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Who Is Satisfied With Effort?

Individual Differences as Determinants of Satisfaction With Effort and Reward

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Abstract: The effort required to obtain certain rewards may influence the level of satisfaction with the following reward. Since people differ in beliefs about the availability of willpower resources required to pursue effortful actions, we investigated how willpower beliefs affect the perception of effort and satisfaction with reward. We hypothesized that people with limited willpower beliefs (i.e., believing that exerting effort leads to depletion of their inner resources) will perceive cognitive tasks as more effortful and will be less satisfied with the subsequent reward than those with non-limited beliefs (i.e., believing that exerting effort is invigorating rather than depleting). We tested this hypothesis by manipulating effort with different difficulty levels of the *N*-back task and measuring participants' perception of effort expenditure and subjective satisfaction with a reward depending on their willpower beliefs. In accordance with the predictions, we found that those with limited willpower beliefs perceived the task as more effortful than those with non-limited willpower beliefs. Furthermore, when asked to subjectively rate their satisfaction with the reward gained for the task, limited believers rated their satisfaction lower than non-limited believers. These findings suggest that people take their willpower capacities into effort-satisfaction calculations. Results are discussed within the context of other models of effort, and practical implications of the findings are suggested.

Keywords: effort, reward satisfaction, willpower theories, lay beliefs



Lay (or implicit) theories, defined as “what ordinary men and women believe about the existence and power of individual differences in personality” (Ross & Nisbett, 1991, p. 119), are shown to impact people’s perceptions and subsequent behavior. For instance, research on lay theories of intelligence showed that those who believe that intelligence is malleable and expandable tended to set higher learning goals and increase effort when facing failures, while those who thought that intelligence is fixed tended to withdraw effort and blame failures on their inability (Dweck & Leggett, 1988). Accordingly, Job and colleagues (2010) suggested that people hold lay theories about willpower as either a limited or a non-limited resource. For this study,

we consider willpower to be “the capacity to exert self-control” (Job et al., 2010). Inzlicht and Schmeichel (2012) define self-control as an individual overriding their tendencies towards another intention. While these terms seem interchangeable, our focus is to specifically use willpower as a measure of an individual’s *capacity* for self-control behaviors. As such, willpower and self-control are closely related.

Job and colleagues (2010) proposed that those who believe willpower is a limited resource believe that willpower can get depleted after exerting effort, eventually resulting in decreased ability to maintain self-control on the following task. On the contrary, those who believe willpower is non-limited, do not expect their self-control to decrease after an effortful task and might even expect their self-control to improve. Indeed, studies conducted by Job and colleagues (2010) show exactly this pattern of results – only participants with limited theories of willpower showed ego depletion effects in the subsequent

task, whereas participants holding non-limited beliefs showed either no change or slight improvement in their performance. Ego depletion is defined as the diminished state of an individual's inner self-control resources, which typically occurs after an effortful task (Inzlicht & Schmeichel, 2012).

Job and colleagues (2010) study was replicated by Chow and colleagues (2015), who found that only among participants who held a limited willpower belief, ego depletion diminished self-efficacy to exert additional control. This reduction of self-efficacy mediated the impact of depletion on self-control, as participants with limited beliefs was more motivated to preserve their mental resources. A large body of research has shown the positive effects of the non-limited mindset. For example, Konze and colleagues (2018) showed that adopting a non-limited willpower theory reduced the impact of emotional dissonance on ego depletion at work.

Furthermore, Jędrzejczyk and Zajenkowski (2020) found a positive correlation between non-limited willpower beliefs and emotional stability.

One important consideration on the topic of willpower and effort is how willpower persists (or does not persist) through varying levels of effortful tasks. Brehm and Self (1989) proposed that when the difficulty level of a task is known, a person who engages in that task will be able to adjust their effort expenditure proportionally. However, this positive relationship between task difficulty and effort expenditure loses its footing when the task's demands become too great for an individual's motivation and/or resources, an upper limit that is referred to as *potential motivation* (Brehm & Self, 1989). This is defined as the limit to which a person is willing to put effort toward a task, and it varies across individuals (Wright, 2008). This model is useful in defining the relationship between task difficulty and effort expenditure. It is also instrumental in determining the limits of this positively-sloped trend, according to individual differences.

The judgment of how much effort a task will cost us is subjective and depends on many physical and psychological factors (Marcora, 2010). For example, a professional athlete might judge an effort of running a distance of 5 km at 12 km/hr speed as not particularly effortful, while a middle-aged person having a sedentary lifestyle would judge it as very effortful.

The actual effort is not required for passing the judgment – a study by Proffitt and colleagues (2003) showed that participants wearing a heavy backpack (but not required to walk with it) judged a distance as long and a hill as steeper than participants with a light backpack. A similar effect was found in a study by Tonković and colleagues (2020) in which participants wearing a heavy backpack judged a psychomotor task more difficult than participants wearing an

empty backpack. Durgin and colleagues (2009) argue that these effects are judgmental biases resulting from the social demands of the experimental context. Thus, people's calculation of how much effort is required is based on the objective task demands and the perception of one's own resources and the social context. Respectively, we hypothesize that people holding limited willpower beliefs (and thus perceiving their resources as more limited) will perceive cognitive tasks as more effortful relative to the people who do not hold such beliefs. After all, if one sees their own resources as limited, engaging in an effortful action should be considered more strenuous, and the required effort should be considered more costly.

Furthermore, we were interested in whether willpower beliefs moderate the relationship between effort and reward satisfaction. Most of the literature suggests that effort is considered costly and aversive (Kool et al. 2010; McGuire & Botvinick, 2010). As the amount of effort required to obtain a reward increases, the subjective value of the reward decreases – a phenomenon known as “effort discounting” (Kivetz, 2003; Phillips et al., 2007; Rudebeck et al., 2006; Westbrook et al., 2013). Therefore, if people holding limited beliefs perceive tasks as more effortful, they should be less satisfied with the same reward than people holding non-limited willpower beliefs.

Supporting this line of reasoning, Job, Bernecker, et al. (2015), based on the Mechanistic Model of Self-Control (Inzlicht & Schmeichel, 2012), showed that the motivation of limited theorists shifts more towards immediate rewards following self-exertion, implying that by comparison, the subjective value of a fixed reward is estimated as lower than as viewed by non-limited theorists.

As we were interested in the effects of effort expenditure and willpower beliefs on satisfaction, we wanted to consider other individual differences in the perception of effort and reward. The need for cognition is a dispositional tendency to engage in and enjoy thinking (Cacioppo & Petty, 1982) and was previously linked to effort perception and expenditure (e.g., Cacioppo et al., 1996). Specifically, individuals high in need for cognition were shown to engage more often and enjoy more complex and effortful thinking. We expected individuals high in need of cognition to perceive tasks as less effortful relative to those low in need of cognition. We expected no effect of the need for cognition on reward satisfaction. We had a similar expectation regarding another individual difference, namely self-efficacy, which was shown to influence the amount of effort devoted to effortful cognitive tasks (Honicke & Broadbent, 2016; Ziegler & Opdenakker, 2018). Given previous literature on the impact of self-efficacy on willpower beliefs and ego depletion (Chow et al., 2015; Job et al., 2010), we believe it is important to measure this individual difference in our own study to compare results.

Furthermore, we wanted to explore the role of other personality traits from the Big Five taxonomy (Costa & McCrae, 2008; McCrae & Costa, 1992; Goldberg, 1990), as previous research has shown relationships between these individual differences and self-control (e.g., Duckworth & Kern, 2011; Jensen-Campbell et al., 2007; Whiteside et al., 2005). For example, Jędrzejczyk and Zajenkowski (2020) found that emotional stability (low neuroticism) was correlated with adopting a non-limited willpower belief, both in the resistance to temptations and strenuous mental effort aspects of willpower theory. Indeed, it might be that people low in neuroticism form a non-limited willpower theory due to their reduced impulsiveness and tendency to surrender to temptations, which means that they can continue exerting mental effort longer (Jędrzejczyk & Zajenkowski, 2020). Moreover, neuroticism was found to be strongly associated with fatigue since the less neurotic a person is, the less fatigue they perceive (Jędrzejczyk & Zajenkowski, 2020). This would be reasonable, as people with limited willpower belief perceive fatigue after mental effort more readily, leading them to rest rather than continue.

The revised Reinforcement Sensitivity Theory (rRST; Carver & White, 1994; Gray & McNaughton, 2000) proposes that variation in sensitivity of the reward system causes individual differences in approach motivation (Krupić & Corr, 2017). Therefore, reward sensitivity might be an important factor influencing the perception of effort and reward. We used three subscales from The Reinforcement Sensitivity Theory of Personality Questionnaire (RST-PQ; Corr & Cooper, 2016): reward interest, goal-driven persistence, and reward reactivity for testing a possible effect on satisfaction with reward in relation to effort expenditure.

Hypotheses

In the current study, we propose that people holding limited willpower beliefs will perceive cognitive tasks as more effortful than people holding non-limited beliefs. Furthermore, we expect people with limited willpower beliefs to be less satisfied with the reward they receive for their efforts than people with non-limited beliefs. Specifically, we manipulated difficulty levels of the *N*-back task (2-, 3-, and 4-back) [since task difficulty has been observed to be a reliable function of actual effort expenditure (Brehm & Self, 1989; Wright, 2008)] and expected that for all participants, as demands of the *N*-back task increase, perception of effort will also increase, while subjective satisfaction with reward will decrease. We anticipated that this effect would be moderated by willpower beliefs, with those holding limited willpower beliefs showing a higher magnitude of these predicted effects than their non-limited counterparts.

However, we expected the 4-back condition to result in the most task disengagement and, therefore, the 3-back condition to show the strongest effect.

To summarize, we had two main hypotheses prior to conducting our study:

Hypothesis 1 (H1): People holding limited willpower beliefs will perceive the tasks as more effortful than people with non-limited willpower beliefs.

Hypothesis 2 (H2): People holding limited willpower beliefs will be less satisfied with the reward they receive for their efforts than people with non-limited beliefs.

Secondary Analysis

In addition to our main hypotheses about the relationship between willpower beliefs and effort and reward satisfaction, we had hypotheses regarding the role of other individual differences, namely the need for cognition, self-efficacy, and the Big Five personality traits in effort perception:

Hypothesis 3 (H3): Participants with low levels of need for cognition will perceive the tasks as more effortful than participants with high levels of need for cognition.

Hypothesis 4 (H4): Participants with low self-efficacy will perceive the tasks as more effortful than participants with high levels of self-efficacy.

Hypothesis 5 (H5): Participants with low levels of conscientiousness, especially in the perseverance sub-trait, will perceive the tasks as more effortful than participants with high levels of conscientiousness.

Hypothesis 6 (H6): Participants with low levels of reinforcement sensitivity, will perceive the tasks as more effortful and will be less satisfied with reward than participants with high levels of reinforcement sensitivity.

Method

Participants and Statistical Power

A sample of 226 individuals was collected from the online recruitment platform Amazon Mechanical Turk, based on a power analysis conducted using G*Power 3.1 (Faul et al., 2009): assuming a medium effect size $f = .25$, $\alpha = .05$ and $1 - \beta = .9$, a sample of 206 would be required. In order to ensure engagement with the study, we implemented two attention check questions and further required

participants to confirm which level of the *N*-back task they had just completed immediately following each block. After exclusions due to incomplete data or incorrectly answering more than one attention check question, our final sample size was 187 participants (66 male, 121 female), with a mean age of 40.43 years ($SD = 10.04$). All participants were US citizens fluent in English.

A power analysis was based on an originally planned multivariate analysis of variance (MANOVA). The subsequently carried out more powerful multi-level modeling approach allows for greater interpretability of the results despite the smaller than anticipated final sample size. To confirm this, a sensitivity analysis was carried out to assess the effect size detectable given our sample size (see Murayama et al., 2020) for proof of the applicability of the summary-statistics approach to the multi-level context. A sample size of 187, with $\alpha = .05$ and $1 - \beta = .95$, gives sufficient power to detect a small to medium effect size of $r = 0.26$.

Procedure

The experiment, developed on the Psytoolkit (Stoet, 2010) platform, was run on Amazon Mechanical Turk. First, participants' implicit theories about willpower, along with other individual differences: the need for cognition, self-efficacy, and Big Five personality traits, were measured using the questionnaires described below. Afterward, participants engaged in three difficulty levels of an *N*-back task (2-, 3-, and 4-back) in a randomized order, answering questions about perceived effort after each level. Each *N*-back round started with a short practice block (10 trials). During the practice block, participants received immediate feedback on their performance, with a green color indicating a correct response and a red color indicating an incorrect response. This way, participants could become familiarized with the task before starting the recorded test.

On completion of the practice round, each *N*-back block lasted approximately 8 min, consisting of 160 trials. Participants did not receive any feedback regarding their performance. This prevented a greater proportion of positive feedback on the easier levels from confounding their satisfaction with the subsequent reward. After each level, participants received a small reward (between 95 and 99 cents) for finishing the level; the slight variation served to maintain the impression of a randomly generated reward while being similar enough to allow fair comparisons. Following the completion of each level, participants were asked to estimate their satisfaction with the given reward. If participants failed to reach the low threshold of 50% accuracy on an *N*-back block, they were piped out of the experiment to ensure that only those who engaged and exerted effort on the task were included in the final sample.

Measures

Implicit Theories About Willpower Beliefs

Willpower theories were measured using a 12-item scale developed by Job and colleagues (2010). Six items assess strenuous mental activity and the other six assess beliefs about resisting temptations. All responses were assessed on a scale ranging from 1 (= *strongly disagree*) to 6 (= *strongly agree*). Higher values represent higher agreement with non-limited resource theory. These responses were based on the participant's life experience and lay beliefs, with no experimental priming. Analysis was completed on the overall average of all 12 items.

Need for Cognition

Need for cognition was measured using the Need for Cognition Scale (Cacioppo et al., 1984). This scale measures the tendency of an individual to engage in and enjoy effortful thinking. It has a total of 18 items scored on a Likert scale ranging from 1 to 5.

Perception of Effort Expenditure

Effort was measured with the NASA Task Load Index (NTLX; Hart & Staveland, 1988). The scale provides an overall workload score based on six subscales: Mental Demands, Physical Demands, Temporal Demands, Own Performance, Effort, and Frustration. All responses were assessed on a scale ranging from 1 to 21.

Reward Interest, Goal-Drive Persistence, Reward Reactivity

These were measured using 24 subscale items from the Reinforcement Sensitivity Theory of Personality Questionnaire (RST-PQ; Corr & Cooper, 2016). All responses were assessed on a scale from 1 to 4.

Additionally, we asked four questions assessing enjoyment, difficulty, engagement, and importance ("How enjoyable did you find the task?"; "How difficult did you find the task?"; "How engaged were you in the task?"; "How important was it to you to perform well on the task?"). All responses were assessed on a scale ranging from 1 (= *not at all*) to 7 (= *extremely*).

Reward Satisfaction

As there was no existing scale to appropriately measure satisfaction in the context of this study, we used an in-house scale with five items to measure reward satisfaction. Four items are questions ("To what extent do you think that the payment was adequate for your effort?"; "How would you judge your satisfaction with the earned amount?"; "How willing would you be to do the task again for the same payment in the future?"; "How likely would you be to recommend this task to another MTurk worker?") that can be answered on a Likert scale ranging from 1 (= *not*

at all) to 7 (= *extremely*). One item is an open-ended question (“What is the minimum payment you would accept to do the task again?”).

Self-Efficacy

To measure self-efficacy, we used a 10-item subscale from the International Personality Item Pool (IPIP; Goldberg et al., 2006). Self-efficacy refers to personal beliefs or an individual’s confidence in his own ability to successfully perform specified tasks (Ziegler & Opdenakker, 2018). Some examples of items are “I complete tasks successfully” and “I excel in what I do”.

Big Five

To measure Extraversion, Agreeableness, Conscientiousness, Neuroticism, and Intellect/Imagination (or Openness), we used the 20-item Big Five scale (Donnellan et al., 2006). Some examples of items are “I get chores done right away” and “I am not interested in abstract ideas”. All the responses are ranged on a 5-point scale.

Results

Data and analysis scripts are available at <https://osf.io/n7my8/>. Since the data possessed a two-level structure with difficulty level being nested within participant, to explore the influence of willpower beliefs and difficulty on effort perception and satisfaction with reward, we utilized a multi-level modeling approach to maximize statistical power (Raudenbush & Bryk, 2002). Analysis was carried out using R (version 4.1.0; R Core Team, 2021) and the lme4 package (Bates, 2010). For all analyses, all scales were z-standardized.

Willpower beliefs were a level 2 variable, and difficulty a level 1 variable nested within the participant.

Confirming the first hypothesis, we found that willpower beliefs influenced effort perception. Specifically, limited willpower beliefs were associated with greater effort perception ($B = 0.24$, 95% CI [0.11, 0.37], $t = 3.65$, $p < .001$, see Table 1) as measured by the NTLX (Cronbach’s $\alpha = .70$, .59, .58 for $N = 2, 3$, and 4, respectively, see Table 6), that is, participants with more limited beliefs perceived the task as more effortful.

To test the second hypothesis, that is, whether willpower beliefs predict satisfaction with reward, we averaged the four closed-ended questions from the reward satisfaction scale (Cronbach’s $\alpha = .86, .87, .89$ for $N = 2, 3$, and 4 respectively). Confirming our second hypothesis, limited willpower beliefs were associated with lower satisfaction with reward ($B = -0.26$, 95% CI [-0.38, -0.13], $t = -4.03$, $p < .001$, see Table 2).

Additionally, we looked at the open-ended question from the reward satisfaction scale about the minimum payment required to repeat the task. The analysis showed no significant effect of difficulty, $F(2, 372) = 2.03$, $p = .13$, nor willpower beliefs, $F(1, 185) = 1.51$, $p = .22$.

When outliers (defined as responses that exceeded the 75% percentile by more than 3 interquartile ranges [Tukey, 1977], 3.03% of cases) were excluded, the amount necessary was significantly greater for $N = 3$ than $N = 2$, $B = 0.17$, 95% CI [0.03, 0.31], $t = 2.45$, $p = .015$, and for $N = 4$ compared to $N = 3$, $B = 0.27$, 95% CI [0.14, 0.41], $t = 3.93$, $p < .001$. The main effect of willpower beliefs was marginally significant, $B = 0.17$, 95% CI [-0.0002, 0.34], $t = 1.96$, $p = .052$, in the direction of limited theorists requiring more to repeat the task than non-limited theorists.

To look further into the interplay between willpower beliefs, effort, and satisfaction, follow-up analyses were conducted and revealed a significant interaction between willpower beliefs and effort perception on satisfaction with reward ($B = -0.10$, 95% CI [-0.18, -0.01], $p = .022$, see Table 3) showing that the influence of subjective effort perception on satisfaction with reward was strongest for those with limited, compared to non-limited, willpower beliefs (see Figure 1). Simple slope analyses confirmed that in non-limited theorists ($-1 SD$), greater effort perception was associated with less reward satisfaction, $B = -0.011$, 95% CI [-.22, -.0034], $t = -2.02$, $p = .044$, however this relationship was stronger in limited theorists ($+1 SD$), $B = -0.31$, 95% CI [-.44, -.18], $t = -4.56$, $p < .001$.

Next, we tested whether difficulty level moderated the effect of willpower beliefs on effort perception and satisfaction with reward. In addition to the main effects of willpower beliefs and difficulty, an interaction term was added to the models predicting effort perception and reward satisfaction and then compared to their respective main effect models to test for improved model fit. The addition of the interaction term did not significantly improve model fit in predicting effort perception, $\chi^2(2) = 0.038$, $p = .98$, nor satisfaction with reward, $\chi^2(2) = 1.92$, $p = .38$.

Participants reported enjoyment, difficulty, engagement, and importance were further analyzed using hierarchical models, with willpower beliefs (level 2) and difficulty level (level 1) as predictors. Those with limited willpower beliefs reported lower enjoyment across each difficulty level, $B = -0.29$, 95% CI [-0.41, -0.17], $t = -4.77$, $p < .001$, and perceived the tasks as more difficult, $B = 0.14$, 95% CI [0.04, 0.24], $t = 2.82$, $p = .005$ than those with non-limited beliefs. Reports of how engaged they were in the task, $B = 0.06$, 95% CI [-0.06, 0.19], $t = 0.99$, $p = .32$, and the importance of performing well on the task, $B = 0.011$, 95% CI [-0.12, 0.14], $t = 0.17$, $p = .87$, did not differ by willpower beliefs.

Table 1. Effect of willpower beliefs and difficulty level on effort perception, with $N = 2$ as reference level

Predictors	Effort perception				
	<i>B</i>	<i>SE</i>	95% CI	<i>t</i>	<i>p</i>
Intercept	-0.13	0.07	[-0.27, 0.01]	-1.84	.066
Willpower beliefs	0.24	0.07	[0.11, 0.37]	3.65	< .001
$N = 3$	0.20	0.05	[0.11, 0.29]	4.39	< .001
$N = 4$	0.19	0.05	[0.10, 0.28]	4.28	< .001
Random effects					
σ^2	0.19				
τ_{00} participant	0.75				
ICC	0.80				
N participant	187				
Observations	561				
Marginal R^2 /Conditional R^2	0.066/0.812				

Note. Bold values indicate $p < .05$.

Table 2. Effect of willpower beliefs and difficulty level on reward satisfaction, with $N = 2$ as reference level

Predictors	Satisfaction with reward				
	<i>B</i>	<i>SE</i>	95% CI	<i>t</i>	<i>p</i>
Intercept	0.18	0.07	[0.04, 0.32]	2.59	.010
Willpower beliefs	-0.26	0.06	[-0.38, -0.13]	-4.03	< .001
$N = 3$	-0.21	0.05	[-0.31, -0.11]	-4.27	< .001
$N = 4$	-0.33	0.05	[-0.43, -0.24]	-6.77	< .001
Random effects					
σ^2	0.23				
τ_{00} participant	0.69				
ICC	0.75				
N participant	187				
Observations	560				
Marginal R^2 /Conditional R^2	0.085/0.774				

Note. Bold values indicate $p < .05$.

Table 3. Effect of willpower beliefs and effort perception on reward satisfaction

Predictors	Satisfaction with reward				
	<i>B</i>	<i>SE</i>	95% CI	<i>t</i>	<i>p</i>
Intercept	0.02	0.07	[-0.10, 0.15]	0.37	.712
Willpower beliefs	-0.20	0.07	[-0.33, -0.07]	-3.10	.002
NASA	-0.21	0.05	[-0.30, -0.12]	-4.66	< .001
Willpower beliefs: NASA	-0.10	0.04	[-0.18, -0.01]	-2.29	.022
Random effects					
σ^2	0.24				
τ_{00} participant	0.70				
ICC	0.74				
N participant	187				
Observations	560				
Marginal R^2 /Conditional R^2	0.106/0.771				

Note. Bold values indicate $p < .05$.

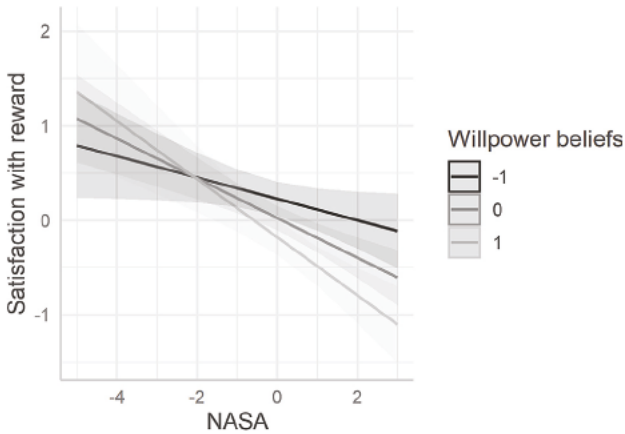


Figure 1. The effect of effort perception (NASA scores) and willpower beliefs on reward satisfaction.

Table 4. Effect of willpower beliefs on effort perception for each of $N = 2, 3,$ and 4

N	Effort perception				
	B	SE	95% CI	t	p
2	0.24	0.07	[0.10, 0.38]	3.40	< .001
3	0.25	0.07	[0.11, 0.39]	3.47	< .001
4	0.24	0.07	[0.10, 0.38]	3.33	< .001

Note. Bold values indicate $p < .05$.

Table 5. Effect of willpower beliefs on reward satisfaction for each of $N = 2, 3,$ and 4

N	Reward satisfaction				
	B	SE	95% CI	t	p
2	-0.30	0.07	[-0.44, -0.16]	-4.25	< .001
3	-0.28	0.07	[-0.42, -0.14]	-3.93	< .001
4	-0.21	0.07	[-0.36, -0.07]	-2.98	.003

Note. Bold values indicate $p < .05$.

Further analyses were conducted separately for each difficulty level. As summarized in Table 4, there was a positive association on each N -back level between willpower beliefs and effort perception, in that limited theorists perceived the task as more effortful than non-limited theorists.

Furthermore, for each difficulty level, those with limited willpower beliefs were significantly less satisfied with rewards than those with non-limited beliefs, as summarized in Table 5. To analyze responses to the question “What is the minimum payment you would accept to do the task again?”, outliers were defined as responses that exceeded the 75% percentile by more than 3 interquartile ranges (Tukey, 1977) and excluded. For $N = 2$, those with limited beliefs would require a higher amount to do the task again than those with non-limited beliefs, $B = 0.19$, 95% CI [0.03, 0.36], $t = 2.31$, $p = .022$. For $N = 3$, the association between willpower beliefs and payment required did not reach significance, $B = 0.11$, 95% CI [-0.07, 0.30], $t = 1.19$, $p =$

.24, and for $N = 4$ the effect reached marginal significance, $B = 0.20$, 95% CI [-0.004, 0.40], $t = 1.93$, $p = .055$.

Secondary Analysis

Consistent with our third hypothesis and previous literature (Sandra & Otto, 2018), the need for cognition was a significant predictor of effort perception, $B = -0.14$, 95% CI [-0.27, -0.01], $t = -2.11$, $p = .035$, with those with a higher need for cognition perceiving the tasks as less effortful than those with a lower need for cognition on each of the N -back levels. This is not surprising, as the need for cognition was moderately associated with willpower beliefs, $r(185) = -0.34$, $p < .0001$ (see Table 6), such that those with more non-limited willpower beliefs tend to also show a higher need for cognition. However, need for cognition was not significantly related to reward satisfaction, $B = 0.06$, 95% CI [-0.07, 0.19], $t = 0.96$, $p = .339$, suggesting that need for cognition and willpower beliefs, though correlated, are indeed separate constructs with differential predictive validity.

Contradictory to the fourth hypothesis, self-efficacy had no significant predictive effect on effort perception as measured by the NTLX, nor satisfaction with reward, $|B| < 0.09$, $p > .21$, despite being significantly correlated with willpower beliefs, $r(185) = -0.30$, $p < .001$, such that limited beliefs were associated with lower self-efficacy.

Regarding the role of Big Five personality traits (especially conscientiousness), no significant associations with effort perception or satisfaction with reward could be observed, $|B| < 0.13$, $p > .06$, even though conscientiousness was negatively correlated with limited willpower beliefs, $r(185) = -0.19$, $p = .008$ and neuroticism was positively correlated with limited willpower beliefs, $r(185) = 0.39$, $p < .001$. Thus, the fifth hypothesis could not be confirmed.

Regarding the sixth hypothesis addressing the role of reinforcement sensitivity, the results were slightly mixed. Reward interest and goal-driven persistence were also not associated with effort perception or satisfaction with reward, $|B| < 0.12$, $p > .06$; reward reactivity significantly negatively predicted effort perception, $B = 0.17$, 95% CI [0.04, 0.30], $t = 2.55$, $p = .011$, but was not significantly associated with reward satisfaction, $B = -0.11$, 95% CI [-0.24, 0.02], $t = 1.64$, $p = .101$.

Discussion

People tend to vary in how satisfied they are with their efforts and the rewards they receive as a result. The same tasks may be experienced as more or less effortful by different people, which motivated our exploration of whether this

Table 6. Means (Ms), standard deviations (SDs), Cronbach's α , skewness, kurtosis, and correlations

Variable	M	SD	Cronbach's α	Skewness	Kurtosis	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.
1. Age	40.43	10.04	NA	0.16	2.09										
2. Gender	1.65	0.48	NA	-0.62	1.38	0.07									
3. NASA	12.87	2.56	0.58-0.70	-0.47	4.19	0.05	-0.03								
4. Satisfaction	4.37	1.61	0.86-0.89	-0.29	2.10	0.04	0.02	-0.14							
5. Performance	1.92	0.74	NA	-0.04	2.87	0.02	-0.02	-0.02	0.10						
6. WP	3.35	0.81	0.86	-0.03	3.19	0.11	-0.04	0.26***	-0.29***	0.02					
7. NFC	3.48	0.92	0.95	-0.74	2.87	-0.06	-0.03	-0.15*	0.08	0.11	-0.34***				
8. Efficacy	4.14	0.55	0.88	-0.59	4.10	0.04	-0.03	0.09	0.00	0.05	-0.30***	0.30***			
9. RI	2.47	0.63	0.81	0.02	2.56	-0.12	0.01	0.01	0.14	-0.07	-0.33***	0.45***	0.45***		
10. DP	2.88	0.81	0.93	-0.28	2.19	-0.11	-0.12	0.03	0.02	-0.06	-0.40***	0.36***	0.62***	0.65***	
11. RR	2.79	0.60	0.86	-0.36	2.90	-0.10	0.20**	0.18*	-0.12	-0.05	0.08	0.03	0.25***	0.38***	0.29***

Note. Gender: 1 = Male, 2 = Female. Satisfaction = Satisfaction with reward (closed questions); Performance = *N*-back performance; WP = Willpower beliefs; NFC = Need for cognition; Efficacy = Self-efficacy; RI = Reward interest; DP = Drive persistence; RR = Reward reactivity. NASA, Satisfaction, and Performance are averaged across all three difficulty levels. * $p < .05$; ** $p < .01$.

is associated with underlying individual differences. Specifically, we were interested in whether differences in lay beliefs about willpower, that is, whether people believe their willpower is a limited or non-limited resource, may influence the perception of effort and satisfaction with reward.

Here, we used a working memory task with three different difficulty levels to measure effort perception and a small monetary reward after each level to measure satisfaction with reward. The analysis yielded two main results confirming our hypotheses. Firstly, we found that those with limited willpower beliefs perceived the task as more difficult than those with non-limited willpower beliefs. Furthermore, when asked to subjectively rate their satisfaction with the reward gained for the task, limited believers rated their satisfaction lower than non-limited believers. This pattern could be seen at each difficulty level, as well as across the levels.

There was no moderating effect of difficulty such that increasing task demands would have a stronger influence on effort perception and reward satisfaction in those with limited compared to non-limited beliefs. However, follow-up analyses revealed that the effect of subjective effort perception on reward satisfaction was strongest in those with limited rather than non-limited beliefs. This analysis also reveals that the lower reward satisfaction observed in limited theorists cannot be explained solely via the mechanism of increased effort perception since even when controlling for effort perception, limited theorists reported lower satisfaction with reward than their non-limited counterparts.

Previous literature points to an abundance of benefits associated with non-limited willpower beliefs (for review, see Francis & Job, 2018). For example, in a longitudinal study involving students, it was discovered that students with non-limited beliefs tended to self-regulate more effectively under high demands than those who hold limited will-

power beliefs (Job, Walton, et al., 2015). These findings suggest that holding non-limited willpower beliefs could benefit students who struggle with procrastination, time management, or performance in school. How students perceive willpower under high demands may be a key factor for predicting and improving academic success. Another area that has shown beneficial traits associated with non-limited beliefs is within romantic relationships (Francis et al., 2020); although limited theorists were better able to perceive their partners' tiredness and low mood than non-limited theorists, their own perceived depleted resources predicted overall lower intentions to provide support.

Various explanations have been proposed for mechanisms by which willpower beliefs affect these outcomes. While previous research has found that willpower beliefs do not influence how difficult or exhausting a task is perceived (Job, Bernecker, et al., 2015; Job et al., 2010; Study 3), the current study found an effect of willpower beliefs on effort perception.

According to the Expected Value of Control theory (Shenhav et al., 2017), the allocation of cognitive resources is determined by offsetting the expected reward of a task by the cost of the cognitive control required to complete it. If limited theorists do indeed perceive tasks as more effortful, these costs could be perceived as greater than for non-limited theorists; coupled with a lower value assigned to the reward (as supported by our second hypothesis), it may be that limited theorists are therefore less inclined to engage in tasks that are effortful but promote positive outcomes, such as studying or supporting a romantic partner.

Recent research has begun to challenge the dominant characterization of effort as inherently costly and suggests that in some contexts, the effort can be experienced as intrinsically rewarding (Inzlicht et al., 2018). Should this be the case, an interesting question is raised regarding

whether increasing the value of effort would also increase the levels of satisfaction for both limited- and non-limited believers.

Regarding other individual differences, the results were somewhat mixed. A higher need for cognition was associated with holding more non-limited willpower beliefs. Exploring the ability of need for cognition in predicting our key outcome variables, we found that while the higher need for cognition was associated with lower effort perception, it was not predictive of satisfaction with reward, an observation that could potentially enable insight when exploring the mechanism of these effects in future research. Furthermore, it provides evidence that lay theories about willpower beliefs and the need for cognition, although correlated, are different constructs, each contributing differently to explaining behavioral outcomes. Other individual differences measured here did not significantly explain the variance in effort perception and reward satisfaction. Only reward reactivity was identified as a weak, negative predictor for effort perception. Weak correlation coefficients between willpower beliefs and other individual differences measured here suggest that willpower beliefs do not overlap strongly with other similar concepts, such as, for example, self-efficacy, and do indeed have unique predictive validity.

Limitations

The online format of our study carries inherent limitations in the controllability of the environment, including factors that could influence our variables of interest. For example, the presence of loud background noises or distractors could result in tasks being perceived as more effortful. Although participants were informed beforehand about the need to focus without interruptions throughout the tasks, a follow-up study in a well-controlled laboratory environment would further enhance the reliability of these results. Additionally, our study format precluded the accurate assessment of task disengagement due to the confound of task ability in determining performance indicators. A laboratory study utilizing cardiovascular measures (e.g., β -adrenergic sympathetic activity, Obrist, 1976) to accurately monitor effort exertion and task disengagement would enable further exploration examining how actual effort expenditure moderates our reported effects.

Although concerns have been raised regarding the quality of the data collected via MTurk (Chmielewski & Kucker, 2020), the employment of attention check questions, as well as several training rounds and a minimum threshold for performance enables us to be confident that participants actively engaged throughout the tasks. Finally, the context of the ongoing COVID-19 pandemic could have influenced participants' willpower beliefs and perception of effort and

reward during data collection. However, the hypotheses and the design of the study were preregistered before the onset of the pandemic, and we hope that the results can be generalized independent of the context. Nevertheless, future direct and conceptual replications can only be recommended.

Overall, our findings support non-limited willpower beliefs being associated with lower perceptions of effort, as well as non-limited willpower beliefs being associated with higher perceptions of reward. Non-limited willpower beliefs were associated with more favorable outcomes (Francis & Job, 2018) in domains as broad as goal pursuit (Bernecker & Job, 2015a), health (Bernecker & Job, 2015b), relationships (Francis et al., 2020), and well-being (Bernecker et al., 2015). The current findings shed some light on the potential underlying mechanisms and may guide the development of interventions targeted at mitigating the negative outcomes related to limited willpower beliefs. If non-limited beliefs can be learned, then we foresee many exciting possibilities for real-world applications to remedy deficits in self-regulation, goal-setting, academic achievement, supportive relationships, and more.

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Conflict of Interest

The authors of this report declare that they have no affiliations with or involvement in any organization or entity with any financial interest or non-financial interest in the subject matter of the present study.

Publication Ethics

The IRB for this study was obtained at the Ethics Committee of the Technische Universität Dresden (SR-EK_132032020).

Open Science

We report how we determined our sample size, all data exclusions (if any), all data inclusion/exclusion criteria, whether inclusion/exclusion criteria were established prior to data analysis, all measures in the study, and all analyses including all tested models. If we use inferential tests, we report exact *p* values, effect sizes, and 95% confidence or credible intervals.

Open Data: The information needed to reproduce all of the reported results are openly accessible at <https://osf.io/n7my8/> (Clay et al., 2022).

Open Materials: The information needed to reproduce all of the reported methodology is not openly accessible. The material is available on request from the authors.


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