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Work first then play: Prior task difficulty increases motivation-related brain responses in a risk game

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ABSTRACT

Task motivation depends on what we did before. A recent theory differentiates between tasks that we want to do and tasks that we have to do. After a have-to task, motivation shifts towards a want-to task. We measured this shift of motivation via brain responses to monetary feedback in a risk game that was used as want-to task in our study. We tested 20 healthy participants that were about 28 years old in a within-subjects design. Participants worked on a Stroop task (have-to task) or an easier version of the Stroop task as a control condition and played a risk game afterwards (want-to task). After the Stroop task, brain responses to monetary feedback in the risk game were larger compared to the easier control task, especially for feedback indicating higher monetary rewards. We conclude that higher amplitudes of feedback-related brain responses in the risk game reflect the shift of motivation after a have-to task towards a want-to task.

1. Introduction

Imagine you just finished a task that you had to do but was not really fun like reading a very complicated research paper. Afterwards, you may feel the urge to do something that is more fun like listening to music or eating chocolate. When you listen to your favorite music or taste the sweet chocolate in your mouth you reward yourself and that feels good, especially after the annoying article.

Recent research addresses the target balance between tasks that you have to do and tasks that you want to do (Inzlicht, Schmeichel, & Macrae, 2014; Kool & Botvinick, 2014). People have a natural tendency to strive for an optimal balance of externally rewarded labor and intrinsically rewarding leisure. That is why after an initial difficult have-to task, motivation shifts towards a rewarding want-to task. Time is limited, and so it is adaptive to maximize the potential reward, which can be extrinsic or intrinsic. Of course it is important to engage in a difficult task like reading complicated papers in order to gather external rewards and resources, but it is also important to be able to disengage from this have-to task and seek for activities that may also be gratifying like listening to music or eat your favorite kind of chocolate. Motivation is seen as the driving force that makes us gravitate towards a want-to task after a have-to task.

But how does this shift of motivation manifest on the neural level? To address that topic in our study, we first had to choose appropriate tasks. As the want-to task, we chose a risk game developed in our lab (Schmidt, Mussel, & Hewig, 2013; Schmidt & Hewig, 2015) (see Fig. 1). In every trial of this task, participants decide if they want to play riskier or less risky. Then they choose one of two turned cards (one win and one loss card) and finally receive feedback about the amount of money they won in the current trial. The total outcome of the game is paid out to the participants in cash. Money is an intrinsically gratifying want-to goal (Hofmann, Vohs, & Baumeister, 2012; Kruglanksi et al., 1975). In addition, research on gambling motivation states that the two main reasons to gamble are winning money and having fun (Neighbors, Lostutter, Cronce, & Larimer, 2002). Therefore, we suggest that the risk game is a good example for a want-to task.

Risky decision making is closely related to sensation seeking (Zuckerman, 2007): people who like to stimulate themselves do that by taking risks. That is why we also measured personality traits like sensation-seeking and impulsivity as well as its opponent, self-control.

To assess the hypothesized shift of motivation towards the want-to task, it is crucial to quantify motivation. One way to do this is to look at

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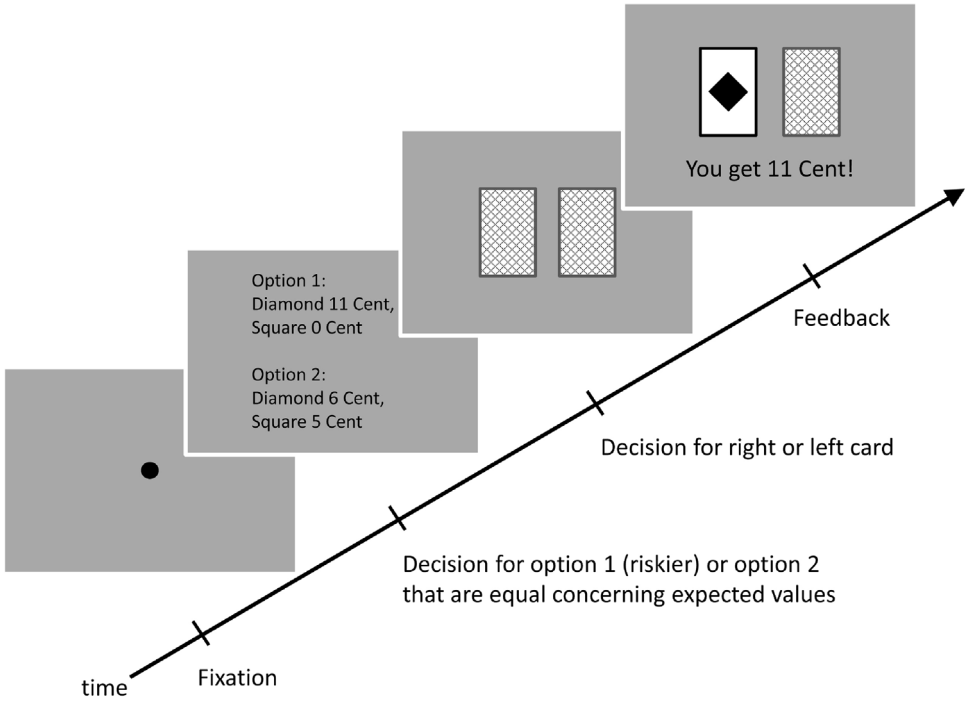

Fig. 1. Time-course of one trial of the risk game with the two events risk decision and monetary feedback. Please note that all words presented in the risk game were German.

the impact of motivation on event-related potential (ERP) components. Recent electrophysiological results suggest that motivation affects the feedback-related negativity (FRN; Masaki, Takeuchi, Gehring, Takasawa, & Yamazaki, 2006). The FRN is a component that is observed after feedback (Miltner, Braun, & Coles, 1997) and differentiates outcomes that are better or worse than expected, especially between winning and losing money (Gehring & Willoughby, 2002). Further results show that FRN amplitudes are larger after surprising unexpected feedback that is either negative or positive (Mueller et al., 2014; Pfabigan, Alexopoulos, Bauer, & Sailer, 2011). Surprising feedback also implies motivational salience (Pfabigan et al., 2011). In addition, there is evidence that the FRN amplitude is enhanced when the participant him/herself actively causes the feedback compared to externally produced passive feedback (Bismark, Hajcak, Whitworth, & Allen, 2013; Martin & Potts, 2011; Yeung, Holroyd, & Cohen, 2005). This effect could be due to the higher motivational relevance of active choices. The risk game developed in our lab and employed here was designed to assess the FRN after feedback concerning the financial outcome. So, if an initial have-to task followed by a want-to task leads to a shift in motivation, there should be an observable effect in the FRN responses in the risk game. Taken together, we predict that increased motivation is mirrored in larger FRN amplitudes.

As appropriate have-to task, we chose the Stroop task that is known to deplete self-control (Hagger, Wood, Stiff, & Chatzisarantis, 2010). When a dominant response has to be overridden, self-control is required (Baumeister, Vohs, & Tice, 2007). The exertion of self-control leads to ego depletion (Baumeister et al., 2007), as cognitive resources are demanded. There is a general bias to avoid cognitive demand (Kool, McGuire, Rosen, & Botvinick, 2010). Therefore, depleting tasks can be treated as have-to tasks. We adapted the task design used by Silvestrini and Rainville (2013). In their Stroop task, participants have to indicate the number of numerals presented on the screen (e.g. two two two; correct response is three) while suppressing the dominant response of reading the words (i.e. two). In this interference task, parallel processing and suppression of irrelevant information challenges attentional resources (MacLeod, 1991). As a control task, we used an easier version of the Stroop task with low interference. Here, the presented words were animal names instead of numerals and the task will be referred to as Animal task. Please note that the Stroop and the Animal task are both have-to tasks that differ concerning the amount of effort you have to spend on them. We think that the core feature of a have-to task is that you have to make an effort to solve it. To measure effort, we asked participants how difficult the tasks were and how hard they tried to perform well on them. But not only effort is important to make a task a have-to task. When motivation is high enough, also an effortful task can be a want-to task (Inzlicht et al., 2014; Tops, Montero-Mar & n, & Quirin, 2016). Therefore, we also asked participants how important it was for them to perform well on the tasks to measure motivation. When the Stroop task is only more effortful and not more motivating than the Animal task, it can be considered the harder have-to task.

The typical depletion experiments are conducted as between-subjects designs (Hagger et al., 2010). To control for group effects, we decided to employ a within-subjects design to see if the ERP results of the participants differed depending on the task that was carried out before. Please note that testing 20 participants in a within-subjects design provides a lot more statistical power than testing 20 participants in a between-subjects design (Maxwell & Delaney, 2003).

Concerning the hypotheses in our study, we want to differentiate between three models: the resource model (Baumeister et al., 2007), the approach model (Schmeichel, Harmon-Jones, & Harmon-Jones, 2010; Wagner, Altman, Boswell, Kelley, & Heatherton, 2013) and the motivational model (Inzlicht et al., 2014). The resource model states that self-control is a limited resource and thus behavior will be less controlled after the exertion of self-control in a previous task. Thus, it predicts that participants play riskier after the Stroop task. The approach model assumes that self-control depletion not only leads to less controlled behavior, but also to higher approach motivation. In our study, the approach model predicts riskier behavior and enhanced motivation-related brain responses in the risk game after the Stroop task, especially when positive feedback is provided. Finally, the motivational model predicts a motivation shift towards a want-to task after an initial have-to task. This should lead to enhanced motivation-related brain responses after the Stroop task, also especially for trials with positive feedback.

To sum up, participants came to the lab twice: once, they worked on