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Implicit fear and effort-related cardiac response

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ABSTRACT

Based on the Implicit-Affect-Primes-Effort (IAPE) model (Gendolla, 2012, 2015), two experiments tested the impact of fear primes on effort-related cardiac response. The main dependent variable was reactivity of cardiac pre-ejection period (PEP) during the performance of cognitive tasks. The IAPE model predicts that activation of implicit fear and sadness results in stronger PEP responses during task performance than activation of implicit happiness or anger. To test this, Experiment 1 exposed participants to masked facial expressions of fear, anger, or happiness while they performed a cognitive "parity task". As expected, PEP responses in the implicit fear condition were stronger than in both the implicit anger and happiness conditions. Experiment 2 conceptually replicated the implicit fear effect and revealed, as expected, stronger PEP responses for implicit fear and sadness than implicit anger during a "mental concentration" task. The findings provide the first evidence for the systematic impact of implicit fear on effort-related cardiac response and complete the existing evidence for the IAPE model.

1. Introduction

Experienced emotions are strong motivators (see Lench, Bench, Darbor, & Moore, 2015). They give behavior an approach or avoidance direction and mobilize the necessary bodily resources to execute it—which is probably the main reason for physiological changes involved in emotional experiences (see Kreibig, 2010). However, a provocative question is if it is really necessary that emotions are experienced to influence behavior. Maybe the implicit activation of peoples' knowledge about emotions is sufficient for this. The present research is part of a series of studies that has tested this idea by investigating if implicitly processed emotional stimuli have a systematic impact on behavior by activating emotion knowledge rather than emotional states.

Referring to resource mobilization—the aspect of behavior that is traditionally of central interest for psychophysiologists—it has been found that implicitly processed motivational stimuli, like incentive cues, can influence related physiological reactions (e.g., Bijleveld, Custers, & Aarts, 2009; Capa, Cleeremans, Bustin, & Hansenne, 2011; Pessiglione et al., 2007; Silvia, 2012). Contributing to this accumulating evidence for automatic resource mobilization, our laboratory has found that implicitly processed affective stimuli that are processed during task performance systematically influence subjective task demand and effort-related cardiovascular response (e.g., Gendolla & Silvestrini, 2011; Lasauskaite, Gendolla, & Silvestrini, 2013; Silvestrini & Gendolla, 2011a). Other laboratories have recently reported corresponding effects of implicit affect on central nervous system (Chaillou, Giersch, Bonnefond, Custers, & Capa, 2015) and muscular force measures of effort (Blanchfield, Hardy, & Marcora, 2014).

Our studies were guided by the Implicit-Affect-Primes-Effort (IAPE) model (Gendolla, 2012, 2015), which posits that people learn in everyday life that coping with challenges is easier in some affective states than in others. Consequently, performance ease or difficulty become features of individuals' mental representations of different affective states—their emotion concepts (see Niedenthal, 2008). The IAPE model posits that rendering this affect knowledge accessible during task performance leads to experiences of low or high task demand. This, in turn, determines the effort people mobilize according to the principles of motivational intensity theory (Brehm & Self, 1989): effort is mobilized proportionally to subjective demand as long as success is possible and the necessary effort is justified. This prediction has been well supported in numerous studies using cardiovascular indices of effort mobilization (see Gendolla, Wright, & Richter, 2012; Wright & Kirby, 2001 for reviews).

In brief, the IAPE model posits that sadness and fear are associated with difficulty, while happiness and anger are associated with ease. The reason for this is that people should learn that performing

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tasks in a sad mood is subjectively more demanding than performing tasks in a happy mood (see Gendolla & Brinkmann, 2005; Gendolla, Brinkmann, & Silvestrini, 2012). That way, ease becomes a feature of the mental representation of happiness, whereas difficulty becomes a feature of the mental representation of sadness. People should also learn to associate fear with difficulty and anger with ease. This occurs because anger, in contrast to fear, is typically linked with experiences of high coping potential or ability (Lerner & Keltner, 2001), which reduces subjective difficulty (e.g., Wright & Dismukes, 1995). Activating the difficulty or ease concepts by exposing people to implicitly processed emotional stimuli should thus systematically influence physiological reactions related to resource mobilization. Importantly, the IAPE model posits that this process works implicitly, by automatic activation of people's mental representations of emotions, rather than by eliciting emotional states.

So far, the predictions of the IAPE model have been tested and supported for implicit happiness, sadness, and anger. As expected, participants who were exposed to briefly flashed facial expressions of sadness during cognitive tasks rated subjective task difficulty as higher and showed stronger responses of cardiac pre-ejection period (PEP) and systolic blood pressure (SBP) than participants exposed to happiness or anger primes (e.g., Gendolla & Silvestrini, 2011; Lasauskaite et al., 2013). None of our studies found evidence that these effects occurred because the implicitly processed affect primes elicited emotional states. However, to date no study has tested the impact of implicit fear on effort-related physiological reactions.

1.1. Implicit fear

Fear is associated with low control, low coping potential, and rather pessimistic judgments (Lerner & Keltner, 2001). Correspondingly, dispositionally anxious individuals have been found to rate the likelihood of negative events as higher than control participants, reflecting higher pessimism (Gasper & Clore, 1998). It has also been shown that anxiety has detrimental effects on creative performance (Byron & Khazanchi, 2010), arithmetic tasks (Ashcraft & Faust, 1994), and academic performance (Cassaday & Johnson, 2002), supporting the idea that fear is associated with obstacles and thus difficulty. Moreover, conscious feelings of fear and anxiety seem to tax working memory capacity, resulting in impaired performance (Eysenck & Calvo, 1992). That is, there is ample support for the idea that fear is associated with performance difficulties. However, all this evidence concerns effects of consciously experienced fear and anxiety on performance outcomes. Nothing seems to be known about the effect of implicit fear on physiological reactions related to resource mobilization. We conducted the present experiments to close this gap.

1.2. Effort-related cardiovascular response

Wright (1996) has integrated motivational intensity theory (Brehm & Self, 1989) with Obrist's (1981) active coping approach. This led to the prediction that beta-adrenergic sympathetic impact on the heart responds proportionally to the level of experienced task demand as long as success is possible and justified. Beta-adrenergic impact on the heart is best assessed as cardiac PEP—a cardiac contractility index defined as the time interval between the beginning of ventricular excitation and the opening of the heart's left ventricular valve in a cardiac cycle (Berntson, Lozano, Chen, & Cacioppo, 2004). In accordance with Wright's integration, empirical evidence indicates that PEP sensitively responds to variations in experienced task demand (Richter, Friedrich, & Gendolla, 2008), incentive value (Richter & Gendolla, 2009), and combinations of both (Richter, 2010a, 2010b; Silvestrini & Gendolla, 2011b).

Several studies have also assessed responses of SBP, which is systematically influenced by cardiac contractility through its impact on cardiac output (see Gendolla & Richter, 2010; Wright & Gendolla, 2012; Wright & Kirby, 2001). However, both SBP and diastolic blood pressure (DBP) are also influenced by peripheral vascular resistance, which is not systematically affected by ß-adrenergic impact (Levick, 2003), and can mask contractility effects on SBP and DBP. Still other studies (e.g., Eubanks, Wright, & Williams, 2002) have quantified effort as responses in heart rate (HR). Though, HR is influenced by both sympathetic and parasympathetic impact and should only reflect resource mobilization if the sympathetic impact is stronger (Berntson, Cacioppo, & Quigley, 1993). Consequently, PEP is the most reliable and valid indicator of effort intensity among these parameters (Kelsey, 2012). Nevertheless, PEP should always be assessed together with blood pressure and HR to control for possible pre-load (ventricular filling) or after-load (arterial pressure) effects (Sherwood et al., 1990).

1.3. The present research

Our goal was to provide the first experimental tests of the IAPE model (Gendolla, 2012, 2015) prediction that implicitly processed fear primes systematically influence effort-related cardiac response. That is, we tested the theory-based hypothesis that implicit fear leads, similarly as implicit sadness, to stronger performance-related PEP reactivity than both implicit happiness or anger. To test this, we conducted two experiments including two different types of task to facilitate generalization of our expected findings. Moreover, we compared the effects of implicit fear with those of implicit anger and happiness primes in Experiment 1, while we contrasted the effect of implicit fear with that of implicit anger and sadness in Experiment 2. That way we aimed at replicating the anticipated effect of implicit fear on performance-related cardiac PEP. Moreover, we did so to test the IAPE model idea that the effects of implicit affect are emotion-specific rather than valence-specific. Finding the predicted effect that fear and sadness primes lead to stronger PEP response than anger primes would support this idea—all three conditions exposed participants to affect primes of negative valence.

2. Experiment 1

Participants worked on a "parity task" (Wolford & Morrison, 1980). During performance, facial expressions of fear, anger, or happiness were briefly flashed. Cardiovascular measures were recorded during a habituation period before the task and during task performance. As predicted by the IAPE model, we expected stronger PEP reactivity in the fear-prime condition than in both the happiness- and anger-prime conditions.

2.1. Method

2.1.1. Participants and design

Fifty-four university students with different majors (36 women, 18 men, mean age 28 years) were randomly assigned to a 3-cell between-persons design (Prime: fear vs. anger vs. happiness). Participation was remunerated with 10 Swiss Francs (approximately 11 USD). We had to remove 1 participant because of incomplete cardiac data due to measurement problems, 1 participant due to bad signal quality of the impedance measure, 1 participant because she took cardiac medication, and 1 participant because her PEP response exceeded the grand mean by 3.77 *SD*s and was thus considered as an outlier. Although we aimed at recruiting 20 participants for each cell as recommended (Simmons, Nelson, & Simonsohn, 2011) this left a final sample of 50 participants for the PEP and HR measures. Moreover, we lost 8 more participants in