

Exertion of Effort Reduces the Willingness to Exert Effort for Rewards in the Future

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Abstract

To obtain rewards, we often have to decide whether exerting the effort that's required is 'worth it'. Sometimes we make these decisions at one moment in time, about effort we will exert much later. E.g., deciding now whether to review a paper in two weeks time. Yet, the motivation to exert effort is susceptible to fatigue, with recent evidence showing that exerting effort increases fatigue and reduces the motivation to exert effort just seconds later. However, little is known about how much these momentary fluctuations affect decisions to exert effort for reward in the future. In this study, participants exerted different levels of physical force (10% or 48% of their max grip strength for 5s), to induce fatigue. After each initial squeeze they made two decisions, choosing between a fixed low-effort/low-reward option and a variable higher-effort/higher-reward offer. Critically, these decisions were about effort they would have to exert for reward after the task, not immediately following their choices. We found that after a high-effort squeeze people were more likely to choose the rest option than after a low-effort squeeze. These findings suggest that people are unable to ignore momentary fluctuations in fatigue when making decisions about future effort, highlighting the implications of fatigue for motivation.

Keywords: motivation; physical effort; reward; decision-making; discounting

Introduction

The motivation to exert effort is fundamental to a successful, healthy life. Moreover, it is reduced in neurological and psychiatric disorders, being linked to symptoms such as persistent fatigue. However, the mechanisms underlying how fatigue impacts on the willingness to exert effort are poorly understood.

Effort-based decisions have been studied in experiments in which people make repeated decisions about whether to exert effort at different levels of difficulty of a task, for different magnitudes of reward. Results show that people subjectively devalue rewards as a function of perceived costs of effort (Chong et al., 2017). Moreover, recently it has been shown that such decisions can fluctuate on a moment-to-moment basis due to fatigue. Brief periods of exertion of high effort can lead to rapid and significant increases in fatigue and reductions in

the motivation to exert effort, which recover after a few seconds of rest (Matthews et al., 2023; Meyniel, Sergent, Rigoux, Daunizeau, & Pessiglione, 2013; Müller & Apps, 2019; Müller, Klein-Flügge, Manohar, Husain, & Apps, 2021).

However, a key feature of everyday decisions is often overlooked: we frequently decide now whether we want to exert effort for reward at a later point in time. In this study, we manipulated moment-to-moment levels of fatigue by requiring participants to exert either a high or low level of force, before making decisions about whether they would exert different levels of effort for reward at the end of the task. This allowed us to test the hypothesis that higher levels of fatigue induced by force, reduces willingness to choose future effortful actions.

Methods

Thirty-one healthy young adults participated in this study (age $M = 24.71$, $Std = 5.23$). Written informed consent was obtained prior to participation. The study was approved by the University of Birmingham (ERN.20-1897AP12). Participants received monetary compensation for their time (£9), plus a bonus payment (max. £3).

Participants conducted a physical effort-based decision-making task in which they made 128 decisions on their willingness to execute effort in the future to gain credits (translated into bonus payment). Physical effort was operationalized as the amount of force exerted on a handheld dynamometer. Each sequence started with an initial squeeze (10% or 48% of the participant's maximum voluntary contraction, MVC), designed to manipulate fatigue, followed by two decisions. Participants choose between a rest option for 1 credit, or a work option with variable effort levels (49, 56, 63, or 70% MVC) and variable reward levels (2, 4, 6, or 8 credits, Figure 1). Crucially, participants were instructed that they would not need to execute their choice during the task but that 16 of their choices would be selected at random to be executed at the end of the task for bonus payment.

To determine whether recently exerted effort influenced the willingness to exert effort in the future, we compared the proportion of rest versus work choices across effort and reward levels with the non-parametric Wilcoxon signed-rank test. To analyse whether choices depend on recently exerted effort, effort level, and reward level we fitted generalized linear mixed models (using the glmmTMB package in RStudio).

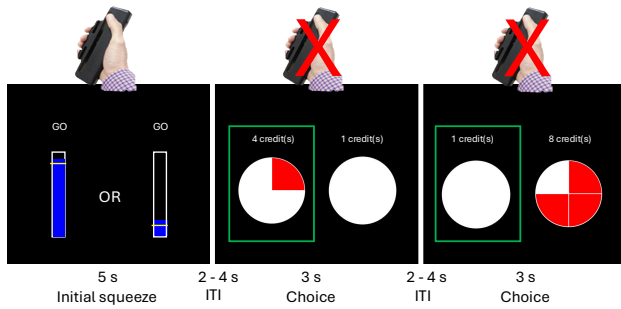


Figure 1: Figure 1: Trial structure effort-based decision task.

Results

Participants were able to successfully execute both the high and low initial squeezes on the majority of first attempts (>95%).

To examine how fatigue manipulation affected choices to exert effort for reward at a later point in time, we compared the proportion of rest versus work choices across effort and reward levels using a Wilcoxon sign-rank test. Our results show that after a high initial squeeze people were more likely to choose the rest option (median 29% versus 24%, $p = .003$; Figure 2a), even though the decision concerned only potential exertion of effort at the end of the experiment and no exertion directly after making the decision. A generalized linear mixed model including predictors for effort level, reward level and initial squeeze as fixed effects, revealed a main effect of initial squeeze ($p = .004$), but no interactions between initial squeeze and reward or effort level ($p = .07$ and $p = .54$ respectively, Figure 2b,c). The figures, however, suggests that this effect possibly only occurs at higher levels of effort and reward, although the study may be underpowered to detect this.

Discussion

In our daily activities we often make decisions related to future effort and reward. Here we show that reward is devalued by effort, not only based on the effort required to obtain the reward but also by effort we recently exerted. After exerting effort, people are more likely to choose for a rest option than a work option that might take place in the future. This choice behaviour is apparent across different effort and reward levels.

The willingness to work is often studied as a static feature that differs between individuals and that might be impaired in various disorders and diseases. However, recent studies show moment-to-moment fluctuations in people's motivation to exert effort for reward related to effects of fatigue (Matthews et al., 2023; Müller & Apps, 2019; Müller et al., 2021). The current study adds a new dimension to our understanding of effort-based decision-making. Effort exerted does not only affect willingness to exert effort in the next moment but makes us less inclined to commit to exerting effort in the future.

Acknowledgments

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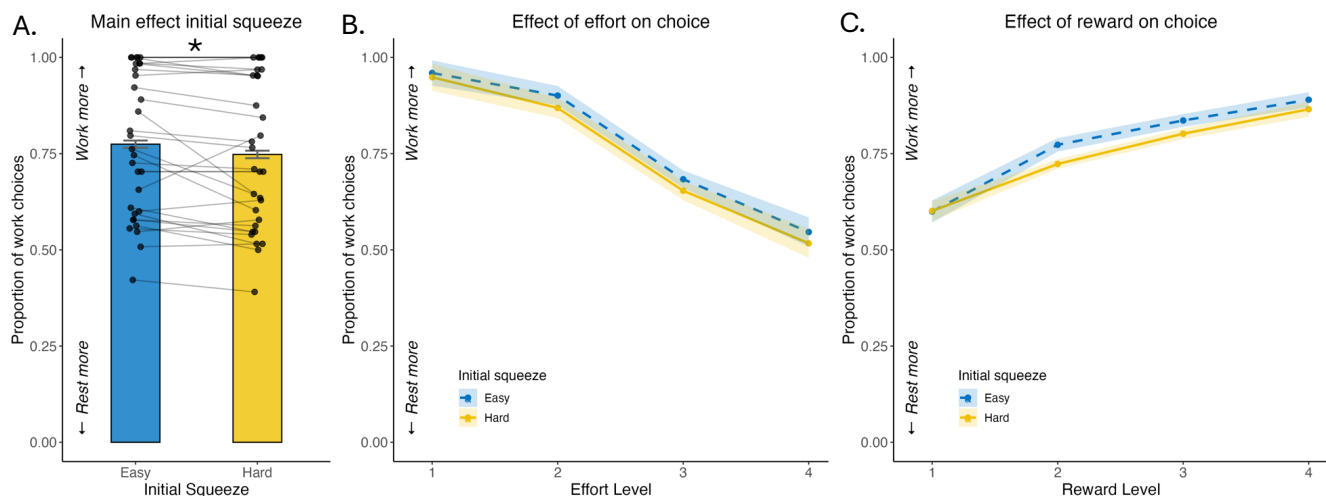


Figure 2: Figure 2: Effect of initial effort on subsequent willingness to exert effort.

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