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Goal striving strategies and effort mobilization: When implementation intentions reduce effort-related cardiac activity during task performance

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ABSTRACT

Two experiments investigate the influence of goal and implementation intentions on effort mobilization during task performance. Although numerous studies have demonstrated the beneficial effects of setting goals and making plans on performance, the effects of goals and plans on effort-related cardiac activity and especially the cardiac preejection period (PEP) during goal striving have not yet been addressed. According to the Motivational Intensity Theory, participants should increase effort mobilization proportionally to task difficulty as long as success is possible and justified. Forming goals and making plans should allow for reduced effort mobilization when participants perform an easy task. However, when the task is difficult, goals and plans should differ in their effect on effort mobilization. Participants who set goals should disengage, whereas participants who made if-then plans should stay in the field showing high effort mobilization during task performance. As expected, using an easy task in Experiment 1, we observed a lower cardiac PEP in both the implementation intention and the goal intention condition than in the control condition. In Experiment 2, we varied task difficulty and demonstrated that while participants with a mere goal intention disengaged from difficult tasks, participants with an implementation intention increased effort mobilization proportionally with task difficulty. These findings demonstrate the influence of goal striving strategies (i.e., mere goals vs. if-then plans) on effort mobilization during task performance.

1. Introduction

Success in goal attainment is highly increased by forming plans. While goal intentions are built as "*I intend to achieve X!*" with *X* representing a desired future, outcome or behavior, implementation intentions are plans with the format of "***If** I encounter situation X, **then** I will initiate response Y!*" Forming an if-then plan is a self-regulatory goal-striving strategy facilitating goal attainment (Gollwitzer, 1993, 1999, 2014; Oettingen and Gollwitzer, 2010). Such plans link an anticipated critical situation (i.e., opportunity or obstacle) to an instrumental goal-directed cognitive, affective, or behavioral response. While goal intentions specify a desired future only, implementation intentions spell out when, where (by specifying the if-component) and how (by specifying the then-component) this desired future shall be attained. It has been demonstrated in extensive research that adding implementation intentions to one's goal intentions is an effective self-regulation strategy for promoting goal attainment (see Wieber et al., 2015). However, the question of the influence of implementation intentions on effort-related cardiac activity during task performance is still unanswered.

Using an if-then plan has for instance been shown to help attaining long-term academic goals (Duckworth et al., 2011), to reduce self-handicapping (Thürmer et al., 2013), to help decrease the consumption of unhealthy snacks (Adriaanse et al., 2009), increase vitamin intake (Sheeran and Orbell, 1999), eat a healthy diet (Chapman and Armitage, 2012; Verplanken and Faes, 1999), facilitate recycling behavior (Holland et al., 2006) as well as breaking old habits (e.g., unhealthy snacking) and creating new ones (Adriaanse et al., 2011). By linking an anticipated critical situation to a goal-directed response, implementation intentions have been found to increase both people's perceptual and behavioral readiness when the critical cue specified in the if-then plan is encountered. Forming implementation intentions leads to a heightened activation of the mental representation of the specified critical situational cue, thus increasing its cognitive accessibility (e.g., Achtziger et al., 2012, Study 1; Parks-Stamm et al., 2007), and it also leads to "strategic automaticity." Once the critical situation is encountered, the specified goal-directed response is initiated immediately (Gollwitzer and Brandstätter, 1997), efficiently (Brandstätter et al., 2001), with low controllability (Achtziger et al., 2012, Study 2; Wieber and Sassenberg, 2006), and low conscious involvement (Bayer et al., 2009).

Although many studies by now have demonstrated the positive influence of implementation intentions on task performance and, in addition, delineated the underlying cognitive processes, there is no direct

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evidence for the effects of implementation intentions on effort-related cardiac activity during task performance. Therefore, the aim of the present research is to investigate the influence of implementation intentions on effort mobilization during task performance.

2. Effort-related cardiovascular response

According to the Motivational Intensity Theory (Brehm and Self, 1989), effort is mobilized proportionally to subjectively experienced task demand as long as success is possible and justified. This model, based on the principle of conserving resources, posits that individuals avoid wasting energy and thus mobilize resources proportionally to subjective task demand as long as success appears possible and attaining it justifies the mobilization of effort. On the basis of this psychophysiological literature (Obrist, 1981; Kelsey, 2012; Wright, 1996), we quantify effort mobilization by performance-related changes in cardiac contractility force regarding the cardiac pre-ejection period (PEP).

Based on Wright's (1996) integration of the Motivational Intensity Theory (Brehm and Self, 1989) and Obrist's (1981) active coping approach, it has been demonstrated that beta-adrenergic receptor activity is directly proportional to the level of experienced task demand, given that success is perceived as possible and effort seems justified. In a non-invasive way, the increase of beta-adrenergic receptor activity relates to the increase of cardiac contractility. A strong cardiac contractility indicates a higher effort mobilization. Among the different cardiac indicators, the increase of the cardiac contractility speaks to a shortened cardiac PEP. The cardiac pre-ejection period is defined as the time interval between the onset of the heart's left ventricular excitation and the opening of the aortic valve (Berntson et al., 2004). This cardiac index (measured in milliseconds) refers directly to the cardiac contractility (the inherent strength of the heart's contraction) of the left ventricle before blood is ejected into the vasculature system. Cardiac PEP is directly influenced by β-adrenergic impact, and is the most reliable indicator of the cardiac contractility force, and thus of effort mobilization during task performance (Kelsey, 2012).

In support of Wright's integrative model (Wright, 1996), cardiac PEP sensitively responds to variations in task difficulty (Freydefont et al., 2012; Richter et al., 2008; Richter, 2012; Richter et al., 2012; Silvestrini and Gendolla, 2013). Various studies also assessed effort in terms of reactivity of systolic blood pressure (SBP), systematically influenced by cardiac contractility through its impact on cardiac output (see Gendolla and Richter, 2010; Wright and Kirby, 2001). However, both systolic and diastolic blood pressure (DBP) are also influenced by peripheral vascular resistance, which is not systematically influenced by β-adrenergic impact (Levick, 2003) and can thus mask contractility effects on SBP and DBP. Still other studies (e.g., Eubanks et al., 2002) have quantified effort in terms of heart rate response (HR). However, HR is influenced by both sympathetic and parasympathetic activity of the heart and thus only reflects effort mobilization if the sympathetic activity is stronger than the parasympathetic activity (Berntson et al., 2004). In sum, of all of the indicators of effort intensity listed above, cardiac PEP is considered to be the most reliable and valid (Kelsey, 2012). Nevertheless, cardiac 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).

3. The present research

Based on both previous research on forming goal and implementation intentions and the literature on effort mobilization during task performance, we conducted two experiments in order to investigate the moderating effect of goal and implementation intentions on effort-related cardiac activity during task performance. Goal intentions achieve their beneficial effects on goal attainment via the induction of a commitment to reach the goal at hand. As long as the goal is easy or only moderately difficult this commitment assures goal attainment (e.g., Locke and Latham, 1990, 2013). However, when goal striving is very challenging, the forming of implementation intentions is needed to attain one's goals (Oettingen, 2012). Forming implementation intentions facilitates goal attainment by creating an automaticity regarding the initiation of goal-directed responses (summary by Gollwitzer, 2014). Once the critical situation specified in the implementation intention is encountered, goal-directed responses are initiated swiftly and efficiently (e.g., Brandstätter et al., 2001). Therefore, based on Brehm and Self (1989), we hypothesized that action control by implementation intentions (as it runs off in an effortless way) should reduce the perceived task demand and subsequent effort mobilization during task performance.

Experiment 1 investigates the influence of forming goal intentions and implementation intentions (compared to a control group with mere task instructions) on effort mobilization during the performance of an easy classification task (i.e., a straightforward number identification task). We predicted a lower effort-related cardiac activity in both the implementation intention and the goal intention conditions compared to the control condition. However, as perceived task demand is also influenced by the level of task difficulty (i.e., the more difficult the task, the higher the experienced task demand as long as success is possible and justified; Richter et al., 2008), we designed Experiment 2 to investigate the conjoint impact of task difficulty and having formed goal vs. implementation intentions on effort mobilization during a difficult and very difficult dual task. In line with the Motivational Intensity Theory (Brehm and Self, 1989), we predicted that participants in the goal intention condition should readily disengage when the task becomes very difficult, as success is no longer perceived as possible and thus effort mobilization does not seem to be justified anymore. In contrast, participants who formed implementation intentions should "stay in the field;" their effort-related cardiac activity should be higher in the very difficult task condition, as successful task performance still appears feasible and justified.

4. Experiment 1: The moderating effect of goal and implementation intentions on effort–related cardiac activity during easy task performance

Past research on goals and plans shows that committing to easy goals facilitates goal attainment (Locke and Latham, 1990). Moreover, making additional plans on how to reach these goals does not provide a further benefit (Gollwitzer and Sheeran, 2006). Rather, forming mere goal intentions suffices to promote goal striving. Based on these findings and according to the Motivational Intensity Theory (Brehm and Self, 1989), we posited that both the goal intention strategy and the implementation intention strategy should moderate task demand when having to perform an easy task, and as a consequence, should reduce effort mobilization during task performance. In order to provide evidence of a moderating effect of goal and implementation intentions on effort-related cardiac activity, an experiment composed of three conditions (goal intention, implementation intention, and control) was conducted. Assessing cardiovascular activity, SBP, DBP, HR, and especially cardiac PEP as a direct measure of effort mobilization during task performance, we predicted a weaker cardiac PEP reactivity in both the goal and the implementation intention conditions as compared to the control condition (where participants only received task instructions).

4.1. Method

4.1.1. Participants and design

Sixty healthy undergraduate psychology students (37 women, $M_{age} = 19.91$, $SD = 1.38$) from New York University were randomly assigned to one of 3 experimental conditions (goal intention vs. implementation intention vs. control). Participation in this experiment was voluntary and course credit was given for participation. However, data from 13 participants were excluded because of incomplete data due to