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Effects of experimentally induced emotions on model-based reasoning

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ABSTRACT

Although previous research has worked with different realizations and operationalizations of positive and negative state-emotions, there is a strong agreement on the necessity of the *experimental induction of emotions* in order to determine their effects on cognition. Accordingly, this experimental study aims at investigating the effects of both positive and negative state-emotions on model-based reasoning processes where the emotions are experimentally induced by using a simulated feedback technique. 81 participants were randomly assigned to three experimental groups in which positive and negative state-emotions were varied during the experiment. They worked in three learning cycles where they had to solve inductive reasoning tasks. Our results indicate that participants with positive induced state-emotions outperformed participants with negative state-emotions. However, results did not reveal patterns of relation between state-emotions and the application of specific strategies. Findings are interpreted as support for the assumption of reciprocal emotions which interact with cognitive information processing.

1. Introduction

Emotions are mental states which arise spontaneously rather than through conscious effort. A growing body of empirical studies shows that cognitive information processing is highly related with emotions (e.g., Funke & Holt, 2006; Gray, 2001; Isen, 1999; Kuhl, 1983, 2000; Spering, Wagener, & Funke, 2005). According to Goetz, Preckel, Pekrun, and Hall (2007), emotions can be differentiated into present emotions (*state-emotions*; e.g., "I am anxious at this moment") and emotions that occur consistently in specific situations (*trait-emotions*; e.g., "I am generally anxious while taking math exams"). Kuhl (1983) introduced a model of emotional emergence which suggests the reciprocal nature of cognitive, emotional, and operational processes. Accordingly, cognitive processes and the reciprocal interactions with emotional states are the basis for goal-directed actions (Gross, 1998). More specifically, positive emotions promote the activation of cognitive processes, whereas negative emotions restrict these activating functions. Baumann and Kuhl (2002) showed that learners in sad mood performed worse while solving tasks than those who were able to regulate negative emotions. Alternatively, positive emotions increase the learner's optimism and confidence and thus facilitate the activation of cognitive processes (Fiedler, 2001; Schwarz, 2000). Cognitive processes include the functions of assimilation and accommodation which are integrated into a comprehensive framework of model-based reasoning (Ifenthaler & Seel, 2011, 2013).

This study contributes to the research on emotions and model-based reasoning in two ways. First, it extends the framework of model-based reasoning processes with regard to the reciprocal interactions of emotions. Second, it investigates the impact of state-emotions on the strategies and performance using an experimental setting.

1.1. Model-based reasoning

The theory of mental models is based on the assumption that cognition operates on the use of mental representations in which individuals organize symbols of experience or thought in such a way that they effect a systematic representation of this experience or thought, as a means of understanding it, or of explaining it to others (Johnson-Laird, 1989). According to Craik (1943), individuals construct internal models (i.e., mental representations) on the basis of retrievable declarative and procedural knowledge in order to understand a given situation or task. These models "work" well when they fit with both the individual's knowledge and the explanatory need of given task(s) to be mastered cognitively. By means of an internal model an individual is also able to simulate real actions in imagination (Markman, 1999; Seel, 2003). Thus, mental models allow one to perform actions entirely internally and to judge the consequences of actions, interpret them, and draw appropriate conclusions. However, since the concept of mental models has been introduced into cognitive science it has been criticized by proponents of schema theories who consider mental models as mere instantiations of local schemas but not as a discrete theoretical construct (Brewer, 1987; Rips, 1987). Still, cognitive scientists agree on the point that schemas and mental models serve different cognitive functions: Schemas represent the generic and abstract knowledge acquired

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on the basis of manifold individual experiences with objects, persons, situations, and behaviors (Mandler, 1984; Rumelhart & Norman, 1978; Rumelhart, Smolensky, McClelland, & Hinton, 1986). As soon as a schema is fully developed it can be applied immediately to assimilate information about new experiences. However, how do people operate cognitively in the case of novel problems for which no schema can be retrieved from memory? The answer of those who advocate model-based reasoning is that people construct a mental model of the situation or problem to be mastered (Gentner & Stevens, 1983; Ifenthaler, Masduki, & Seel, 2011; Ifenthaler & Seel, 2011, 2013; Johnson-Laird, 1989).

In order to meet the requirements of the task to be accomplished, mental models are constructed by integrating tentatively and step-by-step relevant simple structures, or even single bits of domain-specific knowledge, into a coherent design of a working model. Johnson-Laird (1983) considers this process of a stepwise enrichment of mental models as "fleshing out", whereas Seel (1991) describes this process as a "reduction to absurdity", i.e., a process of testing continuously whether a mental model can be replaced with a better model. It can be argued that when a mental model is used successfully, it is reinforced and may eventually become a precompiled, stable conceptual model or even, after many repetitions, a schema (Halford, Bain, Maybery, & Andrews, 1998; Ifenthaler & Seel, 2011). If the model is not satisfactory, it will be revised or rejected in the further progression of learning.

Model-based reasoning consists of progressing through a series of tentative models that will be tested and revised until a sufficiently stabilized model results that can be applied effectively – at least temporarily – to solve specific tasks (Ifenthaler & Seel, 2011; Schaffernicht, 2006). The process of model-based reasoning begins when an assimilation resistance occurs (Piaget, 1976) and it ends with a sufficiently stabilized model. Several studies have explored such model-based reasoning processes (e.g., Darabi, Nelson, & Seel, 2009; Ifenthaler et al., 2011; Ifenthaler & Seel, 2011, 2013; Seel, Darabi, & Nelson, 2006). However, so far none of these studies investigated the impact of state-emotions on model-based reasoning processes.

Model-based reasoning presupposes necessarily an assimilation resistance that not only provokes a cognitive dissonance but also an emotional response (Berlyne, 1971; Festinger, 1957; Funke & Holt, 2006). Accordingly, emotions may have a major impact on model-based reasoning due to the fact that whenever assimilation fails, a state of *disequilibrium* or cognitive dissonance is entered which in turn evokes changes in emotions (Eckblad, 1981; Piaget, 1945).

1.2. Emotions in model-based reasoning

Since the 1970s, cognitive psychologists have been advocating theories of emotion (Lewis, Haviland-Jones, & Feldmann Barrett, 2008). Emotions have been studied extensively, but most studies address simple and basic emotional responses, such as success, fear, or stress (Daniels et al., 2008; Isen, 1999, 2001; Flunger, Pretsch, Schmitt, & Ludwig, 2013; Isen, Rosenzweig, & Young, 1991; Jordan & Troth, 2004; Sanders, 1984; Schwarz, 2000). Dörner (1998) identified three areas of concern of emotion research: (1) Emotions are assessed on an imprecise scale (mostly through a dichotomous comparison of positive and negative emotions). (2) Studies focus on the outcome influence by emotions rather than on the underlying processes. (3) A majority of empirical investigations concentrate on negative emotions which does not allow for a generalization of the results. Additionally, theoretically grounded and valid instruments for the assessment of emotions are scarce (Pekrun, Goetz, Frenzel, Barchfeld, & Perry, 2011; Spering et al., 2005).

In Berlyne's (1971) terms, novelty and complexity of a situation or task can induce a cognitive dissonance that in turns increases arousal mediating an affective reaction, for instance curiosity or anxiety. Of course, complex, novel, or incongruous objects have in common that they resist immediate assimilation and evoke emotions that interact reciprocally with cognitive appraisals (Gray, 2001; Kuhl, 1983), and thus, create a basis for goal-directed actions (Gross, 1998).

The *feelings-as-information model* argues that positive emotions may impair systematic processing and invite to superficial thinking because they eventually signal that the given tasks can be easily solved and this reduce the motivation to scrutinize the available information (Schwarz, 1990). According to the *mood repair hypothesis* (Krohne, Pieper, Knoll, & Breimer, 2002), individuals with negative emotions seem to spend more time for collecting information in a systematic manner in order to cope effectively with the situational demands considered as a cause for negative emotions. Contrarily, negative emotions may result in a less use of information which can impair the performance in given tasks (Fiedler, 2001). Furthermore, negative emotions can result in a constriction of attention and a failure to search for alternative solutions. Accordingly, Fiedler's (2001) *affect–cognition theory* postulates that positive and negative emotions have a strong impact on the modality of information processing and motivation: "While negative mood supports the conservative function of sticking to the […] facts and avoiding mistakes, positive mood supports the creative function of active generation, or enriching the stimulus input with inferences based on prior knowledge" (Fiedler, 2001, p. 3). Interestingly, Fiedler (2001) refers to the Piagetian terms of *accommodation* and *assimilation* (Piaget, 1976). Hence, negative emotions facilitate accommodation, whereas positive emotions support assimilation.

This conception corresponds to a large extent to the above described model-based reasoning processes (Ifenthaler & Seel, 2011, 2013). However, whether and how emotions interact reciprocally with model-based reasoning processes has not been explored empirically until today. Therefore, the present study designates a novel approach within the realm of mental model research.

1.3. The present research

In accordance with a common practice of research on cognitive processes and emotions, the present study operates with the experimental induction of state-emotions. More specifically, we employ an emotion induction procedure operating with variations of simulated feedback on the performance of tasks. Previous research shows that providing students with simulated feedback on their performance on tasks is a suitable and successful method of emotion induction (e.g., Forgas, Bower, & Moylan, 1990; Ingram, 1984; Siemer, Mauss, & Gross, 2007; Spering et al., 2005; Westermann, Spies, Stahl, & Hesse, 1996). Two hypotheses were tested.

First, we assume that positive and negative emotions can be induced through simulated feedback (Hypothesis 1). This corresponds with the affective primacy hypothesis that positive and negative emotions can be evoked with minimal stimulus input (Zajonc, 1980). Although music and film are regarded as most successful techniques to induce emotions (e.g., Spering et al., 2005; Westermann et al., 1996), the applied induction method through simulated feedback was regarded as highly suitable for the anticipated participants of the experiment.

Second, results of the influence of emotions on performance is rather inconsistent (Dörner, 1998; Hesse, Spies, & Lüer, 1983; Spering et al., 2005). It is suggested that positive feedback (indicating success on a performance) will produce more positive emotions in individuals, while negative feedback (indicating failure on a performance) will produce more negative emotions, which in turn will initiate coping processes (Eckblad, 1981). Such coping processes are defined as the conscious use of cognitive efforts to deal effectively with a task that individuals perceive as unpleasant or even harmful due to the given negative feedback on previous task performance. Accordingly, we assume that positive/negative emotions will lead to different (better/worse) task performance (Hypothesis 2a). In addition, we assume that positive/negative emotions will affect the applied strategy on two subsequent tasks (Hypothesis 2b).