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Pay attention to your manipulation checks! Reward impact on cardiac reactivity is moderated by task context

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ABSTRACT

Two experiments assessed the moderating impact of task context on the relationship between reward and cardiovascular response. Randomly assigned to the cells of a 2 (task context: reward vs. demand) × 2 (reward value: low vs. high) between-persons design, participants performed either a memory task with an unclear performance standard (Experiment 1) or a visual scanning task with an unfixed performance standard (Experiment 2). Before performing the task—where participants could earn either a low or a high reward—participants responded to questions about either task reward or task demand. In accordance with the theoretical predictions derived from Wright's (1996) integrative model, reactivity of pre-ejection period increased with reward value if participants had rated aspects of task reward before performing the task. If they had rated task demand, pre-ejection period did not differ as a function of reward.

Common sense suggests that the more you desire something the harder you will work to get it. In cardiovascular psychophysiology this idea is reflected by the hypothesis that cardiovascular responses are a direct function of reward value: the more valuable a reward, the higher the cardiovascular response (e.g., Belanger and Feldman, 1962; Brenner et al., 2005; Elliot, 1969; Fowles, 1983; Fowles et al., 1982; Lipsitt et al., 1976; Smith et al., 1989, 1997, 2000; Tranel, 1983; Tranel et al., 1982). Drawing on an analysis by Wright (1996), Richter and Gendolla (2006, 2007, 2009) specified the conditions under which cardiovascular responses in active coping situations should be a function of reward value. They demonstrated that the proportional relationship between reward value and cardiovascular response only holds if individuals perform a task with an *unclear* performance standard. If individuals perform a task with a *clear* performance standard, reward and cardiovascular responses bear no direct relation. These results seem to suggest that the clarity of the performance standard determines the impact of reward on cardiovascular responses. The present research aims to broaden this perspective by demonstrating that the performance standard is not crucial but that the general task context moderates the reward–cardiovascular response relationship.

1. Motivational intensity theory and active coping

Integrating motivational intensity theory (Brehm and Self, 1989) and the active coping approach (Obrist, 1981), Wright (1996) developed a model that predicts cardiovascular responses in active coping situations. Motivational intensity theory is concerned with the mobilization of resources for the execution of instrumental behavior. According to the theory, resource mobilization is governed by a conservation principle. Trying to avoid wasting resources, individuals invest only the resources that are necessary for task success. Since task difficulty indicates the amount of necessary resources, resource investment should rise with increasing task difficulty. This proportional relationship between task difficulty and resource mobilization is limited by two variables: task difficulty and success importance. (1) If task difficulty is so high that success is impossible, individuals should withhold resources. (2) If the necessary resources for task success outweigh the benefits, individuals should disengage, as well. In sum, resource mobilization should depend on task difficulty as long as task success is possible and the necessary resources are justified by success importance. However, this hypothesis should only be valid for instrumental tasks with a clear and fixed performance standard. In contrast, if the performance standard (i.e., task difficulty) is either unclear or can be chosen by the performers themselves, resource mobilization should directly increase with success importance—which depends on needs, task instrumentality, and reward value.[1]

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[1] In the literature on motivational intensity theory, the terms "fixed difficulty", "unclear difficulty", and "unfixed difficulty" are used to refer to the three kinds of tasks. "Fixed difficulty" refers to tasks where the performance standard is fixed and where individuals know about the level of this standard. "Unclear difficulty" refers to tasks where the performance standard is fixed but individuals do not know about the exact level of this standard. In both kinds of tasks, task outcome is dichotomous: If an individual attains or exceeds the required performance standard, the task counts

Wright (1996) integrated these predictions of motivational intensity theory (Brehm and Self, 1989) with Obrist's observation that task engagement in active coping tasks (i.e., when task outcome depends on the performer's performance) is associated with (sympathetic) beta-adrenergic impact on the heart (e.g., Light and Obrist, 1980; Obrist, 1976; Obrist et al., 1978, 1987). Drawing on both approaches, Wright predicted that cardiovascular reactivity—the change in cardiovascular activity from rest to task performance—should rise with task difficulty as long as the necessary resources are justified and task success is possible. If the performance standard is unknown, cardiovascular reactivity should be a direct function of success importance. He further specified that among the cardiovascular parameters systolic blood pressure (SBP), diastolic blood pressure (DBP), and heart rate (HR), SBP should be the most sensitive to variations in resource investment or task engagement, respectively. SBP is a function of both the force of myocardial contraction and the total peripheral resistance. Correspondingly, it reflects beta-adrenergic activity—which is the main determinant of myocardial contraction force (Berne and Levy, 1977; Ganong, 2005)—when the effects of total peripheral resistance are negligible. Since total peripheral resistance has a strong influence on DBP, effects of myocardial contraction force on DBP are more likely to be masked by effects of total peripheral resistance than effects on SBP. HR is a function of both sympathetic and parasympathetic effects and only reflects sympathetic changes if parasympathetic activity does not change.

In the last 10 years evidence supporting Wright's approach has accumulated (Gendolla and Wright, 2005; Richter et al., 2006; Wright and Kirby, 2001, for reviews). Various empirical studies have demonstrated that cardiovascular reactivity—especially SBP reactivity—in active coping situations is a joint function of task difficulty and success importance if performance standards are fixed and clear (e.g., Eubanks et al., 2002; Gendolla and Richter, 2006; Wright et al., 1998). Researchers have also begun to investigate the underlying physiological mechanisms in more detail by assessing pre-ejection period (PEP) (Annis et al., 2001; Richter et al., 2008; Richter and Gendolla, 2009). PEP is the time interval between the onset of ventricular depolarization and the opening of the aortic valve. It constitutes one of the best non-invasive indicators of beta-adrenergic impact on the heart (Sherwood et al., 1990) and enables a more valid test of whether myocardial beta-adrenergic activity plays the predicted role in resource mobilization.

There is also support for the hypothesis that success importance directly determines cardiovascular reactivity when individuals have no clear idea about the performance standard of a task (Richter and Gendolla, 2006, 2007, 2009) or when they are free to choose their own performance standard (Wright et al., 2002, 1995). Participants in a study by Richter and Gendolla (2006) worked on either an easy (Experiment 1) or an impossible (Experiment 2) memory task. In both experiments participants could earn either a low or a high reward by successfully performing the task. All participants were informed about the general task procedure but only one half received additional information about the difficulty of the task. The other half received no task difficulty information. In both experiments, cardiovascular reactivity was higher in the high reward condition than in the low reward condition if participants were not informed in advance about the difficulty of the task. If participants received task difficulty information before performing the task, reward value and cardiovascular reactivity were dissociated.

as success. If an individual falls short of the required standard, the task counts as failure. "Unfixed difficulty" refers to tasks where no performance standard is fixed in advance and individuals are free to choose their own level of performance. As a consequence of this, there is no success–failure dichotomy in tasks with "unfixed difficulty".

The results reviewed above seem to suggest that the clarity of the performance standard determines if reward value and cardiovascular response are associated in active coping tasks. However, these effects might also reflect a more general principle. Informing participants that they can earn a reward by successfully performing a task renders task reward salient. Providing additional information about task difficulty heightens the salience of task demand. According to motivational intensity theory, resource mobilization should be governed by task difficulty if task demand is salient, whereas task reward should determine resource mobilization if task demand is unknown (i.e., not salient). Correspondingly, the impact of reward on cardiovascular reactivity should vary with the task context. (1) If the task context renders task reward salient, cardiovascular reactivity should increase with increasing reward value. (2) If task demand is salient in a given context, reward value should have no direct impact on cardiovascular reactivity.

The aim of the presented research was to demonstrate that the impact of reward on cardiovascular responses is moderated by the task context. Specifically, I tried to demonstrate that "manipulation checks" presented before task performance can modify the impact of reward on cardiovascular reactivity. If participants respond to questions about task reward, task reward should be salient and reward value should directly determine cardiovascular reactivity (i.e., high cardiovascular reactivity under conditions of high reward, low cardiovascular reactivity under conditions of low reward). If they answer questions about task demand, task difficulty should be salient and reward value should have no impact on cardiovascular reactivity. Based on previous research and Obrist's hypothesis about the association between task engagement and beta-adrenergic impact, I expected the joint effect of task context and reward to be especially pronounced for PEP reactivity.

2. Experiment 1

2.1. Method

2.1.1. Participants and design

Fifty-one psychology students (mean age 24 years) participated for course credit. They were randomly assigned to the cells of a 2 (task context: reward vs. demand) × 2 (reward: 2 Swiss Francs vs. 12 Swiss Francs) between-persons design. The distribution of women and men was as follows: 13 women and 1 man in the demand-2-Swiss-Francs cell, 12 women and 2 men in the demand-12-Swiss-Francs cell, 12 women and 1 man in the reward-2-Swiss-Francs cell, and 10 women in the reward-12-Swiss-Francs cell. Participation was anonymous and voluntary. Given the low number of men, I will only report the results for the sample restricted to female participants. The results for the unrestricted sample were virtually identical.

2.1.2. Apparatus and physiological measurement

A Vasotrac APM 205A system (Medwave, Arden Hills, MN) and a Cardioscreen 1000 system (medis, Ilmenau, Germany) assessed cardiovascular measures during baseline period and task performance. The Vasotrac system measured SBP, MAP, and DBP (all in millimeters of mercury [mmHg]) with a cuff placed around the wrist of the participant's non-dominant arm. One blood pressure measure was obtained every 12–15 heart beats. The Cardioscreen system used four pairs of disposable spot electrodes to assess an electrocardiogram (ECG) and thoracic impedance (impedance cardiogram, ICG) (see Scherhag et al., 2005, for a validation of the system). Sampling rate was 800 Hz. The spot electrodes were placed on the right and left side of the base of the participant's neck and on the left and right middle axillary line at the height of the xiphoid. Both systems directly stored the collected measures on a computer