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Abstract

In contrast to the motive literature, motivational intensity theory predicts that the implicit achievement motive (nAch) should only exert an indirect impact on effort by limiting the impact of task difficulty. To contrast these two views, sixty-eight participants with a low or high nAch performed an easy or difficult arithmetic task. Effort was assessed using cardiac pre-ejection period (PEP). Supporting motivational intensity theory's view, PEP response was low in both easy-task conditions but stronger in the high-nAch group than in the low-nAch group in the difficult task. These findings suggest that nAch exerts an indirect effect on effort investment by setting the maximally justified effort instead of directly determining the amount of effort that is invested to satisfy the motive.

Keywords: Implicit achievement motive, effort, motivational intensity theory, pre-ejection period, task difficulty

Implicit achievement motive limits the impact of task difficulty on effort-related cardiovascular response

1. Introduction

Motives (or needs) direct and energize human behavior (McClelland, 1987; McClelland, Koestner, & Weinberger, 1989). Hunger urges us to search for food, the motive to reproduce leads us to mate and have offspring, and social motives, like the affiliation motive, push us to invest time and effort in our interpersonal relationships. Interestingly, there is an abundance of research on how motives determine the actions that we execute but there is much less empirical research on motive's impact on *how* we execute a specific action. In particular, the impact of motives on the effort that we invest in a task has rarely been empirically addressed. Most motivation psychology literature suggests that motives exert a direct effect on effort: the stronger the motive, the higher the effort investment (Biernat, 1989; McClelland, 1987). Thus, individuals with a high motive should mobilize more effort than individuals with a low motive, independent of other personal or situational factors. However, one major effort theory, motivational intensity theory (Brehm & Self, 1989), makes a conflicting prediction by arguing that motives only exert an indirect effect by setting the upper limit of effort that individuals are willing to invest in a task. Thus, for easy tasks, effort mobilization should be low and independent of motive strength. In contrast, for more difficult tasks, only individuals with a high motive should mobilize high effort. The present study aims to test these opposing views by examining the impact of the implicit achievement motive on effort invested in a cognitive task. This comparison will provide insights into the joint impact of individual differences in implicit achievement motive strength and task difficulty on effort. Apart from closing an important gap in the achievement motivation literature, the present study has implications for applied contexts (for instance, education).

The achievement motive is one of three motive systems that have been suggested by McClelland (1987). It refers to the need for significant accomplishments, skill mastery, and attainment of standards of excellence. Previously, the achievement motive was measured by either self-report (i.e., explicit) or projective (i.e., implicit) measures. However, many studies (deCharms, Morrison, Reitman, & McClelland, 1955; Schultheiss, Yankova, Dirlikov, & Schad, 2009; Spangler, 1992) have consistently shown that self-report and projective motive measures do not correlate and that their behavioral correlates are different. Rather, the achievement motive comprises two subclasses: an explicit and an implicit achievement motive. The explicit achievement motive (i.e., self-attributed need for achievement, sanAch) refers to a self-attributed motivational disposition, whereas the implicit achievement motive (i.e., need for achievement, nAch) represents a nonconscious motivational disposition. According to McClelland et al. (1989), the explicit achievement motive is related to social goals and norms and the implicit achievement motive represents a more primitive motivation system of affective experiences. The explicit achievement motive predicts respondent, conscious, verbal, and controlled behavior, whereas the implicit achievement motive predicts nonconscious, nonverbal, and spontaneous behavior and energizes spontaneous impulses to succeed (e.g., effective task performances). Being consciously represented, the explicit achievement motive can be assessed by self-report measures (e.g., Personality Research Form, Jackson, 1984). In contrast, having no conscious representation, the implicit achievement motive has to be measured indirectly, by projective content-coding measures, such as the Picture Story Exercise (Schultheiss & Pang, 2007).

Like any other motive, the explicit and implicit achievement motives only exert an impact on behavior if they are 'aroused' by situational cues suggesting that need satisfaction is possible in the current environment. The explicit achievement motive is aroused by incentives extrinsic to the activity (e.g., social comparison information or norm-referenced feedback), whereas the implicit achievement motive is aroused through incentives inherent to performing an activity (e.g., self-referenced feedback or challenging instructions) (Brunstein & Hoyer, 2002; Brunstein & Maier, 2005; Brunstein & Schmitt, 2004). According to the achievement motive literature, these subclasses have a similar impact on effort-related parameters (e.g., performance) if they are aroused by their specific incentives. Thus, individuals with a high—explicit or implicit—achievement motive are more interested in engaging in tasks that allow them to attain achievement-related goals than individuals with a low achievement motive. Moreover, a high achievement motive is supposed to lead to high effort investment in tasks that enable the individual to develop skill mastery and to excel in relation to a standard of excellence (McClelland, 1987).

The theoretical notion that the strength of the achievement motive should directly determine the amount of effort that is invested is in sharp contrast to the predictions of motivational intensity theory (Brehm & Self, 1989). According to this theory, motives determine the importance of successfully performing a task and thus set the maximum amount of effort that an individual is willing to invest in a task. Motives should, however, not directly affect the invested effort if the difficulty of a task is fixed and information about task difficulty is available (i.e., if task difficulty is clear). Under these conditions, effort should be a function of task difficulty: If success is possible and if the required effort does not exceed the maximum amount that the individual is willing to invest, effort should increase with increasing task difficulty. Motives should only exert an indirect effect by determining the difficulty level at which individuals disengage and invest no effort. Individuals with a weak motive should disengage at a lower difficulty level than individuals with a strong motive given that the maximum amount of effort that they are willing to invest for task success should be lower. Figure 1 displays the predicted interaction effect of task difficulty and motive strength.

Wright (1996) integrated motivational intensity theory (Brehm & Self, 1989) with Obrist's (1981) active coping approach. This led to the prediction that beta-adrenergic sympathetic impact on the heart responds proportionally to the level of experienced task demand as long as success is possible and justified. Beta-adrenergic activity influences cardiac contractility, which is reflected in pre-ejection period (PEP)—the time interval (in ms) between the onset of left ventricular depolarization and the opening of the left aortic valve (Berntson, Lozano, Chen, & Cacioppo, 2004; Sherwood et al., 1990) and the best non-invasive measure of beta-adrenergic sympathetic impact on the heart that is available (Kelsey, 2012). Following Wright's integrative model, past research on motivational intensity theory found positive evidence for the theory's predictions by examining the impact of biological and psychological needs (motives) on cardiovascular indicators of effort (e.g., Richter, Baeriswyl, & Roets, 2012; Storey, Wright, & Williams, 1996). For instance, Storey and colleagues manipulated participants' need for something to drink by asking one half of their participants not to drink anything for several hours before coming to the lab. As predicted by motivational intensity theory, the relationship between task difficulty and effort varied with participants' level of thirst. Thirsty participants invested more effort in a cognitive task that allowed them to obtain a drink if the task was difficult than if it was easy. Participants who were not thirsty invested low effort independent of the difficulty of the task suggesting that their level of thirst did not justify the effort required to successfully perform the difficult task. The Richter et al. study constitutes another example for the effect of motive strength on the relationship between task difficulty and effort. They observed that the impact of need for closure—the motive to avoid ambiguous situations—on effort varies as a function of task demand. The effort that individuals invested to resolve an ambiguous situation did not differ as a function of their level of need for closure if it was easy to resolve the situation. However, if it was difficult, individuals with a high need for closure invested more effort than individuals with a low need for closure supporting the notion that the lower motive strength of individuals with a low need for closure did not suffice to justify the high effort investment needed for success.

Even if there is already research on motivational intensity theory that provides evidence for the indirect impact of biological and psychological needs, research has never contrasted the theory's view with the view that motives exert a direct effect on effort, suggested by the traditional motive literature on McClelland's motive trichotomy (e.g., McClelland, 1987; Thrash & Elliot, 2002). There is, however, an abundance of empirical research that supports the theoretical notions of the motive literature regarding the influence of achievement, affiliation, and power motives on other aspects of behavior. For instance, individuals with a high explicit achievement motive were found to be more likely to persist in a task (Atkinson, 1957; Brunstein & Maier, 2005), to aim at higher sports goals (Wegner & Teubel, 2014), and to perform better than individuals with a low explicit achievement motive (Karabenick & Youssef, 1968; Rothstein, Paunonen, Rush, & King, 1994). Moreover, a high implicit achievement motive led to faster reaction times (Brunstein & Maier, 2005), more creative outcomes (Fodor & Carver, 2000; Schoen, 2015), better performances in a team tournament (Wegner & Teubel, 2014), and more participation in sports activities (Gröpel, Wegner, & Schüler, 2016). Consistent with the notion that achievement motivated people view difficulty as an opportunity for mastery, high implicit achievement motive individuals showed less of a stress response in terms of cortisol release than low implicit achievement motive individuals when confronted with demanding tasks (Schultheiss, Wiemers, & Wolf, 2014).

There are also a few studies that aimed to test the impact of implicit and explicit achievement motives on effort. Interpreting heart rate and heart rate variability as indicators of effort, Beh (1990) observed that a high explicit achievement motive resulted in higher effort investment in a vigilance task than a low explicit achievement motive. Capa and colleagues (Capa & Audiffren, 2009; Capa, Audiffren, & Ragot, 2008b, 2008a) used midfrequency heart rate variability as a measure of effort and found that individuals with a high motive to achieve success invested more effort than individuals with a high motive to avoid failure. Brunstein and Schmitt (2010) reported a study on the interaction between the implicit achievement motive and task demand using systolic blood pressure response as indicator of effort. Their data revealed a quadratic relationship between task demand and effort for high implicit achievement motive participants (effort was high if task difficulty was moderate but low if it was easy or extremely difficult) and a linear relationship for low implicit achievement motive participants (effort increased with increasing task demand). The existing effort-related studies provide thus some evidence for the theoretical notion that a high achievement motive results in high effort investment (McClelland, 1987). However, the results could also be interpreted in terms of motivational intensity theory. The low effort investment of individuals with a low achievement motive might have been the result of low achievement motive participants disengaging from the task because of the required effort not being justified. Alternatively, it might have resulted from task difficulty not being clear—a condition under which motivational intensity theory would predict a main effect of motives on effort (for an overview, see Richter, Gendolla, & Wright, 2016).

1.1.The present study

Given the conflicting predictions of the literature on McClelland's motive trichotomy and motivational intensity theory regarding motives' impact on effort, we aimed to compare both views by examining the impact of the implicit achievement motive on effort investment in a mental arithmetic task with two difficulty levels. According to the traditional achievement motive literature, motive strength should exert a main effect on effort: A high implicit achievement motive should lead to more effort than a low implicit achievement motive. Motivational intensity theory, however, would predict an interaction between the implicit achievement motive and task difficulty. If task difficulty is low, effort should be low and independent of the implicit achievement motive. If task difficulty is high, effort should be high if the implicit achievement motive is high but low if the implicit achievement motive is low. In line with preceding research and theorizing on motivational intensity theory (Gendolla, Wright, & Richter, 2012; Wright, 1996), effort investment was assessed as myocardial sympathetic activity during task performance. In particular, we used the change in pre-ejection period from rest to task performance to quantify effort.

2. Method

2.1. Participants and Design

Data were collected during two sessions at the University of Geneva. In an initial session, we administered the Picture Story Exercise (PSE; Schultheiss & Pang, 2007) to 313 university students who participated at screening sessions for an introductory psychology class. To maximize the difference between the groups and thus to maximize potential effects, we invited extreme groups of forty participants with implicit achievement motive (i.e., need for achievement, nAch) scores in the lower quartile of all participants' scores (≤ 7.73) and forty participants with nAch scores in the upper quartile (≥ 14.61) to the second session (for this extreme group approach, see also Richter et al., 2012).[1] Cutoff scores were thus determined on an empirical basis. Participants received course credit for their participation. They were randomly assigned to one of two task difficulty conditions (*easy* vs. *difficult*). Final cell distributions were as follows: 18 participants (14 women) in the low-nAch-easy condition, 12 participants (9 women) in the high-nAch-easy condition, 18 participants (15 women) in the low-nAch-difficult condition, and 20 participants (18 women) in the high-nAch-difficult condition. The data of twelve participants could not be used for the analysis because of poor impedance cardiogram signal quality. The final sample thus consisted of 68 participants (56 women, mean age = 20.82 years, *SD* = 3.78). Thirty-six participants with a PSE score (*M* = 5.01, *SD* = 1.59) in the lower quartile of the PSE score distribution constituted the *low-nAch* group. Thirty-two participants with a PSE score (*M* = 18.21, *SD* = 3.26) in the upper quartile constituted the *high-nAch* group. Given the few men in our sample, we repeated all analyses by including women only. The patterns of results did not change for any of the analyses.

2.2. Measures and Material

2.2.1. Cardiovascular measures

We measured pre-ejection period (PEP), systolic blood pressure (SBP), diastolic blood pressure (DBP), and heart rate (HR) during two periods: habituation (rest period) and task performance. PEP constituted our primary variable, as presented above. SBP is the maximum blood pressure after the ejection of blood from the left ventricle into the aorta following a heartbeat. It is influenced by beta-adrenergic impact of the sympathetic nervous system on the force of heart contraction but also by heart rate and total peripheral resistance, which are less systematically related to beta-adrenergic impact on the heart. SBP was assessed to enable comparisons with preceding research on motivational intensity theory, which strongly relied on SBP as effort-related measure. DBP is the minimum blood pressure between two heartbeats. It depends essentially on peripheral resistance and heart rate. HR is the number of heartbeats per minute. It depends on sympathetic and parasympathetic activity. It can thus reflect effort mobilization only if the sympathetic impact is stronger (Berntson, Cacioppo, & Quigley, 1993). DBP and HR were assessed to verify that PEP responses reflected changes in myocardial sympathetic activity and not pre- or afterload effects (Obrist, 1981; Obrist, Light, James, & Strogatz, 1987; Sherwood et al., 1990).

PEP [in milliseconds (ms)] was assessed using an impedance cardiogram (ICG) and an electrocardiogram (ECG) collected with a CardioScreen1000 system (Medis, Ilmenau, Germany) at a sampling rate of 1000 Hz. Four dual gel-pad sensors (medis-ZTECT^{TM}) were placed on the right and left sides of the base of participants' neck and on the right and left middle axillary lines at the level of the xiphoid. The ICG and ECG signals were analyzed offline with BlueBox software (Richter, 2010) to determine PEP and HR [in beats per minute (bpm)]. SBP (in millimeters of mercury [mmHg]) and DBP (in millimeters of mercury [mmHg]) were measured using a Dinamap Procare monitor (GE Medical Systems, Information Technologies Inc., Milwaukee, WI), which uses the oscillometric method to determine arterial blood pressure. A blood pressure cuff was placed over the brachial artery above the elbow of participants' nondominant arm, and one blood pressure reading was obtained every minute.

2.2.2. Picture-story exercise

The strength of the implicit achievement motive was measured using a variant of the Thematic Apperception Test (Murray, 1943): the Picture Story Exercise (PSE; Schultheiss & Pang, 2007). The PSE is the most widely used measure in recent implicit motive research (e.g., Denzinger, Backes, Job, & Brandstätter, 2016) and considered a valid measure of implicit motives, especially with respect to causal validity (Borsboom, Mellenbergh, & van Heerden, 2004; Schultheiss & Pang, 2007). Four pictures were presented on the computer screen in random order. The pictures depicted (1) two female scientists working in a laboratory, (2) a boxer, (3) a man and a woman on a trapeze, and (4) a cycling race. These pictures have been successfully used in previous research on implicit motives, and their properties are described in Schultheiss and Pang (2007). Each picture was presented for 15 seconds. Following the presentation of each picture, participants had five minutes to write an imaginative story related to the content of the picture (Pang, 2010). Following Winter's (1994) scoring system, stories were coded for achievement imagery using the following five categories: (1) adjectives that positively evaluate performances, (2) goals or performances that are described in ways that suggest positive evaluation, (3) mention of winning or competing with others, (4) failure, doing badly, or other lack of excellence, and (5) unique accomplishments. Two trained scorers, who were native French speakers and who had previously attained over 85% agreement with training materials pre-scored by experts (Winter, 1994), coded all stories. The two coders double-coded 30% of all stories and reached a high agreement (ICC[2,1] = .81) on these stories.

In the low-nAch group, the mean nAch raw score was 2.53 (*SD* =0.88), the average number of words written across the four stories was 511.08 (*SD* = 114.56), and the correlation between both variables was positive, *r* =.45. In the high-nAch group, the mean nAch raw score was 7.38 (*SD* = 2.00), the average number of words was 405.78 (*SD* = 83.32), and the correlation between nAch raw scores and written words was .73. Given the relationship between written words and nAch raw scores, we expressed nAch scores in terms of motive images per 1,000 words throughout the paper, as recommended by Schultheiss and Pang (2007).

2.3.Procedure and Experimental Task

The individual experimental sessions took about 35 minutes and used experimental software (Inquisit 4.0, Millisecond Software, Seattle, WA) to present information and collect participants' responses. At the beginning of the session, the experimenter, who was blind to hypotheses and to participants' nAch groups, explained the procedure to the participant. After having obtained informed consent, the experimenter attached the electrodes and blood pressure cuff, started the experimental software, and monitored the experiment from an outside control room. Participants first completed a demographic questionnaire that assessed their age and gender. They then watched a relaxing movie depicting underwater landscapes for 8 minutes during which cardiovascular baseline measures were collected.

Participants then received instructions for the mental arithmetic task (LaGory, Dearen, Tebo, & Wright, 2011). They learned that they would have to add up single-digit numbers presented one after another on the screen and enter the final total using the keyboard. Each trial started with a fixation cross displayed centrally for 500 ms followed by the digit series. Trial duration was the same in both difficulty conditions but the conditions differed regarding the presented digits and the number of presented digits. In the easy condition, the digit series included only the digits 1 and 2 and each series consisted of six digits displayed for 600 ms and followed by a blank screen presented for 4400 ms. In the difficult condition, 15 digits between 1 and 9 were presented for 600 ms with a blank screen presented for 1400 ms between the individual digits. At the end of each digit series, participants had 10 seconds to enter the total. For each total that they entered, they received an immediate feedback ("correct" or "incorrect"). Participants could thus repeatedly correct their response during the allotted time window if the preceding response was incorrect. At the end of the response time window, a feedback screen indicated the participant's last entry, the correct response, and the sentence "Currently, you have correctly solved X out of 10 additions". Participants in the high-nAch group should find this self-referenced feedback structure of the task motive-arousing, since they could track their own performance and individual progress (see Brunstein & Maier, 2005). Participants performed 10 additions for a total task duration of 405 seconds.

After the task, participants rated their engagement during the task period ("To what extent did you stay engaged during the mental arithmetic task?") and the difficulty of the task ("To what extent did the task appear difficult to you?") on 7-point scales ranging from "not at all" (1) to "very much" (7). Finally, participants were carefully debriefed.

2.4.Data processing and Analysis

The collected ICG signals were differentiated and the resulting dZ/dt signal was used in combination with the ECG R-peaks to construct ensemble averages for each minute. R-onset and B-point were scored for each ensemble average by two independent raters following Sherwood et al.'s (1990) guidelines. PEP was computed as the time interval between R-onset and B-point and the arithmetic means of both raters' PEP values (ICCs[2,1] > .99) were used in the statistical analyses. HR was determined counting the detected R-peaks for each minute. For all cardiovascular parameters we computed the arithmetic means of the last four minutes during baseline (Cronbach's αs > .99) and the first six minutes of the task period (Cronbach's αs > .99) to obtain cardiovascular baseline and task averages. In order to control for variability between individuals, we normalized all cardiovascular data by subtracting baseline scores from task scores to obtain change scores (Llabre, Spitzer, Saab, Ironson, & Schneiderman, 1991). This is a standard approach to analyzing task-induced cardiovascular responses (e.g., Brinkmann & Franzen, 2017).

To test motivational intensity theory's hypothesis about the effect of the implicit achievement motive on the relationship between task difficult and effort, we calculated a-priori planned contrasts (Rosenthal & Rosnow, 1985). Contrast weights were -1 for the easy conditions, -1 for the difficult-low-nAch condition, and +3 for the difficult-high-nAch condition. To compare motivational intensity theory's hypothesis with the nAch-main-effect hypothesis suggested by the motive literature, we computed Bayes Factors (Masson, 2011; Richter, 2016; Wagenmakers, 2007) comparing both models.

3. Results

3.1. Cardiovascular baselines

Means and standard errors of cardiovascular baseline scores are shown in Table 1. Results of 2 (task difficulty) x 2 (nAch group) x 8 (time) mixed-model ANOVAs of PEP, HR, SBP, and DBP activity, assessed during the eight-min habituation period, revealed significant time main effects, *Fs* > 6.33, *ps* < .001 due to higher cardiovascular activity at the beginning of the habituation period. Consequently, we calculated cardiovascular baseline scores by averaging the values of the last 4 min of the habituation period, which did not differ significantly according to Tukey tests (*ps* > .08) and showed high internal consistency (Cronbach's αs > .99).

3.2. Cardiovascular responses

Means and standard errors of cardiovascular reactivity scores are shown in Table 2. Supporting motivational intensity theory's prediction that nAch exerts an indirect effect on effort, the planned contrast was significant for PEP reactivity, $F(1, 64) = 8.48$, $p = .05$, $\eta^2_p =$

.12. PEP reactivity was low and independent of the nAch group if task difficult was low. However, if the task was difficult, PEP reactivity of individuals with a high nAch was stronger than PEP reactivity of individuals with a low nAch. Figure 2 displays this pattern. A comparison of motivational intensity theory's predictions with the motive main effect model resulted in a *BF* of 2.27 providing positive evidence in favor of motivational intensity theory.

The significant planned contrast for SBP reactivity, $F(1, 64) = 10.99$, $p = .001$, $\eta^2_p = .15$, is in line with preceding work on motivational intensity that found that SBP changes closely follow motivational intensity theory's predictions. SBP reactivity was high in the difficult-high-nAch condition, lower in the difficult-low-nAch group, and low in the easy conditions. The model comparison provided strong evidence in favor of motivational intensity theory's prediction, *BF* = 9.54.

The planned contrasts were also significant for DBP reactivity, $F(1, 64) = 14.27$, $p < .001$, $\eta^2_p = .18$, and HR reactivity, $F(1, 64) = 13.69$, $p < .001$, $\eta^2_p = .18$. DBP reactivity was high in the difficult-high-nAch condition and low in the other three conditions. HR reactivity was high in the difficult-high-nAch condition, lower in the difficult-low-nAch group, and low in the easy conditions. *BF*s comparing motivational intensity theory's prediction with the motive main effect model were 44.61 (DBP reactivity) and 16.74 (HR reactivity).

3.3.Task Performance and Subjective Measures

Means and standard errors of task performance and subjective measures are shown in Table 3. A significant difficulty main effect in a 2 (task difficulty) x 2 (nAch group) ANOVA demonstrated that participants perceived the difficult task version to be more difficult than the easy version, $F(1, 64) = 219.94$, $p < .001$, $\eta^2_p = .76$ (all other *p*s > .08). Participants in the easy-low-nAch and the easy-high-nAch conditions rated the task to be easier than participants in the difficult-low-nAch and the difficult-high-nAch conditions. A 2 (task difficulty) x 2 (nAch group) ANOVA of the engagement ratings revealed a significant interaction effect, $F(1, 64) =$

13.11, $p < .001$, $\eta^2_p = .17$ (all other *p*s > .10). Participants in the easy-high-nAch condition reported to have been less engaged during task performance than participants in the easy-low-nAch condition, the difficult-low-nAch condition or the difficult-high-nAch condition.

We did not use an inferential test to analyze the effect of task difficulty and nAch group on the number of correctly solved additions given that there was almost no variance in the easy conditions. As presented in Table 3, performance in the difficult conditions was lower than performance in the easy conditions. Across all conditions, the number of correctly solved additions was associated with the reactivity of all cardiovascular measures ($r = .24$ for PEP reactivity, $r = -.38$ for SBP reactivity, $r = -.44$ for DBP reactivity, and $r = -.58$ for HR reactivity, all *p*s < .05).

4. Discussion

The presented study examined the impact of the implicit achievement motive on effort-related cardiovascular responses to test whether motives exert a direct or indirect impact on effort if task demand is clear. Providing positive evidence for motivational intensity theory's view that motives play an indirect role under this condition, we found that PEP and SBP reactivity differed between the two implicit achievement motive groups if task difficulty was high but not if it was low. Participants with a high implicit achievement motive showed stronger responses than low implicit achievement motive individuals if they performed the difficult arithmetic task. Cardiovascular responses were low and did not differ as a function of the implicit achievement motive strength if participants performed the easy arithmetic task. Given that HR and DBP reactivity mirrored the PEP response pattern, changes in cardiac pre- and afterload are unlikely as cause of the observed PEP response and it is likely that the observed PEP responses were indicative of changes in myocardial sympathetic activity (Obrist et al., 1987; Sherwood et al., 1990) and thus reflected participants' effort while performing the task. It is noteworthy that not only our planned a priori contrast was significant but that we also found positive evidence in favor of motivational intensity theory when directly comparing its predictions to the view of the traditional achievement motive literature: The observed PEP data were 2.27 times more likely assuming a model that predicts an indirect effect of the implicit achievement motive than under a model that predicts a direct effect of the implicit achievement motive. Our data thus provide strong support for the notion that motives exert an indirect impact on effort.

It is of note that our study is not the first empirical work that suggests that the achievement motive does not exert a direct impact on effort. Brunstein and Schmitt (2010) described a study in which a high implicit achievement motive resulted in more effort (reflected in a stronger SBP response) than a low implicit achievement motive if the difficulty of a memory task was moderate but not if it was low or high. Capa and colleagues observed varying differences between participants with a strong explicit motive to achieve success and participants with a strong explicit motive to avoid failure. The two groups differed regarding effort mobilization (assessed as reduced midfrequency heart rate variability) in a visual memory search task if task difficulty was high but not if it was low (Capa et al., 2008a, 2008b) and in a cued reaction time task if they were instructed to beat their own reaction time but not if they were asked to respond as fast as possible. Our study is thus not the first one finding evidence against a direct impact of the achievement motive on effort but to our knowledge it is the first one that offers a consistent theoretical frame for the observed indirect effect. The negative relationship that we observed between our cardiovascular indicators of effort and task performance might seem surprising at first sight. Intuitively one would probably expect relationships in the opposite to the direction that we observed. We found that less strong PEP and SBP reactivity—suggesting low effort—were associated with better task performance. However, it is possible that this relationship was an artifact of the task difficulty manipulation. Given that the easy task was very easy, those participants could achieve an excellent performance with a low amount of effort. Participants in the difficult conditions had to invest high effort to cope with the high task demand but the effort that they invested might not have been sufficient to compensate for the high difficulty. Other studies that manipulated task difficulty also often observed a negative relationship between the magnitude of the cardiovascular response and performance (Gendolla & Richter, 2005; Richter, Friedrich, & Gendolla, 2008). However, studies using performance indices that were less vulnerable to the difficulty-manipulation artifact (Gendolla & Richter, 2006) or analyzing the relationship within each one of the difficulty conditions (Silvia, McCord, & Gendolla, 2010) found evidence for the positive relationship between effort-related cardiovascular activity and performance that one would intuitively expect.

Some readers might wonder how the presented research relates to popular theories of achievement motivation, like self-determination theory (Deci & Ryan, 2000) or Wigfield and Eccles' expectancy-value theory of achievement motivation (e.g., Wigfield & Eccles, 2000). A comparison of these theories with our integrative model based on motivational intensity theory is difficult because of the different scopes of the models. Self-determination theory and expectancy-value theory of achievement motivation are theories that aim to explain a broad range of parameters of behavior (choice, initiation, persistence, direction, effort, and performance) whereas motivational intensity theory only focuses on a single parameter (effort). Given the broad scope, it is small wonder that self-determination theory and expectancy-value theory of achievement motivation do not offer specific predictions that could directly be applied to our experimental design.

Expectancy-value theory's main determinants of behavior, expectancy and value, overlap with task difficulty and success importance (magnitude of the achievement motive) but the theory does not provide any guidance on how expectancy and value should jointly determine effort investment once the decision to execute a certain behavior has been made. Self-determination theory provides effort-related predictions but the overlap between the main variables is low. The theory postulates that individuals invest effort to satisfy the fundamental psychological needs of relatedness, competence, and autonomy, and also suggests that high autonomous motivation leads to task engagement and effort. However, it is difficult to directly relate autonomous motivation or psychological needs to task difficulty and success importance. In sum, even if self-determination theory and expectancy-value theory of achievement motivation are popular achievement-related theories, a straightforward interpretation of our findings in the light of these theories is difficult because of differences in scope and terminology.

A few issues limit the degree to which our results can be generalized. First, our study was conducted in an academic context. In this environment, the study of the achievement motive is facilitated but it is important to extend our results to other contexts (e.g., a business context) for generalizing our results. Second, further research is needed to generalize our results to the explicit achievement motive. In the preceding paragraphs we largely ignored the rich literature on the differentiation between explicit and implicit motives. The main reason for this is that this distinction does not make any difference for motivational intensity theory. According to the theory, motives determine the maximum amount of effort that someone is willing to invest to satisfy the motive. It does not matter whether the motive reflects a self-attributed or a nonconscious motivational disposition. It is, however, important to note that there is no disagreement between the achievement motive literature and motivational intensity theory on this point. Both are complementary: The achievement motive literature specifies the cues that arouse a given motive, the situations in which specific motives should be expressed, and the types of behaviors or other outcomes that should be affected. Motivational intensity theory describes the impact that the expressed motives should have on effort mobilization. For instance, in one performance situation nonverbal, task-intrinsic incentives might be present and activate the implicit achievement motive whereas in another situation verbal, task-extrinsic incentives might arouse the explicit achievement motive (McClelland et al., 1989; Schultheiss, 2008). Independent of the type of aroused motive, motivational intensity theory would predict in both situations that the maximum effort that individuals are willing to invest is a function of the strength of the activated motive.

Third, we have not taken motive congruence into account in our study. The motive congruence literature shows that individuals with a high implicit achievement motive are not necessarily the same individuals than those with a high explicit achievement motive, and that the incongruence between the implicit and explicit motive can have a strong impact on behavior (Thrash, Maruskin, & Martin, 2012). However, we are not aware of any study that has shown an impact of motive congruence on effort. Moreover, the question whether there is motive congruence or not does not seem to be relevant in the context of effort mobilization: According to motivational intensity theory, the dominating motivational tendency should determine success importance and the maximum amount of effort that individuals are willing to invest in a task.

Fourth, we did not measure individual differences in skill levels for the arithmetic task. According to an extension of motivational intensity theory, individual perceptions of task difficulty might interact with objective task difficulty to influence effort mobilization (for an overview, see Richter, Gendolla, & Wright, 2016). It is of note, however, that individual differences in motive strength are supposed to influence success importance rather than perceptions of task difficulty. Indeed, there was no evidence that both implicit achievement motive groups differed in their evaluations of the difficulty of the arithmetic task.

5. Conclusions and Implications

In combination with the preceding work by Brunstein and Schmitt (2010) and Capa and colleagues (Capa & Audiffren, 2009; Capa et al., 2008a, 2008b), our findings provide strong support for the view that the implicit achievement motive does not exert a direct impact on effort if task demand is known. Instead, the strength of the implicit achievement motive only sets the upper limit of the difficulty-effort relationship. Interindividual differences in implicit achievement motive strength do not make a difference if task demand is low. However, they decide whether one gives up or not if task demand is high. This finding has important implications. Many intervention programs aim at enhancing people's motivation to mobilize effort and by this way to yield higher (performance) outcomes. For instance, creating an educational context that arouses pupils' achievement motive can indeed have positive consequences if the demands of the situation are high. However, if the required effort is higher than justified by a rather weak achievement motive the respective pupil will disengage from the task, not mobilize effort, and possibly achieve lower outcomes. Moreover, arousing the achievement motive will not make any difference regarding effort mobilization if a task is rather easy. It is thus crucial to take into consideration both, objective and subjective task demands as well as individual differences in achievement motive strength.

Footnotes

[1] We performed an a priori power analysis (Faul, Erdfelder, Lang, & Buchner, 2007) to determine the sample size required to detect the predicted effect with a one degree of freedom a priori contrast at an alpha error probability of .05 and a statistical power of .80. Given that our most recent studies (Brinkmann & Franzen, 2017; Franzen, Brinkmann, Gendolla, & Sentissi, 2019; Richter, Baeriswyl, & Roets, 2012) on the impact of personality (dysphoria and need for closure) on effort found Cohen's *d*s between .80 and .90, we used an expected medium-to-large effect (d = .65) for the power analysis. Results indicated a required sample size of 60 participants.

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Table 1

Means and standard errors of cardiovascular baseline scores

Condition	*M*	*SE*
	PEP baseline score	
Easy-low-nAch	95.92	2.90
Easy-high-nAch	97.72	3.29
Difficult-low-nAch	101.95	2.90
Difficult-high-nAch	101.78	2.60
	SBP baseline score	
Easy-low-nAch	102.64	2.66
Easy-high-nAch	103.04	1.26
Difficult-low-nAch	97.97	2.32
Difficult-high-nAch	101.27	1.77
	DBP baseline score	
Easy-low-nAch	52.26	1.66
Easy-high-nAch	58.58	1.49
Difficult-low-nAch	56.44	1.73
Difficult-high-nAch	56.67	1.21
	HR baseline score	
Easy-low-nAch	73.24	2.57
Easy-high-nAch	83.12	3.26
Difficult-low-nAch	75.37	3.61
Difficult-high-nAch	80.52	2.57

Note. PEP is indicated in milliseconds, SBP and DBP are indicated in millimeters of mercury and HR is indicated in beats per minute.

Table 2

Means and standard errors of cardiovascular reactivity scores

Condition	*M*	*SE*
	PEP reactivity score	
Easy-low-nAch	-0.55	0.56
Easy-high-nAch	-1.31	0.87
Difficult-low-nAch	-2.14	1.00
Difficult-high-nAch	-4.32	1.07
	SBP reactivity score	
Easy-low-nAch	0.94	0.74
Easy-high-nAch	1.26	0.69
Difficult-low-nAch	5.99	1.50
Difficult-high-nAch	6.76	1.03
	DBP reactivity score	
Easy-low-nAch	0.41	0.74
Easy-high-nAch	-0.76	0.87
Difficult-low-nAch	2.83	0.89
Difficult-high-nAch	4.20	0.73
	HR reactivity score	
Easy-low-nAch	0.87	0.43
Easy-high-nAch	1.62	0.89
Difficult-low-nAch	6.29	0.94
Difficult-high-nAch	6.65	1.11

Note. *PEP* is indicated in milliseconds, *SBP* and *DBP* are indicated in millimeters of mercury and *HR* is indicated in beats per minute.

Table 3

Means and standard errors of task performance and subjective measures

Condition	*M*	*SE*
	Subjective task difficulty	
Easy-low-nAch	1.22	0.10
Easy-high-nAch	1.58	0.36
Difficult-low-nAch	5.28	0.36
Difficult-high-nAch	5.90	0.25
	Engagement during the task period	
Easy-low-nAch	5.89	0.40
Easy-high-nAch	4.08	0.45
Difficult-low-nAch	5.17	0.28
Difficult-high-nAch	5.85	0.25
	Task performance	
Easy-low-nAch	9.44	0.78
Easy-high-nAch	10.00	0.00
Difficult-low-nAch	3.67	2.43
Difficult-high-nAch	3.10	2.59

Note. Subjective task difficulty and Engagement during the task period are evaluated on 7-point Likert scales ranging from “not at all” (1) to “very much” (7). Task performance can vary from 0 to 10 correctly solved additions.

Figure 1

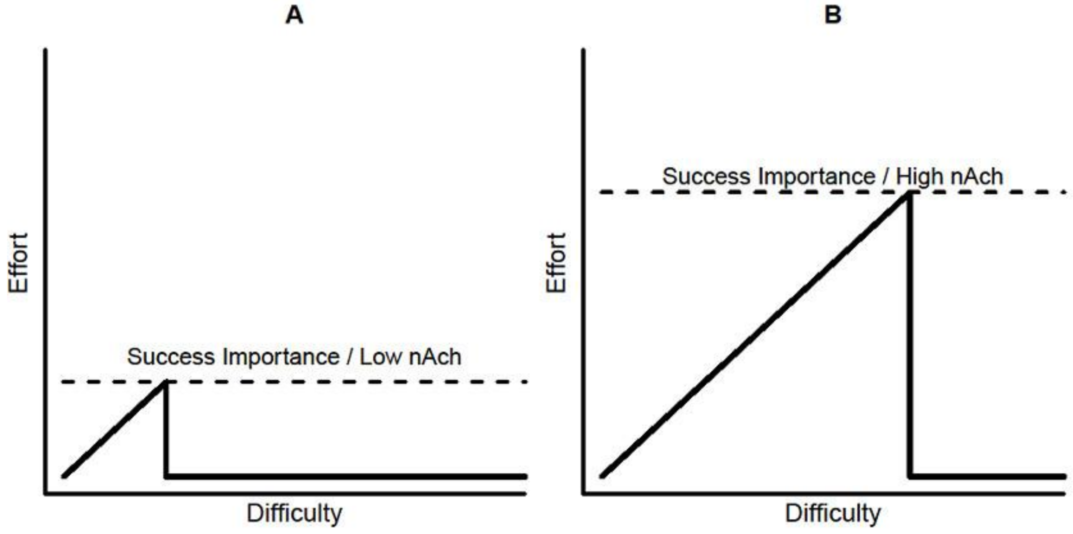
A
B
Effort
Effort
Success Importance / Low nAch
Success Importance / High nAch
Difficulty
Difficulty

Figure 2

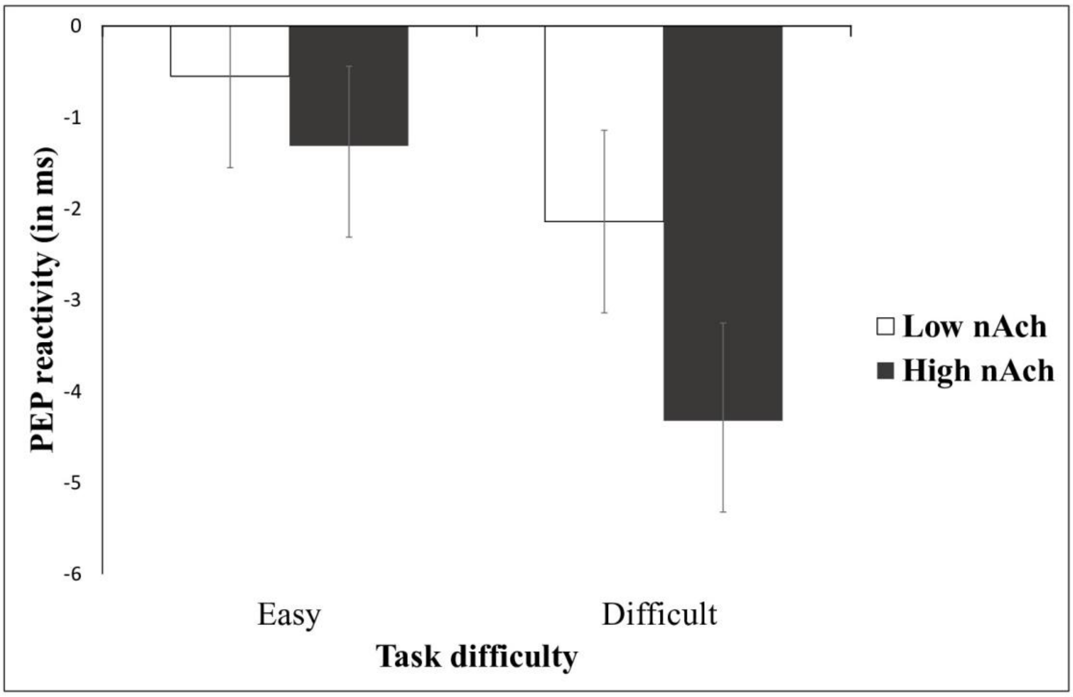
0
-1
-2
-3
-4
-5
-6
PEP reactivity (in ms)
Easy
Difficult
Task difficulty
Low nAch
High nAch

Figure captions

Figure1. Predictions of motivational intensity theory (Brehm & Self, 1989) for tasks with clear and fixed difficulty. Panel A shows the predictions for conditions of low motive strength (success importance). Panel B displays the predictions for conditions of high motive strength (success importance).

Figure 2. Cell means and standard errors of pre-ejection period reactivity (in ms) during the arithmetic task.