8][9][10]. In this sense, one problem to investigate is to what extent, if any, the interaction of positive and negative affects intervene in the process and products in CIS.

Understanding how affective processes of individuals and team members impact the information search process could lead to system designs that mediate effectively the collaboration between team members by providing appropriate resources for awareness (both emotional and cognitive), communication, control, and coordination, among other relevant aspects.

2.1 Research Questions

Based on the rationale presented above, the proposed research will focus in answering the following research questions (RQs):

RQ1: How do initial affective states and their interactions shape the way team members collaborate when searching information?

RQ2: What emotions are typically experienced and expressed (physically, physiologically, and verbally) by team members when collaborating in an information search task?

RQ3: To what extent, if any, do positive and negative affects derived from the collaboration of individuals in an information search task influence team performance?

RQ4: To what extent, if any, the relation 3:1 between positive and negative affects (P/N) applies to CIS?

Based on studies that have successfully evaluated the relation 3:1 (P/N), it would be expected that teams whose P/N ratio is above this baseline should outperform (in a number of performance measures) those below it; however, this is an hypothesis to be tested in the proposed study.

3. BACKGROUND

Research in CIS has been performed in various domains, including both natural and experimental settings [2][6]. Unlike information seeking and information retrieval, CIS lacks of its own general models and theories that describe behavioral patterns of group members. Most of the models and theories used to explore CIS in the past have been borrowed from areas such as computer-supported cooperative work (CSCW), communication, information seeking, and social psychology, among others.

In CIS, users' behaviors would be shaped not only by information-related events, but also by socio-emotional aspects derived from the underlying interactive processes that are necessary to collaborate. Yet, it is hard to argue whether affects or other affective processes influence or not the ISP. In fact, as stated in [18], there are two questions to ask when trying to understand the role of emotions in information seeking: "[(Q1)] do [people] feel a certain way because [they] find (or do not find) information? or [(Q2)] do [people] find (or do not find) information because [they] feel a certain way?" (p. 2). The first question frames emotions as ISP-dependent, in other words, emotions are mere consequences derived from various ISP's stages. On the other hand, the second question frames the ISP as emotion-dependent, which means that emotions from a Darwinian perspective [11][12][13], have specific functions within the process of searching information. Intuitively, one could argue that emotions could be derived from the ISP and consecutively they could influence the way information is searched, evaluated, and used. Nevertheless, in order to provide evidence to support this proposition, both questions must be addressed either separately or in conjunction.

Past research in information science has focused primarily on the first question (Q1); this is by looking at how users feel while searching information. A seminal piece in this regard is Kuhlthau's work [14], in which a list of specific feelings that individuals experienced at different stages of the ISP was provided. An extensive compilation of exemplar research about the affective dimension in information seeking can be found in [15].

More recent studies in this regard have introduced the use of new technologies such as facial expression recognition, in combination with traditional methods (e.g. self-assessment, interviews, etc.) to dynamically study affective reactions (more specifically: emotions) of individuals during the ISP [16][17][18].

In a recent work, the second question (Q2) was partially addressed by studying the effects of mood in the performance of information searchers [17]. The study was based in the analysis of participants' self-reports about their affective state (i.e. feelings). The author concluded that positive mood would be related to specific search behaviors.

On the contrary, [18] explored the role of happiness and self-reported feelings in the ISP of individuals and teams. One of the analyses provided in this study showed that negative feelings could be better predictors of the performance of searchers in terms of the coverage of relevant information. Moreover, it was found that smiles are also positively correlated with levels of individuals' pride, which as described in [19] is related to the feeling of certainty.

In another study, an investigation of the relations between emotional expressions and information retrieval patterns was conducted [20]. The author suggested that emotions expressed before a given information-related event may affect decision-making in that situation, which is reflected on specific actions. At the same time, this may provoke specific emotional changes after the decision is made.

When the social dimension is incorporated as part of the ISP, addressing questions regarding emotions become more complex. Such complexity is due to emotions in such scenarios may be derived from and/or may influence not only information-related processes, but also the dynamics of groups.

In a study about collaborative information behavior in an educational setting, a comparison of the behaviors of group members and individuals, using Kuhlthau's ISP model [14] as a reference was conducted [21][22]. With respect to the affective dimension, the author found that affective experiences in this specific collaborative scenario were shaped not only by information related activities, but also by the dynamics of groups. Another relevant finding was that group members did not necessarily reach affective relief after completing the ISP of the task in which they were involved.

Similar results were found later in a laboratory study in which Kuhlthau's ISP stages were mapped to a CIS situation [23]. In

terms of affective processes as well as relevance judgments, it was found that group members verbally express their feelings with respect to the situation as well as information when a communication channel is available. Based on the same study, it was later suggested in [24] that relevance judgments are socially constructed through both objective and emotional discourse; meaning that team members share their opinions (e.g. "This page contains useful information"), reactions (e.g. "I loved this page"), and objective comments (e.g. "This information came from the president of the company") with respect to the information they find. Furthermore, it was argued that social interactions carried out when selecting relevant material may dynamically shape: feelings, engagement, and confidence of team members.

In [18], the authors addressed the problem of emotions in CIS by studying the participation of one particular emotion, namely happiness. Results showed that participants working in collaboration with others, smiled significantly more than those working in solo mode. As described by the authors, smiling episodes of team members were mostly correlated with their interactions through the exchange of text messages. It was showed, however, in a separate study that different communication channels have different effects on the affective load of participants when performing a CIS task [25].

4. STUDY DESCRIPTION

4.1 Study Design

In order to address the research questions and hypothesis stated above, a mixed-methods approach will be followed. From a quantitative standpoint, an experimental study based on a multiple-group design is proposed. The first research question (RQ1) is used as a starting point to define three specific experimental treatments that will be randomly applied to teams formed by two members. Following, a description of each treatment is detailed.

$\mathbf{X}_{++}$: Both team members receive stimuli to elicit positive affects prior to starting the task.

$\mathbf{X}_{+-}$: One team member receives stimuli to elicit positive affects and the other stimuli to elicit negative affects prior to starting the task.

$\mathbf{X}_{--}$: Both team members receive stimuli to elicit negative affects prior to starting the task.

The overall experimental design is summarized in Table 1:

Table 1. Experimental design summary. (R): Random assignation, (PT): Pre-Task, (O): observations, (X): treatment, and (T): task.

R	O_1	P_T	O_2	$\mathbf{X}_{++}$	O_3	T_1	O_4	...	T_n	O_{n+3}
R	O_1	P_T	O_2	$\mathbf{X}_{+-}$	O_3	T_1	O_4	...	T_n	O_{n+3}
R	O_1	P_T	O_2	$\mathbf{X}_{--}$	O_3	T_1	O_4	...	T_n	O_{n+3}

In order to have a baseline, this study also considers individual participants in two different conditions who will receive specific stimuli to elicit positive (X+) and negative affects (X-).

The study will be framed as a competition in which participants (both individuals and teams) with the best performance will have the possibility to win a prize. With respect to the collaboration format, teams will work synchronously and remotely located using text chat to communicate while performing a set of short information search tasks. This decision was made based on results described in [18][24][25][26].

4.2 Stimuli

In order to elicit the specific initial affective state in each experimental condition, proper stimuli will be applied. Even though the psychology and neuroscience literature describes some stimuli to elicit positive and negative affects, they must be empirically evaluated in the pilot study in order to verify to what extent they evoke the desired initial state. Verifications will be based on two kinds of measures: (1) discrete, this through the use of self-reports as part of the pretest-posttest experimental design; and (2) continuous, this through the use of physiological and expressive measures during the application of the stimulus. Both measures will enable to contrast the subjective and objective experience of affective process. In this regard, the former (self reports) focuses in feelings as a subjective measure, while the second (physiological and expressive measures) focuses on affects, moods, and specific emotions as objective measures.

4.3 Recruitment

Using a sample of convenience, 90 subjects in 45 pairs (15 pairs per collaborative condition) and 30 individual users for the baseline (15 per individual condition) will be recruited. Each pair (team) will participate in one session of approximately 60 minutes.

Teams will not be randomly generated, on the contrary, participants will be asked to sign up in pairs with someone they have had previous experience collaborating with. This design decision is based on previous studies in which participants reported feeling comfortable and confident when working with someone they already know and with whom they have worked in the past [18][23][28].

During the recruitment stage, participants will be informed that their performance will be assessed and compared to the performance of other participants, and that those with the best performance will receive a prize in addition to the compensation obtained for their participation.

4.4 Task

The task that teams and solo participants must accomplish in this study consists on answering a set of questions from A Google a Day (http://agoogleaday.com). The questions that will be used in this study will be randomly collected including the ideal search path and the corresponding answer.

Unlike simple fact finding tasks, A Google a Day questions require multiple steps and sometimes complex queries to find the answers. Furthermore, as a collaborative task, these questions are not dividable, thus communication is promoted during the collaboration process. Moreover, participants will be restricted to work in one question at a time. Prior responding each question, participants will be asked about their familiarity with the topic and the perceived complexity of the task. While responding each question, participants will be required to save relevant snippets that help them to answer each question. When participants feel ready to answer a question or if they run out of time, they will be asked to complete questionnaires about confidence levels with respect to the answer provided (if any) and how difficult for them was to find it. Once questions are either answered or skipped, there is no going back.

After each question is answered or skipped, neither positive nor negative reinforcement will be given to participants. This decision is made to avoid effects of an explicit intervening variable (task reinforcement).

4.5 System

Among the few systems that provide support for CIS, this study will be carried out with Coagmento [27][28], which is a highly modular platform that provides a number of logging capabilities. Coagmento offers support for CIS in terms of awareness, communication, information sharing, and information synthesis, among other features. For this particular study, the system will be adapted to address specific aspects of the experimental design described above as well as from the session workflow. Moreover, specific components of Coagmento that may result in intervening or distracting elements while the task is being performed will be removed.

4.6 Instruments

During the sessions, multimodal data will be captured, including: search trails, users' actions, desktop activity, facial expressions, gestures, communication logs, physiological data (i.e. electro dermal activity and temperature [29]), self assessment about affective states (Self Assessment Manikin [30] and PANAS [31]) and cognitive load (NASA's TLX [32]), and interviews.

4.7 Analyses

To respond each research question as well as test possible hypotheses, different analyses will be performed. Due to the various sources of data that will be used in this study, it is possible to use a wide range of analyses techniques. Nevertheless, not every analysis will be useful to address each research question. Table 2 lists different analyses that will be performed, its outcomes, and the research questions that they will help to respond.

Table 2. Qualitative and quantitative analyses, its expected products, and research questions that they will to respond.

		RQ			
Analysis	**Products**	**1**	**2**	**3**	**4**
Communication analyses	Themes/ Strategies/ Coding Scheme	X	X		
Communication (coded) analyses	Statistics	X	X	X	X
Interviews analyses	Themes	X		X	
Search trials analyses (query + content browsing)	Possible patterns/Behaviors description	X			
SCR Signal analyses	Possible patterns/Behaviors description	X	X	X	X
Facial expression analyses	Possible patterns/Behaviors description	X	X	X	X
One-way ANOVA	Comparison across condition with respect to different variables				X
Correlation analyses	Possible correlations between meaningful pairs of variables	X		X	X
Repeated Measures Analysis of Variance	Comparison of repeated measures and analysis of significance	X	X		X
Time series analyses	Comparison at different moments in the session	X		X	X
Cluster analyses	Possible patterns	X			X
Content analyses of desktop activity	Possible patterns/Behaviors description	X			
Performance analyses	Statistics			X	X

Additional considerations about recruitment, protocol, instrumentation, and analyses will be available for consultation. Moreover, the proposed design as well as other decisions may change after a pilot study is carried out.

5. EXPECTED IMPLICATIONS

From the study above it is expected to obtain: (1) meaningful evidence to respond the four research questions and hypothesis stated above, (2) behavioral patterns of pairs of users working on an exploratory search task, (3) affective patterns, (4) possible correlations between emotions and team performance, (5) a list of affects, emotions, and feelings that are experienced during a CIS task, (6) patterns on strategy definition, and (7) patterns in conflict resolution. This list of expected results is not extensive; hence, there may be outcomes that could be derived from the analyses that will be performed.

It is expected that investigating the proposed research questions will contribute to gain a better understanding of the role of the affective dimension in the dynamics of teams engaging in social information processing. Knowing how particular emotions, feelings, and affects participate in the information search process of teams could help to: (1) properly define teams to optimize their performance and manage the effects on their members; (2) predict team's performance in terms of affective states before and during the collaboration process; (3) reach a better understanding of how systems can be improved to support specific affective aspects and processes that take place in CIS, such as emotional awareness, collaborative emotion regulation, and group's affective relevance; this with the aim to allow users to align their behaviors and also to promote effective and synergic collaboration; (4) identify affective aspects and processes that could be used to improve algorithmic mediation for collaboration techniques, and (5) design mechanisms that take advantage of users' affective processes to mediate effectively the interaction with information retrieval systems.

To some extent this study involves exploratory, explanatory, and descriptive components. As one of the first research projects of its kind in CIS, this study will produce results that will in turn open a wide range of research possibilities, with issues even more specific than the one that will be addressed in this study or with particular problems that connect with other understudied aspects of CIS, such as: communication, evaluation, system support, and theoretical foundations.

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