Definition and Application of User Affective Factors in Information Seeking and Retrieval: Postprint

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Abstract

[Purpose/Significance] Through investigation and review of affect-related research in the field of information seeking and retrieval, this study summarizes the conceptualization of affective factors and their current application status. [Method/Process] From an affective perspective, this paper analyzes both domestic and international research involving affect in information seeking and retrieval, examining concepts of affect-related terminology, types of affective factors, emotion theory-based affective representation, and their applications. [Results/Conclusions] Affect-related terminology is diverse, broadly including two categories: affect and affective factors. The former mainly encompasses impression, emotion, affect, and feeling, among others. The latter is broader than the former and also involves non-emotional factors. Overall, research that defines and represents affective factors based on emotion theory is the most prevalent, mostly adopting related concepts from psychology with few strict distinctions made. Finally, we summarize from the perspectives of affect concepts, types of affective factors, affect measurement, and application, and propose future research directions.

Full Text

The Definition and Application of User Affective Factors in Information Seeking and Retrieval

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Abstract

[**Purpose/Significance**] This paper aims to systematically review and analyze affective research in the field of information seeking and retrieval, examining the current state of conceptual definitions and applications of affective factors. [**Method/Process**] From an emotional perspective, we analyze domestic and international research on affective issues in information seeking and retrieval, focusing on the conceptualization of affect-related terminology, types of affective factors, and the representation of affect based on emotion theories and their applications. [**Result/Conclusion**] Affective-related terminology is diverse, broadly categorized into two types: "affect" and "affective factors." The former primarily includes impression, emotion, feeling, and affection, while the latter is more encompassing, also involving non-emotional elements. Overall, research based on emotion theories to define and represent affective factors is most common, largely adopting concepts from psychology with few strict distinctions made. Finally, we summarize from the perspectives of affective concepts, types of affective factors, and the measurement and application of affect, and propose future research directions.

Keywords: library science; information science; affect; information behavior

1. Introduction

With advances in cognitive and neuropsychology, the role of affect in human decision-making, perception, and creativity has gained increasing attention. Research in information seeking and retrieval began addressing user emotions during information acquisition, processing, searching, and utilization around the 1980s. In 1981, T.D. Wilson identified emotion as a primary driver of information seeking from the perspective of fundamental human needs[1]. In 1983, B. Dervin explored the role of emotion and affect in sense-making[2]. In 1986, C.A. Mellon specifically examined factors influencing user anxiety in library environments[3]. Around the 1990s, the rise of affective computing and Kansei engineering spurred development in affective information processing, generating theories, methods, and technologies for human emotion detection, recognition, simulation, expression, and application, which in turn promoted exploration of affective issues in user-information and user-system interactions within library and information science[4]. C.C. Kuhlthau was among the early pioneers; in 1991, she incorporated affect into information search process models, highlighting relationships among emotion, cognition, and search behavior[5]. In 2004, D. Nahl proposed the affective load theory of information behavior from a socio-bio-information technology perspective[6]. In August 2006, the ASIST annual conference hosted a specialized workshop on "Emotion and Affect in Information Seeking and Use." Subsequently, numerous studies explored user emotions across various information behaviors including searching, retrieval, reading, and new technology applications[4]. Additionally, many researchers examined affective

issues from the perspective of information resource description and retrieval, investigating emotion feature identification, extraction, and retrieval system development at the methodological and technical levels[7]. Human behavior and activities result from the combined influence of rational thinking and emotion/affect, with affective factors sometimes exerting greater influence than cognitive abilities on user information seeking activities[6]. Therefore, information retrieval systems face the challenge of perceiving and understanding user emotions to facilitate successful retrieval experiences under positive affective states.

In recent years, both user-oriented information seeking behavior research and technology-oriented information retrieval research have incorporated affect into their frameworks, though using different terminology. These generally fall into two categories: "affect" and "affective factors." The former primarily includes emotion[6], feelings[8], affection[9–10], and subjective experience[11–12]. The latter is broader, also encompassing non-emotional elements such as affective control[13–14] and affective value[15]. These terminological differences and varying operationalizations of affect and affective factors in empirical research create difficulties for comparative analysis. Therefore, we systematically and comprehensively collected research incorporating affective perspectives in information seeking and retrieval, analyzing the meanings of affect-related terminology, the definition and measurement of affective factors in empirical studies, and the representation and application of affective factors based on emotion theories, aiming to reveal relationships among different conceptualizations and provide references for fellow researchers.

2. Affective-Related Terminology

Information seeking and retrieval research has employed several typical terms, which we analyze below in conjunction with conceptual definitions from psychology and their application in our field.

2.1 Sensation Sensation (sensation[16], sense[17]) has two primary interpretations: (1) The first views sensation as the brain' s response to individual properties of objective things directly acting on sensory organs—non-inferential judgments about the external world. Sensation depends on sensory organs, through which people perceive properties like color, brightness, odor, and hardness, while also experiencing internal bodily stimuli such as pain, hunger, and thirst[18]. This interpretation treats sensation as a physiological mechanism triggering emotion. (2) The second interpretation considers sensation not merely as perception of objective properties but as understanding and cognition produced by external stimuli[19].

In information seeking and retrieval research, sensation[16], sense[6], and feeling[21] appear in relevant studies, with the first interpretation being more common, particularly in multimedia retrieval research. These studies often treat sensory stimuli and immediate user responses to multimedia information as sensation features. In image retrieval, some research defines sensation narrowly as user

responses to image color, such as "cool" or "strong" feelings[20]. Other researchers categorize all user responses to visual physical features as sensation, defining it as physical-level affective features of images such as warmth/coolness, brightness/darkness, saturation, roughness, and smoothness[21].

2.2 Emotion Emotion generally refers to people' s attitudes and experiences toward objective things. In the narrow sense, emotion denotes temporary attitudinal experiences arising when basic needs are met or unmet upon external stimulation. In the broad sense, emotion encompasses complex components including emotional experience, emotional behavior, emotional arousal, and cognition of emotional stimuli[22].

In information seeking and retrieval research, definitions of emotion are relatively consistent, referring to user experiences and attitudes toward retrieval objects or processes. However, specific representations draw on different emotion theories, such as discrete emotion theory or dimensional theory. For example, some studies describe emotions of digital library users based on basic emotion types[23], while others collect user emotional responses to images, audio, and video for indexing and retrieval based on dimensional theory[24].

2.3 Affect Affect (feelings, affect) typically refers to people's subjective experience of emotions—the subjective feeling or experience within emotional processes. From a psychological perspective, affect is considered one aspect of emotion in the broad sense, primarily manifested as emotional experience or feeling[25]. Emotion influences psychology and behavior, typically through affect[26].

In information seeking and retrieval research, feelings[8] and affect[27] have been used to express user affect. In psychological literature translation, feelings generally corresponds to "affect," while affect typically corresponds to "affection." Affection generally serves as a collective term for emotion and affect phenomena, representing general emotional and affective states[28]. However, in information seeking behavior research, researchers do not strictly distinguish between feelings and affect, or between affect and emotion, sometimes using them interchangeably. In 2000, D. Bilal[29] used the term feelings to study children' s emotions when using search engines, employing interviews to capture emotional states and changes, effectively examining positive and negative emotion manifestations and their causes. In 2008, C. Tenopir et al.[30] used both affect and feelings when studying user affective and cognitive behaviors in web searching, with the former as a general reference and the latter referring to specific states (e.g., satisfaction, annoyance), though the terms appeared interchangeably without strict distinction.

Unlike information seeking behavior research, information retrieval technology studies have used affect to express emotional semantics of multimedia information. Domestic research has also employed various terms such as affective features[31], emotional semantics[32], and Kansei features[21]. Although terminology varies, meanings are similar, generally referring to subjective experiences

including sensation, impression, emotion, and affect elicited by multimedia information, covering multiple levels of subjective experience[33–34], thus differing somewhat from psychological definitions of affect.

2.4 Mood Mood (mood) reflects mild to moderate affect lasting longer than emotion[35]. Mood appears primarily in information seeking behavior research, with some researchers using mood to describe user affect[36]. In 2006, J. Lazar et al.[36] examined factors influencing user frustration in computing environments, considering user mood by measuring life satisfaction to infer pre- and post-search mood states, finding that higher satisfaction correlated with better mood. Results showed that students experiencing greater frustration during information retrieval reported worse post-search mood, which was also highly correlated with computer anxiety levels, perceived expertise, pre-search mood, computer use comfort, problem-solving willingness, and perceived problem-solving ability. In 2009, I. Lopatovska[37] used mood to describe affective phenomena in research on task difficulty and affect, measuring mood with the Positive and Negative Affect Scale (PANAS).

2.5 Summary As seen above, information seeking and retrieval research primarily adopts affect-related concepts from psychology. Although psychology distinguishes these concepts clearly—for example, affect emphasizes social needs more than emotion, representing more complex and stable psychological experiences with greater social and human dimensions[38], while mood reflects milder, longer-lasting affect than emotion[35]—the information field rarely makes strict distinctions. K.R. Scherer[39] differentiated basic concepts like emotion, affect, and mood when studying affect measurement, and I. Lopatovska[40] distinguished emotion from mood. However, most research does not maintain strict distinctions. For instance, I. Lopatovska used both mood and emotion in 2009[37] and 2014[40] with similar meanings referring to user affect. In Chinese literature, researchers often use "affect" and "emotion" interchangeably as general terms[41–43].

3. Types of User Affective Factors

Existing research defines affective factors from two perspectives: (1) defining and measuring user affective factors based solely on emotion, treating affect-related concepts as components of affective factors; and (2) treating both emotion and users' control and valuation of affect as components of affective factors.

3.1 Emotion-Based Affective Factors Research defining affective factors based on emotion falls into two categories: (1) Studies that adopt psychological concepts but make few strict distinctions, mostly using self-report scales such as the Geneva Appraisal Questionnaire (GAQ) and PANAS for measuring emotion and affect. Other methods include think-aloud protocols transcribed for affective analysis[36], sentiment analysis of web-generated content (e.g., reviews)[44], and physiological measures like eye tracking, skin conductance, and

facial expression recognition[4,45]. (2) Studies focusing on specific emotion types, such as library anxiety and affective load. C.A. Mellon' s library anxiety refers to anxiety produced when students cannot effectively handle problems using library resources, measured by tools like the Library Anxiety Scale (LAS) and State-Trait Anxiety Inventory (STAI)[46]. Affective load measurement primarily uses D. Nahl' s questionnaire, which identifies affective load as four negative emotions—stimulation, anxiety, frustration, and anger—over time[6]. Other researchers focus on specific emotions like frustration, success, satisfaction, and engagement[36].

3.2 Affective Factors Including Emotion Control and Valuation Some researchers in information seeking and retrieval also include affective value, affective control, and self-efficacy as components of affective factors, discussing affective issues more broadly with more diverse application contexts. These non-emotion-centered affective factors have relatively independent conceptual connotations and scopes:

(1) **Affective value** typically refers to users' evaluations of information usefulness and interest, often related to personal style, perceived usefulness, and interest. Measurement methods include questionnaires, self-reports, and think-aloud protocols. In 2008, I. Lopatovska et al.[15] used questionnaires to assess affective value from willingness-to-pay and experienced utility perspectives, finding that users felt positive when reading interesting or useful web content. Affective value was influenced by usefulness, reliability, thoroughness, personal style, interest, and website ambiguity.

(2) **Affective control** has been measured using the personal control subscale of the Psychosomatic Inventory (PSI) or PTSD scales. In 2008, K.S. Kim[13] used PSI to measure pre-experiment affective control, finding that users with high affective control tended to use fewer forward buttons and keyword searches. Good affective control positively impacted task completion and could compensate for limited cognitive skills. Similarly, J.H. Koo[9] used PTSD scales to examine how life stress and negative affect influenced North Korean refugees' information seeking in South Korea, finding that higher PTSD correlated with more passive information seeking and unclear recognition of information needs.

(3) **Self-efficacy** has also been included as an affective factor component. D. Nahl[47–48] measured affective factors through self-efficacy and optimism when studying emotions in web information seeking. Common measurement tools include questionnaires and self-efficacy scales, typically assessing search operation evaluation, task assessment, result prediction, and self-cognition, which correlate with cognitive behavior and retrieval performance[49].

4. Representation and Application of Affective Factors Based on Emotion Theory

Affective factors encompass both emotional and non-emotional components. Since most research represents affect based on emotion theories, we focus on studies using discrete and continuous emotion theories.

4.1 Discrete Emotion Theory-Based Representation and Application

Discrete emotion theory posits that emotions have discrete structures, with several basic emotions forming the foundation and other emotions representing combinations of these basics, termed complex emotions[52]. It holds that core human emotions are physiologically determined affective responses shared across races and cultures[50]. While consensus on the number and types of basic emotions remains elusive, P. Ekman' s classification of happiness, sadness, fear, anger, surprise, and disgust is widely applied in information seeking and retrieval[51]. In discrete emotion theory, aside from core emotions like joy, anger, and fear, other affects are viewed as combinations of basic emotions or socially learned complex emotions[52].

Information seeking and retrieval research using discrete emotion theory includes three approaches:

(1) **Focus on basic emotions**, most commonly using P. Ekman' s theory. In information seeking behavior research, I. Lopatovska and C. Cool[23] used facial expression recognition to capture seven basic emotions during digital library searches, finding no significant effect of retrieval effectiveness on emotional expression. Users' facial expressions primarily reflected disgust, with positive emotions increasing when lab assistants entered. Individual differences existed—one user expressed 57 strong emotions while another expressed only nine. In 2011, I. Lopatovska[53] again used Ekman' s six basic emotions to examine relationships with 12 specific retrieval behaviors (categorized as selection, text manipulation, and re-examination strategies), finding that left-click operations preceded relatively calm states, followed by increased surprise or sadness, while most clicks immediately increased negative emotions. Behaviors improving emotional states included repeated scrolling or re-examining selected pages.

In image emotion recognition, S. Schmidt and W.G. Stock[55] used Ekman' s six basic emotions to annotate 30 images for emotion elicitation levels. In text sentiment mining, C. Strapparava and R. Mihalcea[56] designed emotion classification algorithms for news headlines based on six basic emotions. In music retrieval, Y. Feng et al.[57] built a visual music retrieval system using P.N. Juslin' s theory, categorizing musical emotions into happiness, sadness, anger, and fear, with neural network-based classifiers.

(2) **Focus on complex emotions**. Library and information science research includes two types: First, studies examining the entire information seeking process to capture user affective states, often reflecting complex

emotions. C.C. Kuhlthau' s Information Search Process (ISP) model reveals emotions at each stage: initiation (uncertainty, apprehension), selection (optimism), exploration (confusion, frustration, doubt), formulation (clarity), collection (confidence, direction), and presentation (satisfaction/dissatisfaction)[5],[458]. Many researchers have further explored user emotional responses in various contexts. For instance, A.D. Orlu[59] applied Kuhlthau' s ISP model to graduate students' thesis writing, identifying common emotions including fear, uncertainty, optimism, confusion, frustration, doubt, clarity, confidence, satisfaction, and dissatisfaction.

Second, studies focusing on specific complex emotions like success, failure, frustration, and satisfaction. Some researchers model emotions from log data to predict user frustration and satisfaction. H.A. Feild et al.[60] built frustration prediction models using logistic regression based on query length, dwell time, operations, and URL visits. K.R. Scherer[61] studied physiological and behavioral changes during frustrating searches, finding decreased blood volume pressure and increased skin conductance and mouse clicks. S. Fox et al.[62] used decision trees and Bayesian classifiers for satisfaction modeling, identifying mouse clicks, dwell time, and exit behaviors as key predictors. H.L. O' Brien and E.G. Toms[63] used the User Engagement Scale (UES)[64] to measure engagement, finding higher task interest correlated with higher engagement, which was associated with less browsing time and fewer pages accessed.

(3) **Comprehensive study of basic and complex emotions**. In 2014, I. Lopatovska[40] distinguished primary emotions (raw responses to stimuli, collectable via physiological signals) from secondary emotions (resulting from appraisal of primary emotions, collectable via think-aloud, questionnaires, and interviews). Using facial recognition for seven basic emotions and PANAS/ interviews for secondary emotions, the study found surprise most common during searching, followed by neutral, sad, fearful, happy, disgusted, and angry states. Most users did not experience intense emotions, with only a few reporting secondary emotions like annoyance, frustration, excitement, achievement, and interest, which showed little relationship to process or outcomes. Laboratory and natural search experiences differed affectively.

4.2 Continuous Emotion Theory-Based Representation and Application Continuous emotion theory posits that emotions possess characteristics like activation, intensity, and tension, each with positive and negative polarities. These characteristics, called dimensions, enable continuous representation of affect[65]. Researchers propose various dimensional models: two-dimensional models like L.F. Barrett and J.A. Russell' s circumplex model (valence and activation)[66] and R.E. Thayer' s energy-stress model[67]; and three-dimensional models like R. Plutchik' s intensity-similarity-polarity model[68], H. Schlosberg' s pleasantness-pleasantness/attention-rejection/activation model[69], W.M. Wundt' s pleasantness-excitement/calmness-tension/relaxation model[70],

and A. Mehrabian and J.A. Russell' s PAD model (pleasure, arousal, dominance)[71].

Both two- and three-dimensional models are applied in information seeking and retrieval:

(1) **Two-dimensional models** primarily use valence and activation. In information seeking behavior research, M. Zhou[72] studied university students' online search emotions, recruiting 170 participants to select from 10 basic emotion words based on the circumplex model before and after tasks, then cluster-analyzing them into six categories: active-positive, neutral-positive, inactive-positive, active-negative, neutral-negative, and inactive-negative. The study also examined achievement goal orientation, finding avoidance-oriented groups showed significantly higher negative emotions (boredom, confusion) pre-task, while mastery-approach groups showed higher positive emotions (excitement, eagerness) post-task. In collaborative information retrieval, Qiu and Wu[73] similarly used valence and intensity dimensions, extracting emotion words from chat logs and categorizing them into positive, neutral, and negative emotions, each with high, medium, and low intensity levels.

In information retrieval research, semantic differential scales based on dimensional theory capture user affect. R. Panda and P.P. Rui[24] used Thayer' s two-dimensional model for music emotion, identifying positions in four affective categories defined by valence and activation, achieving 56.3% accuracy with SVM. ImageCLEF[74] used Russell' s two-dimensional theory to annotate 8,000+ images for affective training.

(2) **Three-dimensional models** appear mainly in multimedia retrieval. Wang and Chen[75] applied Plutchik' s three-dimensional model to build a four-dimensional affective space for image Kansei evaluation and retrieval, with axes representing joy/approval/expectation/annoyance (positive) and sadness/dislike/surprise/fear (negative). They used radial basis function neural networks to link image features with affective space and interactive genetic algorithms for retrieval. The VeraaM German audio-visual emotion database also used Schlosberg' s three-dimensional model, annotating 947 German TV interview speech samples on activation, valence, and control dimensions[76–77].

5. Conclusion

This comprehensive review of affective research in information seeking and retrieval reveals:

(1) **Conceptually**, two main categories exist: (a) Psychological concepts of impression, emotion, feeling, and mood, often used interchangeably as "emotion" or "affect" in Chinese literature and more frequently as "affect" or "emotion" in English literature, with few strict distinctions. Most repre-

sentation relies on emotion theories (discrete or continuous). (b) Domain-specific concepts include particular emotions (e.g., library anxiety) and comprehensive constructs (e.g., affective load), measured by specialized questionnaires.

(2) **Typologically**, two approaches exist: (a) Emotion-centered definitions where affective factors align with common emotion concepts; and (b) Broader definitions including emotion control and valuation. Empirical studies use affective factors as either independent variables examining effects on information behavior[78] or as dependent variables examining factors influencing user emotions[79].

(3) **Methodologically**, despite conceptual differences, measurement falls into three categories: (a) Questionnaires and scales, including adapted psychological instruments (PANAS[37], PTSD[9], STAI[80–82], GAQ[83]) and researcher-developed tools (Nahl' s affective load questionnaire); (b) Physiological measures including skin conductance[45], temperature[84], heart rate[40], blood pressure, and respiration[85], with facial expression recognition (based on Ekman' s basic emotions) being common; and (c) Interview and think-aloud methods converting verbal reports to text for affective analysis[36] or using retrospective recall[30].

In summary, information seeking and retrieval has made progress in affective research, but the complexity of human emotion offers vast exploration space. Future research should address:

(1) **User affective model construction** for information seeking and retrieval applications, clarifying relationships among affective concepts, integrating theories from psychology and cognitive science, and building comprehensive models from basic to complex emotions and from emotion-related to emotion-control factors to facilitate cross-study comparison.

(2) **Relationships between affective factors and user information behavior**, establishing systematic connections across different affective levels and types to organize fragmented findings and support affective recognition, prediction, and intervention based on interaction behaviors.

(3) **Stability and reliability of affective measurement**. The complexity and subjectivity of human emotion challenge measurement and data utilization. Most current studies employ relatively single methods; integrating multiple measurement approaches can better approximate users' real states and ensure measurement stability and reliability.

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Note: Figure translations are in progress. See original paper for figures.