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Gloomy and Lazy? On the Impact of Mood and Depressive Symptoms on Effort-Related Cardiovascular Response

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Gloomy and Lazy? On the Impact of Mood and Depressive Symptoms on Effort-Related Cardiovascular Response

This chapter presents recent findings from a program of research on the systematic influence of transient mood states and depressive symptoms on resource mobilization for coping with mental challenges. The tested predictions stem from an integrative theory about the impact of mood states on behavior—the mood-behavior-model (MBM; Gendolla, 2000)—under consideration of the principles of motivational intensity theory (Brehm & Self, 1989) and their integration with Obrist's (1981) active coping approach by Wright (1996).

During the last decade, most of our studies in this program of research have focused on changes in systolic blood pressures (SBP) during the induction of mood states and the subsequent performance of mental challenges. Our focus on SBP has been based on the ample evidence for its sensitive reactivity to manipulations of experienced task demand as long as success on a challenge is perceived as possible and justified (see Wright, 1996; Wright & Kirby, 2001, for reviews). Evidence for effects on diastolic blood pressure (DBP) and heart rate (HR) is existent but less consistent—which is plausible for physiological reasons. Both SBP and DBP are influenced by myocardial contractility that is potentiated by β-adrenergic sympathetic discharge. But effects on DBP are more likely to be masked by changes in total peripheral resistance than effects on SBP (Levick, 2003). Therefore, SBP shows similar reactivity patterns to task difficulty manipulations as measures of myocardial contractility (e.g., Richter, Friedrich, & Gendolla, 2008). HR, another frequently assessed cardiovascular parameter is determined by both sympathetic and parasympathetic arousal and should thus only respond to effort mobilization when the sympathetic impact is stronger, which is not always the case (Berntson, Cacioppo, & Quigley, 1993; Brownley, Hurwitz, & Schneidermann, 2000; Obrist, 1981).

In this chapter we will first briefly present the theoretical reasoning about why and how moods can influence effort-related cardiovascular response. Then we will present and discuss recent research that tested these predictions in experiments with manipulated mood states and studies that investigated the impact of individual differences in depressive symptoms on effort-related responses of the cardiovascular system.

The Mood-Behavior-Model

Moods are long lasting affective states that are experienced without concurrent awareness of their origins (e.g., Schwarz & Clore, 1988). These characteristics of mood states have important consequences for their potential impact on behavior, which becomes clear by comparing moods with emotions: Whereas short lived, specific, object-related emotions (e.g., happy, sad, angry about…) provide goals (e.g., fear - security, anger - destruction) and relatively short autonomic adjustments that reflect the mobilization of resources for emotion-specific action (e.g., Kreibig, Gendolla, & Scherer, 2010; see Kreibig this volume), moods are feeling states themselves without a clear motivational function. Nevertheless, the mood-behavior-model posits that moods systematically influence resource mobilization in instrumental behavior by means of their informational and directive impacts.

Informational mood impact. Individuals can use their moods as diagnostic information for behavior-relevant appraisals like “How difficult is the task?“, or “Am I able to succeed?”. Given the ample evidence that resource mobilization follows an energy conservation principle according to which individuals avoid wasting resources (Brehm & Self, 1989), the type of appraisal that is central for effort mobilization is the subjective impressions of task *demand* or *difficulty*. As for any kind of evaluative judgment (see Wyer, Clore, & Isbell, 1999, for a review), moods can influence such appraisals in a mood congruent manner—people are more optimistic and make more positive judgments in a positive than in a negative mood. Consequently, a task is experienced as more difficult in a negative mood than in a positive mood—but only as long as the diagnostic, informative value of mood for appraising demand is not called into question (Gendolla & Krüsken, 2002a). Resulting effects of mood on effort-related cardiovascular response are depicted in Figure 1.

When people perform a task without fixed difficulty under “do your best” instructions, mood is one type of salient information for evaluating task demand. Subjective task difficulty is thus higher in a negative mood than in a positive mood. The result is stronger effort-related cardiovascular activity in a negative mood than in a positive mood (e.g., Gendolla, Abele, &

Krüsken, 2001; Gendolla & Krüsken, 2001a).

However, a negative mood does not always lead to higher effort. If people work on a task with fixed task difficulty, the mood-behavior-model states that they will pragmatically use both types of information—mood and task difficulty—as demonstrated in recent experiments (e.g., Gendolla & Krüsken, 2001b, 2002b). Consequently, for an easy task effort is higher in a negative mood than in a positive mood, because subjective demand and—as a result—mobilized resources are higher in a negative mood. But when a task is objectively difficult, effort is higher in a positive mood than in a negative mood. The reason is that here subjective demand is high but not yet too high in a positive mood, whereas it is already too high for active coping in a negative mood. Finally, when objective task difficulty is extremely high, so that active coping is obviously impossible, mood cannot provide additional diagnostic information and mobilized resources are low due to disengagement (Gendolla & Krüsken, 2002c).

Directive mood impact. Beside the informational mood impact, the MBM posits that moods can have a directive impact on the instigation and direction of behavior in compliance with a hedonic motive. This directive mood impact influences the extent to which people prefer actions that are instrumental for hedonic affect-regulation—i.e., maximizing pleasure and minimizing distress. The mood-behavior-model predicts that the strength of a person's hedonic motive—i.e., the momentary need for the experience of well-being—increases with mood intensity. Both intense positive and negative moods result in a high interest in activities that promising positive affect through their pleasant associations or consequences (e.g., Silvestrini & Gendolla, 2007). Referring to motivational intensity theory (Brehm & Self, 1989), opportunities for affect regulation should influence the level of justified resources (i.e, potential motivation). Up to this limit actual effort is mobilized in proportion to the level of experienced demand.

Mood Impact on Cardiovascular Response: Empirical Evidence

During the last decade, the predictions outlined so far have received ample empirical support from a series of experimental studies. The basic experimental protocol in this research consisted of (1) a habituation period to assess physiological baseline values, (2) mood inductions with video excerpts, music presentations, or autobiographical recollection tasks, and (3) a cognitive challenge—typically an attention or memory task. The dependent variable was cardiovascular reactivity—especially SBP—during the mood inductions and task performance with reference to baseline values assessed during habituation.

In support of the predictions of the mood-behavior-model it was found that (1) demand appraisals were higher in a negative mood and produced stronger SBP reactivity during performance than in a positive mood if task difficulty was not fixed and participants performed under “do your best” instructions (e.g., Gendolla et al., 2001; Gendolla & Krüsken, 2001a, 2002b). (2) These mood effects were neutralized when the diagnostic value of mood for demand appraisals was called into question by the experimental context (Gendolla & Krüsken, 2002a). (3) When participants performed tasks with fixed performance standards, they used both their mood and the performance standard to appraise demand, resulting in the anticipated crossover pattern of mood and objective task difficulty (Gendolla & Krüsken, 2001b, 2002b): For easy tasks, SBP reactivity was stronger in a negative mood than in a positive mood, because subjective demand for participants in a negative mood was higher than for those in a positive mood. However, for difficult tasks, systolic reactivity was stronger in a positive mood than in a negative mood, because here subjective difficulty was high but still feasible in a positive mood, whereas it was too high in a negative mood, resulting in disengagement. The effects of positive and negative moods for easy and difficult tasks resemble those of high and low ability (e.g., Wright & Dismukes, 1993) and high and low fatigue (e.g., Wright, Martin, & Bland, 2003; see Wright & Stewart, this volume). (4) Finally, as initial support for the idea that a positive hedonic incentive justifies high effort, we found that pleasant performance-contingent consequences of success can eliminate the motivational deficit of people who face a difficult task in a negative mood (Gendolla & Krüsken, 2002c). None of those studies had found mood effects on cardiovascular reactivity during the mood inductions.

Recent Findings on the Effect of Transient Mood States

None of our studies discussed above found mood effects on cardiovascular reactivity during the mood inductions. However, a recent experiment (de Burgo & Gendolla, 2009) was conducted as a more conclusive test of the mood-behavior-model assumption that moods themselves are not motivational states and that they thus do only have an impact on cardiovascular response when they can be used as task-relevant information for demand appraisals. After being induced in positive vs. negative moods with video excerpts, participants were presented a list of letter series. In an intentional learning condition the list presentation was clearly framed as an achievement task—participants were explicitly instructed to correctly memorize all series within five minutes. By contrast, in an incidental learning condition, the list was merely presented and nothing was mentioned concerning memorizing or achievement measures. As in our previous studies SBP reactivity did not differ between the mood conditions during the mood inductions, although the verbal mood manipulation checks indicated successfully manipulated positive and negative mood states. Most relevant, in the intentional learning condition SBP reactivity was, as expected, stronger in a negative mood than in a positive mood, while mood had no effect in the incidental learning condition. DBP reactivity revealed a similar pattern. The results support the idea that moods have only an effect on cardiovascular response when they can be used as task-relevant information for demand appraisals.

Another recent experiment (Silvestrini & Gendolla, 2007) investigated the influence of mood on effort-related cardiovascular response in a mood regulation task. Participants were asked to regulate their feelings within 5 min to attain a hedonically positive outcome. Predictions were as follows: Based on the informational mood impact, participants in a positive mood should evaluate this task as easier than those in a so called “neutral” (i.e., less intense) and especially those in a negative mood. However, according to the directive mood impact, both participants in a negative and a positive mood should have a higher need for well-being than those in a neutral mood. Consequently, cardiovascular response during the mood regulation task should be higher in a negative mood (high subjective difficulty/high justified effort) than in both a neutral (relatively high difficulty/low justified effort) and a positive mood (low subjective difficulty/high justified effort).

After habituation, participants were first induced into a negative, a neutral, or a positive mood through film presentations and then performed the affect regulation task. SBP reactivity exactly described the predicted pattern and was stronger in a negative mood than in both the neutral and positive mood conditions, which did not differ from one-another. Additionally, changes in tonic skin conductance level resembled that pattern, which is supportive to the idea that mood regulation is an act of difficult self-control, which is typically associated with increased electrodermal activity (e.g., Wegner, Shortt, Blake, & Page, 1990). Additional analyses of facial electromyogram during the mood induction period revealed stronger zygomaticus major reactivity in the positive mood condition than in both the neutral and negative mood cells. During the affect regulation task there was a general increase in zygomatic activity. In accordance with verbal mood manipulation checks, this indicates that the mood inductions were effective and that participants in all conditions succeeded on the affect regulation task—although those in the negative mood condition had to mobilize more resources for this outcome, as indicated by the SBP reactivity pattern.

A study by Richter and Gendolla (2009a) considered the possibility that mood may—under certain conditions—also influence effort mobilization by its informational impact on appraisals of the instrumentality of success. Participants were induced into positive, neutral, or negative moods by an autobiographical recollection task and worked then on a memory task with *unclear* task difficulty. For this type of task, the difficulty of the task can be fixed—the difficulty level is, however, unknown to participants (see Richter, this volume). In the administered memory task participants were presented with letter series they had to memorize. However, they did neither know how many series would appear, nor how long the task would last, nor in which time intervals the series would appear. Unlike the unfixed task difficulty tasks described above, participants were not asked to “do their best” but to memorize all series that would appear. Previous research has found that reward value directly determines effort intensity when task difficulty is unclear (e.g., Richter & Gendolla, 2006, 2009b).

Before task onset participants learned that they could earn the chance of winning a monetary reward if they succeeded and rated the probability of winning the monetary reward. Probability ratings in a positive mood were higher than those in a negative mood—suggesting that success was more worthwhile in a positive mood (high probability to get the reward) than in a negative mood (low probability to get the reward). Corresponding to this, SBP reactivity during task performance increased from negative to positive mood. This effect was statistically mediated by participants' subjective probability ratings of winning the monetary reward for successful performance. These results demonstrate that mood can influence effort mobilization not only by taking effect on appraisals of subjective demand, but also by influencing judgments of the instrumentality of success. Furthermore the findings sustain the mood-behavior-model argument that moods have no fixed effects on resource mobilization. Rather, moods' impact on resource mobilization depends on the type of judgment—e.g., instrumentality vs. demand—for which they are used as information.

Effects of Depressive Symptoms

Other studies have applied the mood-behavior-model reasoning to an experimental analysis of depressive symptoms' impact on effort-related cardiovascular response. Based on the common view of depression (see Gotlib & Hammen, 2002), one could hypothesize that depression is characterized by a general motivational deficit. Our analysis, however, challenges this view at least with respect to resource mobilization. Considering that a persistent negative mood is a core symptom of depression, we hypothesized that the impact of depressive symptoms on effort mobilization is moderated by task characteristics and mood-congruent appraisals of task demand. In general, the impact of clinical as well as subclinical depressive symptoms should resemble that of transient mood states.

Our first studies (Gendolla & Brinkmann, 2007) recruited undergraduate students with low ("nondysphoric") versus high ("dysphoric") scores on a self-report depression scale and confronted them with tasks of unfixed difficulty ("do your best"). In one protocol participants were presented with a list of letter series and were asked to correctly memorize within 5 min as many series as possible. In accordance with our hypotheses, dysphoric participants showed stronger SBP reactivity at the beginning of the performance period than nondysphorics. This result was replicated in a second study using a mental concentration task. During the whole performance period, dysphoric participants showed stronger SBP and HR reactivity than nondysphorics. These two studies suggest that depression is not associated with a general motivational deficit. Rather, at least with respect to resource mobilization, a task that asks to “do one’s best” can elicit high effort in dysphoric individuals.

In a second pair of studies (Brinkmann & Gendolla, 2008) dysphoric and nondysphoric participants’ performed either an easy or a difficult version of a concentration task (Study 1) or the memory task (Study 2). In both studies, results revealed the expected cross-over interaction pattern that had been previously observed for manipulated negative and positive moods and fixed task difficulty (see above): In the easy condition dysphoric participants showed stronger SBP reactivity than nondysphoric participants. In the difficult task condition, however, nondysphoric participants showed stronger SBP reactivity (Figure 2). Moreover, demand appraisals assessed before performance indicated that dysphoric participants perceived the memory task in Study 2 as more difficult. It is also of note that dysphoric and nondysphoric participants did not differ in cardiovascular baseline activity in any of the four studies discussed above.

In summary, these findings show that depressive symptoms are not necessarily associated with a motivational deficit in effort mobilization and that task difficulty plays an important role in determining whether depression leads to enhanced or attenuated cardiovascular response: When task difficulty is unfixed or easy, dysphoric individuals mobilize even more effort that nondysphorics.

The Joint Impact of Mood, Task Difficulty, and Reward

Another line of our research focused on a differentiated analysis of the simultaneous effect of informational and directive mood impacts on effort-related cardiovascular response, as conceptualized in the mood-behavior-model. These studies were built on the basic idea that actions that are instrumental for hedonic affect regulation—i.e., attaining or maintaining positive affect—justify the investment of more effort than actions without positive hedonic characteristics or outcomes. To test this, these studies simultaneously manipulated mood, task difficulty, and hedonic incentive. In terms of motivational intensity theory (Brehm & Self, 1989), positive hedonic incentive should justify relatively high resources—it makes success worthwhile. The actual intensity of mobilized effort should, however, depend on subjective task difficulty that is jointly determined by objective task difficulty and mood, as outlined above (e.g., Brinkmann & Gendolla, 2008; Gendolla & Krüsken, 2001b, 2002b).

Specific predictions for the joint effect of mood, task difficulty, and hedonic incentive are as follows: When success is only connected with low hedonic incentive, the amount of justified effort is low. Up to this relatively low level of maximally justified resources effort-related cardiovascular response is determined by the informational mood impact. If a task is objectively easy, people in a negative mood tend to mobilize more effort than do people in a positive mood; if a task is objectively difficult, people in a negative mood tend to mobilize little effort, as discussed above. By contrast, when the hedonic incentive of success is positive, more resources are justified because successful performance is appetitive. Those justified resources are, however, only mobilized when the level of experienced task demand necessitates this. This is the case when a negative mood is combined with a difficult task (the condition that leads to disengagement because of too high subjective demand when only low resources are justified). That is, high hedonic incentive of success should eliminate the motivational deficit of people in a negative mood who face a difficult task.

We tested these predictions in an experiment that simultaneously manipulated mood, task difficulty, and hedonic incentive (Silvestrini & Gendolla, 2009a). After habituation and manipulation of positive vs. negative moods, participants performed either an easy or a difficult memory task with either pleasant or unpleasant consequences of success. In the high-hedonic-incentive condition, participants were promised the presentation of a comedy video after success, whereas in the low—in fact negative—incentive condition they expected the presentation of a distressing video after success. As depicted in Figure 3, SBP reactivity during task performance depicted the predicted pattern: When success provided low hedonic incentive, SBP reactivity revealed the crossover interaction pattern anticipated for the joint effect of mood and objective task difficulty. However, when the hedonic incentive of success was high, SBP reactivity of participants in the negative-mood/difficult-task condition increased significantly, because the positive incentive justified the very high effort that was perceived as necessary here. These results suggest that it is not success per se that justifies the mobilization of high effort. Rather, positive hedonic aspects of succeeding are necessary. Corresponding results were found in an experiment in which we manipulated mood, task difficulty, and pleasantness vs. unpleasantness of a task itself (Gendolla & Silvestrini, 2009b). Task pleasantness had the same effects as positive hedonic incentive in the study discussed above.

Depressive Symptoms, Reward-Responsiveness, and Cardiovascular Response

The Silvestrini and Gendolla (2009a) experiment has shown that hedonically positive consequences of success have a strong impact on effort-related cardiovascular response: they can motivate people who face a difficult task in a negative mood to mobilize the high effort that appears to be necessary for success. However, research on responsiveness to reward and punishment suggests that this may be different for individuals suffering from depressive symptoms: depressed and dysphoric individuals do not behaviorally respond to monetary reward and punishment (e.g., Henriques & Davidson, 2000), report less behavioral approach motivation (e.g., Kasch, Rottenberg, Arnow, & Gotlib, 2002), show hypoactivation of left frontal regions associated with approach behavior (e.g., Davidson, Pizzagalli, Nitschke, & Putnam, 2002), and have altered neurotransmission and activation of cortical and subcortical reward areas (e.g., Nestler & Carlezon, 2006). Based on this evidence, studies by Brinkmann, Schüppach, Ancel Joye, and Gendolla (2009) directly tested the hypothesis of a reduced responsiveness to reward and punishment in dysphoric individuals in terms of effort mobilization. These studies administered tasks with unclear difficulty, because this type of task permits a direct test of the effects of reward and punishment on effort mobilization (see Richter, this volume). People in general mobilize more effort when reward is high than when reward under conditions of unclear task difficulty (Richter & Gendolla, 2006, 2009b). The reduced reward-responsiveness hypothesis suggests that this should not be the case for depressed individuals.

Participants in the first study by Brinkmann et al. performed a mental arithmetic task under one of three conditions: reward of 10 Swiss Francs for success, punishment asking for refunding previously received 10 Swiss Francs, or no performance-contingent consequence. Results confirmed that participants with high depression scores—in contrast to those with low scores—did not respond with increased SBP reactivity to anticipated punishment. The second study replicated these results for reward. In accordance with prior studies (Richter & Gendolla, 2006, 2009b), nondysphoric participants showed strong increases in both SBP and myocardial contractility (reflected by shortened pre-ejection period [PEP]) if they were offered 10 Swiss Francs for successful performance. In contrast, dysphoric participants' cardiovascular reactivity was rather low and did not differ from the neutral condition without performance-related consequences (see Figure 4).

Taken together, depressives' reduced responsiveness to reward and punishment is also evident in reduced effort-related cardiovascular response. More important, these studies suggest that depressed individuals cannot as easily be motivated to mobilize effort in order to cope with difficult or very difficult demands. Strategies to increase motivation and effort mobilization—such as high importance of task success or a task's incentive value itself—might not work for depressed individuals, though they work for people in a transitorily negative mood (e.g., Gendolla & Krüsken, 2002b; Silvestrini & Gendolla, 2009a, 2009b).

Summary and Conclusions

Following the first wave of research on the impact of mood states on effort-related cardiovascular response (see Gendolla & Brinkmann, 2005, for a review), the studies discussed in this chapter have brought new insights, particularly about the informational impact of mood on effort mobilization, the role of mood in affect-regulation, and the effect of depressive symptoms.

The experiment by de Burgo and Gendolla (2009) has provided conclusive evidence for the assumption that moods per se are not motivational states and that moods only systematically influence resource mobilization when they can be used as information for demand appraisals. That is, moods themselves have no impact on resource mobilization—a finding that contradicts approaches that have attributed stable motivational implications to moods (e.g., Morris, 1992; Schwarz, 1990). The Richter and Gendolla (2009a) study has demonstrated that mood effects on effort-related cardiovascular response are not limited to their effect on demand appraisals. When task difficulty is unclear, moods can influence effort mobilization by affecting instrumentality appraisals and thus the importance of success. This further shows that mood effects on resource mobilization heavily depend on task context.

The studies by Silvestrini and Gendolla (2009a, 2009b) have shown that the effort mobilization deficit typically shown by people who face a difficult task in a negative mood (e.g., Gendolla & Krüsken, 2001) can be eliminated if success is instrumental for hedonic affect regulation. However, regarding the effect of performance-contingent incentive in general, the studies by Brinkmann et al. (2009) suggest that such incentive effects do not apply to people suffering from depressive symptoms. Although depressive symptoms have effects on effort-related cardiovascular response that correspond to those of transient mood states when incentive is not manipulated—i.e., a merely informational impact on experienced demand (Brinkmann & Gendolla, 2007, 2008)—individuals with depressive symptoms have been found to be “immune” to performance-contingent incentive. Integrating these findings suggests that depression is not associated with a general motivational deficit—depressives mobilized more effort under “do your best” instructions or for an easy task than non-depressives. Rather, depression seems to be related to a deficit in incentive motivation.

In this context, it is important to note that previous studies did not come to unequivocal conclusions about the enhancing or attenuating effect of depression and dysphoria on cardiovascular activity (e.g., Carroll, Phillips, Hunt, & Der, 2007; Kibler & Ma, 2004; Salomon, Clift, Karlsdóttir, & Rottenberg, 2009). According to our analysis and findings, “blunted reactivity” of depressed individuals (see Carroll, Phillips, & Lovallo, this volume) is explicable by disengagement due to over-challenge. This occurs when depressed individuals are confronted with difficult demands that appear to be over-challenging due to an informational impact of depressed mood on demand appraisals, as discussed above. This situation might also arise when only little effort is justified because of depressives' devaluation of hedonic task consequences. We think it is a major shortcoming of previous research that task characteristics and task difficulty of administered laboratory stressors have not been further considered. A careful and theoretically driven inspection of the behavioral challenges and contextual conditions seems indispensable.

The present application of our integrative analysis is, however, not limited to negative mood and depressive symptoms. First of all, the personality construct of general negative affectivity is associated with affective, cognitive, and motivational symptoms of depression (Klein, Durbin, Shankman, & Santiago, 2002). Moreover, as a rather broad construct, negative affectivity is underlying most other psychopathologies as well. Various psychosocial characteristics are similar in depression and other psychopathologies involving negative affective states (Hokanson, Rubert, Welker, Hollander, & Hedeen, 1989). Especially the anxiety disorders are characterized by negative affect and show a high degree of comorbidity with depression. As our theoretical reasoning is mainly based on the influence of dispositional and transient negative mood on effort mobilization via an informational mood impact (Gendolla, 2000), one can imagine that results similar to those of depression and dysphoria emerge for other negative affective states and traits as well. This implies that individual mood differences (clinical as well as nonclinical) play an important role in determining how people approach upcoming challenges, how vigorously they pursue their daily tasks, and at what point they disengage from effort mobilization.

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Figure Captions

Figure 1. Theoretical prediction for the informational impact of mood on effort-related cardiovascular response. Figure adapted from Gendolla and Brinkmann (2005). Copyright: Hogrefe.

Figure 2. Cell means and standard errors of systolic blood pressure reactivity during performance on a memory task in Study 2 by Brinkmann and Gendolla (2008). Copyright: APA.

Figure 3. Cell means and standard errors of systolic blood pressure reactivity during memory task performance in the experiment by Slivestrini and Gendolla (2009a). Copyright: Elsevier.

Figure 4. Cell means and standard errors of pre-ejection period (left panel) and systolic blood pressure reactivity (right panel) during performance of a mental arithmetic task in Study 2 by Brinkmann, Schüpbach, Ancel Joye, and Gendolla (2009). Copyright: Elsevier.

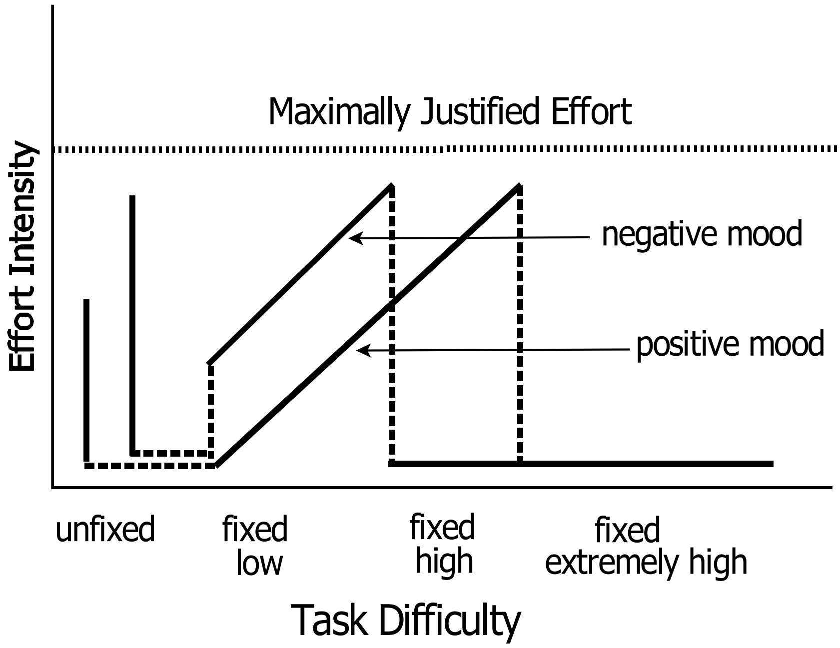

Figure 1

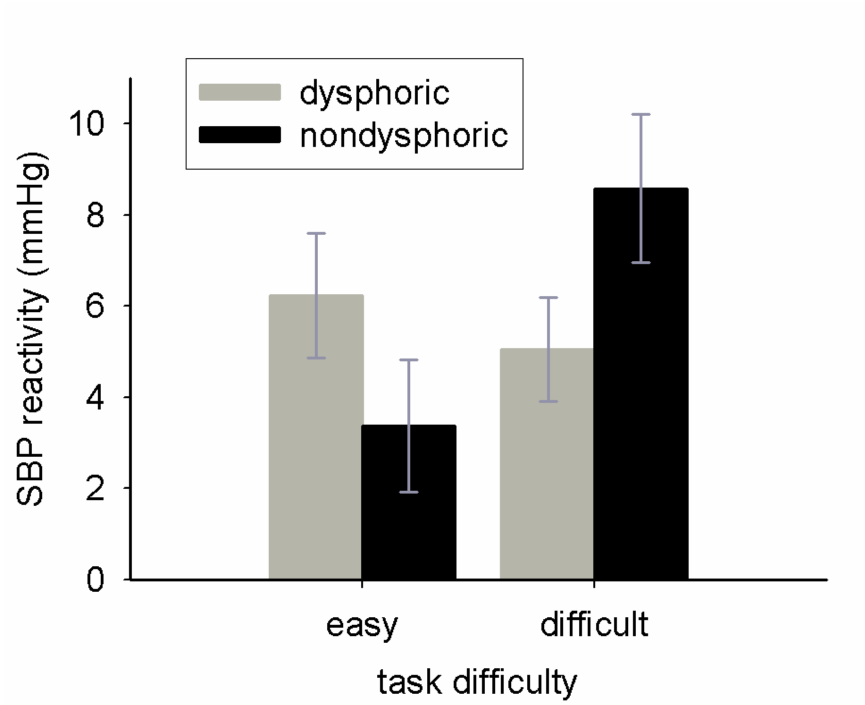

Figure 2

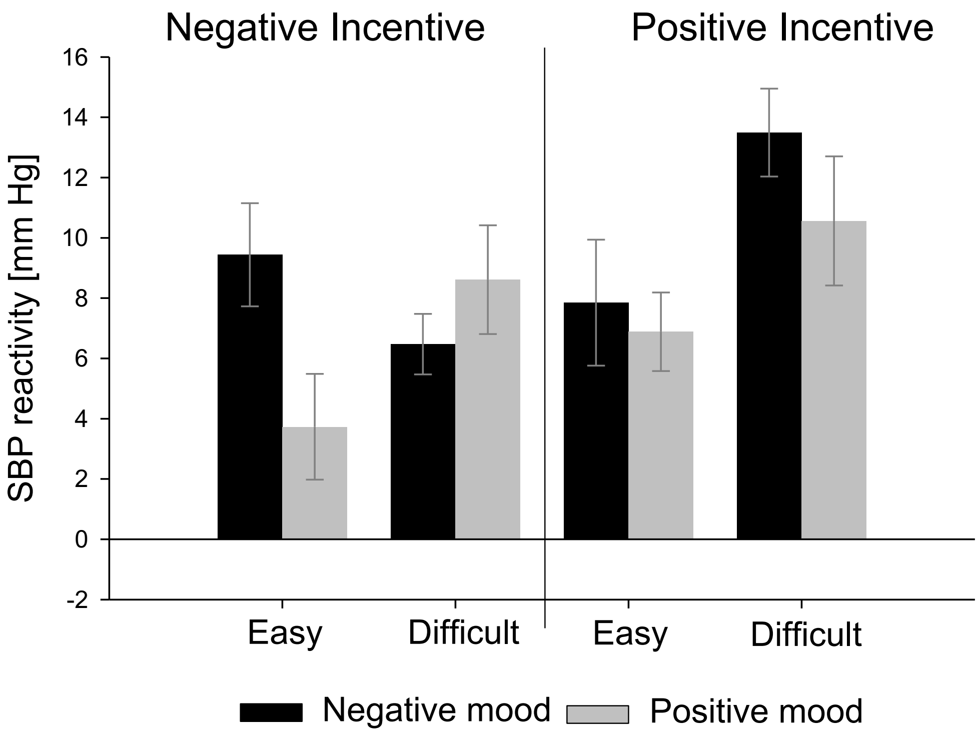

Figure 3

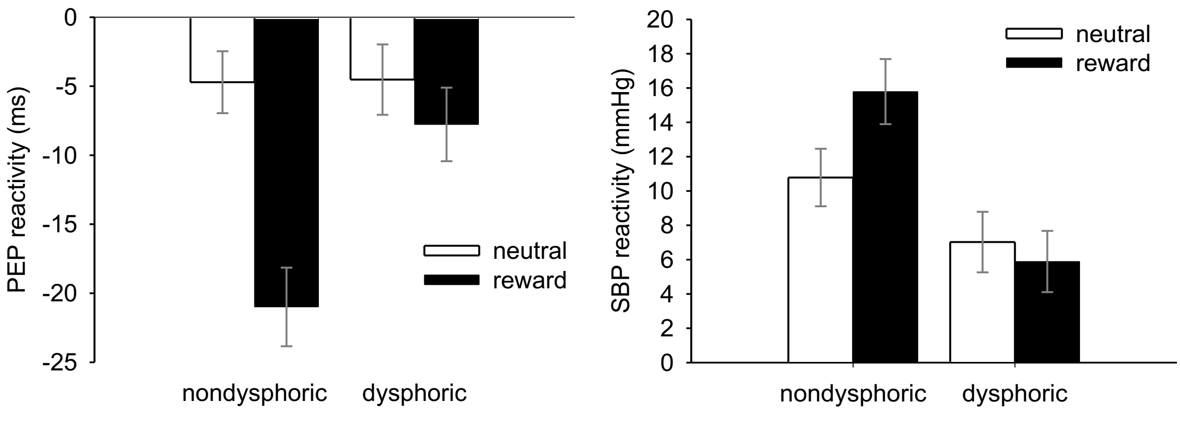

Figure 4