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
Emotions and other affective processes have long been considered a key component in people's life. Despite research conducted in several research domains, little is known about the role of emotions in the information seeking process of both individuals and teams. This research proposal introduces one problem in collaborative information seeking (CIS) concerning with the interaction of positive and negative affects in the information search process. Along with rationale, research questions, and literature review, this proposal describes 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.

KEYWORDS
Collaborative Information Seeking, Emotions, Performance.

1. INTRODUCTION

It has been argued that emotions play an important role in different aspects of life such as survival or social interactions. For example, studies in psychology and economics, among other disciplines have shown that human emotions are necessary for decision making (Figner & Murphy, 2011), a process that has long been attributed to rational thinking.

Although emotions have been widely studied in different research domains, little is known about their participation in the information search process (ISP) of both individuals and teams. Some researchers have indicated that emotions are present at different stages of the ISP (Kuhlthau, 1991); however, their implications on the way people search or assess information is still understudied. Recent studies have partially addressed research questions about the emotions that individuals would experience during the ISP and how they would relate to specific search behaviors (Arapaski et al., 2008, Lopatovska, 2009; González- Ibáñez et al., 2011).

In collaborative scenarios, studies in this regard are scarcer. Indeed, 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 (Reddy & Jansen, 2008; Shah, 2010a). 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 (Twidale et al., 1997; Sonnenwald & Pierce, 2000; Reddy & Dourish, 2002). In collaborative information seeking (CIS), for example, emotions have been acknowledged to take an active part in the ISP of teams (Hyldegard, 2006; Shah & González-Ibáñez, 2010; González-Ibáñez & Shah 2010); nevertheless, to the best of our knowledge, no studies have been specially designed to investigate emotions nor other affective processes in this domain.

Due to the scope and complexity of this problem to be investigated as a whole, this research focuses in one specific sub-problem, namely, affects interaction and its implications in online 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 both individuals and 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 (Morris, 2008; Shah & González-Ibáñez, 2010; 2011; González-Ibáñez & Shah 2010). One such problem 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 their implications, if any, in CIS settings.

Affective processes in CIS differ from those in solo information seeking in that the former 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.

The affective dimension and even specific affective processes such as affects, mood, emotions, and feelings, as research topics in CIS is too broad to approach a as whole. The proposed work, therefore, focuses on the following two specific aspects regarding affect interactions: (1) effects of positive and negative affects in the collaboration process of teams seeking information and (2) effects of positive and negative affects in team's performance.

The study of positive and negative affects in team's 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 (Losada & Heaphy, 2004; Fredrickson & Losada, 2005; Waugh & Fredrickson, 2006). 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 of CIS. To the best of our knowledge, no studies have been conducted in this regard.

Understanding how affective processes of individuals and team members impact the information search process could lead to systems designs that mediate effectively the information search process as well as 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 four 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 a hypothesis to be tested in the proposed study.

3. BACKGROUND

In order to properly address the themes discussed in this manuscript, definitions for two key concepts used in this study are provided, namely: emotion and CIS. First of all, Palmero et al.'s (2006) definition of emotions and related concepts such as mood, affect, and feeling was adopted. In summary, the term emotion refers to spontaneous and short-duration affective responses that can be classified under a categorical approach (e.g. happy, sad, and angry). The terms affect and mood, though slightly different, correspond to affective states that last longer than emotions and are described under a dimensional approach (e.g. arousal: excited-calm, valence: positive-negative). Finally, feelings correspond to the subjective component of underlying affective processes. In other words, feelings take place when individuals become aware that they are experiencing a given emotion or mood. The second concept corresponds to CIS, which according to Foster (2006) corresponds to "the study of the systems and practices that enable individuals to collaborate during the seeking, searching, and retrieval of information" (p. 330).

In information science, Kuhlthau (1991) introduced one of the first models that considered feelings as an active part of the ISP of individuals. More recently, the introduction of new technologies and methodologies have enabled scientists to take a closer look at the problem of the affective dimension in information seeking, enabling them to quantitatively measure affective factors in the ISP. For example, Lopatovska (2009) and González-Ibáñez et al. (2011) incorporated automatic facial expression recognition as well as self-assessment to study the expressivity of basic emotions and the experience of feelings in an information search task.

In CIS, however, emotions are still understudied. Authors such as Hyldegard (2006) and Shah and González-Ibáñez (2010) explored the applicability of Kulhtauh's ISP model to collaborative settings, with a limited attention given to exploring emotions in the ISP of teams. Hyldegard (2006), for example, found that affective experiences in a collaborative educational setting 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 by Shah and González-Ibáñez (2010), who indicated 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 by González-Ibáñez & Shah 2010 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 a different study, González-Ibáñez et al. (2011) studied the expressivity of happiness in the ISP of pairs working in an exploratory search task. According to the authors, unlike individual information seeking, in collaborative settings team members are more likely to express emotions. However, such episodes occur as a result of interactions among team members and they are not necessarily connected to information-related events.

Regardless of the differences between individuals and teams, emotions could be not only a consequence but also a cause of information behaviors. As González-Ibáñez et al. (2011) pointed out, the following two questions should be addressed: "[(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). While emotion research in information seeking has focused primarily in Q1, the implications of prior affective processes in the search process (Q2) of both individuals and teams may have larger implications in this research field. From a positive-psychology perspective, both positive and negative affects would have a crucial role in daily activities (Fredrickson & Losada, 2005). If emotions play such a role in people's life, would it be the case that they also change the way people search, assess, and make sense of information? These two questions (Q1 and Q2), are implicitly addressed as part of the research questions stated in the previous section.

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.

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

2. **X_{+-}**: One team member will receive a stimulus to elicit positive affects and the other a stimulus to elicit negative affects prior to starting the task.

3. **X_{--}**: Both team members will receive a stimulus to elicit negative affects prior to starting the task.

In order to have a baseline, this study also considers individual participants in three different conditions. In the first two individual conditions, participants will receive specific stimuli to elicit positive (X_+) and negative affects (X_-). Finally, the third condition is the control, in which participant will not receive treatment.

The overall experimental design is summarized in Table 1:

R	O_1	PreT	O_2	**X ++**	O_n	PosT	O_{n+1}	MT	O_{n+m}
R	O_1	PreT	O_2	**X +-**	O_n	PosT	O_{n+1}	MT	O_{n+m}
R	O_1	PreT	O_2	**X --**	O_n	PosT	O_{n+1}	MT	O_{n+m}
R	O_1	PreT	O_2	**X +**	O_n	PosT	O_{n+1}	MT	O_{n+m}
R	O_1	PreT	O_2	**X -**	O_n	PosT	O_{n+1}	MT	O_{n+m}
R	O_1	PreT	O_2		O_n	PosT	O_{n+1}	MT	O_{n+m}

Table 1. New experimental design summary. (R): Randomization, (PreT): Pre-Task, (PosT): Post-Task, (O): observations, (X): treatment/stimuli, and (MT): main task.

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 by González- Ibáñez and Shah (2010), González- Ibáñez et al. (2011), Shah and González- Ibáñez (2011), González- Ibáñez et al. (2012) as well as a pilot study conducted during Spring 2012 (González-Ibáñez & Shah, 2012).

4.2 Stimuli

Among the variety of possible stimuli that can be applied to elicit specific affective responses in each condition (Coan & Allen, 2007), a pilot study conducted during Spring 2012 showed that the false-feedback approach (Zhao, 2006) produces the desired changes in affective responses. This technique consists on providing either positive or negative feedback (e.g. "You are doing great!", "This does not look good", "That was close. You are doing great!") to the user regardless of his/her actual performance when working on a given task. After the pilot study, the duration of stimuli stage was set in 10 minutes.

4.3 Recruitment

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

The target population will be undergraduate students from Rutgers University, English native speakers, with intermediate typing and search skills, and with ages ranging between 18 and 24 years old.

For the case of teams, these 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 in order to ensure they had common ground (Clark & Brennanm, 1991). 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 (González- Ibáñez & Shah, 2010; González- Ibáñez et al., 2011; Shah and González- Ibáñez, 2011; González- Ibáñez et al., 2012).

Each subject will get paid $10 in cash for their voluntary participation. 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

In order to have better control, a multiple-step fact-finding and non-dividable search task was designed for this study. The task consists on answering a set of questions randomly collected from A Google a Day (http://agoogleaday.com). Each question was objectively rated based on the number of steps or queries suggested in A Google a Day to find its answer. As a result, the number of steps or complexity level for the entire set of questions ranged between 2 and 5. Based on the results obtained during the pilot study, only level-2 questions were selected for the task. Questions above this level of complexity were found to be very challenging by participants to be accomplished within 5 minutes, which is the time that participants will be given to find the answers. While the task is not intended to be realistic, it is adequate to properly investigate and evaluate affective reactions and their implications in the ISP in an experimental setting, which is the focus of this research.

Unlike simple fact finding tasks, A Google a Day questions (a trivia game) 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, there is no going back.

4.5 System

Among the few systems that provide support for CIS, this study will be carried out with an adapted version of Coagmento (Shah, 2010b; González- Ibáñez & Shah, 2011). Coagmento is a highly modular platform that provides a number of logging capabilities. This collaborative system offers support for CIS in terms of awareness, communication, information sharing, and information synthesis, among other features. For this particular study, Coagmento was adapted to address specific aspects of the experimental design described above as well as aspects derived from the research protocol. This new version of the system was named Coagmento Collaboratory.

4.6 Instruments

During the sessions, multimodal data will be captured, including: search trails, users' actions, desktop activity, facial expressions, gestures, eye fixations, communication logs, physiological data (i.e. electro dermal activity (EDA) and temperature (Poh et al., 2010)), affective self assessment (Self Assessment Manikin (Bradley & Lang, 1994) and PANAS (Watson et al., 1988)), cognitive load (NASA's TLX (Hart & Staveland, 1988)), and interviews. Most of these instruments were embedded or integrated within Coagmento Collaboratory.

4.7 Analyses

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

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

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 every research question. Table 2 lists

different analyses that will be performed, its outcomes, and the research questions that they will help to respond.

The analyses listed in Table 2 may vary as the research progress. For example, integrated analyses with multimodal data may be performed to address specific hypotheses as well as new research questions that could be derived as results are produced. Additional considerations about recruitment, protocol, instrumentation, and analyses will be available for consultation.

5. CURRENT STATUS

The research proposal summarized above is a refined version as a result of multiple iterations and the results from a pilot study (González-Ibáñez & Shah, 2012). Currently, the project is in the data collection stage. At the time this proposal is being submitted, 33.3% of the required samples have been collected. Data collection also involves preliminary observation derived from non-participant observations performed by the researcher in each experimental session. These observations will be integrated later in the project either to perform analyses of other sources of data or for interpreting results.

6. EXPECTED IMPLICATIONS AND SIGNIFICANCE

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 in turn will 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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