International Journal of Psychophysiology 91 (2014) 155–162

Contents lists available at ScienceDirect

International Journal of Psychophysiology

journal homepage: www.elsevier.com/locate/ijpsycho

How friendly *is* a little friendly competition? Evidence of self-interest and empathy during outcome evaluation ☆

Yiwen Wang [a,*], Bo Yuan [a], Kathryn Roberts [b,*], Yuan Wang [a], Chongde Lin [c], Robert F. Simons [b]

[a] Academy of Psychology and Behavior, Tianjin Normal University, China
[b] Department of Psychology, University of Delaware, United States
[c] State Key Laboratory of Cognitive Neuroscience and Learning, Beijing Normal University, China

ARTICLE INFO

Article history:
Received 25 April 2013
Received in revised form 28 September 2013
Accepted 14 October 2013
Available online 20 October 2013

Keywords:
Outcome evaluation
Interpersonal relationship
Competition
Perspective-Taking
Empathy
ERP
FRN
P300

ABSTRACT

Although previous studies have shown that brain potentials recorded from passive observers differ when gambling-task outcomes are delivered to a friend or a stranger, it is unclear how these outcome evaluations are reflected in brain potentials during active competition. The present study recorded event-related potentials (ERP) from 16 normal adults playing an interactive gambling task against both a friend and a stranger. In this task, the P300 was modulated by the feedback valence (gain or loss) and the nature of the interpersonal relationship, such that it was larger when competing against strangers. Regression analyses indicated that empathy to another's personal distress was negatively related to P300 amplitudes when competing against friends. The dFRN, defined as the difference between losses and gains, varied with Perspective-Taking when competing against friends, such that smaller dFRN amplitudes were correlated with increased Perspective-Taking. The modulation of ERP components indicates that interpersonal relationships may influence outcome evaluations in competitive situations. Correlations between ERP components and empathy measures also provide preliminary support of a relationship between one's empathy and the processing of outcomes during competition against a friend.

1. Introduction

Our ability to evaluate outcomes of prior actions allows us to modify our previous behavior so that we may function more adaptively in the environment. When interpersonal relationships are woven into our immediate environment, it may also become advantageous to evaluate others' outcomes in order to improve personal and/or group functioning. Recently, outcome evaluation tasks have been coupled with psychophysiological measures to explore how the type of relationship between two people affects how one individual reacts to the positive or negative outcomes of another. With one exception (Itagaki and Katayama, 2008), research paradigms have only required participants to observe others complete a task that gave rise to the positive and negative outcomes (Leng and Zhou, 2010; Ma et al., 2011), such that in all cases, the participants had no personal investment in either outcome. The current study examines outcome evaluation as one individual competes against a friend and stranger, in order to determine how the type of interpersonal relationship between opponents influences personal outcome evaluation in competitive conditions.

Several studies have demonstrated that the effects of friendships are evident in both behavior and physiological arousal. In an iterated prisoner's dilemma task, Majolo et al. (2006) found that individuals cooperate more with, and donate more money to, a friend than a stranger. During competition, individuals reported feeling more engaged and aroused, and had faster heart rates, when competing against a friend than a stranger (Ravaja et al., 2006). When Guroglu et al. (2008) used functional magnetic resonance imaging (fMRI) to explore the neurological correlates of friendships, they found that the amygdala, hippocampus, nucleus accumbens, and ventro-medial prefrontal cortex were more strongly activated when subjects interacted with friends than other peers or even celebrities. Alongside emotional regulation and reward processing, these brain structures have been linked to a particular aspect of friendship, empathy.

Empathy has been defined as a shared emotional experience that occurs when one person perceives another's emotions and comes to feel similarly (Preston, 2007). Depending on individual and contextual factors, empathy emerges in various forms, ranging from agitation to another's distress to a full understanding of their state (Preston and de Waal, 2002). Studies have found that empathy has short-term benefits such as enhancing helping behaviors, cooperation, and understanding, as well as personal long-term benefits like enhancing the friendship, self-interest and reciprocity (Batson and Ahmad, 2001; Batson et al.,

☆ This work was supported by the National Natural Science Foundation of China [31371045], the MOE Project of Key Research Institute of Humanities and Social Sciences at Universities [12JJD190004, 12YJA190020] and Program for New Century Excellent Talents in Universities [NCET-11-1065].

* Corresponding authors.
E-mail addresses: wangeven@126.com (Y. Wang), kroberts@psych.udel.edu (K. Roberts).

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http://dx.doi.org/10.1016/j.ijpsycho.2013.10.009

1995; Lakin and Chartrand, 2003; Rumble et al., 2010). As individuals report increased empathic feelings and behaviors towards those with whom they have closer relationships (Batson and Ahmad, 2001; Batson et al., 1995), modulating the type of interpersonal relationship that an individual shares with an opponent in a competitive task will likely vary the level of empathy activated when evaluating task outcomes.

The evaluation of one's own or another's outcomes, such as labeling them as good or bad, is an important step in adaptive decision-making (Paulus, 2005), and recent research suggests that empathy may play a role in this classification process (Leng and Zhou, 2010; Ma et al., 2011). Specifically, the brain has developed mechanisms to quickly assess properties of the outcome like valence and magnitude in order to objectively classify outcomes. However, these mechanisms also permit the attachment of subjective, motivational value to the feedback that alters the extent to which it is classified as positive or negative. An emerging line of work precipitating the present study has found that interpersonal factors like empathy and the individual's level of closeness to the person whose outcomes are being evaluated can be captured in this subjective reaction to feedback (Leng and Zhou, 2010; Ma et al., 2011).

One component of the event-related brain potential (ERP) called the P300 has been used to explore individual's evaluations of outcomes. It is believed to reflect attention allocated to the outcome, as well as the outcome's motivational/affective salience (Nieuwenhuis et al., 2005). Specifically, the P300 is larger following unexpected outcomes, as well as following gains rather than losses (Hajcak et al., 2005, 2007). The P300 is a positive-going deflection, maximal over centro-parietal electrodes about 300 to 600 ms after feedback presentation.

A second ERP component called feedback-related negativity (FRN) may provide additional information useful in deciphering outcome evaluation. The FRN has been consistently found to be more prominent for unfavorable, as opposed to favorable, outcomes (Holroyd et al., 2004) and is larger for outcomes of greater motivational significance (Gehring and Willoughby, 2002). It is therefore believed to reflect the processing and motivational significance of outcome events. The FRN appears earlier than the P300 and is characterized as a negative peak about 200 to 300 ms after the onset of outcome feedback. While traditionally conceptualized as negative-going component sensitive to losses, a recent line of works suggests that it may, in fact, be a positivity sensitive to rewards but absent to losses (Carlson et al., 2011; Foti et al., 2011).

The P300 and FRN have been used to explore how outcomes for the self and others are modulated by interpersonal variables like cooperation and competition. Until now, research paradigms have involved two trial types as a participant's brain activity is simultaneously recorded. On some trials, the participant completes a choice task and observes her own feedback; on other trials, the same participant passively observes another person complete the same task and receive feedback. Itagaki and Katayama (2008), for example, designed a task in which participants played a monetary game either competitively or cooperatively with a virtual player. The participant and virtual player took turns in the game, and the participant's brain activity was recorded as she observed her own and the virtual player's feedback. Results indicated that participants had larger FRNs when the virtual player lost money in a cooperative context and when the virtual player gained money in a competitive context, both of which resulted in a loss of money for the participant herself. The authors concluded that the FRN reflects an individual's system of evaluating the outcome as positive or negative for herself, regardless of the outcomes for others.

In comparison to Itagaki and Katayama's (2008) paradigm that investigated interpersonal variables involved in manipulating one's own outcome, Leng and Zhou (2010) explored how the type of interpersonal relationship between two individuals modulates how one person perceives another's outcome, independent of personal outcomes. In their study, Leng and Zhou employed a gambling task in which a participant, her friend, and a stranger took turns individually playing against the computer. The participant observed her own, her friend's, and the stranger's monetary feedback while brain potentials were recorded. Results of this study indicated that the type of interpersonal relationship modulated the P300, such that larger P300s were present for her friend's, rather than the stranger's, outcomes. No comparable FRN differences were observed. Leng and Zhou (2010) argue that this outcome reflects evidence that empathic processing occurs in two parts. The authors first suggest that the FRN is a reflexive process that is sensitive to gains and losses but occurs too early to reflect the nuances of the participant's interpersonal relationship with the other player. The later P300 response, given its well documented sensitivity to attention and motivationally significant stimuli (Bradley, 2009), may be related to empathic processes involved in the sharing of another's experience and feelings, such that a friend's outcome would elicit stronger empathetic responses than a stranger's outcome.

After using an experimental design similar to Leng and Zhou's (2010) to replicate their results, Ma et al. (2011) performed a follow-up study to investigate how one perceives others' outcomes during a competitive situation. In this task, a participant observed the outcomes of a gambling competition between her friend and a stranger. The P300 was again larger for her friend's, rather than the stranger's, outcomes. In contrast to previous research, however, Ma and colleagues found that the FRN was greater when observing the outcomes of friends than strangers. The presence of this FRN distinction contradicted Leng and Zhou's hypothesis that the FRN occurs too early to capture empathic processes. Further, because the FRN was distinctively present when the participant passively observed another, but not when the participant was personally engaged in completing the task, Ma et al. postulate that outcome evaluation may be modulated by situational context. They suggest that egocentric attitudes present when the participant is actively engaged in the task, such that she is concerned about her own performance in the task, are incompatible with empathy activation.

The purpose of the present study is twofold. First, we aimed to determine how the type of interpersonal relationship between individuals affects reactions to personal outcomes during competition. In previous studies of empathy, the participant merely observed her friend's or the stranger's outcome, with no personal stake in the task. By imposing a competition and varying the type of interpersonal relationship between competitors, in which the player likely has different levels of investment in the other's outcome, we examined neural reactions to personal outcomes. Studying these components in a different situational context allowed us to obtain additional information about their sensitivities. The second aim of the study was to clarify Leng and Zhou's and Ma et al.'s assumptions of empathy towards friends by measuring empathy directly. For the experiment, we recruited groups of three gender-matched participants, of which two were friends and one was a stranger. Brain potentials of the participant were recorded while playing against her friend and the stranger individually in a gambling task, and the participant's P300 and FRN were evaluated during outcome feedback.

Consistent with previous research, we hypothesized that the P300 would be larger for gain outcomes, and the FRN would be larger for personal loss outcomes. Because of differences in cognition and affect in competing against a friend or stranger (Ravaja et al., 2006), we also speculated that the P300 and FRN would differ depending on the competitor. Specifically, due to P300's sensitivity to attention allocation and motivational significance, competing against a stranger would induce a larger P300 because of less empathy towards, and greater desire to win against, the stranger relative to the friend. We hypothesized that the FRN would be larger when observing the outcomes of a friend in a competitive situation, reflecting increased sensitivity to a friend's losses relative to a stranger's. With regards to empathy, on the basis of previous research in which empathic responses have been found to modulate people's evaluation of others' gains and losses (Fukushima and Hiraki,