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Close games versus blowouts: Optimal challenge reinforces one's intrinsic motivation to win

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ABSTRACT

When immersed in intrinsically motivating activities, individuals actively seek optimal challenge, which generally brings the most satisfaction as they play hard and finally win. To better simulate real-life scenarios in the controlled laboratory setting, a two-player online StopWatch (SW) game was developed, whose format is similar to that of a badminton tournament. During the game, a male opponent played by a confederate ensured that the same-sex participant paired with him won both matches, one with a wide margin (the lack of challenge condition) and another with a narrow one (the optimal challenge condition). Electrophysiological data were recorded during the entire experiment. An enlarged Stimulus-preceding negativity (SPN) was observed in the optimal challenge condition, indicating a more concentrated anticipatory attention toward the feedback and a stronger intrinsic motivation during close games. Thus, this study provided original neural evidence for predictions of Self-determination theory (SDT) and Flow theory, and confirmed and emphasized the significant role of optimal challenge in promoting one's intrinsic motivation to win.

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1. Introduction

> "Accept the challenges so that you may feel the exhilaration of victory."
>
> [(General George S. Patton)]

In our daily life, many people seek to engage themselves in intrinsically motivating activities, from rock climbing and chess to competitive sports. Although not paid to do so, they generally enjoy themselves in the process. Interestingly, the underlying challenge level of these kinds of activities seems to be a deterministic factor of the enjoyment of the participant. It was widely reported that the more cognitively effortful or challenging these activities are, the more intrinsically motivating they will be (Cacioppo et al., 1996). Indeed, even if these activities turn out to be rather difficult or even dangerous, people may still actively take part in them in the absence of extrinsic rewards (Abuhamdeh and Csikszentmihalyi, 2013).

Researchers have long been working to clarify this interesting phenomenon. Mainstream motivation theories consistently indicate that intrinsically motivating activities should provide optimal challenges to participants in order to be sufficiently appealing (Fong et al., 2015; Ryan and Deci, 2000). In other words, challenges should be matched to the capacities of the participants (Abuhamdeh et al., 2015). Some researchers suggested that, as successes in challenging activities can engender a real sense of pride, people would try their best to succeed (Ruedy et al., 2013). According to Self-determination theory (SDT), which is among the most influential theories of motivation, individuals have three innate psychological needs: autonomy, competence and relatedness. Competence is defined as feeling efficient, effective or masterful, the satisfaction of which is critical for the maintenance and promotion of intrinsic motivation. Succeeding in optimally challenging tasks gives rise to maximum perceived competence and thus effectively enhances one's intrinsic motivation (Bassi and Delle, 2012; Deci and Ryan, 2000). In contrast to SDT, which categories and sums up basic psychological needs, Flow theory tries to describe key characteristics of the intrinsically motivating state. Flow refers to an idealized state in which individuals are fully engaged in activities and simultaneously perceive high levels of challenge and skill. On the basis of Flow theory, one's skill and perceived challenge should be well balanced, creating the experience of flow (Abuhamdeh and Csikszentmihalyi, 2013; Abuhamdeh et al., 2015).

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While mainstream motivation theories give consistent predictions, and a positive role of optimal challenge in boosting one's intrinsic motivation has been reported in studies adopting the experience sampling method (Larson and Csikszentmihalyi, 1983), direct experimental evidence in support of this point of view is still quite rare. Given the significance of optimal challenge for intrinsically motivating activities, we have aimed to manipulate different levels of challenge in a controlled laboratory setting and further examine the effect of challenge on one's intrinsic motivation to win when people are competing with others. Game, a representative intrinsically motivating activity, is adopted in this study. Most games (e.g., sport events, computer games) are inherently competitive and provide challenges of certain levels (Dimenichi and Tricomi, 2015), which makes them ideal for the manipulation of perceived challenge. It is understandable that people long for a victory and enjoy blowouts (games in which they win by a wide margin). However, will they be more eager to win if it is a close game instead? In this study, we engaged participants in competitive games in which participants were paired with a same-sex opponent and played the StopWatch (SW) game (see Fig. 1), the format of which is similar to that of a badminton tournament. Since individuals need to feel competent (Deci and Ryan, 2000; Ryan and Deci, 2000), we made sure that participants finally won in both rounds. To manipulate challenge levels, participants won one round with a wide margin and the other round with a narrow one. Previous studies on human motivation have mainly relied on measurement scales, which are highly subjective and are found to bring observable biases and large variance (Camerer, 2010). To overcome the deficiency of self-report, we resorted to neural indicators to measure intrinsic motivation in a more objective way. To be specific, electroencephalograms (EEGs) were recorded throughout the experiment to understand the temporal dynamics of motivational processes.

To achieve the aim of this study, we needed to find Event-related potential (ERP) components that are both appropriate and reliable for the measurement of one's (intrinsic) motivation level. In a pioneering electrophysiological study, Feedback-related negativity (FRN), a representative ERP component of feedback processing and outcome evaluation, was adopted (Meng and Ma, 2015). Because a mainstream theory of FRN, the motivational significance theory, suggests that the magnitude of the FRN lose-win difference wave (d-FRN) reflects a rapid evaluation of the outcome's motivational significance (Gehring and Willoughby, 2002), the authors used d-FRN upon feedback as a real-time electrophysiological indicator of one's intrinsic motivation when extrinsic rewards were absent (Meng and Ma, 2015). While the motivational significance account of d-FRN is well accepted, and findings of various studies have confirmed it (San Martín, 2012), d-FRN is not able to be a candidate ERP component of intrinsic motivation given the current experimental manipulation. In this study, we made sure that participants would win with a wide margin in one round and with a narrow margin in another, which means that the frequencies upon winning would be highly different between the two rounds. Reinforcement learning theory of FRN suggests that the magnitude of FRN is sensitive to one's expectation, such that improbable and less expected outcomes would lead to a more pronounced FRN (for a recent review, see San Martín, 2012). In the study conducted by Meng and Ma (2015), success rates were approximately 50% in both conditions being compared. Thus, the frequencies of the wins and losses did not interfere with the observed d-FRN pattern. In the current study, however, failures are encountered far less frequently during blowouts than in close games. Thus, we would predict to observe a significantly larger d-FRN in the former case. However, this does not necessarily mean that individuals are more intrinsically motivated during blowouts.

In the same pioneering study that probed electrophysiological correlates of intrinsic motivation, the authors also paid close attention to the outcome anticipation stage and proposed another candidate neural indicator of one's intrinsic motivation (Meng and Ma, 2015). The Stimulus-preceding negativity (SPN) is an ERP component that reflects processes related to anticipatory attention (Brunia and Van Boxtel, 2004) and is a sustained, negative shift that occurs when a subject anticipates the onset of certain task-relevant stimuli (for a recent review, see Brunia et al., 2012). Consistent with the motivational significance theory of FRN, previous studies have shown that the affective-motivational valence of an anticipated stimulus is a crucial factor for inducing an SPN (Brunia et al., 2012; Kotani et al., 2015). In the study conducted by Meng and Ma (2015), the opportunity to choose between tasks of equal difficulty was manipulated, and the effect of autonomy support was directly examined. A more negative SPN toward the outcome was observed, indicating a greater anticipatory attention toward the upcoming feedback when a prior task choice was available. Because the amplitude of SPN is sensitive to the motivation level, the authors suggested that participants would be more intrinsically motivated to win when given a prior choice in tasks. In the current study, task performance bears more motivational relevance to participants in close games, and participants are predicted to be more intrinsically motivated to win the match (Abuhamdeh and Csikszentmihalyi, 2013; Deci and Ryan, 2000). Thus, we predict that subjects will pay more sustained anticipatory attention toward the upcoming feedback in close games, resulting in an enhanced SPN. If this is indeed the case, the present study will provide original neural evidence for the positive effect of challenge in boosting one's intrinsic motivation to win and then give direct empirical support for SDT as well as Flow theory in a controlled laboratory setting.

2. Methods

2.1. Participants

Eighteen healthy, right-handed subjects aged 19–24 years ($M = 21.89$ years, $SD = 1.45$ years) participated in this study, all of whom were male. All subjects were registered students of Zhejiang University and had normal or corrected to normal vision. All subjects reported no history of neurological disorders or mental diseases. The review board of the institution approved this study, and informed consents were obtained from all subjects before the experiment. In the formal experiment, a male experimenter unacquainted with the participants played as the opponent and was paired with each of them. Experimental conditions were successfully manipulated for all participants. Thus, data from all subjects went into the final analysis.

2.2. Stimuli and procedure

Subjects were comfortably seated in a dimly lit, sound-attenuated and electrically shielded room. The stimuli were presented at the center of a computer screen at the distance of 100 cm with a visual angle of $7.50° \times 5.40°$. Subjects were instructed to use the keypad to complete the SW tasks. The experiment consisted of 2 blocks, each containing a minimum of 32 trials and a maximum of 50 trials. Before the experiment, the participant met and was briefly introduced to his counterpart (the opponent played by the confederate). Experimental facilities unfamiliar to subjects were also introduced. We took care to strictly follow these procedures to make sure that the actual participant believed in the authenticity of the two-player online game. The two players were then led to take seats in separate rooms and read the paper version of the instructions.

The experimental task we adopted was the SW game. During the game, a stopwatch would automatically start, and participants should try their best to stop the watch at approximately 3 s (Murayama et al., 2010). Single-player SW games always have pre-defined success intervals. For example, in one of our previous studies adopting this task, if the stopping time fell between 2.93 s and 3.07 s, it would be deemed as a successful attempt. Otherwise, it would be deemed as a failure

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