



Electrophysiological correlates of processing facial attractiveness and its influence on cooperative behavior

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ABSTRACT

The present study investigated the temporal features of processing facial attractiveness, and its influence on the subsequent cooperative behavior. Event-related potentials (ERPs) were recorded for both face stimuli (attractive or unattractive faces) and feedback stimuli (loss or gain) while participants performed a modified trust game task, in which participants decided whether to cooperate with fictional partners (attractive or unattractive faces) for a chance to earn monetary rewards; feedback (loss or gain) were presented after their decisions. The behavioral results showed that participants were more likely to cooperate with the attractive partners than with the unattractive partners. The ERP analysis for face stimuli showed that a smaller P2 amplitude was elicited by attractive faces compared to unattractive faces. In addition, attractive faces elicited larger N2 and smaller late positive component (LPC) amplitudes than unattractive faces. More interestingly, a larger feedback related negativity (FRN) was elicited within the attractive face condition compared with the unattractive face condition. Therefore, our findings demonstrate that the discrimination of attractive and unattractive faces occurs at the early P2 stage, reflecting automatic processing of facial attractiveness. Moreover, the present study further demonstrates that facial attractiveness facilitates cooperative behavior, and that FRN elicited by outcome stimuli might be used as an index of how people judge and predict another's behavior in a social game.

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1. Introduction

Physical attractiveness is an important characteristic in human social interactions. For example, it has been argued that facial attractiveness indicates good genetic quality and reproductive capacity [26]. Moreover, it has been widely reported that physical attractiveness may influence human social behavior [16,30]. Mulford et al. found that people were more likely to cooperate with attractive partners in the Prisoner's Dilemma games [16]. Attractive partners were also considered to be more trustworthy than unattractive partners [30]. Interestingly, several studies revealed that attractive people were more likely to be hired and promoted [15], and earn more money than unattractive people [2].

As described above, behavioral studies have shown that physical attractiveness plays an important role in human social interactions. Recently, some neuroimaging studies have found that the reward-related brain area, the orbitofrontal cortex (OFC), is involved

in attractiveness perception, with enhanced OFC activation for attractive faces compared to unattractive faces [1,31]. Additionally, Johnston and collaborators found that a larger late positive component (LPC) was elicited by attractive faces compared to unattractive faces when subjects were performing an attractiveness rating task [11,17]. Werheid et al. used an attractiveness category task and found that the facial attractiveness effect occurred not only in the early processing stage, as indexed by a posterior negative component, but also occurred in the late LPC processing stage [29]. Furthermore, Schacht et al. [21] found that larger P2 and LPC amplitudes were elicited for attractive and unattractive faces than for faces of intermediate attractiveness when using an attractiveness rating task, and no event-related potential (ERP) differences were observed between attractive and unattractive faces. More interestingly, the attractiveness effects were absent when using an attractiveness-irrelevant gender classification task in the Schacht et al. study, suggesting that the attractiveness effects could be modulated by task requirements, and that the appraisal of facial beauty is rapid but not automatic [21]. However, some behavioral and neuroimaging studies indicate that facial attractiveness can be detected in a single brief glance or in a task unrelated to the explicit task of judging facial attractiveness, suggesting the automatic processing of facial attractiveness [1,14,18,25,31].

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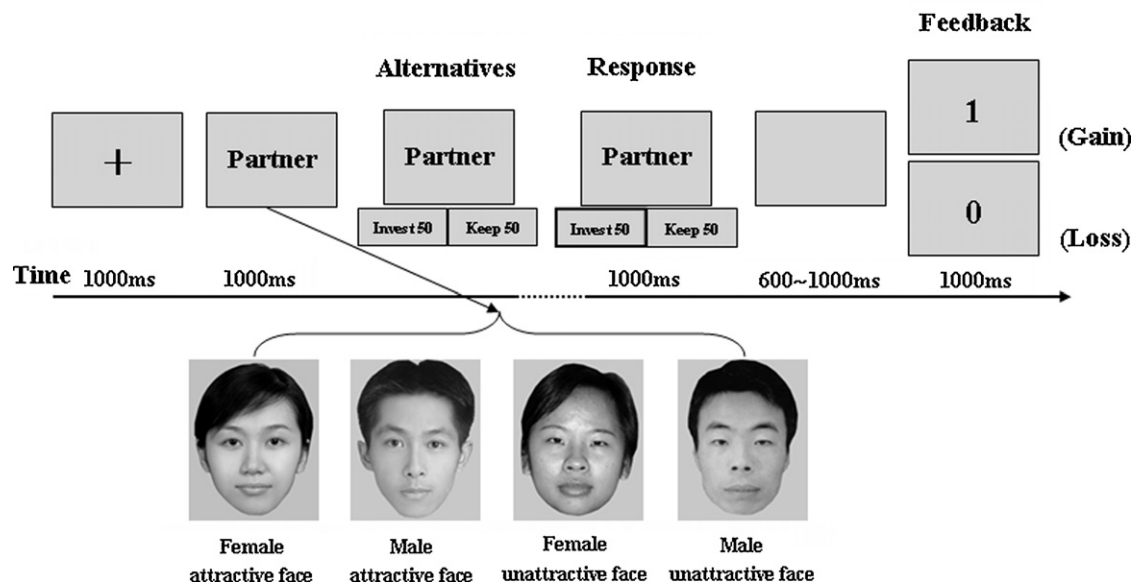


Fig. 1. The modified trust game task and partner's face type used in the ERPs experiment.

Given the variation in the reported findings relating to how facial attractiveness is processed, it would be interesting to test whether facial attractiveness can be detected automatically in a social context. Therefore, the first aim of the present study is to explore the temporal features of processing attractive and unattractive faces by using the high temporal resolution of ERPs while participants perform a modified trust game task, in which participants are instructed to play with fictional partners, and decide whether they want to cooperate with the partners for a chance to earn a monetary reward. Based on the automatic and effortless processing of attractiveness reported by previous behavioral studies [1,14,18,25,31], we predict that the dissociative neural processing of attractive and unattractive faces will occur in the early bottom-up processing stage, even when participants perform a trust game unrelated to the explicit task of judging facial attractiveness.

The second aim of the present study is to further explore the influence of attractiveness on cooperative behavior in the trust game task, a task typically used to explore cooperative behavior [6,12]. Given the reports which suggest that attractive people are more likely to be hired and promoted, and be judged more trustworthy compared to unattractive people [16,30], it is predicted that participants will be more likely to cooperate with the attractive partners. In other words, the level of reward expectations will be stronger in the attractive relative to the unattractive partner condition.

The FRN component is a negative-going deflection that peaks approximately 250–300 ms after the onset of external feedback. The magnitude of the FRN difference wave (negative minus positive feedback) is modulated by reward expectation, with a larger FRN difference wave in the strong than in the weak expectation condition [7,8]. Therefore, consistent with previous studies, we further predict that the FRN difference wave will be larger in the attractive partner condition than in the unattractive partner condition.

2. Materials and methods

2.1. Subjects

Fourteen undergraduate students (7 females), aged 19–23 years ($M=21.9$), were paid to participate in the experiment. All subjects were healthy, right-handed, with normal or corrected-to-normal

vision, and reported no history of affective disorders. Furthermore, all subjects gave written informed consent.

2.2. Stimulus materials

All face images were obtained from the Internet, and were unfamiliar to the participants, with no movie stars, musicians, or other celebrities. All faces were characterized by neutral expression, frontal view and forward eye-gaze, and edited to equal luminance and uniform size (11 by 8.5 cm; 450 by 350 pixels).

Prior to the ERP experiment, 420 Chinese faces were rated by 32 college students (16 females, aged 18–23 years, $M=20.8$). These faces were rated for attractiveness (from 1 = 'not attractive at all' to 7 = 'extremely attractive') and emotional expression (from 1 = 'extremely angry' to 7 = 'extremely happy') on a 7-point scale [21,29]. Finally, a total of 120 faces were selected for the ERP experiment: 60 attractive faces (30 female faces) and 60 unattractive faces (30 female faces). The ratings of the two categories of faces were compared by paired t -test, wherein the attractiveness was significantly different [$M_{\text{attractive}}=4.68$ ($SD=0.65$), $M_{\text{unattractive}}=2.55$ ($SD=0.85$); $t(31)=12.78$, $p<0.01$], but the emotional expression was similar [$M_{\text{attractive}}=4.08$ ($SD=0.51$), $M_{\text{unattractive}}=3.94$ ($SD=0.54$); $t(31)=0.72$, $p=0.35$]. There were no significant differences between male and female faces in the attractive [$M_{\text{male}}=4.57$ ($SD=0.83$), $M_{\text{female}}=4.8$ ($SD=0.88$), $t(31)=-1.18$, $p=0.25$] and unattractive [$M_{\text{male}}=2.43$ ($SD=0.97$), $M_{\text{female}}=2.67$ ($SD=0.93$), $t(31)=-1.62$, $p=0.12$] face categories.

2.3. Task and procedures

Prior to the experiment, participants were informed they would take part in a game in which they should make a decision of whether or not to cooperate with fictional partners, represented by attractive or unattractive face pictures (Fig. 1). Participants were given 2000 cents (about US\$3.15) at the start of the game, and they could either keep 50 cents on a given trial or invest it, in which case the partner would receive 200 cents. Then the partner could either keep the entire 200 cents or give half of it back to participants. The amount of money accumulated could be increased by such investment behavior. Participants were offered remuneration equal to the amount accumulated at the end of the game.

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