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The Intensity Side of Volition: A Theoretical and Empirical Overview of Effortful Striving

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Abstract

Attaining sports or health goals requires not only a high motivation but also the willpower to translate sport-behavior intentions into successful action. This volitional regulation calls for the mobilization of effort to overcome obstacles in the pursuit of goals. The present article provides a theoretical and empirical overview of motivation intensity theory (Brehm & Self, 1989)—a conceptual framework that makes clear and testable predictions about effort mobilization in various contexts. First, we present the guiding principles of this theory and its operationalizations by measures of effort-related cardiovascular reactivity and physical handgrip force. Second, we review a selection of empirical tests of the theory's basic assumptions and the impact of psychological moderator variables such as affect, fatigue, pain, and personality on effort mobilization. Finally, we discuss important implications of those findings for the sports and health domains and make suggestions for future research.

Keywords: Effort Mobilization, Motivation Intensity, Cardiovascular Reactivity, Handgrip Force

The Intensity Side of Volition: A Theoretical and Empirical Overview of Effortful Striving

Asked about important personal goals, most people will mention at least one health or sports goal (YouGov, 2020). However, those intentions do not always translate into action and people frequently fail to reach their goals, meaning an intention-behavior gap (Sheeran, 2002). Thus, high motivation alone does not guarantee successful goal pursuit—volitional regulation is required to initiate action and overcome obstacles during goal pursuit (Gollwitzer, 2012). Volitional regulation of behavior calls, amongst others, for mobilization of effort, that is, the mobilization of resources to carry out behavior (Gendolla & Wright, 2009). People need to invest, for instance, time and financial resources to reach their sports or health goals. Moreover, people need to mobilize effort at a specific point in time to overcome obstacles. But what are the underlying mechanisms of effort mobilization? Which amount of effort is mobilized in a specific situation? According to motivation intensity theory (Brehm & Self, 1989; Brehm et al., 1983) both physical and cognitive effort mobilization is guided by clear and testable principles that have found sound empirical support (for an overview see Gendolla et al., 2019). We assume that effort mobilization for sports or health goals should be guided by the same principles.

In the following, we first outline the main assumptions of motivation intensity theory and the operationalizations of effort as action-related responses in the cardiovascular system and physical handgrip force. We then provide an overview of empirical findings supporting the basic hypotheses and highlight psychological moderator variables such as affect, fatigue, pain, or personality, and end with a discussion of the implications of those findings for the sports and health domains.

Motivation Intensity Theory

Imagine you were a runner and you participated in a competition. How much effort would you mobilize in the following situations? (1) To qualify for the next round of a competition, you have to sprint a 100-meter-distance in less than 12 seconds. (2) To qualify for the next round of a cross-country competition, you must be amongst the 10 fastest runners. However, the runners start one after the other and you do not know how your competitors perform on this unknown natural terrain and under the varying weather conditions. (3) Your goal is to run as fast as you can to climb up as much as possible in a ranking list. These typical sports situations perfectly match three prototypical task difficulty conditions highlighted by motivation intensity theory (Brehm & Self, 1989).

In outlining the principles guiding effort mobilization at a specific point of time, motivation intensity theory draws on the fundamental principle of resource conservation (Zipf, 1949). Accordingly, wasting resources is aversive and should be avoided. Moreover, the theory makes an important distinction between the amount of effort that is maximally *justified* for goal pursuit and the amount of effort that is actually *mobilized* at one moment (Wright, 2008). The former is termed *potential motivation* and is determined by factors traditionally thought to influence motivation, such as individual needs, incentive value, and a task's instrumentality for reaching one's goal (Gendolla et al., 2019). The latter is termed *motivation intensity* and varies with the difficulty of the action to be carried out, as formulated in the difficulty law of motivation (Ach, 1910). The specific predictions outlined in the following can be derived from the resource conservation principle either directly or by making additional assumptions (Richter, 2013). It should be noted that motivation intensity theory's resource conservation principle is neutral regarding the valence of invested effort. It assumes that wasting resources is aversive, but it does not posit that investing effort to complete a task has a negative valence. Invested effort may even have a positive valence given that it enables the individual to attain personal goals.

Coming back to the different situations a runner can be faced with, motivation intensity theory would classify them as either (1) tasks with *clear and fixed difficulty*, (2) tasks with *unclear difficulty*, and (3) tasks with *unfixed difficulty* (see Figure 1). In the first case, the runner should mobilize effort proportionally to perceived task demand: the more difficult the time limit of the 100-meter-run, the more effort should be invested—running the distance in less than 30 seconds is rather easy and requires little effort, whereas running the distance in less than 12 seconds is rather difficult and requires much effort. Importantly, this proportional relationship between task difficulty and effort mobilization should hold as long as success is possible and justified: If it is clearly out of the athlete's scope to run 100 meters in less than 12 seconds or if qualifying for the next round does not matter to her or him, the runner should withhold effort mobilization and disengage—any effort mobilization would be a waste of resources. In the second case, where the athlete has no information about the time needed to be amongst the 10 fastest runners, task difficulty cannot be taken into consideration and effort mobilization should therefore vary as a direct function of potential motivation: The more important it is for the runner to qualify for the next round, the more effort she or he should invest. In the end, the runner might have mobilized more effort than needed, but she or he has not mobilized more effort than subjectively justified. In the third case, where the runner wants to run as fast as he or she can, potential motivation should again be the only determinant of effort mobilization. Also here, effort mobilization should be a direct function of the importance to climb up in the ranking or the success incentive the athlete expects. These processes of adapting to task demand and success importance do not require conscious awareness, but may become conscious.

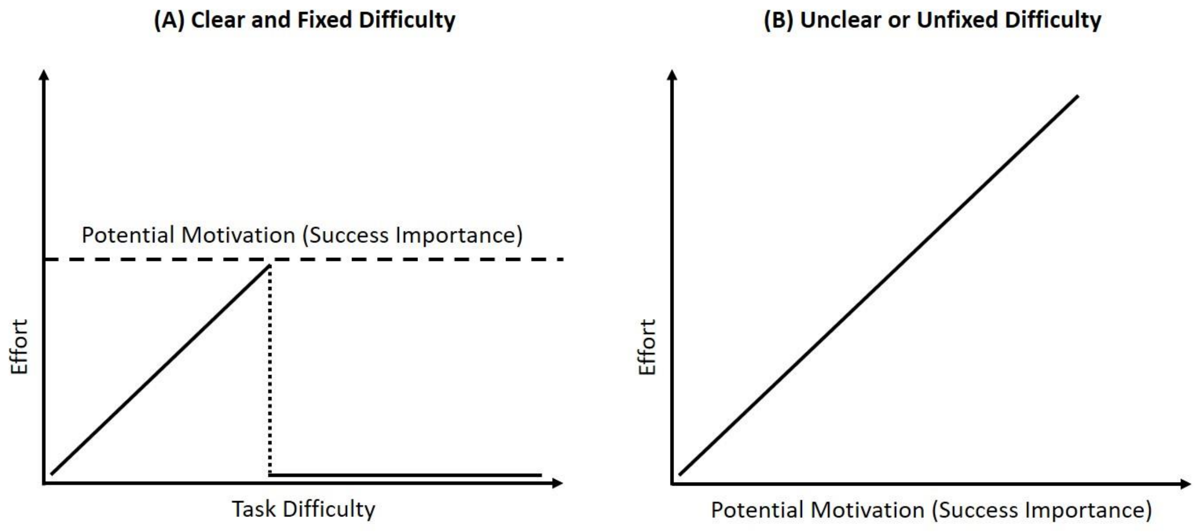

Figure 1: Predictions of motivation intensity theory for tasks with clear and fixed difficulty (panel A) and for tasks with unclear or unfixed difficulty (panel B)

Originally, motivation intensity theory was developed to predict changes in subjective goal valence (Brehm et al., 1983). Effort mobilization was an intervening variable linking task characteristics with goal valence (Richter et al., 2016; Wright & Brehm, 1989). However, over time, the focus of researchers changed and the mechanisms underlying effort mobilization became the center of interest. The bulk of empirical evidence stems from research on cardiovascular adjustments during performance on cognitive tasks in laboratory settings (for overviews see Gendolla et al., 2012; Gendolla et al., 2019; Wright & Kirby, 2001). Recently, a number of studies measuring energy investment in handgrip tasks complemented this research. In the following, we introduce both operationalizations of effort mobilization and illustrate the empirical support for motivation intensity theory by means of selected studies.

Effort-Related Cardiovascular Reactivity

Unlike self-reported effort or performance outcomes, effort-related physiological responses are direct and objective indicators of bodily changes related to resource mobilization. Performance outcomes, on the other hand, are determined not only by effort intensity but also by persistence, individual capacities, and strategy use and thus cannot be equated with effort intensity (e.g., Locke & Latham, 1990). Cardiovascular adjustments in proportion to task difficulty can be observed in physically challenging situations (i.e., typical sports contexts). However, they can also be observed during performance of cognitive challenges, that is, independent of metabolic demand (cardiac-somatic uncoupling; Obrist, 1981). In situations where a person can actively cope with a demand, especially beta-adrenergic sympathetic influences on the heart follow the pattern posited by motivation intensity theory (Wright, 1996). Research in the framework of Wright's integrative model has primarily relied on changes in pre-ejection period (PEP), systolic blood pressure (SBP), diastolic blood pressure (DBP), and heart rate (HR) from a rest to a task period to quantify effort mobilization. Beta-adrenergic influences on the heart directly influence myocardial contractility force. A shortening of the PEP—the time interval (in ms) between the onset of left ventricular depolarization and the opening of the left aortic valve—reliably reflects increases in sympathetic arousal (Berntson et al., 2004; Sherwood et al., 1990). Moreover, increases in SBP and (to a lesser extent) in DBP can index beta-adrenergic impact on the heart to the degree that blood pressure is determined by myocardial contractility and sympathetic influences on HR (Levick, 2003).

Typical study protocols include (1) a habituation period where participants sit quietly and (2) a task period where participants perform a cognitive task. Effort-related cardiovascular reactivity is calculated as changes from habituation to task values. Typical manipulations include variations of task difficulty, task clarity, and incentives but also assessment or manipulation of moderator variables like ability, mood, fatigue, or personality.

Handgrip Force

As a general model of effort investment, motivation intensity theory (Brehm & Self, 1989) aims to predict effort in all types of tasks—including physical tasks. The sympathetic-driven cardiovascular measures that have been used in most studies may provide a means to assess the effort invested in physical tasks. However, Richter (2015) suggested an alternative approach relying on the close association between adenosine triphosphate (ATP) consumption and exerted muscular force. The binding and bending of myosin-actin cross-bridges underlying muscle contraction and the production of muscular force consumes ATP—the primary energy compound fueling human action. In isometric muscle contraction tasks—i.e., when a muscle creates tension without a change in muscle length—the amount of consumed ATP is proportional to the number of active cross-bridges and thus proportional to the produced force (e.g., Boska, 1994; Szentesi et al., 2001). Consequently, force exertion in isometric tasks is an appropriate indicator of exerted energy and thus physical effort. It should, however, be noted that the assessment of exerted force does not constitute a measure of absolute energy investment. Like the cardiovascular parameters discussed in the preceding paragraph, exerted muscle force only constitutes a relative effort indicator: Observing that—under standardized conditions—an individual exerted in a first trial a force of 20 Newton (N) and in a second trial a force of 120 N suggests that she or he invested more effort in the second than in the first trial. It is, however, impossible to know whether two individuals who both exert 120 N exert the same amount of energy.

Basic Effort Findings

Effort-Related Cardiovascular Reactivity

Numerous studies have observed changes in cardiovascular reactivity as a function of variations in task difficulty, supporting the basic predictions by motivation intensity theory. Early examples are studies by Wright, Contrada, and Patane (1986) that presented participants with a math task and a memory task of varying difficulty. SBP reactivity assessed just before task performance was higher for the difficult task but lower for the easy and impossible tasks, suggesting that anticipatory effort mobilization was higher for a difficult than for an easy task, and that participants disengaged when the task was clearly impossible. Smith, Baldwin, and Christensen (1990) observed a similar SBP response pattern during preparation and delivery of a persuasive communication. Richter, Friedrich, and Gendolla (2008) assessed not only blood pressure and HR but also PEP as a more direct indicator of beta-adrenergic sympathetic impact on the heart. Participants performed one of four difficulty conditions of a Sternberg short-term memory task. Supporting motivation intensity theory's basic predictions for tasks with clear and fixed difficulty, PEP became shorter and SBP increased with increasing task difficulty until responding correctly became impossible because of too fast presentations of the stimuli (see Figure 2).

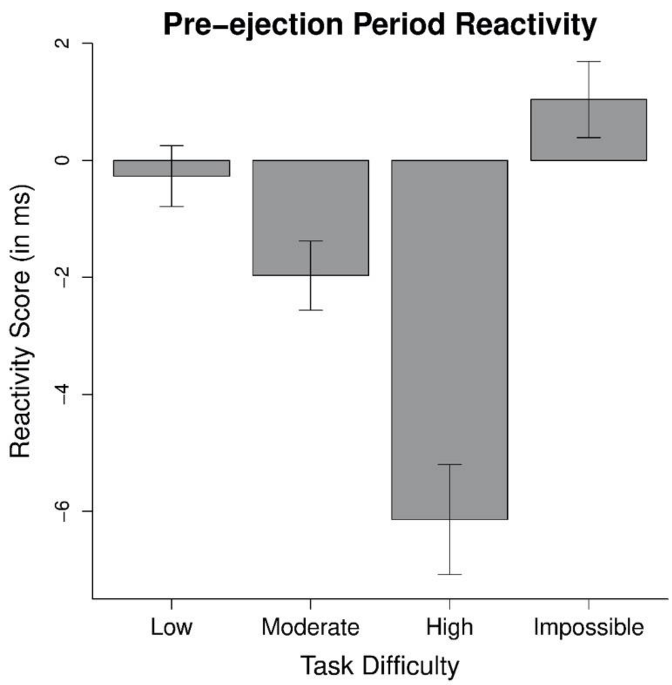

Figure 2: Means and standard errors of pre-ejection period reactivity in the study by Richter, Friedrich, and Gendolla (2008). Michael Richter, Antonia Friedrich, and Guido H. E. Gendolla, Task difficulty effects on cardiac activity, *Psychophysiology*, *45*, 869-875, 2008, Wiley, reprinted with permission.

Several other studies have supported motivation intensity theory's predictions regarding the effects of unclear and unfixed difficulty. Here, effort mobilization should directly depend on potential motivation, that is, on success importance. Richter and Gendolla (2009) had participants perform a delayed-matching-to-sample task. Importantly, task difficulty was kept unclear to the participants by varying difficulty from trial to trial. In addition, the number of correct responses required to get a reward was determined randomly at the end of the task. PEP reactivity increased (i.e., PEP became shorter) with increasing incentive value from 1 to 15 to 30 Swiss Francs for successful performance. A similar effect was reported by Wright, Killebrew, and Pimpalapure (2002, Study 2). In an unfixed task difficulty condition, participants could work as fast as they wanted on a letter-scanning task, consisting of locating and circling "E"s on pages full of jumbled letters, thereby setting their own performance standard. In an easy condition SBP reactivity was generally low and independent of incentive value. However, participants in an unfixed difficulty condition showed stronger SBP increases when monetary incentive was relatively high than when it was rather low. In sum, a number of studies using cardiovascular changes to index effort mobilization during the performance of cognitive tasks provide compelling evidence for the basic predictions of motivation intensity theory: Effort mobilization rose proportionally with subjective task difficulty as long as success was possible and justified. Moreover, potential motivation (i.e., success importance) determined effort when task difficulty was unclear (i.e., unknown to the performer) or unfixed (i.e., can be determined by the performer) (for reviews see Gendolla et al., 2012; Gendolla et al., 2019; Richter et al., 2016; Wright & Kirby, 2001).

Handgrip Force

Richter and Stanek (Richter, 2015; Stanek & Richter, 2016) examined the impact of task difficulty on effort investment in physical tasks relying on the proportional relationship between exerted force and ATP consumption in isometric tasks (e.g., Boska, 1994; Szentesi et al., 2001). They developed a paradigm called the "Ketchup Task", in which participants have to squeeze a handgrip dynamometer that represents a clogged Ketchup bottle. If a participant attains or exceeds a preset force standard, she or he frees the clogged bottle, the trial counts as success, and the participant receives a reward. Manipulating task demand across several possible (force standards ranged from 50 N to 150 N) and impossible levels (force standard of 500 N) in five studies with both between-persons and within-person designs, Richter and Stanek conceptually replicated the results of the cardiovascular studies: The force that participants exerted on the handgrip dynamometer increased from the lowest force standard to the highest possible standard and was again low if the standard was impossible (see Figure 3 for an example).

Richter and Stanek's studies not only added to the existing positive evidence for the task-difficulty-effort relationship predicted by motivation intensity theory. They also extended preceding work by testing the theory's prediction that individuals should only invest the minimum effort required for task success and disengage if success is impossible. All five studies failed to provide evidence for this hypothesis. Even if participants had demonstrated in the practice periods that they were able to exert the required minimum force with a high precision, they consistently invested more energy than required in the critical task trials. That is, they exceeded the force standard and even exerted 100% more force than required in some conditions. So far, there are no studies that have explored the reasons why individuals overshoot the required force in these handgrip tasks. We have discussed potential reasons in preceding publications (Richter, 2015; Stanek & Richter, 2016, 2021), but a theoretical integration of this finding into motivation intensity theory is pending.

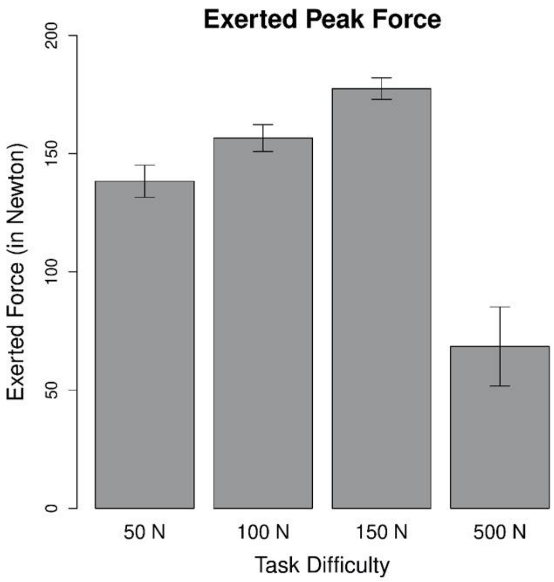

Figure 3: Means and standard errors of exerted handgrip force in Study 3 by Stanek and Richter (2016). Joséphine Stanek and Michael Richter, Evidence against the primacy of energy conservation: Exerted force in possible and impossible handgrip tasks, *Motivation Science, 2*, 1, 49-65, 2016, APA, reprinted with permission.

Moderators of Effort Mobilization

Effort-Related Cardiovascular Reactivity

Based on the evidence for the basic predictions of motivation intensity theory (Brehm & Self, 1989), several lines of research have investigated possible moderators of effort mobilization that are of direct importance for the sports and health domains: perceived ability, fatigue, momentary mood, depressive symptoms, implicit affect, social evaluation, self-awareness, and personality. In the following, we exemplarily present a selection of findings that might be of particular interest for sports and health contexts. We show how these moderator variables influence either perceptions of task difficulty, or potential motivation (i.e., success importance), or both. For more detailed discussions of the fundamental mechanisms underlying these effects, the interested reader is referred to recent reviews by Gendolla et al. (2019) and Richter et al. (2016).

Moderators of Task Difficulty Perceptions

An important early extension of the principles of motivation intensity theory was Wright's (1998) analysis of ability effects on effort mobilization. Accordingly, perceiving one's task-related abilities as low (or actually having low abilities in the respective domain) leads to higher subjective task demand and therefore to higher effort mobilization for tasks of easy to moderate difficulty. Moreover, higher subjective task demand leads to task disengagement at higher levels of task difficulty, because the subjectively high demand either appears to exceed the person's abilities or calls for the mobilization of more resources than justified by success importance. In contrast, perceiving one's task-related abilities as high (or actually having high abilities in the respective domain) leads to lower subjective task demand and therefore to lower effort mobilization, thereby enabling task engagement even at higher levels of task difficulty.[1] A number of early studies have confirmed the hypothesized interaction effect of task difficulty and ability (e.g., Wright et al., 1994). For instance, Wright and Dill (1993) first let participants believe to have low versus high ability for a scanning task. When subsequently performing the respective task, SBP reactivity was high for low-ability participants working on the easy task and for high-ability participants working on the difficult task. Importantly, low-ability participants disengaged in the difficult task.

A similar reasoning has been applied to the effects of mental or physical fatigue: Being fatigued (for instance because of a preceding demanding task) leads to higher subjective demand in a subsequent task and therefore to higher effort mobilization at low objective difficulty levels and to disengagement when difficulty is objectively high. An early study involving muscular fatigue required participants to perform a couple of easy or difficult hand dynamometer grips with either their left or right hand (Wright & Penacerrada, 2002). Subsequently, participants had to hold a modest grip with their right hand while cardiovascular measures were taken. SBP reactivity in this second task was stronger for right-hand participants who had previously performed the difficult task than for those

[1] A comparison with the impact of self-efficacy beliefs (Bandura, 1997) on health behaviors is beyond the scope of the present analysis. Nevertheless, there are a couple of interesting analogies between the effects of perceived ability in the present framework and the effects of self-efficacy beliefs in models of (health) behavior (change) (e.g., Ajzen, 1991; Schwarzer, 2001).

who had performed the easy task. Effort mobilization did not differ as a function of task difficulty for left-hand participants. Further studies have replicated the joint impact of fatigue and task difficulty on subsequent effort mobilization in cognitive tasks (e.g., Stewart et al., 2009). Importantly, studies presenting different tasks for the two phases (fatigue induction and test) did not find evidence that fatigue effects were task specific—they generalized across different tasks (e.g., Wright et al., 2007). Recently, Wright and Mlynski (2019) have extended the ability analysis to explain performance decrements in self-control tasks due to fatigue effects on effort. Overall, the motivation intensity theory studies on fatigue suggest that fatigue effects can be either task specific or unspecific. In some contexts, central contributions to fatigue (e.g., Nordlund et al., 1985) may dominate and lead to unspecific effects. In other contexts, peripheral contributions may dominate and result in task-specific effects.

While it is easy to imagine ability and fatigue influences on subjective task difficulty and effort mobilization in the sports or health domains (think, for instance, of the runner who is convinced that she or he is very well trained for the 100-meter sprint, or who feels exhausted after having to hurry to arrive at time at the competition), other moderator variables might be less obvious. Amongst those are the affective influences stemming from momentary or dispositional mood and implicit affective cues on subjective task difficulty. The mood-behavior-model (Gendolla, 2000) posits that moods have an informational impact on task-related judgments. Accordingly, a negative mood leads to higher subjective task demand and therefore to higher effort mobilization for easy to moderate tasks but to task disengagement for difficult tasks due to subjectively too high task demand. Typical studies involve a mood-induction period followed by a task period, where participants work on a cognitive task. Confirming the expected crossover interaction pattern, Gendolla and Krüsken (2001) found that participants in a negative mood showed higher SBP reactivity when working on an easy (high subjective task demand) than on a difficult (disengagement) letter-cancellation task. The opposite pattern was true for participants in a positive mood, who mobilized more effort for the difficult than for the easy task. Similar studies have replicated and extended these basic findings (e.g., Gendolla & Krüsken, 2002; Silvestrini & Gendolla, 2009).

However, not only experimentally induced mood can impact subjective task difficulty and subsequent effort mobilization. Stable individual differences in naturally occurring, dispositional mood might likewise lead to stronger effort mobilization or task disengagement. In two studies, Brinkmann and Gendolla (2008) assessed individual differences in depressive symptoms in non-clinical samples. Results demonstrated the same crossover interaction pattern as described above: Participants with high levels of depressive symptoms, who are characterized by high levels of negative mood, showed stronger SBP reactivity for easy cognitive tasks but disengagement for difficult tasks. In contrast, participants with low levels of depressive symptoms mobilized less effort for the easy tasks but stayed engaged for the difficult tasks. These findings have been replicated by Silvia et al. (2016) using measures of PEP and extending the analysis over four difficulty levels.

The research lines on feeling states presented above have relied on explicit affective states, either by inducing people into a negative or positive mood that was also experienced as such by participants, or by explicitly asking people about their affective experiences and depressive symptoms. These feeling states exert their influence on effort mobilization via their impact on explicit effort-related evaluations of task demand. A recent analysis has extended these effects to the domain of implicit affect. According to the implicit-affect-primes-effort model (Gendolla, 2012), the mere activation of knowledge about affective states can lead to the experience of a task as being difficult or easy and thereby impact effort mobilization. This phenomenon is based on the mental representations people have about affective states. People have learned that it feels easier to cope with a demand when being angry or happy but that it feels more difficult to cope with the same demand when being sad or fearful. Typical paradigms in this line of research consist of cognitive tasks with emotion primes directly embedded in the task trials in form of brief flashes of low-resolution pictures of emotional expressions. In support of the hypotheses, Chatelain and Gendolla (2015) demonstrated that participants had stronger increases in PEP reactivity while working on moderately difficult tasks that included emotional primes of sadness or fear than while working on tasks that included emotional primes of happiness or anger (see also Gendolla & Silvestrini, 2011; Silvestrini & Gendolla, 2011). Moreover, the same PEP reactivity interaction pattern of emotional primes and task difficulty described for explicit mood states has been confirmed for implicit affect (e.g., Chatelain et al., 2016; Freydefont et al., 2012). Importantly, people typically do not experience an affective state after being exposed to affect primes. That is, they do not report feeling angry, sad, happy, etc. (Chatelain et al., 2016; Lasauskaite et al., 2013).

Interestingly, not only affect primes of fear and sadness are linked to the experience of difficulty, implicitly processed words related to pain might trigger the same effects on perceived task difficulty and effort mobilization (Silvestrini, 2015). In line with this hypothesis, two studies by Silvestrini (2018) found the same PEP reactivity interaction pattern as described above: Participants who had been primed with pain cues mobilized more effort for an easy task but disengaged from a difficult task, in contrast to participants having received neutral or anger primes. These mood and affect prime extensions of motivation intensity theory offer important insights into effort mobilization in sports or health domains. Similar to the laboratory studies presented above, a runner might experience a positive or negative mood state during the run, due to an event that took place just before the run (e.g., a phone call bringing good news) or due to her or his general tendency to "feeling blue". Less obvious but of equal importance are affective primes that the runner might be faced with before or during the run: The encouraging smile of a friend, the sad expression of a spectator talking with his neighbor about a recent death in the family, the angry face of the coach who thinks the athlete should speed up, or the painful facial expression of a competitor who just stumbled and fell—all these cues might change the runners' experience of the run's difficulty and influence effort mobilization by this way. Interestingly, Blanchfield, Hardy, and Marcora (2014) could show that the presentation of masked happiness primes led to longer persistence in a physical endurance task than the presentation of sadness primes. This persistence effect is compatible with the above discussed implicit affect effects on effort intensity.

Moderators of Success Importance

The moderating influences discussed thus far all refer to variables that cause a change in the perception of task difficulty and therefore alter effort mobilization during tasks where task demand appraisals matter. According to motivation intensity theory, depending on the type of task, potential motivation (i.e., success importance) exerts an important indirect or direct impact, either by setting the upper limit of justified resources or by directly determining effort mobilization in unfixed or unclear settings. Variables like individual needs, task incentives, or the task's instrumentality for reaching one's goal are typical determinants of potential motivation (Brehm & Self, 1989). Especially, monetary incentives have been used in many studies showing money's capacity to increase success importance of a clear and fixed challenge (e.g., Eubanks et al., 2002) or to directly impact effort mobilization in unfixed or unclear tasks (e.g., Richter & Gendolla, 2009; Wright et al., 2002). Besides the obvious role of monetary incentives in professional sports, other forms of incentives like social recognition are prominent in the sports or health domains as well. In the following, we present examples of situational and individual differences variables that have been found to impact potential motivation in the laboratory and that should also be important in sports or health contexts.

Amongst the situational variables impacting success importance are contexts that include social evaluation, ego involvement, and self-awareness (see Gendolla & Richter, 2010, for an overview). In particular, a series of studies by Wright and colleagues revealed higher SBP reactivity during performance of difficult or unfixed tasks when participants expected their performance to be monitored by other people, especially by high status observers, compared to private performance situations (e.g., Wright et al., 2002; Wright et al., 1995). In contrast, when the tasks were easy, participants' SBP reactivity did not differ according to the presence or absence of an observer. These experiments demonstrate that social evaluation justified the mobilization of high resources but led to higher effort mobilization only if the task required high effort or if participants could choose their performance standard themselves. A similar pattern was observed when participants' performance was merely observed by a physically present person without being explicitly evaluated (Gendolla & Richter, 2006a). Furthermore, similar effects occur in situations that emphasize ego involvement, that is, when people believe that a valued ability is being evaluated (Klein & Schoenfeld, 1941). To induce a state of ego involvement, Gendolla and Richter (2005) let student participants believe that a letter cancelation task was indicative of their ability to concentrate, which in turn was presented as an important predictor of academic success. Results confirmed that ego involvement led to higher

SBP reactivity when task difficulty was unfixed but not when task difficulty was fixed and easy—even if success importance was high in the ego involvement condition, the easy task did not require high effort mobilization (see also Gendolla & Richter, 2006b).

Another situational variable that enhances success importance is self-awareness, that is, a state in which people focus their attention on themselves as an object. Self-aware people compare their actual behavior with the relevant situational standard, leading to efforts to reduce possible discrepancies between actual and desired states (Duval & Wicklund, 1972). Typical ways to induce self-awareness are the exposure to one's own picture or name. Gendolla, Richter, and Silvia (2008) exposed participants to a video monitor showing their own face recorded from the side. As expected, SBP reactivity was higher in the self-awareness condition than in a control condition when task difficulty was unfixed or difficult, but not if a challenge was easy or clearly impossible. Further studies have confirmed these findings using a mirror (Silvia et al., 2010) or first-name priming (Silvia et al., 2014) to induce state self-awareness. Moreover, individual differences in trait self-focus had corresponding effects (e.g., Silvia et al., 2013).

The so far discussed situational variables affecting success importance are of clear importance for the sports and health domains. Social observation and social evaluation are omnipresent in both competitive and leisure sports. Moreover, if sport or health behaviors have become part of one's identity, situations that emphasize their evaluation might induce a state of ego involvement. Finally, reminders of one's self that enhance people's self-awareness can be found in many fitness centers, where walls are typically covered with mirrors. In all those settings we can expect high success importance that justifies high effort mobilization if an exercising task's difficulty is high, unfixed, or unclear.

Amongst several extensions of motivation intensity theory relating to individual differences (e.g., Richter et al., 2012), a recent analysis of achievement motivation and effort mobilization is of particular importance for the sports context and extents other approaches on the role of needs in sports (e.g., Furley et al., 2019; Marjanović et al., 2019). Traditionally, the need for achievement (or achievement motive) is defined as the need for significant accomplishments, skill mastery, and attainment of standards of excellence (McClelland, 1987). In sports, the need for achievement is apparent when it comes to surpassing oneself or experiencing positive or negative affect in reaction to (lack of) excellence. Mazeres, Brinkmann, and Richter (2019) have argued that success in a task that incorporates achievement incentives would be more important for individuals with a high need for achievement than for those with a low need for achievement. Similar to the analyses presented above, high success importance should justify high effort mobilization, leading to higher cardiovascular reactivity for difficult, unfixed, or unclear tasks. Using measures of PEP reactivity, Mazeres et al. have corroborated these hypotheses.

We finish this section about the effects of individual differences on potential motivation with a caveat with respect to contexts in which typical incentives that normally justify high effort mobilization might not work as expected. Individuals suffering from clinical or subclinical symptoms of depression typically experience anhedonia, that is, a loss of interest or pleasure (Loas, 1996). A series of studies has compared cardiovascular reactivity of individuals with low versus high levels of depressive symptoms during the performance of cognitive tasks with unclear or unfixed difficulty allowing participants to obtain different kinds of positive incentives (i.e., rewards) or avoid negative outcomes (i.e., punishments). PEP reactivity of individuals with low levels of depressive symptoms increased, as expected, with growing monetary rewards or punishments. However, individuals with high levels of depressive symptoms did not respond to high monetary incentives (e.g., Brinkmann & Franzen, 2013; Franzen & Brinkmann, 2015, 2016; Silvia et al., 2020). Similar results have been obtained when social recognition instead of a monetary reward was offered as incentive (Brinkmann & Franzen, 2017; Brinkmann et al., 2014), and results have been replicated in a sample of patients with major depressive disorder (Franzen et al., 2019). Taken together, even though there exist different ways of enhancing individuals’ potential motivation and subsequent effort mobilization via tangible and non-tangible incentives, it is important to consider conditions like anhedonia, under which these measures might not work as expected.

Handgrip Force

In contrast to the broad literature on effort-related cardiovascular reactivity, evidence for moderating effects on handgrip force has just started to emerge. Stanek and Richter (2021) aimed in a series of five studies to replicate the interaction effect of task difficulty and success importance consistently observed in the cardiovascular studies on motivation intensity theory. Each of these studies manipulated task difficulty by presenting two different force standards—from 50 N to 180 N—and varied success importance by offering two different levels of reward, which varied between 0.0005 and 0.50 Swiss Francs per successful trial. Motivation intensity theory would predict that the reward level only influences exerted force if the force standard is high but not if the force standard is low—the low reward should not justify the energy that is needed to exert the high force. Surprisingly, all but one study failed to provide support for this interaction. Four out of the five studies favored an additive model, in which task difficulty and success importance exert independent cumulative effects on effort investment. In the sports context, it is thus important to consider both, the objective difficulty of the training session or competition, the value of success for the athlete, as well as the possibility of additional goals the athlete might hold (for a detailed discussion see Stanek & Richter, 2021).

Conclusions and Implications

In this article we have presented the principles of motivation intensity theory (Brehm & Self, 1989) and an exemplary selection of studies that have tested (1) its basic predictions for the processes underlying effort mobilization and (2) the important role of psychological moderator variables, such as ability, mood, implicit affect, depressive symptoms, social and monetary incentives, and needs. Although that research was nearly exclusively experimental and psychological, we have outlined clear implications for the sports and health domains with our recurrent runner example. We could easily translate experimental settings to real-life situations in the sports domain.

As it should be clear now, we have no reason to believe that the psychological process of effort mobilization fundamentally differs between laboratory and real-life settings or between cognitive and physical exercise tasks. The above discussed handgrip studies may provide the easiest link between these settings and have provided evidence for the central role of task difficulty for energy investment in physical performance. Even though sports activities usually involve much more complex muscular work and motor coordination than pressing a dynamometer, this research concerns a core aspect of all sports activities—muscular force exertion. Moreover, other researchers have already started to apply the principles of motivation intensity theory to study sports performance, e.g. in physical endurance tasks (e.g., Marcora, 2008), with a special focus on the links between perceived and exerted effort (for an overview see De Morree & Marcora, 2015). This makes it still more evident that motivation intensity theory provides a useful framework for studying effort mobilization in the sports and health domains.

As we have outlined in our runner example throughout this article, it is easily possible to translate the interactive effects of fixed, unfixed, and unclear task difficulty and the importance of success to typical settings of competitive and leisure sports. Thus, we regard the principles of motivation intensity theory as being fundamental, general, and independent of a person's specific activity—be it physical or cognitive. However, we are also aware of one possible difference between physical exercise and cognitive activity contexts regarding the regulation of effort-related cardiovascular activity: In real-life sports, the effect of objective task difficulty on cardiovascular responses could be more pronounced and less moderated by subjective moderator variables like, for example, affect than in the context of cognitive activity. The reason for this is so-called cardio-somatic coupling in physical activity (Obrist, 1981).

The primary physiological function of the cardiovascular system is providing sufficient blood flow in dependance on the body's metabolic demands (Papillo & Shapiro, 1990). During physical exercise, cardiovascular activity is basically coupled to these demands—the cardiovascular regulation system can get neural feedback from the organs and the musculature, making strong objective demand effects on cardiovascular activity possible. During physical exercise, the body can better calibrate what it needs from the cardiovascular resource transport system than during cognitive activity. In the latter context, cardiovascular activity is typically uncoupled from sheer metabolic demands (Obrist, 1981). An interesting future research question is thus whether the psychological moderator variables of objective task difficulty's effects on effort-related cardiovascular responses we have discussed above will have the same significance during physical exercise as during cognitive challenges. As a working hypothesis we can state that this should be the case to the extent to which the mind can rule the body. This degree has, however, to be determined by empirical tests. Regarding fatigue (e.g., Wright et al., 2012) and implicit affect (e.g., Blanchfield et al., 2014), evidence for their significant role as effort moderators in aerobic activity is already existing. To determine the roles of the other psychological moderator variables discussed above, we need more empirical tests.

However, considering that cardiovascular activity is typically coupled to the body's metabolic demands, while it is less so during cognitive activity, does not suggest that the principles of motivation intensity should not apply to the sports and health domains. Also in those domains, actions vary regarding their difficulty and the importance to succeed. Accordingly, the principles of motivation intensity theory should apply to sports and health-related behavior. At least, those principles provide a very clear framework for testing whether this assumption is true. We regard this as an excellent basis for further testing its predictions in real-life health and sports activity contexts and we hope that the present analysis can be a starting point for this.

Based on this present analysis, a couple of implications can already be derived for the interested practitioner. As stated at the outset, effort mobilization is essential to cope with obstacles in goal pursuit and overcome the intention-behavior gap. Being aware of the determinants of effort mobilization and moderating influences can help adjusting effort to objective task demands and avoid unnecessary disengagement and effort reduction. Such unwanted outcomes can occur due to the subjective impression of not being well trained, due to a bad mood resulting from an unrelated preceding event, or due to the negative impact of the facial expression of a spectator—to name just a few of the examples outlined above. It is equally important to avoid situations in which the athletes overextend themselves and mobilize more effort than necessary, which occurs, for instance, when faced with unclear or unfixed situations. Being observed or evaluated, being in a state of ego involvement or self-awareness, or having a high achievement motive might lead to the deployment of considerable resources to cope with an unfixed or unclear situation. Furthermore, as first evidence from hand-grip tasks suggests (Stanek & Richter, 2021), athletes might invest more energy than necessary, potentially driven by an additive effect of the difficulty of the sports challenge and the value of success for them. To cope with all the situations outlined above, coaches can help their athletes by setting up circumstances conducive to the specific training or competition goals: They can minimize undesirable influences on subjective task difficulty, they can clarify the difficulty of the challenge to avoid overinvestment, or they can keep task difficulty voluntarily unclear to incite effort mobilization in relation to success importance. Moreover, they can make athletes aware of their selves and their goals. Finally, they can emphasize low success importance and the possibility of effort reduction or even disengagement to avoid overextending in an unimportant training session or competition.

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