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Affective guidance of intelligent agents: How emotion controls cognition

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Abstract

How do emotions and moods color cognition? In this article, we examine how such reactions influence both judgments and cognitive performance. We argue that many affective influences are due, not to affective reactions themselves, but to the information they carry about value. The specific kind of influence that occurs depends on the focus of the agent at the time. When making evaluative judgments, for example, an agent's positive affect may emerge as a positive attitude toward a person or object. But when an agent focuses on a cognitive task, positive affect may act like feedback about the value of one's approach. As a result, positive affect tends to promote cognitive, relational processes, whereas negative affect tends to inhibit relational processing, resulting in more perceptual, stimulus-specific processing. As a consequence, many textbook phenomena from cognitive psychology occur readily in happy moods, but are inhibited or even absent in sad moods (149).

Keywords: Affective computing; Emotion; Affect; Judgment; Cognitive processing; Believable agents

Optimism or pessimism about the human condition often turns on people's belief in the possibility of rational thought unsullied by emotion. That view has been common from the Greeks through the enlightenment to the present day. From that perspective, the absence of emotion in artificially intelligent systems might seem ideal. But it turns out that affect and emotion play critical roles in good judgment and in the adaptive regulation of thought. Indeed, the inability to use affective information as a result of brain-damage has profoundly negative consequences for judgment and decision-making (Damasio, 1994). And "emotional intelligence" appears to be an important factor in effective social functioning (Mayer, Salovey, & Caruso, 2004). Accordingly, in this article we focus on the functional aspects of affect and emotion.

1. Emotion

Investigators have often bemoaned the difficulty of defining emotion. However, moods and emotions can be usefully characterized simply as "affective states." In this designation, the term "affective" applies to anything evaluative. Affect, then, is an embodied reaction of pleasure or displeasure signifying the goodness or badness of something. And a psychological "state" is assumed to exist whenever multiple systems of an organism reflect the same condition at the same time. Thus, an affective state of anger might involve not only angry thoughts and feelings, but anger expressed in the face and body, in gestures, inclinations, and in actions. Not all of these systems have to be involved, but affective states involve *multi-system registrations of the goodness or badness of something*.

Emotions typically involve both conscious experiences and bodily reactions. Since silicon-based agents have neither experiences nor bodies, the idea of "affective computing" (Picard, 1997) initially seems absurd. However, some psychologists are currently rethinking the concept of

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emotion. Research does not find that different emotions are well differentiated in terms of brain activation, expression, or behavior (Barrett, Mesquita, Ochsner, & Gross, 2007). Instead, they differ primarily in the different psychological situations they represent (e.g., Barrett, 2006; Clore & Ortony, 2008). That is, certain kinds of situations that are important for thriving and surviving recur in the lives of animate organisms and are signified by specific emotions. Accordingly, modelers may want to focus on these psychologically significant situations and their implications, rather than on some of the more mysterious and ineffable aspects of emotions.

2. Overview

Interest in emotion has increased in the AI community on the heels of efforts to create "believable agents" (Reilly, 1996). Some developers have incorporated appraisal theories of emotion, such as the OCC model (Ortony, Clore, & Collins, 1988). For example, agents in the "Affective Reasoner" make inferences about emotion and then test them by asking questions (Elliott, 1992). Some have also extended appraisal models to incorporate ways that agents can cope with emotional situations (e.g., Gratch & Marsella, 2004). In the current article, rather than focusing on the elicitation of affect and emotion by appraisals, we focus on their consequences. And rather than focusing only on specific emotions, we examine the influences of affective reactions more generally. These results have yet to be incorporated within artificially intelligent agents. They tell us how such believable agents should react to affective events, and how human agents interacting with them are likely to respond to affect in the interaction.

Many of the experiments we review involve the induction of happy or sad mood. Rather than reflecting a special interest in mood, however, this focus on mood is a research tool that allows us to vary affect independently of cognition. In everyday life, affect and cognition are hopelessly intertwined; objects of positive or negative feelings are usually also objects of positive or negative beliefs. Since moods have little cognitive content, they provide a ready source of unattached positive or negative affect. In addition, making the source of the mood thematically irrelevant further ensures that observed effects reflect affect rather than belief.

The results of these experiments are intended to apply to any affective reaction from the feedback during mundane tasks to potentially intense emotional states of anger, fear, or joy. For example, we find that undifferentiated affect from negative moods tends to focus people's attention onto perceptual details. Similarly, the more targeted negative affect of the emotion of fear should constrain attention specifically to threat-relevant details, and the negative affect of anger should direct attention to blame-relevant details. These are effects discussed further in the second section on Affect and Processing. But first, we review several experiments that illustrate how affect influences judgment.

3. Affect and judgment

The study of judgment and decision-making has a long history. Theorists traditionally focused on how people combine information about objects of judgment (e.g., Anderson, 1971). They assumed that judgments reflected evaluative beliefs about the objects of judgment. Similarly, attitude theorists assumed that attitudes were combinations of the evaluative implications of beliefs about attitude objects (e.g., Fishbein & Ajzen, 1975).

However, at some point, research emerged showing that such judgments also reflected the moods that judges happened to be in at the time (e.g., Bower, 1981; Clore, 1975). To assimilate such results to the traditional view that judgments reflect the attributes of judged objects, theorists invoked the spreading activation model of memory (e.g., Collins & Loftus, 1975). They proposed that moods activate mood-congruent material in memory, resulting in mood-congruent judgments (Bower, Monteiro, & Gilligan, 1978; Forgas, 1995; Isen, Shalker, Clark, & Karp, 1978).

4. Affect-as-Information

An explanation that we prefer assumes that instead of stimulating intervening memories, affect informs judges directly about their evaluative reactions to objects of judgment (Schwarz & Clore, 1983). Research suggests that people often make evaluative judgments essentially by asking themselves, "How do I feel about it?" (Schwarz & Clore, 1988). Consider how people might evaluate whether they like the food they are eating in a restaurant. If one were eating lasagna, for example, would the system look up the value of lasagna in memory to determine its likability and then conclude, "Since I am eating lasagna, and I know from memory that I like lasagna, I must be enjoying my dinner?" Robots might be designed to take such an approach, but humans tend to taste the food and then use that subjective experience of pleasure or displeasure as the answer to the question. This is the sort of process envisioned for all kinds of evaluative judgments by the "affect-as-information" approach (Clore et al., 2001; Schwarz & Clore, 2007). It asserts that affective reactions serve as information about what one likes or dislikes.

This explanation assumes that, just as affective expressions inform us about others, affective feelings inform us about ourselves. Such feelings vary in valence (the pleasantness-unpleasantness dimension of affect), which conveys information about value. They also vary in arousal (the exciting-calm dimension), which conveys information about urgency or importance. Thus, affective reactions provide information both about value and importance (Clore & Schnall, 2005).

One might ask why it is necessary to be informed about our own emotional reactions, since emotions are assumed to be self-generated reflections of the personal value of events. But like many important psychological processes, those governing the evaluation of objects and events are