Advancing Issues in Motivation Intensity Research: Updated Insights from the Cardiovascular System

Gendolla, Guido H.E.; Wright, Rex A.; Richter, Michael

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Guido H.E. Gendolla

University of Geneva

Rex A. Wright

University of North Texas

Michael Richter

Liverpool John Moores University

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Corresponding Author: Guido H.E. Gendolla
Geneva Motivation Lab
University of Geneva
FPSE, Dept. of Psychology
40, Bd. du Pont d'Arve
CH-1211 Geneva 4, Switzerland
Telephone: +41 22 379 92 31
Fax: +41 22 379 92 19
E-mail: guido.gendolla@unige.ch

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Abstract

What determines effort intensity in instrumental behavior? According to motivation intensity theory, effort should be proportional to experienced task difficulty as long as success is possible and justified and low when success is impossible or excessively difficult, given the available benefit. When task difficulty is unspecified or unknown, effort should be proportional to the importance of success. We report an extensive program of research that has operationalized effort intensity as cardiovascular reactivity during task performance and used multiple manipulations of variables influencing subjective task difficulty (e.g., performance standards, instrumentality, ability, fatigue, mood, depressive symptoms, implicit affect, implicit and biological aging) and the amount of justified effort (e.g., material incentive, instrumentality, needs, personal and social evaluation, mortality salience). In this second edition of this handbook, we focus on recent empirical evidence for the principles of motivation intensity theory and discuss challenges for other theoretical accounts.

Keywords: Effort, Motivation Intensity, Cardiovascular Response

(h1) *Introduction*

In brief, motivation can be defined as the process that determines the energization and direction of behavior (Elliot, 2006), meaning that action needs both resources and goals. This chapter focuses on the first aspect—effort, the mobilization of resources for instrumental behavior (Gendolla & Wright, 2009). More precisely, we deal with effort intensity, which refers to the resources organisms mobilize at one point in time.

Understanding the intensity aspect of behavior is essential for learning how motivation influences action. However, traditionally, most motivation research has focused on the direction of behavior or *what* people do rather than *how intensively* they do it—as can be seen in this handbook. Three decades of research inspired by motivation intensity theory (Brehm & Self, 1989; Brehm, Wright, Solomon, Silka, & Greenberg, 1983; see also Brehm, 1975) represent a break with tradition and have generated significant insights relating to processes underlying effort mobilization. An initial wave of research investigated core variables identified in this theory. A later wave, conducted in the past two decades, involved theoretical extensions, applications, and the development of second order theories that explain how variables like fatigue, affective experience, depressive symptomatology, gender, and implicitly processed stimuli influence the mobilization of resources. This chapter focuses on what has been found in the time since the first edition of this handbook was published. That is, rather than providing a complete overview of research on the intensity of motivation, we will highlight recent findings. Readers interested in earlier research are referred to previous overviews, including the one in the first edition of this handbook (Gendolla, Wright, & Richter, 2012; see also Richter, Gendolla, & Wright, 2016; Wright & Kirby, 2001). Before discussing recent research, we will first describe motivation intensity theory and its origin—the principle of resource conservation.

Following pioneering work by Gibson (1900), psychologists recognized early that organisms tend to mobilize just the resources that are necessary for goal attainment (e.g., Hull, 1943; Tolman, 1932). Moreover, drawing on the idea that effort functions to cope with obstacles during goal pursuit, it was postulated that resource mobilization follows a "difficulty law of motivation" (e.g., Ach, 1935; Hillgruber, 1912). Accordingly, effort is mobilized proportionally to the experienced difficulty of instrumental behavior—the higher the obstacles encountered during goal pursuit, the more effort is mobilized. Brehm's motivation intensity theory is the most influential elaboration of these basic principles of resource mobilization.

(h1) *Motivation Intensity Theory*

Motivation intensity theory (Brehm et al., 1983; Brehm & Self, 1989; see also Brehm, 1975) is grounded in the resource conservation principle. People are expected to mobilize effort (1) only to the degree that is needed, and (2) only when expenditure yields sufficient return (i.e., a benefit) to justify the necessary effort. The required effort is determined by the difficulty of instrumental behavior—the difficulty of activity that must be carried out to attain desired outcomes and avoid aversive ones. Consequently, effort should vary nonmonotonically with the perceived difficulty of instrumental behavior. As long as success is viewed as both possible and worth the investment that it requires, effort should correspond to difficulty—people should invest greater effort the more difficult they perceive their task to be. But, importantly, effort should drop because of disengagement if success appears to be impossible or if the necessary effort is not justified by the benefit it should accrue. This is because in both cases high engagement would violate the basic principle of resource mobilization. Thus, put in one sentence, motivation intensity theory predicts that effort rises proportionally to subjective task difficulty as long success appears to be possible and the necessary effort is justified (Figure 1).

(h2) *The Role of Benefit*

An important point about the central proposition above is that expected benefit should not determine effort directly. Rather, benefit should determine effort *indirectly* by setting the upper limit of what is justified and what people are willing to do. Brehm referred to this upper limit as the level of *potential motivation*—a concept that has re-attained recent attention (e.g., Kruglanski, Chernikova, Rosenzweig, & Kopetz, 2014). In theory, factors related to benefit (e.g., the value of and need for an available incentive) should have no impact on effort as long as success is possible and benefit is great enough to justify the required effort.

To illustrate, consider a person offered at different points in time $10, $20, and $30 to lift a weight that he/she could lift and was willing to lift for $10. The present view suggests that the person's effort should correspond to the *difficulty* of the lift, and not the value of the *incentive*, at the different points. Next, consider what would happen under conditions where this person was unwilling to lift the weight even for $30. The present view suggests that his/her effort should be consistently low at the different points. Finally, consider what would happen if the person were offered the different incentives for lifting a weight that he/she knew exceeded his/her strength. Once again, effort should be low at all points.

(h2) *Unclear Difficulty*

A further point to note about the central proposition discussed above is that it assumes that people know what will be required to succeed—which will, however, not always be the case. Consider, for example, (1) a student confronted with an exam from a new teacher, (2) a person awakened in the middle of the night by a noise in the bedroom closet, or (3) an athlete who must compete with a completely unknown adversary. People sometimes know that action is called for, but are unsure what exactly needs to be done and how much effort needs to be mobilized for it. This can be the case if difficulty levels during an action vary in a random-like fashion or if a task has a fixed difficulty level that is, however, not known by the person. Motivation intensity theory asserts for such conditions of *unclear* difficulty that effort will be proportional to potential motivation.

At first glance, this assertion might seem contrary to the guiding principle of resource conservation. But it is not when one considers that using potential motivation to calibrate effort intensity allows individuals to avoid mobilizing more resources than justified. Given that people do not know what will be required to succeed when task difficulty is unknown, they are at risk of engaging either more than necessary or not enough, meaning a waste of effort in both cases. However, by mobilizing effort proportional to potential motivation they can assure that they will not exceed the amount of justified effort. They might invest more than required but they will not invest more than justified.

(h2) *Unfixed Difficulty*

A third point to note is that motivation intensity theory recognizes that performance contingencies (i.e., benefits) do not always have an all-or-none character. The contingencies sometimes do, as would it be the case if a person learned that he/she could earn an amount of money by lifting a specific amount of weight. However, they sometimes do not. Consider, for example, a person told that he/she can earn $1 for every lift he/she makes or, alternatively, a child told he/she can earn a bite of dessert for every bite of broccoli that he/she takes. In circumstances like these, benefit rises in constant proportion to performance. Brehm referred to such circumstances as conditions of *unfixed* difficulty (e.g., Brehm & Self, 1989). Additionally, persons can be asked to do their best (or what they want) without being confronted with a clear performance standard (see Locke & Latham, 1990). Also under this condition task difficulty is not fixed.

Once again, motivation intensity theory assumes that effort will be proportional to potential motivation (here, the total benefit that can be accrued) up to the point that people can try no harder. Thus, the persons in the examples above would be expected to exert more effort the more benefit they could make until attaining their effort peak.

(h2) *Summary*

To summarize, motivation intensity theory maintains that effort intensity does not vary with potential benefit directly, but rather with the difficulty of behavior necessary to attain goals. As long as success is possible and the necessary effort is justified, effort should thus correspond to difficulty. Where success is deemed impossible or excessively difficult, given the available benefit, effort should be low due to disengagement. In theory, benefit should determine the upper limit of what performers are *willing* to do, thus determining the drop point of effort along possible levels on a difficulty continuum. Motivation intensity theory considers that people sometimes believe that action is—or might be—needed, but are unsure what exactly needs to be done and that people sometimes can decide on their own how much effort they want to invest. In such circumstances, people are expected to expend effort in proportion to their potential motivation—that is, their willingness to act—up to the point that they can try no harder.

(h1) *Measuring Effort*

Motivation intensity theory provides a very clear and elegant theoretical picture of effort mobilization. However, its validity is by no means self-evident. This leads to the important question of how to measure effort mobilization for testing the theory's predictions.

One idea to quantify effort intensity, applied for decades, has been to obtain self-reports of effort mobilization (e.g., Efklides, Kourkoulou, Mitsiou, & Ziliaskopoulou, 2006; Meyer & Hallermann, 1977; Roets, Van Hiel, Cornelis, & Soetens, 2008). However, self-report measures of effort are problematic for several reasons. For one thing, effort self-reports are highly vulnerable to self-presentational influences (Pyszczynski & Greenberg, 1983; Rhodewalt & Fairfield, 1991). In addition, there is concern that people might not always know how hard they are (or are not) trying, because introspection abilities are (very) limited (Wilson, 2002).

A second idea has been to measure performance—a behavioral outcome that multiple motivation researchers have directly linked to the intensity aspect of motivation (e.g., Atkinson

& Raynor, 1974; Bandura & Cervone, 1983; Bijleveld, Custers, & Aarts, 2010; Eisenberger, 1992; Kukla, 1972; Locke & Latham, 1990). However, this is problematic as well, because of obvious disconnections between effort and different performance outcomes, including the speed and quality of responses (see Harkins, 2006). Moreover, performance is determined by more factors than effort alone—at least ability, persistence, and strategy use have also (and sometimes even stronger) influences on it (see Locke & Latham, 1990). Related to this, effort can be compensatory (Hockey, 1997)—it can be mobilized to compensate for objective or experienced ability deficits. A person with lower ability must mobilize more effort to attain the same performance outcome as another person with high ability (e.g., Smith & Hess, 2015; Wright & Dismukes, 1995).

A third idea is, in our view, more promising. It is to assess effort *physiologically*, that is, by examining adjustments in bodily systems that should—in theory—be involved in mobilizing people for action. This draws attention to the cardiovascular (CV) system.

(h2) *Effort-Related Cardiovascular Response*

There are at least two reasons why the CV system has attracted effort investigators' interest. First, there is wide agreement that the CV system functions chiefly to sustain behavior (Papillo & Shapiro, 1990). Second, research in psychophysiology—particularly that by Elliott (1969) and Obrist (1976)—has indicated that effort not only affects CV responses, but does so by certain *sympathetic* nervous system mechanisms, that is, mechanisms associated with the branch of the autonomic nervous system involved in *activation*. Given that effort refers to the mobilization of resources for instrumental behavior (Gendolla & Wright, 2009), this physiological "go" system should be of high interest for quantifying effort.

It is beyond the scope of this chapter to delve into all details of sympathetic CV influence or to examine carefully the evidence linking effort to it. Interested readers are thus referred to other sources (Berntson, Cacioppo, & Quigley, 1993; Brownley, Hurwitz, &

Schneiderman, 2000; Kelsey, 2012; Obrist, 1981; Papillo & Shapiro, 1990; Wright & Gendolla, 2012). For present purposes, two observations are sufficient. First, in theory, the best indicators of the sympathetic mechanisms mentioned above should be related to beta-adrenergic sympathetic impact, which becomes especially manifest in cardiac pre-ejection period (PEP)—a cardiac contractility measure defined as the time interval between the onset of left ventricular cardiac excitation and the opening of the aortic valve in a cardiac cycle (Berntson, Lozano, Chen, & Cacioppo, 2004). This time interval, which takes about 100 ms during rest, becomes *shorter* when beta-adrenergic impact increases.

Cardiac contractility can also systematically influence other indices of CV activity, especially systolic blood pressure (SBP)—the maximal arterial pressure between two heartbeats (Brownley, Hurwitz, & Schneiderman, 2000). Therefore, several studies have relied on SBP as an index of effort (see Gendolla et al., 2012; Wright & Kirby, 2001) and other studies found that both PEP and SBP respond to the level of experienced task demand (e.g., Richter, Friedrich, & Gendolla, 2008), incentive (e.g., Richter & Gendolla, 2009), and combinations of both variables (e.g., Silvestrini & Gendolla, 2011a). However, although performance-related changes in SBP are a very suitable index of effort mobilization, PEP is the purer and more sensitive effort measure, because SBP is also determined by peripheral vascular resistance, which is independent of beta-adrenergic sympathetic nervous system impact. Diastolic blood pressure (DBP)—the minimal vascular pressure between two heart beats—is even more strongly determined by peripheral resistance. Heart rate (HR—the pace of heart contraction) should tend to be indicative as well. However, HR can increase because of both sympathetic activation and *para*sympathetic deactivation, making it difficult to interpret HR changes. Thus, especially PEP and also SBP are more suitable measures of effort mobilization.

(h1) *Empirical Evidence*

We will now present studies that have systematically investigated the principles of motivation intensity theory and operationalized effort intensity as CV response—i.e. performance-related changes in CV activity with reference to baseline values. The protocol of a typical study consists of two phases. Participants are first habituated to the laboratory (ca. 10 min). During that time, participants are inactive and CV baseline activity is assessed. Then participants work on a task, (typically ca. 5 min), and CV activity is again assessed during performance. Some studies additionally assessed CV activity immediately before task performance. Participants' CV *re*activity—the dependent variable referring to effort intensity—is expressed in the mean task-related changes in CV activity with reference to the individual baseline values.

(h2) *The Role of Variables Affecting Difficulty and Effort*

Especially early studies involved direct difficulty manipulations by exposing participants to varying levels of objective task difficulty or performance standards. Examples are the number of items participants were asked to memorize within a specific time or the stimulus presentation and/or response time windows in attention or short-term memory tasks. Those studies found clear and replicated support for motivation intensity theory's predictions: SBP rose with task difficulty until task demand became so high that success was impossible. At this point effort dropped, which was interpreted as disengagement (e.g., Smith, Baldwin, & Christenson, 1990; Wright, 1984; Wright, Contrada, & Patane, 1986). A later experiment by Richter, Friedrich, and Gendolla (2008) additionally included measures of PEP, the purer index of beta-adrenergic sympathetic impact and found corresponding results. As depicted in Figure 2, reactivity of both PEP and SBP during a short-term memory task became progressively stronger from a low- via a moderate- to a high difficulty condition, and then dropped.

More recent studies extended the preceding research by applying more indirect manipulations by investigating psychological variables influencing subjective task demand. As one example, recent experiments by Freydefont, Gollwitzer, and Oettingen (2016) found that detailed action planning in terms of "if-then" plans for task execution functions as a difficulty buffer with corresponding effects of PEP reactivity during task performance. Similar effects were reported for individual differences in cognitive flexibility—cognitive flexibility reduced subjective task demand with corresponding effects on effort-related CV response (Kato, 2017). Other studies highlighted the role of affect as factor influencing subjective task demand.

(h3) *Mood and Depressive Symptoms*

A major line of research by Gendolla and colleagues investigated the influence of mood states on effort mobilization (see Gendolla & Brinkmann, 2005; Gendolla, Brinkmann, & Silvestrini, 2012, for more detailed reviews). Instigated by the mood-behavior-model (Gendolla, 2000), these studies tested the idea that people use their moods as task relevant information for their appraisals of task demand when they are confronted with a task. In those studies, elated and depressed moods were first manipulated with exposure to videos, music, or by autobiographical recollection of personal events. Subsequently, participants worked on a cognitive task. These studies brought replicated evidence that people in a depressed mood indeed evaluate task demand as higher and show stronger SBP responses during performance than people in a happy mood (e.g., Gendolla, Abele, & Krüsken, 2001; Gendolla & Krüsken, 2001a, 2002a). However, these effects disappear if the informational value of mood is called into question (Gendolla & Krüsken, 2002b) or if mood cannot be used as task-relevant information (de Burgo & Gendolla, 2009).

Other studies investigated dispositional variables that are associated with relatively stable differences in affective experiences. Effects that corresponded to those of transient mood states on effort-related CV response were found for individual differences in dysphoria/depression (e.g., Brinkmann & Gendolla, 2007), and extraversion (Kemper, Leue, Chavanon, Henninghausen, & Stemmler, 2008). Similar effects were found for individual differences in fatigue: The more fatigued individuals felt, the more effort they mobilized during a cognitive task (e.g., Mlynski, Wright, Agtarap, & Rojas, in press; Schmidt, Richter, Gendolla, & Van der Linden, 2010).

(h3) *Implicit Affect*

Research on the mood-behavior-model (Gendolla, 2000) revealed replicated evidence that feeling states can systematically influence effort-related CV responses. Gendolla (2012) suggested in his implicit-affect-primes-effort (IAPE) model that the mere activation of knowledge about affective states leads to similar effects. The main difference between the two models is the type and origin of affect-related information that influences subjective task demand. The mood-behavior-model applies to experienced *feelings*. The IAPE model applies to stimuli (affect primes) that activate affect-related *knowledge*, which implicitly influences subjective demand.

According to the IAPE model, individuals learn that coping with challenges is easier in some affective states than in others. Consequently, performance ease and difficulty become features of peoples' mental representations of different affective states—their emotion concepts (see Niedenthal, 2008). Rendering this knowledge accessible leads to experiences of low or high task demand. More specifically, people should have learned that it feels relatively easy to work on a task if one is happy or angry (high coping potential), whereas it feels relatively difficult to do so when one feels sad or fearful (low coping potential). That way, ease becomes a feature of people's mental representation of happiness and anger, whereas difficulty should become a feature of the representations of sadness and fear. Implicit activation of these mental representations should render the ease and difficulty features accessible, resulting in lower or higher subjective task demand.

In studies on the IAPE model, participants worked on cognitive tasks during which they processed very briefly flashed pictures of emotional expressions to activate implicit affect. As predicted, processing sadness- and fear-primes during performance led to stronger cardiac PEP response than processing happiness- and anger-primes (e.g., Chatelain & Gendolla, 2015; Gendolla & Silvestrini, 2011; Lasauskaite, Gendolla, & Silvestrini, 2013). This suggests that the mere implicit activation of people's mental representations of emotions is sufficient to systematically influence task demand and thus effort.

(h3) *Implicit Aging*

Recently, the IAPE model logic was extended to the effects of implicit activation of the aging stereotype. In Western societies, there is a widely shared belief that aging is associated with cognitive difficulties (e.g., Cuddy, Norton, & Fiske, 2005). The mere implicit activation of this aging stereotype should be sufficient to increase subjective demand and effort—also in biologically young individuals. Zafeiriou and Gendolla (in press) tested this idea in an experiment in which university students worked on a moderately difficult mental arithmetic task. During the task flashed pictures of young vs. elderly individuals' faces, or dotted silhouettes in the shape of a human head in an additional neutral prime control condition, appeared briefly. The age-primes influenced CV reactivity during performance. Responses of HR and DBP increased from the youth-prime condition via the control condition to the elderly-prime condition. These effects of implicit aging are compatible with those of biological aging on effort mobilization we will discuss below.

(h2) *Moderation Effects of Objective Task Difficulty*

Several studies investigated how psychological variables can moderate the effect of objective task difficulty on effort. The starting point of this research was an elaboration of motivation intensity theory's predictions in terms of ability effects by Wright and colleagues.

(h3) *The Role of Ability, Fatigue, and Biological Aging*

According to Wright (1998), subjective task difficulty is systematically influenced by individuals' ability (i.e., capacity with respect to the features of the task). Less capable people view success at any given objective difficulty level as harder than more capable individuals (Heider, 1958; Hockey, 1997; Kukla, 1972; cf., Bandura, 1986). It follows that: (1) Effort should be stronger for low- than high-ability people as long as the low-ability performers perceive success as both possible and worthwhile; (2) Low-ability individuals should withhold effort and display reduced CV responses at a lower difficulty level than should high-ability individuals, creating a window of difficulty levels within which effort is weaker for low- than high-ability performers; (3) Effort should be low for both ability groups under conditions where success calls for more than high ability performers can or will do (Figure 3). This holds for both objective ability and subjective ability beliefs.

The ability extension of motivation intensity theory has received ample empirical support. Indeed, in objectively easy tasks, people with lower ability show stronger reactivity than people with higher ability. Conversely, for difficult tasks, people with high ability show stronger reactivity than those with lower ability (e.g., Wright & Dill, 1993; Wright & Dismukes, 1995; Wright, Wadley, Pharr, & Butler, 1994). Another set of studies further elaborated the ability extension and investigated the role of fatigue in effort mobilization. Those studies have assumed that ability falls as fatigue rises. Accordingly, fatigue should interact with difficulty to determine effort-related CV responses in the same way as ability does, with high fatigue corresponding to low ability and low fatigue corresponding to high ability. Results were as expected: Fatigue moderated the effect of objective difficulty on effort in the same way as ability (e.g., Wright & Penacerrada, 2002). Participants in a study by Wright, Martin, and Bland (2003) first performed an easy or difficult counting task to manipulate fatigue. Next, the investigators presented participants mental arithmetic problems with instructions that they could earn a prize if they attained a low or high performance standard. As expected, high fatigue participants showed stronger SBP responses than low fatigue participants when the standard was low. By contrast, they had weaker responses than low fatigue participants when the standard was high (Figure 4). DBP and mean arterial pressure (MAP) data revealed the same interactions with means in similar crossover patterns.

Hess and colleagues applied aspects of the ability analysis to address questions pertaining to effort and CV responsiveness in older adults (see Hess, 2014). They reasoned that, due to normal age-related cognitive decline, older adults should find it more difficult to meet cognitive challenges. As a result, older adults should try harder and evince stronger CV responses than younger adults so long as they perceive success as possible and worthwhile and they disengage due to subjective over-challenge at high levels of perceived difficulty (Hess, Smith, & Sharifian, 2016). Further, they should withhold effort at a lower objective difficulty level, with success importance determining the point at which they do so as long as they perceive success as possible. Indeed, older people mobilized more resources and show stronger effort-related responses of the CV system than younger adults when they cognitively performed on a similar level (Smith & Hess, 2015). Moreover, Hess and Ennis (2012) found stronger SBP responses in older adults during both a fatigue induction period in which participants were presented a simple or complex counting challenge and an ensuing fatigue influence period in which participants solved multiplication problems.

However, a qualified exception is seen in an experiment by Stewart, Wright, and Griffith (2016) that examined CV responses in cognitively healthy older adults and patients diagnosed with mild cognitive impairment (MCI), the prodromal state of clinical dementia. MCI is characterized by cognitive decline that is greater than that expected with normal aging, but not so great that it interferes with daily function. Investigators assigned the cognitively healthy older adults and MCI patients three versions of a modified Sternberg memory task designed to range in difficulty from low to high. As expected, work-related SBP responses rose with difficulty for cognitively healthy older adults. By contrast, the responses were consistently low for MCI patients, possibly because they viewed success as excessively difficult or impossible at all difficulty levels.

(h3) *Moderation of Affective Influences on Effort*

Objective task difficulty also systematically moderates the earlier discussed mood impact on effort mobilization. The effects of positive and negative moods in easy and difficult tasks resemble those of the just presented effects of high and low ability and high and low fatigue. When people in a depressed or happy mood work on a task with fixed task difficulty, the mood-behavior-model (Gendolla, 2000) posits that they will pragmatically use both types of information—mood and task difficulty—to calibrate effort. Consequently, as shown in experiments (e.g., Gendolla & Krüsken, 2001b, 2002b), in objectively easy tasks, effort is higher in a negative mood than in a positive mood, because subjective demand and 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 for this moderation is that subjective demand for a difficult task is high but still feasible in a positive mood, whereas it appears as over-challenging in a negative mood. However, when objective task difficulty is extremely high, so that succeeding is obviously impossible, mood cannot provide additional diagnostic information. Here, due to disengagement, mobilized resources are low in general (Gendolla & Krüsken, 2002c).

Objective task difficulty also moderates the effects of depressive symptoms on effort. Dysphoric individuals mobilize higher effort than non-dysphorics in easy tasks. But when difficulty is high, the opposite pattern occurs (Brinkmann & Gendolla, 2008). This moderator effect of objective task difficulty on the impact of depressive symptoms on effort mobilization has been replicated and extended by Silvia and colleagues (see Silvia et al., 2016). Corresponding to the effects of consciously experienced affective states on effort, objective task difficulty also moderates the impact of implicit affect on effort mobilization (Chatelain, Silvestrini, & Gendolla, 2016; Freydefont, Gendolla, & Silvestrini, 2012; Lasauskaite, Gendolla, & Silvestrini, 2014; Silvestrini & Gendolla, 2011c; see also Blanchfield, Hardy, & Marcora, 2014): In objectively easy tasks, sadness or fear primes lead to higher effort than happiness or anger primes. However, in objectively difficult tasks, this pattern turns around and processing anger or happiness primes results in stronger PEP reactivity than processing sadness or fear primes. The reason is that sadness and fear primes should increase the subjective difficulty of an easy task, resulting in relatively high effort because of high subjective demand. But the same affect primes should lead to low effort in difficult tasks, because of disengagement due to excessive subjective demand. This effect of objective task difficulty should be inverted by happiness or anger primes. Priming happiness or anger in objectively easy tasks should lead to low effort due to low subjective demand. By contrast, effort should be high for an objectively difficult task, because subjective demand should be high but feasible. Figure 5 shows the results of an experiment by Chatelain, Silvestrini, and Gendolla (2016). Participants worked on an objectively easy or difficult mental arithmetic task during which they were primed with fear or anger. As expected, fear primes led to higher effort (i.e. shorter PEP) than anger primes when the task was objectively easy. But when the task was objectively difficult, implicit fear led to lower effort than anger.

In summary, there is solid evidence that task difficulty systematically influences effort mobilization. Effort rises with increasing demand up to a point where (1) success is either not possible or (2) the necessary effort is not justified. The second limit of the difficulty-effort relationship was further investigated in studies that manipulated the level of potential motivation together with variables influencing subjective task difficulty.

(h2) *The Role of Variables Affecting the Importance of Success*

Several studies have investigated the impact of variables influencing the level of potential motivation—the amount of maximally justified effort for goal attainment. One major part of this research has focused on tasks with manipulated fixed difficulty levels. Others have investigated effort mobilization in tasks where difficulty was unspecified. As outlined in the first section of this chapter, motivation intensity theory predicts that effort intensity should be proportional to task difficulty as long as success is justified. Consequently, high potential motivation should justify the high effort that is necessary to cope with highly difficult demands, while low potential motivation should not, resulting in earlier disengagement on lower difficulty levels. Moreover, effort intensity should be proportional to potential motivation when task difficulty is unspecified or unknown. These ideas were tested in experiments using various manipulations of potential motivation ranging from a material incentive to affective and self-esteem related consequences of success.

(h3) *Material Incentive*

One line of research investigated the effect of monetary incentive on effort mobilization when task difficulty was fixed. Eubanks, Wright, and Williams (2002) let participants work on a computerized recognition memory task with difficulty levels ranging from very easy to very difficult. They could gain either $ 10 or $100 for success. The results were most pronounced for changes in HR, which increased over the whole range of difficulty conditions in the high incentive condition. In the low incentive condition, HR reactivity first increased with difficulty but dropped on the difficult and very difficult levels. This supports the idea that high monetary incentive leads to high effort for difficult tasks by justifying the necessary high effort. When task difficulty is rather low, incentive has no increasing effect on effort, because low effort is sufficient for succeeding.

Recent research tested the effects of monetary incentive in a new domain: listening effort. In contrast to preceding work that mainly focused on effort mobilization in tasks that strongly rely on memory or attention systems, Richter and colleagues examined task difficulty effects in listening tasks (Pichora-Fuller et al., 2016; Richter, 2016). Participants in Richter’s (2016) study had to successfully discriminate tones of different frequencies to earn a monetary reward. Replicating preceding research, PEP reactivity was a function of task difficulty if participants could earn a high reward: Effort mobilization was high if the frequency difference between tones was small but low if the frequency difference was large. However, if participants were offered only a small reward for successful task performance, PEP reactivity was low and independent of task difficulty: Participants in the easy condition invested low effort because only a low amount of effort was required for task success, and participants in the difficult condition disengaged.

Moreover, high monetary success incentive could also eliminate the above reported effort mobilization deficit of people working on an objectively difficult task while being primed with sadness or fear (Chatelain & Gendolla, 2016; Freydefont & Gendolla, 2012). Corresponding to the principles of motivational intensity theory, high monetary incentive could justify the very high effort that was subjectively necessary when implicit fear or sadness were activated during the performance of an objectively difficult task. But without high incentive, implicit fear and sadness resulted in low effort, reflecting disengagement in objectively difficult tasks. Extending the research on implicit influences on effort mobilization, Silvestrini (2015) found that high monetary incentive also increased effort-related CV responses of participants who implicitly processed pain-related words during a difficult cognitive task. Zafeiriou and Gendolla (2017) found a corresponding moderator effect of monetary incentive on implicitly processed aging primes. In summary, these studies show that high monetary incentive can justify high subjectively necessary effort. However, if high effort is not necessary, because subjective task demand is low, even high monetary incentive does not result in increased effort.

Research on incentive effects when task difficulty is unknown started with studies by Richter and Gendolla. In their first study (Richter & Gendolla, 2006, Experiment 1) participants worked on a memory task and could either earn an attractive or an unattractive poster for success. In an unknown difficulty condition they had to memorize appearing letter series but did not know how many series would appear or how long the task would take. In the fixed difficulty version of this task, this information was provided—the task was actually easy. As expected, SBP reactivity during task performance was jointly determined by difficulty and incentive. Reactivity was stronger under high- than low incentive value conditions when difficulty was unknown, but it was relatively low and constant across incentive value levels when difficulty was low. These effects were conceptually replicated for the effects of low vs. high monetary incentive (Richter & Gendolla, 2006a, Experiment 2). Another set of studies administered tasks of unknown difficulty and offered monetary incentive on different levels. Results revealed that SBP (Richter & Gendolla, 2007) and PEP (Richter & Gendolla, 2009a) linearly increased with incentive. This provides replicated evidence that effort rises with the value of a material incentive when task difficulty is not specified.

(h3) *Material Incentive in Depressed Individuals*

Other research by Brinkmann and colleagues investigated the impact of incentive in individuals suffering from depressive symptoms (see Brinkmann & Franzen, 2015 for a more detailed discussion). As discussed above, if incentive is not manipulated, the effects of depressive symptoms on effort-related CV response resemble those of a negative mood (Brinkmann & Gendolla, 2007, 2008). But it is questionable if incentive has the same influences on effort mobilization in depressed/dysphoric individuals as in nondepressed/nondysphoric people. The reason is that depressed individuals do not behaviorally respond to monetary reward and punishment (e.g., Henriques & Davidson, 2000).

Brinkmann, Schüppach, Ancel Joye, and Gendolla (2009, Study 2) therefore directly tested the hypothesis of reduced reward responsiveness in dysphoric individuals in terms of effort mobilization. The study used a task with unclear difficulty. In the reward condition participants learned that they could win a relatively high monetary reward for correctly solving arithmetic operations, leading to a final correct or incorrect result in the end. No incentive was mentioned in the no-reward condition. In the reward condition, PEP, SBP, DBP, HR, strongly increased for nondysphoric participants, reflecting the typical incentive effect in tasks with unclear difficulty (Richter & Gendolla, 2006, 2009a). In contrast, dysphorics' reactivity was significantly lower and did not differ from the no-reward condition. Franzen and Brinkmann (2014) conceptually replicated these studies and found significant reward and punishment effects on PEP and HR during a memory task in non-dysphorics, but not in dysphorics. Another study by Brinkmann and Franzen (2013) focused on monetary reward and found corresponding results: Non-dysphoric participants' reactivity of PEP and HR increased with the extent of monetary incentive of success in a short-term memory task of unclear difficulty. By contrast, dysphorics were not sensitive to the reward and showed a modest cardiac response in general. In summary, these studies show that depressives' reduced responsiveness to reward is also evident in effort mobilization.

(h3) *Outcome Expectancy (Instrumentality)*

Studies by Wright and colleagues operationalized potential motivation in terms of outcome expectancy—the perceived likelihood that success on a task will lead to a desired outcome (Maddox, 1995). Outcome expectancy also is referred to as the instrumentality of behavior. In theory, the importance of success should be greater where it is high than where it is low. Thus, outcome expectancy should determine individuals' upper effort limit—the level of potential motivation. As expected, these studies revealed replicated evidence that high instrumentality of success justifies high effort, leading to strong CV response when task difficulty is high, but not when it is low (e.g., Wright & Gregorich, 1989; Wright, Williams, & Dill, 1992).

Richter and Gendolla (2009b) tested the idea that mood influences effort mobilization not only through its informational impact on demand appraisals, as discussed above. Rather, when people are confronted with a task of unknown difficulty, mood should also influence potential motivation—e.g., by its effect on outcome expectancies. Participants' probability ratings to receive a monetary reward were indeed higher in a positive mood than in a negative mood. Correspondingly, SBP reactivity during performance increased from a negative via a neutral to a positive mood condition. This SBP effect was statistically mediated by participants' subjective probability ratings of winning the monetary reward for successful performance.

Another study by Stewart, Wright, Hui, and Simmons (2009) investigated combined effects of fatigue and outcome expectancy on CV response. Participants first performed an easy (fatigue low) or difficult (fatigue high) version of a mental concentration task. Subsequently, they worked on mental arithmetic problems and believed to have a high vs. low chance of winning a prize for attaining a moderate performance standard. The central prediction was that fatigue would potentiate effort-related CV responses during the second period when the chance of winning was high, but not when it was low. Potentiation was not expected under low chance (importance) conditions, because available benefit under those conditions was not expected to be great enough to justify the added effort requirement associated with fatigue. SBP responses assessed during the second period were supportive.

In summary, outcome expectancy studies have yielded effects that are highly compatible with those of material incentive. In accordance with the principles of motivation intensity theory, outcome expectancy moderates the relation between difficulty and effort when task difficulty is fixed and it predicts effort directly when task difficulty is unknown.

(h3) *Social Evaluation and Social Incentive*

Some studies have tested the idea that social evaluation of one's performance augments the importance of success and thus increases the amount of justified effort (potential motivation). Consequently, social evaluation should lead to high effort when task difficulty is fixed and high or unspecified. Supporting evidence stemmed from studies in which participants were explicitly told that their responses could vs. could not be monitored by the experimenter (Wright, Dill, Geen, & Anderson, 1998; Wright, Tunstall, Williams, Goodwin, & Harmon-Jones, 1995, Study 2). Matching effects were observed for social evaluation by high, but not low-, status observers (Wright, Killebrew, & Pimpalature, 2002). Another experiment by Gendolla and Richter (2006a) found corresponding effects for implicit social evaluation manipulated by the mere presence of a passive observer during task performance.

The preceding social evaluation studies challenge other approaches that have posited that social observation should lead to a general increase in autonomic nervous system activity (e.g., Baron, 1986; Cottrell, 1968; Zajonc, 1965) or a general increase in effort (Harkins, 2006). Supporting the principles of motivation intensity theory, social evaluation resulted in relatively strong reactivity of one specific autonomic arousal measure—CV reactivity—when task difficult was high or not specified.

Corresponding to the above discussed reduced responsiveness to material reward of persons suffering from depressive symptoms, Brinkmann, Franzen, Rossier, and Gendolla (2014) found that dysphorics were also insensitive to social reward in terms of social approval. While non-dysphorics showed stronger SBP, DBP, and HR reactivity during a recognition memory task of unclear difficulty when they expected to be allowed to enter their name into a "best list" if they performed well, dysphorics did not (see Figure 6).

(h3) *Ego Involvement*

Ego involvement refers to an increased sense of success importance that occurs when people believe that a valuable ability is being evaluated (Klein & Schoenfeld, 1941). Studies by Gendolla and Richter tested the idea that ego involvement thus increases the level of potential motivation and should result in high effort-related CV response when task difficulty is fixed and high or unspecified. Results of studies by Gendolla and Richter (2005, 2006b; see also Gendolla, 1999) supported these predictions. A more recent study by Wright, Patrick, Thomas, and Barreto (2013) found that high ego-involvement can also compensate the effort mobilization deficit of fatigued individuals: Manipulated high fatigue combined with ego-involvement boosted participants SBP responses during a scanning task.

The studies on ego involvement challenge earlier views of Nicholls (1984) and Dweck (1986) who had formulated reservations against the assumption that the difficulty law of motivation applies to evaluations of important abilities. Those authors suggested that the difficulty-effort relationship is only proportional when people *do not* try to demonstrate valuable abilities—that is, *not* under ego involvement. Apparently, this is wrong.

(h3) *Self-Evaluation*

Self-awareness theory (Duval & Wicklund, 1972) posits that focusing individuals' attention to themselves induces a state of self-evaluation: Persons compare their actual behavior with the momentarily relevant standards. In the context of achievement behavior, self-focused attention should, thus, justify relatively high resources, because self-evaluation makes success relatively important. Consequently, effort should be high when self-awareness is combined with fixed high or unspecified task difficulty, but not when task difficulty is low. Individuals who were reminded of themselves by exposure to a picture of themselves during task performance (Gendolla, Richter, & Silvia, 1998; Silvia, McCord, & Gendolla, 2010; Silvia, Moore, & Nardello, 2014) or who were dispositionally highly self-focused (Silvia, Jones, Kelly, & Zibaie, 2011; see also Silvia, Kelly, Zibaie, Nardello, & Moore, 2014) invested more effort when difficulty was unfixed or fixed and high than people who were not self-aware. When difficulty was low, self-focus made no difference (see Silvia, 2015 for a more detailed overview). This effect was extended to implicit self-awareness. People who were exposed to their briefly flashed name during performance showed the same effects as those who were made explicitly self-aware (Silvia, 2012).

(h3) *Personality: Need for closure*

In one of the rather rare studies on motivation intensity theory that assessed the impact of personality traits on effort mobilization, Richter, Baeriswyl, and Roets (2012) examined the impact of dispositional need for closure—the aversion toward ambiguity—on effort-related CV activity. They suggested that success in tasks that represent ambiguous situations should be more important for individuals with a high need for closure than for individuals scoring low in this need. Correspondingly, high need for closure individuals should be willing to invest effort in more difficult tasks than low need for closure individuals. Task-induced PEP responses in a task where participants had to discover a hidden rule that classified patterns of colored shapes corroborated these predictions. Only participants with a high dispositional need for closure invested effort in the difficult version of the categorization task. Participants with a low dispositional need for closure disengaged (see also Szumowska, Szwed, Kossowska, & Wright, in press).

(h3) Gender-Specific Incentive Effects

Some experiments have applied motivation intensity theory reasoning to better understand gender differences in CV response, drawing on the idea that men and women might sometimes place different value on available performance incentives. In circumstances where they do, one would expect the gender with higher value appraisals to have greater willingness to expend effort, with this greater willingness translating into greater effort when difficulty is high or unspecified.

Findings have been mostly supportive. Consider for example an experiment by Barreto, Wong, Estes, and Wright (2012). Participants worked on an easy or difficult mental addition task and were told they could win a traditionally masculine incentive (a type of deodorant) by performing at a particular level. As expected, SBP responses during the task were stronger under difficult- than easy conditions among men, but low under both difficulty conditions among women. Findings for DBP and HR followed in close order.

A study that attempted to conceptually replicate and extend the work above (Barreto, Wright, Krubinski, Molzof, & Hur, 2015), surprisingly found that both men and women showed stronger responses under difficult task conditions. However, careful examination of masculine incentive ratings revealed that the male and female participants had more comparable incentive appraisals than male and female participants in the original study. Men and women in this study had sharply different appraisals of an available feminine incentive and—consistent with expectations—showed the original interactional pattern in reverse. Here, SBP responses during work were stronger under difficult- than easy conditions among *women*, but low under both difficulty conditions among men (see also Frazier, Barreto, & Wright, 2008).

(h3) *Mortality Salience*

Terror management theory asserts that humans have a unique capacity to comprehend their own mortality (Greenberg, Pyszczynski, & Solomon, 1986). Attention to mortality should engender a potential for existential terror that can be addressed through the construction and embrace of cultural worldviews that assure a literal or symbolic afterlife. When people live up to personal worldview standards, they attain positive self-regard and protection. Schuler, Mlynski, and Wright (2017) drew connections to motivation intensity theory, focusing on the implication that people should place greater value on approximating personal worldview standards when reminded of their mortality. They presented participants a task relevant to their identity after the participants had been exposed to a prime that made mortality more or less salient. For half of the participants, difficulty was fixed at a low level; for the rest, difficulty was unfixed. As expected, mortality salience increased participants' SBP responses during task performance when difficulty was unfixed, while reactivity rested low when the task was easy. Effects on HR, DBP, and MAP described corresponding patterns.

(h3) *Behavioral Restraint*

Recent work has investigated motivation intensity theory implications for *behavioral restraint* (Wright, 2014; Wright & Agtarap, 2015). Behavioral restraint involves expending oneself to meet a performance challenge that one can restrain in different measures. In light of this, it is reasonable to suppose that three factors should play roles in determining restraint intensity and associated CV responses. One is the *magnitude of the urge being resisted*, which should set the difficulty of the behavioral restraint challenge. Another factor is the *value or importance placed on restraint success*, which should determine how hard people are willing to resist. The third factor is the *level of restraint ability*, including ability determined by the level of fatigue. Ability should determine difficulty appraisals at different urge levels. The resulting model of restraint intensity can be visualized by viewing Figure 3 relabeling the difficulty axis as "Urge Magnitude" and the effort axis as "Restraint Intensity".

The best evidence for the application comes from an experiment that tested the implication that restraint success importance should combine with urge magnitude to determine restraint intensity (Agtarap, Wright, Mlynski, Hammad, & Blackledge, 2016). If importance is high enough to justify the effort required to restraint, restraint intensity should correspond to urge magnitude. If importance is not high enough to do so, restraint intensity should be low. The experimental challenge was to inhibit responses to a video that was more or less emotionally evocative. Participants were presented a mildly- or strongly evocative violent film clip and asked to refrain from showing any facial response, operating under conditions designed to make success more or less important. As expected, SBP responses were proportional to the evocativeness of the film clip (i.e., urge magnitude) when importance was high, but low regardless of clip evocativeness when importance was low.

(h3) *Hedonic Incentive: Effort for Affect Regulation*

Several studies by Gendolla and colleagues have investigated the combined effects of mood, task difficulty, and the hedonic incentive of success on effort-related CV response. This research tested the mood-behavior-model (Gendolla, 2000) idea that actions that are instrumental for mood regulation (maintaining a positive mood, repairing a negative mood) justify relatively high resources. One consequence of this suggestion is that positive hedonic incentive should eliminate the previously discussed effort withdrawal of people who face a difficult task in a negative mood (e.g., Gendolla & Krüsken, 2001b, 2002a). The studies built on initial evidence for this hypothesis (Gendolla & Krüsken, 2002c) and followed the same logic as the above discussed studies on the joint effect of affective influences and material incentive on effort mobilization.

Silvestrini and Gendolla (2009a) induced participants in a positive vs. negative mood and let them work on a memory task that was either easy or difficult. Before performance, participants were informed about the hedonic consequences of success. They either expected the presentation of a comedy video (positive incentive) or a distressing video (negative incentive) after success. SBP reactivity during task performance described the predicted pattern: When success incentive was negative, and thus did not justify high effort, SBP reactivity conformed to the crossover interaction pattern anticipated and shown for the joint effect of mood and objective task difficulty on experienced demand and corresponding effort intensity. But when success incentive was positive, SBP reactivity of participants who worked on the difficult task in a negative mood increased significantly. Another study manipulated the hedonic aspects of task performance itself and brought compatible results (Silvestrini & Gendolla, 2009b): A pleasant version of a sentence completion task justified higher effort than an unpleasant version. Finally, Silvestrini and Gendolla (2012c) found matching effects on PEP reactivity. Taken together, these results highlight the hedonic aspects of achievement motivation. Accordingly, it is not success per se that justifies the mobilization of high effort—success did not justify high resources when it led to unpleasant consequences. Rather, success must be bound-up with positive hedonic aspects to justify high effort.

In summary, numerous studies with multiple manipulations of potential motivation brought replicated evidence that variables that influence the importance of success can justify the mobilization of high effort when task difficulty is unspecified or fixed and high. However, suffering from depressive symptoms is a boundary condition of this effect.

(h1) *Conclusions*

This chapter has highlighted the question of what determines effort intensity in instrumental behavior. The analysis was guided by the predictions of motivation intensity theory (Brehm et al., 1983; Brehm & Self, 1989; see also Brehm, 1975), which states in brief that effort intensity corresponds to subjective difficulty as long as success is seen as possible and justified and that success importance (i.e. potential motivation) only influences effort directly when task difficulty is unspecified. We have discussed empirical evidence from studies that have operationalized effort intensity as CV response in the context of task performance. Many studies have investigated several psychological variables that have a systematic impact on subjective difficulty and potential motivation. Those studies have brought highly concordant evidence for motivation intensity theory's predictions. In addition to supporting this theory's principles, this evidence challenges a number of other ideas about the determination of effort intensity.

Some of these challenges were already mentioned above in the context of the presentation of our empirical work. In addition to that, our findings also limit approaches suggesting that reward directly determines effort mobilization (e.g., Eisenberger, 1992; Fowles, 1983). The studies discussed here have revealed that a direct incentive effect on the intensity of motivation only occurs when difficulty is unspecified or unknown rather than in general. Our findings are also not compatible with the idea that motivation is less intense if people perform tasks without a clear performance standard ("do your best") than if they perform tasks fixed high standards (Locke & Latham, 1990). According to the findings presented here, these conditions produce the same effects on effort-related CV response. Moreover, our findings contradict the (historically popular) idea that the intensity of motivation is maximal on intermediate task difficulty levels, as, for example, expressed in Atkinson's (1957) influential risk taking model. The studies presented here have found that effort intensity is maximal on the highest possible and justified rather than an intermediate difficulty level. Compatible with this, and further challenging the risk-taking model, experiments by Capa, Audiffen, and Ragot (2008a, 2008b) have found that a strong achievement orientation justifies high effort, resulting in stronger CV reactivity when task difficulty is high (see Capa, 2012 for a detailed review).

(h2) *Coda*

Taken together, studies provide solid evidence for the idea that effort-related CV response is systematically influenced by experienced task difficulty and the level of maximally justified effort (potential motivation), supporting the principles of motivation intensity theory. In this second edition of this handbook, we have focused on more recent research that was inspired by this theory. These new research lines focused on the roles of implicit processes, needs, and individual differences in effort mobilization—psychological variables we had considered to be studied in future research, when the first edition of this handbook appeared. However, although this research has revealed additional solid additional evidence for factors that systematically influence the mobilization of resources for instrumental behavior, the process of effort mobilization is certainly not yet fully understood.

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Figure Captions

Figure 1

Theoretical predictions of the joint impact of task difficulty and potential motivation on effort intensity. Panel A shows predictions for effort mobilization when low effort is justified (i.e., low potential motivation). Panel B shows predictions for the condition that high effort is justified (i.e., high potential motivation). (Figure adapted from Gendolla & Wright, 2009, p. 134. Copyright: Oxford University Press, reproduced with permission).

Figure 2

PEP (Panel A) and SBP (Panel B) reactivity in dependence on task difficulty in the Study by Richter, Friedrich, and Gendolla (2008). (Copyright: Society for Psychophysiological Research, reproduced with permission).

Figure 3

Relation between effort and difficulty for people with low- and high ability. (Adapted from a highly similar figure presented by Wright and Franklin, 2004, p. 190. Copyright: Erlbaum Press.)

Figure 4

SBP reactivity as a function of difficulty for low- and high fatigued participants. Based on data presented by Wright et al. (2003).

Figure 5

Cardiac pre-ejection period (PEP) reactivity during a short-term memory task in the experiment by Chatelain, Gendolla, and Silvestrini (2016). (Copyright: Elsevier, reproduced with permission).

Figure 6

SBP reactivity in dependence on dysphoria (depressive symptoms) and social reward in the study by Brinkmann, Franzen, Rossier, and Gendolla (2014). (Copyright: Springer, reproduced with permission).

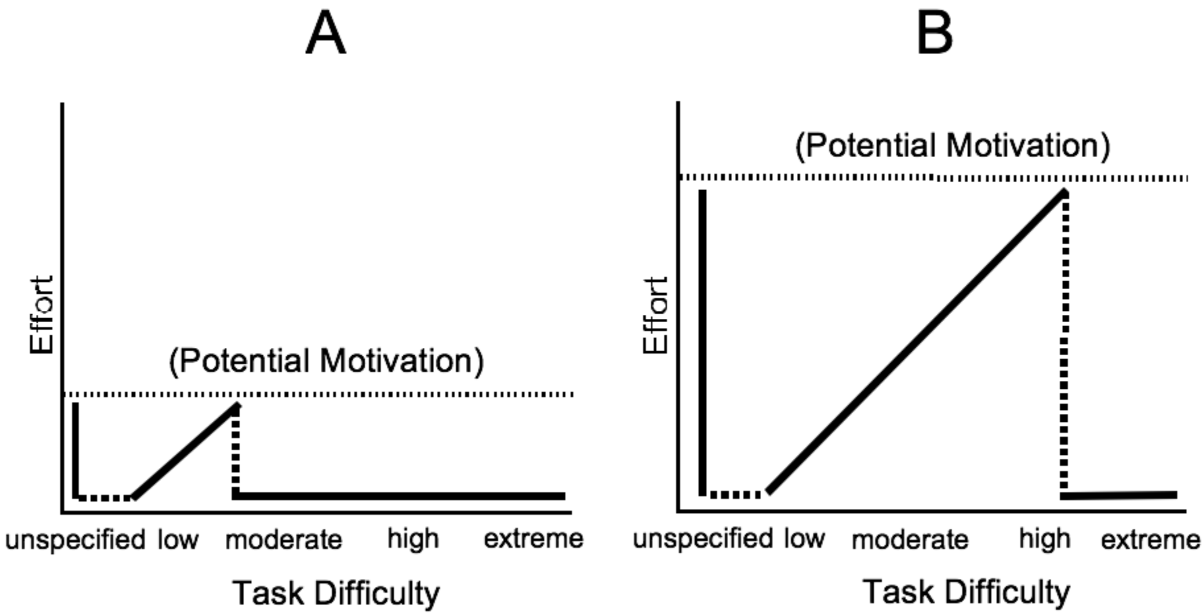

Figure 1

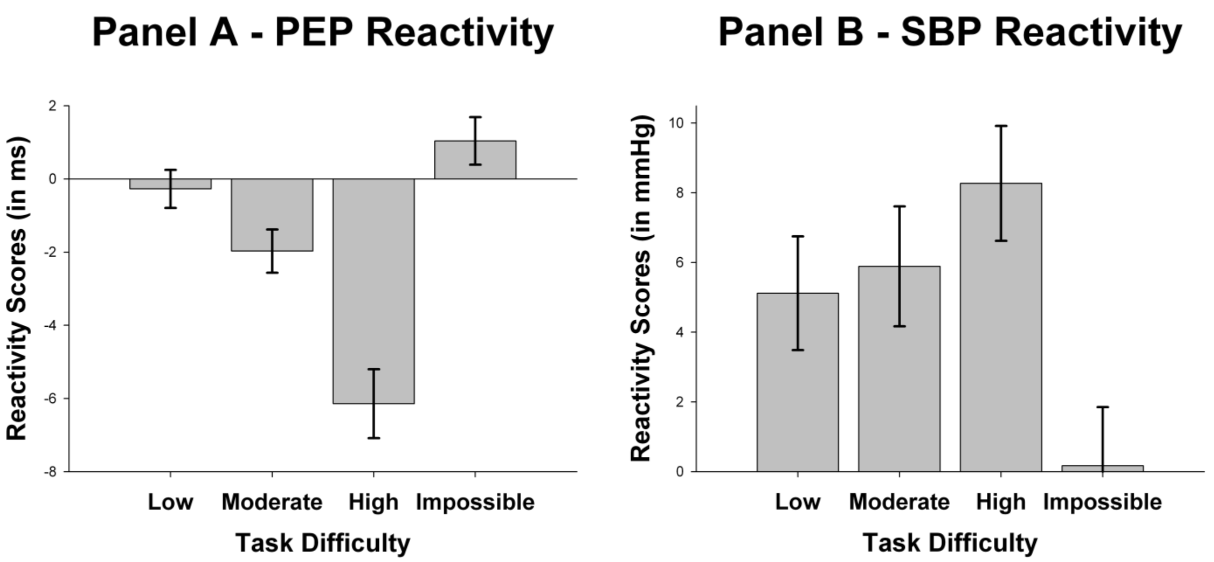

Figure 2

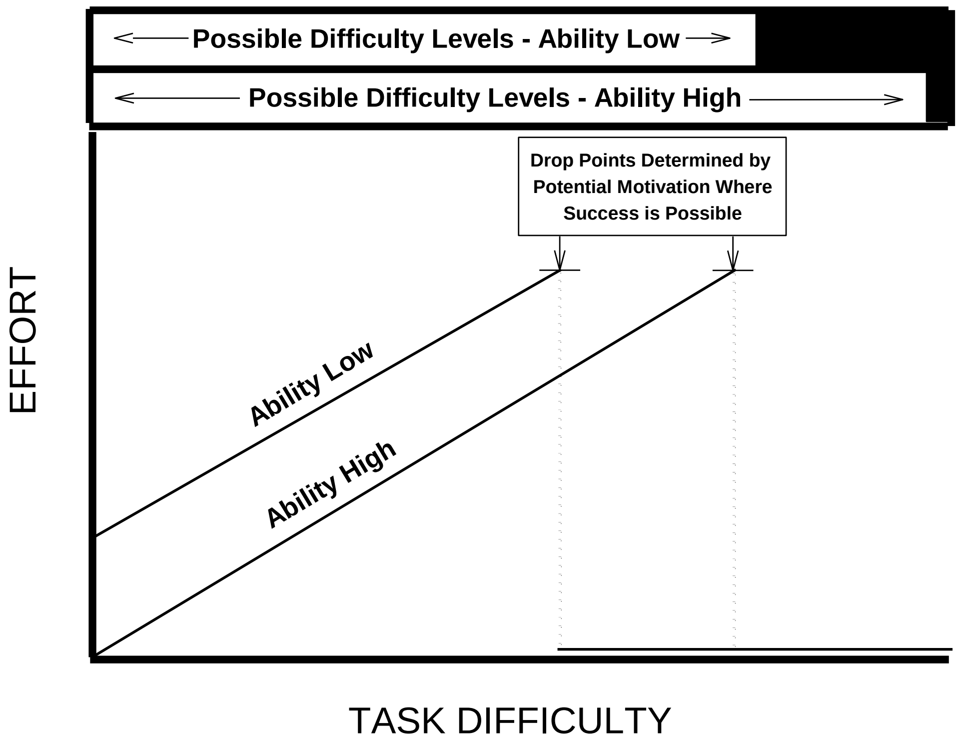

Figure 3

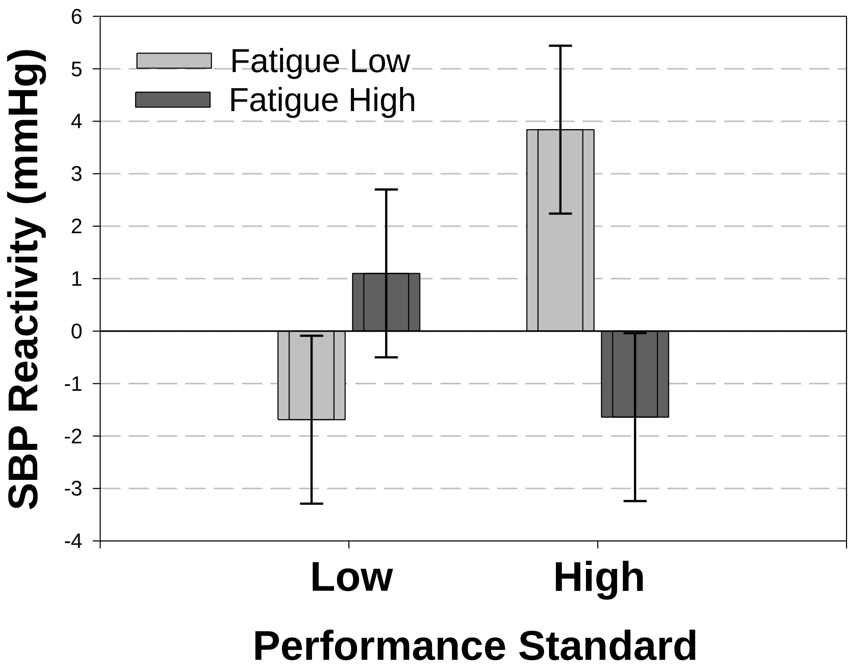

Figure 4

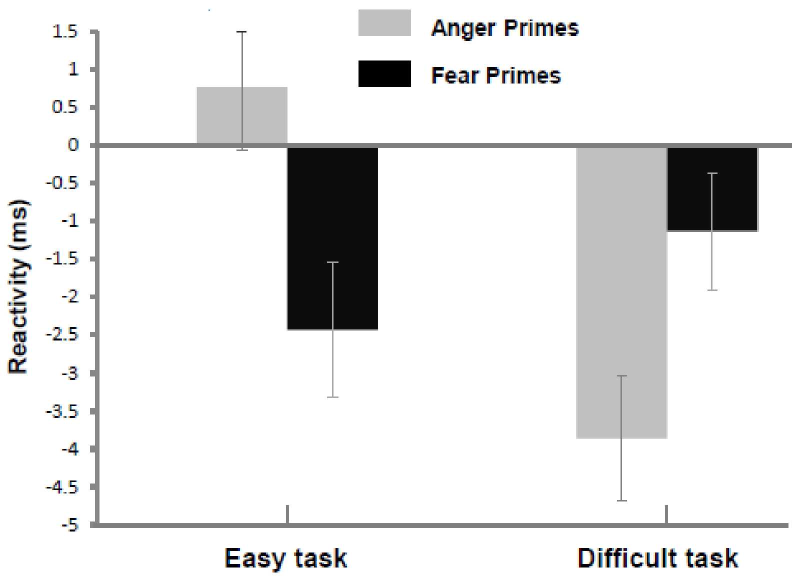

Figure 5

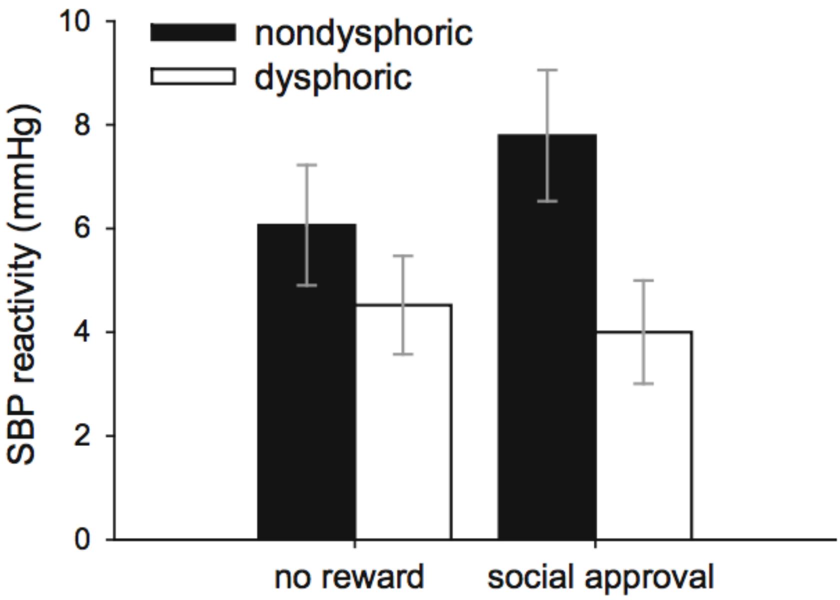

Figure 6