Researching Emotion: Challenges and Solutions

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ABSTRACT

Interest in emotions within the information use context is on the rise. Yet, the reports of the emotion studies rarely mention some of the methodological challenges involved in research. New researchers who are entering the field are often unaware of the challenges and potential solutions related to emotions' examinations. This paper attempts to educate researchers about some of the methodological options that are available at various stages of emotion study, including selection of theory and methods, data collection and analysis, extraction of meaning from data, and application of the findings to the real life problems. The paper offers recommendations for handling some of the challenges that might arise during a project.

Categories and Subject Descriptors

H.1.3 [User/Machine Systems]: Human Factors.

I.3.6 [Methodology and Techniques]

G.3 [Probability and statistics]: Experimental design.

General Terms

Measurement, Reliability, Experimentation, Human Factors, Theory.

Keywords

Emotion, affect, research methodology, measurement, information retrieval, information use, information behavior.

1. INTRODUCTION

Interest in emotion is increasing across multiple disciplines: field of economics had established an entire branch of behavioral economics to investigate the role of cognitive and emotional aspects of economic decisions; a sub-field of psychology is conducting hedonic research on the factors that affect the quality of life, computer science has seen an increased interest in "affective computing".

Information science is no exception. Increased interest in emotion is evident in the growing number of publications that discuss emotions[1]; in the new conferences (e.g., International Conference on Affective Computing and Intelligent Interaction) journals (e.g., The IEEE Transactions on Affective Computing), and monographs [1] dedicated to discussing issues of emotion; there is even an emotion markup language being developed by the World Wide Web Consortium [2]. Emotions are studied in the context of improving human-computer interactions [3, 4], search motivation [5], search decisions [6] and behaviors [7], relevance judgments [8], affective tagging of video [9], music [10], and images [11] and other contexts. While the number of publications reporting results of emotion research is growing, these publications rarely discuss the challenges the authors face and the technical solutions they develop while conducting their studies. This article attempts to educate the researchers who consider investigating emotions in the information use contexts about some of the issues they might face in conducting research. The paper is organized around the choices and challenges encountered at every stage of emotion research, including selection of theory and methods, data collection and analysis, description of findings and application of the findings to the real life problems. While some of the discussed challenges and solutions (e.g., the pros and cons of controlled and naturalistic settings, the need to conduct a thorough literature review, etc.) are not unique to the emotion research, they are discussed in the context of and illustrated with the emotion studies.

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[1] Within Library, Information Science and Technology Abstracts database, the number of articles containing the word "emotion" in the subject line increased from 11 articles published between 1990 and 2000 to 250 articles published between 2000 and 2010

The points outlined in the paper are based on the author's personal experience in conducting emotion research and on conversations with other researchers in the field.

2. DEFINING EMOTION

One of the earliest steps in conducting any kind of study is defining the investigated phenomenon. Once a researcher makes the decision to investigate emotional phenomena in the context of information use, we advise to invest time in understanding the difference between affect, emotion, mood, feeling, or other types of emotional phenomena. The literature offers a myriad of definitions for each of the emotional concepts. Affect, for example, has been defined as the experience of pleasure or pain [12]. Emotion has been defined as "the response to a significant event, consisting of elements from one or more of the components of experience, behavior, and physiological reaction [12, p. 191]; and mood as a relatively long lasting feeling that, unlike emotion, is not felt "about" anything [13].

For the emotion phenomenon alone, Kleinginna and Kleinginna [14] collected more than 90 definitions of emotion. Lack of a single definition of emotion is related to the disagreements about relationships between emotion and emotional stimuli. One group of theories invokes cognition, or a cognitive appraisal, as a necessary element of emotion [15]; while the other group of theories emphasizes somatic factors and argues that bodily responses, and not cognitive judgments, cause emotional reactions [16].

There is also no agreement about the structure and manifestation of emotions. The two dominant views on emotions' structure are the discrete and continuous approaches. Discrete emotion theorists, following Darwin's work, suggest the existence of six or more basic emotions (happiness, sadness, anger, fear, disgust, and surprise), which are universally displayed and recognized [17, 18]. The continuous approach assumes the existence of two (arousal-valence) or more dimensions that describe and distinguish between different emotions and correlate with various bodily activities, such as pulse rate or skin conductance [19, 20].

Each theoretical perspective on the nature and structure of emotion is in turn linked to a specific set of methods. For example, the methods for measuring discrete emotions often include analysis of the facial [21], vocal, or body [22] expressions of the basic emotions; or rely on the use of self-report techniques like questionnaires [23] or diaries [24]. The methods for measuring continuous emotions often include the use of neuro-physiological instruments (blood pressure monitors, pulse rate and skin conductance sensors, electrocardiograph) for measuring responses to emotional stimuli; and/or map emotional experiences on a three-dimensional space formed by the valence (positive-negative), arousal (calm-excited), and tension (tense-relaxed) dimensions [20].[2]

In the environment where there is no scarcity of theories and methods it is easy to be opportunistic, and use methods that are the most convenient and/or more traditional for a certain discipline. We would not discourage researchers from using multiple methods. In fact, use of multiple methods would increase reliability of findings and more comprehensively cover multiple facets of emotions [20]. However, we would advise the researchers to peruse interdisciplinary literature in order to understand available theories and frameworks; connect their research to a larger theoretical framework and be prepared to justify and defend their methods.[3] We would also encourage researchers to always define the investigated phenomena, a practice that is frequently missing from the library and information science literature, but could strengthen any publication and add value to our field.

3. SELECTING METHOD

This section will focus on several methodological choices available to emotion researchers, namely the choices related to a study's setting, data collection instruments and data interpretation.

Almost every research method textbook will emphasize the importance of choosing the study setting (experimental-naturalistic) and the level of control over the study variables. These choices become critically important in conducting emotion research. Emotion is a complex phenomenon that can be influenced by a lot of factors, including environment, general mood, and levels of involvement in a current activity, motivation, individual emotional expressivity, etc. Experimental setting allows higher level of control over some of these variables (e.g., all the participants receive the same emotional stimuli, in the same (laboratory) setting, having roughly the same motivation to complete the task). In fact, psychologists who study emotion conduct most of their experiments using very simple stimuli (e.g., sound [27], water temperature [28]) and non goal-oriented tasks, and use variables that are less complex than the information search scenario variables, for example. Choosing experimental setting also allows the use of some data collection instruments that cannot be used in a naturalistic setting (e.g., neuro-physiological sensors). However, the experimental setting itself can influence participants' behavior and emotions (e.g., knowing that one is being observed might introduce additional stress and anxiety that can color the rest of the emotions). In addition, motivation to complete experimental tasks can hardly be compared to the motivation to engage in the real-life information search/use. We would encourage researchers to carefully evaluate all the pros and the cons of the two research approaches, and if possible, use a combination of methods to mitigate the negative effects of experimental or naturalistic approaches (e.g., give people experimental tasks that closely resemble their routine activities, offer a reward structure that

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2 For a more detailed description of emotion theories and methods, see Lopatovska and Arapakis [25]

3 The study that examined different ways of mitigating game-related frustration (Klein, [3] was criticized by Muller [26] for the misuse for physiological measures that could only indicate the changing levels of arousal (continues approach), not frustration (discrete emotion). Instead, Muller suggested using ethnographic research methods for studying frustration.

provides close-to-life motivations, find a way to record real-life information uses, etc.)

When the time comes to select specific data collection instruments, we would advise to start by reviewing comparable studies and talking to the colleagues who are investigating similar problems. Although emotion research is a relatively new research area, a lot of the instruments were developed for measuring emotions and its correlates. The data collection options include standardized questionnaires for measuring emotions (e.g., State Trait Anxiety Inventory (STAI) for measuring anxiety is available starts at $120.00; Positive Affect and Negative Affect Scale (PANAS) is free), programs that extract and interpret facial expressions of emotions from the video stream (e.g., FaceReader at around $5,000,00; eMotion is free), sensors that capture changes in physiological activities (e.g., a unique LifeShirt sensor system that monitors cardiovascular, respiratory, metabolic and other physiological effects of physical or emotional stress [29], interviews, diaries and many others. In addition to the differences related to the cost and the complexity, the instruments also vary in the levels of obtrusiveness (e.g., wearing sensors is more obtrusive than filling out a questionnaire), 'objectiveness' (self-report v observer or physiological data), cost, requirements for special hardware (e.g., video or audio recorder) or researcher's skills (e.g., knowledge of the Facial Action Coding System (FACS)). All these factors should be taken into consideration when selecting the data collection instrument.

Due to the novelty of the research methods for studying emotions and disagreements about the nature of emotion, there is still plenty of uncertainty when it comes to interpreting the data. After the instrument is chosen and some pilot data is collected, the researcher has to decide which data to interpret in addressing the research question(s). We will illustrate this point with an example. Let's assume a researcher is interested in measuring emotions before and/or after stimulus X. What time intervals, before and after a participant was exposed to a stimuli, should be selected for analysis? The answer would depend on how long the emotions last: if emotions are short-lasting experiences, short intervals should be selected, and if emotions last longer, emotional patterns over longer intervals should be analyzed. Unfortunately, there is no agreement on the duration of emotion. The literature suggests that the duration of emotion depends on 1) the type of emotion [30]; 2) emotion intensity [31]; and 3) cultural background and personality types [30; 32], and varies from a few seconds to several days and can depend on the type of the experienced emotion[4] [30; 31]. In our example, a researcher examined the variance of emotional expressions around the stimuli to determine that on average emotions varied every three seconds and chose to interpret emotion data recorded during those 3 second intervals.

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[4] Scherer et al, [33] found that fear is one of the shortest lasting emotions and lasts from a few seconds up to a maximum of an hour, while sadness can last from one day to several days.

While having so many methodological options might seem overwhelming, having these options allows researcher to pick the data collection methods that best address research objectives, match researcher's skills, and can be covered by a wide range of study budgets.

4. INTEGRATING DATA

We feel that researchers who develop an emotion study rarely have a clear understanding of the challenges related to preparing data for analysis. Publications that report the results of emotional research hardly ever mention this step, while awareness about some of these challenges can influence study's designs and timelines. We will briefly mention a few issues related to preparing and integrating data for analysis that we hope will be useful to the reader.

1. *Quantity of data.* It is easy to imagine the amount of data collected by a 10-item questionnaire from 50, or even 500 people. It is harder to imagine the quantity of audio or video data that represents the slightest variations of emotions expressed over even a short period of time. For example, eMotion software that classifies facial expressions of emotions describes about 15,000 video frames for 10 minutes search recording. The amount of data can be overwhelming, in addition, not all the collected data are meaningful (e.g. participants get distracted; they might be engaged in some activities that may not be related to the focus of the study.) In this situation, a researcher needs to choose the 'meaningful' elements of the data, or select particular intervals of interest (e.g., most frequent emotion expressed over a selected time interval, emotion expressed right after the encounter with the stimulus, etc.)

2. *Quality of data.* Data collection tools are not perfect, so a researcher has to be prepared to differentiate between 'good' and 'bad' data. In some cases, the sensor will not capture the data. In other cases, participants will get distracted and exhibit emotions not relevant to the study. In yet other cases, the software will not be able to accurately interpret the data (e.g., the accuracy of most facial recognition programs is around 60-70%). Having at least two sources of emotion data (e.g., log files, plus video, or questionnaire) captured by various instruments can help to cross-validate the findings and ensure that only quality data is selected for the analysis (and the quality issues are mentioned in the description of study limitations).

   Another example of a decision related to selecting data for analysis, is deciding which emotion recognition software output to interpret. Most of the software packages that interpret video feed by identifying and classifying emotional expressions (e.g., facial expressions of 6 or 7 universal emotions [21]), produce two types of outputs. One type of output assigns emotion label to each video frame (e.g., a video frame of a neutral facial expression can be characterized by Neutral/0.999[probability], Happy/0.000, Surprised/0.000, Angry/0.000, Disgust/0.000, Fear/0.000 and Sad/0.000). The other type of output

offers a motion vector features' information (so that a neutral expression might be described as positions of various facial features: "-0.702 -0.029 -0.129 0.029 -0.004 0.254 0.128 -0.230 -0.151 -0.686 -0.677 -0.087"). Use of the discrete emotion's label output might be easier, but it is limited to the pre-programmed categories, and relies on the software's accuracy in interpreting video data. Use of the vector output might be more challenging to interpret, but it offers more flexibility in interpreting vector spaces, assigning customizable labels (e.g., variations of an angry expression), etc.

3. *Compatibility with other data.* In most cases, the researcher will want to correlate the emotion data with the data about stimulus, effects of the emotional reaction, or other contextual variables. Very rarely one instrument is designed to collect all the data necessary to address the research questions. That means that after collecting the data from various sources, a researcher is facing a technical challenge of synchronizing the data and bringing it to the common denominator (e.g. one instrument might record video frame every 150th millisecond, while another instrument will log on-screen activities when they happen, and often times multiple activities will be associated with the same timestamp). Once a research is aware of these problems, s/he might consider designing a program that would help synchronizing the data while it is actually being collected.

We offered just a few examples of the data preparation issues that might not all be relevant to a specific research. However, regardless of the type of instruments and data analysis techniques, we would advise a researcher to always test the instruments and examine preliminary data, and to find the solutions to arising problems before conducting the full study.

5. DERIVING MEANING

After the data is collected and analyzed, a researcher is facing an exciting challenge of answering the 'so what' question: identifying significance and implications of the study's findings. We will mention a few things that we think a researcher should keep in mind while discussing the results of an emotion study.

- The map is not the territory, and a manifestation of emotion is not an emotion. A researcher should always remember that there is always a chance that a physiological or self-reported change that appears to be caused by an emotion can in fact be caused by something else (a mental or physiological activity, desire to fit into the socially accepted norms of behavior, etc.) Since there is not much a researcher can do about this limitation, the best way to handle it is to acknowledge it.
- We are usually investigating emotions in complex environments. Unlike psychologists, who deal with simple stimuli, like harsh sound or an unpleasant image, we are dealing with complex stimuli, like

information (both content and presentation), information systems, motivation to complete tasks, etc. We always have to be aware of (and acknowledge) all the variables that can influence the emotions' readings, and employ multiple methods of collecting data whenever possible (e.g., in addition to collecting pulse rate, consider collecting eye tracking data to determine participant's focus, use interview or other techniques for gathering participants' accounts on what was happening to them when an emotional episode occurred).

- In our field, we investigate emotion not as a stand alone phenomenon, but in a larger context of information production and use. Once we discover certain patterns of emotional expressions/representations, we should explain how to use this knowledge for making computers more attuned to users' needs (personalization), making users' experiences more pleasant (affective computing), improving information retrieval (emotional tagging), etc. The task of making emotion knowledge 'useful' can be made easier if the research is performed in conjunction with a larger project (e.g. usability study, personalization research). Collaborative projects also allow combining interdisciplinary expertise and offer a broader range of channels for disseminating results.

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6. CONCLUSION

The article outlined some of the challenges of investigating emotion in the information use context. Most of the challenges can be addressed by investing time into reviewing relevant literature (to learn about available theoretical and methodological choices) and by running pilot studies to understand and mitigate the complexity of the data collection and analysis stages.

We feel that now is a great time to investigate emotions in the context of information use. There is plenty of evidence to suggest that emotion is an important element of human-computer interaction; knowledge about experienced emotions can be used to improve information organization, retrieval, and use. While the field of emotion research is still very young and has a lot of untapped potential, it has accumulated enough theories and methods that can aid researchers in developing their studies. We encourage beginner researchers not to shy away from the inevitable challenges of investigating emotions, and instead view them as opportunities to define and develop the norms of emotions' research in our field.

7. ACKNOWLEDGMENTS

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