



Being the chosen one: social inclusion modulates decisions in the ultimatum game. An ERP study

Agnès Falco, Cédric Albinet, Anne-Claire Rattat, Isabelle Paul, Eve Fabre

► To cite this version:

Agnès Falco, Cédric Albinet, Anne-Claire Rattat, Isabelle Paul, Eve Fabre. Being the chosen one: social inclusion modulates decisions in the ultimatum game. An ERP study. *Social Cognitive and Affective Neuroscience*, 2019, 14 (2), pp.141-149. <10.1093/scan/nsy118>. <hal-02430332>

HAL Id: hal-02430332

<https://hal.science/hal-02430332v1>

Submitted on 7 Jan 2020

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.



Distributed under a Creative Commons CC BY-NC-ND 4.0 - Attribution - Non-commercial use - No Derivative Works - International License

Being the chosen one: social inclusion modulates decisions in the ultimatum game. An ERP study

Agnès Falco,¹ Cédric Albinet,¹ Anne-Claire Rattat,¹ Isabelle Paul,¹ and Eve Fabre²

¹Sciences of Cognition, Technology and Ergonomics Laboratory, Champollion National University Institute, Federal University of Toulouse, 81000 Albi, France, and ²Department of Aerospace Vehicle Design and Control, National Higher School of Aeronautics and Space, Federal University of Toulouse, 31400 Toulouse, France

Correspondence should be addressed to Agnès Falco, Institut National Universitaire Jean-François Champollion, Place de Verdun, 81000 Albi, France.
E-mail: falcoagnes@gmail.com.

Abstract

In the present study, participants played a modified ultimatum game simulating a situation of inclusion/exclusion, in which either the participant or a rival could be selected to play as the responder. This selection was made either randomly by a computer (i.e. random pairing mode) or by the proposer (i.e. choice mode), based on physical appearance. Being chosen by the proposer triggered positive reciprocal behavior in participants, who accepted unfair offers more frequently than when they had been selected by the computer. Independently of selection mode, greater P200 amplitudes were found when participants received fair offers than when they received unfair offers and when unfair shares were offered to their rivals rather than to them, suggesting that receiving fair offers or observing a rival's misfortune was rewarding for participants. While participants generally showed more interest in the offers they themselves received (i.e. greater P300 responses to these offers), observing their rivals receive fair shares after the latter had been chosen by the proposer triggered an increase in P300 amplitude likely to reflect a feeling of envy. This study provides new insights into both the cognitive and affective processes underpinning economic decision making in a context of social inclusion/exclusion.

Key words: ultimatum game; social inclusion/exclusion; biological market; responder; ERP

Introduction

Human societies are based on very complex social interactions. A large proportion of these interactions have an economic nature. The free market offers the possibility to select a specific economic partner among different potential partners. Despite the fact that the different economic actors evolve in an inclusion/exclusion context, very little is known about how this particular context impacts economic decision making and associated neural correlates.

Being included: the cornerstone of social interactions

Humans are social individuals who need regular and satisfying interactions with their peers to meet their needs for belonging and social inclusion (Maslow, 1968; Baumeister and Leary, 1995; Williams et al., 2005). However, some interactions (e.g. romantic relationships or economic interactions) are, by nature, exclusive, leading to the selection of a single partner from among all the potential ones. According to the theory of biological market (Noë and Hammerstein, 1995; Barclay, 2016), these potential partners

Received: 26 March 2018; Revised: 28 October 2018; Accepted: 21 December 2018

© The Author(s) 2019. Published by Oxford University Press.

This is an Open Access article distributed under the terms of the Creative Commons Attribution NonCommercial-NoDerivs licence (<http://creativecommons.org/licenses/by-nc-nd/4.0/>), which permits non-commercial reproduction and distribution of the work, in any medium, provided the original work is not altered or transformed in any way, and that the work properly cited. For commercial re-use, please contact journals.permissions@oup.com

are ranked according to their value (e.g. attractive, honest and hardworking), and the highest ranking individual is then selected for the interaction.

Some studies have demonstrated that being included in a social interaction triggers a positive emotional reaction (i.e. happiness and satisfaction) and increases self-esteem (Leary and Baumeister, 2000). On the other hand, being socially excluded has been shown to trigger jealousy, anger and envy (Leary, 1990; DeSteno et al., 2006). This 'negative emotional reaction to the perception that one is being excluded from desired relationships or being devalued by desired relationship partners or groups' (MacDonald and Leary, 2005) is called social pain. Social pain is extremely unpleasant and its brain bases are similar to those of physical pain (Eisenberger et al., 2003; Lieberman and Eisenberger, 2005).

From an evolutionary perspective, the need for social inclusion is deeply rooted in the human species. The survival of early humans depended on their ability to create and maintain social bonds, both to achieve reproductive success (i.e. reproduce and raise offspring to reproductive age) and to fulfill their survival needs (e.g. food sharing and protection from both animal and human enemies) (Baumeister and Leary, 1995; Stillman et al., 2009). Consequently, natural selection favored those individuals who were able to recognize and react to the threat of social exclusion (i.e. feeling social pain) and who adopted attitudes and behaviors preventing social exclusion, such as cooperation or reciprocity (Gintis, et al., 2003; Masclet et al., 2003; Cinyabuguma et al., 2005; Kerr et al., 2009; Maier-Rigaud et al., 2010). The impact of social exclusion has been widely investigated in the laboratory, using paradigms such as Cyberball (Cacioppo et al., 2013; Rotge et al., 2015; Hartgerink et al., 2015) and O-Cam paradigm (Goodacre and Zadro, 2010; Godwin, et al., 2014) but poorly investigated in an economic decision-making context.

The ultimatum game: a matter of reciprocity and intentions

The ultimatum game (Güth et al., 1982) has been widely used in the laboratory to investigate economic decision making in a social context (Güth et al., 1982; Van Damme et al., 2014). In this paradigm, a proposer is given a set amount of money (e.g. €10) that has to be shared with a responder. If the responder accepts the offer, the amount of money is divided as per the proposer's offer. If, however, the responder refuses the offer, the money is lost and neither player receives anything. According to classical game theory, to maximize their gains, responders should accept every share that is offered to them (von Neumann and Morgenstern, 1947; Güth et al., 1982; Güth and Tietz, 1990). However, a large body of literature contradicts the predictions of game theory, showing that responders do not accept any offer, however low, to maximize their gains, and prefer fairness. More than half the time, they were found to reject the offers of <20% of the total amount (e.g. Güth et al., 1982; Knoch et al., 2006; Sanfey, 2009). According to the theory of reciprocity (Fehr and Gächter, 2000; Falk and Fischbacher, 2006), responders interpret the offer of an unfair share by the proposer as a hostile move and adopt a negative behavior (i.e. rejecting the offer) to harm the proposer in return. The responder's decision to reciprocate positively or negatively is highly dependent on the proposer's intentions (e.g. Nelson, 2002; Sutter, 2007; Falk et al., 2008). Responders are thus more prone to accept unfair offers if they think that the proposer has no bad intentions.

The proposer's decision to socially include or exclude a responder is likely to impact the way in which that responder

perceives the proposer's intentions (i.e. 'Was I chosen because I have a greater social value or for strategic reasons because the proposer thinks I will accept very low offers?'). Consequently, it seems worthwhile investigating the extent to which the proposer's decision to include a responder in the game (i.e. selection for the economic interaction) modulates the latter's reciprocal behavior.

The present study

The present study was designed to investigate how being placed in a biological market context, in which responders may be selected or not for an interaction based on their physical appearance, influences the economic decision making of responders playing the ultimatum game. Participants played a modified version of the repeated one-shot ultimatum game in which the proposer could play either with the participant or with a rival responder. The pairing of the proposer with one of the responders (participant or rival) could be decided either by a computer (i.e. random pairing) or by the proposer, based on photos (i.e. proposer's choice).

The first aim of this study was to determine the extent to which being selected for the interaction by the proposer (proposer's choice), rather than by the computer (i.e. random pairing) modulated responders' reciprocal behavior, depending on the share that was offered to them (i.e. fair vs unfair). The high temporal resolution of event-related potentials (ERPs) makes them a valuable source of information about brain processes in real time (Luck and Kappenman, 2012) and enables to investigate cognitive and affective neural correlates associated with economic decision making (Fabre et al., 2015). The second aim of the study was thus to analyze participants' brain electrophysiological correlates to investigate how offers are processed, depending on the selection mode (i.e. random pairing vs proposer's choice) and whether or not participants had been selected for the interaction. We analyzed three ERPs that have repeatedly been found in economic decision-making studies. The first was feedback-related negativity (FRN; Walsh and Anderson, 2012), a negative component that occurs in the 200–300 ms time window after stimulus onset and is maximal at frontal–central sites. Overall, greater FRN amplitudes have been found in response to unfair offers than to fair offers (e.g. Wu et al., 2011; Alexopoulos et al., 2012; Fabre et al., 2015) and have been functionally interpreted as reflecting the value of the outcome. The second was the P300 (Luck and Kappenman, 2012), a positive component that occurs in the 300–600 ms time window after the stimulus onset and maximal at central–parietal sites. This component has been found to underpin the allocation of attentional resources to the decision-making process (e.g. Gray et al., 2004; Linden, 2005) and to reflect the decision maker's motivational state (Yeung and Sanfey, 2004; Nieuwenhuis et al., 2005; Wu and Zhou, 2009). Finally, we investigated the P200, a positive component that occurs in the 150–275 ms time window after stimulus onset (Carretié et al., 2001). Greater P200 amplitudes have been found in response to high rewards than to low rewards in previous ultimatum game studies (Rigoni et al., 2010), but the function of this component is still not well understood and needs further investigation.

We predicted that the way participants interpreted the proposer's intentions would modulate their decision making (Falk et al., 2003). If they interpreted their being chosen by the proposer and being offered an unfair share as a form of social inclusion (i.e. 'An unfair share would have been offered in any case, but I was preferred for the interaction'), they would exhibit

positive reciprocal behavior (Fehr and Gächter, 2000). In this case, we would observe higher acceptance rates and lower FRN responses to unfair offers in the proposer's choice condition than in the random pairing condition. If, however, the same situation was interpreted as a hostile strategic move (i.e. 'I have been chosen because the proposer thinks I am more likely than my rival to accept low shares'), the opposite pattern of results would be observed. As the participants' motivation might be greater when they played as the responder than when their rival played, we expected to observe a greater P300 in response to shares that were offered to them rather than to their rival, reflecting a greater allocation of attentional resources (Rigoni et al., 2010). A study by Zhong et al. (2013) showed that stimuli that trigger envy in participants also elicited greater P300 responses. As participants might particularly envy rivals who were chosen by the proposer and then offered fair shares (van Dijk et al., 2006; Takahashi et al., 2009), we expected to observe greater P300 responses when rival responders were offered fair shares than unfair shares in the proposer's choice mode. As the analysis of the P200 component was mostly exploratory, we made no particular predictions regarding this ERP.

Materials and methods

Participants

Thirty French participants (15 females; $M_{\text{age}} = 19.17$ (s.d., ± 1.39), age range: 18–23 years) from the University of Albi participated in this experiment. All were right handed as assessed by the Edinburgh Handedness Inventory (Oldfield, 1971), had normal or corrected-to-normal vision and reported no history of neurological or psychiatric disorders.

Ethics statement

The study was conducted in accordance with the Declaration of Helsinki (1973, revised in 1983) and was approved by the ethics committee (CERNI-Federal University of Toulouse no. 2016-028). After being informed of their rights, all participants gave their written consent. Participants were told that they would be paid a percentage of what they won during the game, based on randomly chosen trials. In actual fact, all participants received the same amount of money (i.e. €15).

Paradigm

Participants played a modified version of a repeated one-shot ultimatum game, where there was a different proposer in each trial (Fabre et al., 2015; Güth et al., 1982). In this version of the game, participants were not necessarily the responders, as the proposer interacted half of the time with a *rival responder*. Depending on the trial, the responder was either randomly selected by the computer (i.e. random pairing mode) or chosen by the proposer (i.e. proposer's choice mode). The participants were led to think both the proposers and the rival responders were real-life people, but in reality they were fictitious.

Procedure

Participants were contacted by telephone or email and were told that the experiment would take place in two phases. In the first phase, they would have to come to the laboratory to be photographed. Two weeks later, they would have to come back for the second phase, namely, the experimental session. At the start of this session, participants were given the following instructions:

'You are about to play a game called the ultimatum game, as responder against different proposers. In this game, a proposer is given a fix amount of money (i.e., 10€) and chooses how much of that money (i.e., 1€, 3€ or 5€ on 10€) s/he wants to offer the responder. Each time you are proposed an offer, you can either accept it, in which case s/he gets the share decided by the proposer, or refuse it, in which case neither player gets any money. In the present experiment, you will be playing a modified version of this game, where you will not always be the responder, as the proposers can also interact with a rival responder. The selection of the responder for the economic interaction will be made either by the proposer or by the computer. As it is impossible to ask hundreds of participants to come to the laboratory at the same time, the proposers with whom you are going to play have already been to the laboratory and made their decisions, based on the photos of responders taken earlier. They will be paid at the end of the experiment, based on the decisions of the responders (you included) to accept or reject their offers. The rival responders have either already played the ultimatum game or will do so over the coming days. However, you will be able to see the offers made to them as well. Each time you are selected for the economic interaction, you will have to indicate your decision about the offer by pressing the "C" key to accept it or the "N" key to reject it. When it is the rival responder who is selected, you will be asked to report how much s/he is offered by pressing the corresponding key on the keyboard. Before the experimental session, you will take part in a training session. The results of this session will not be taken into account when calculating the outcome.'

The choice of the response keys was counterbalanced across participants. In this experiment, three within factors were manipulated: the selection mode (random pairing, proposer's choice), the responder selected for the interaction (participant, rival responder) and the offer proposed to the responders (€1; €5 on €10). Participants also performed 60 filler trials, which were also presented to the participants (i.e. €3 offers) but were not analyzed, in order to increase the plausibility of the offers. The experimental session consisted of 240 trials of interest, divided in two blocks of 120 trials each. Participants were told that in one block, the responders would be randomly selected by the computer, while in the second block the proposer would choose the responder s/he wanted to interact with (see Figure 1). The order of presentation of the blocks was counterbalanced across participants. At the end of the study, participants were debriefed, paid and thanked.

Data acquisition

Experimental apparatus. The experimental paradigm was presented using E-Prime 2® (Psychology Software Tools Inc., Pittsburgh, PA, USA) on a computer screen in the laboratory.

Electroencephalography recordings. Electroencephalography (EEG) was amplified and recorded with a BioSemi ActiveTwo system (<http://www.biosemi.com>) from 32 Ag/AgCl active electrodes (FP1, FP2, AF3, AF4, F7, F3, Fz, F4, F8, FC5, FC1, FC2, FC6, CP5, CP1, Cz, CP2, CP6, P7, P3, Pz, P4, P8, T7, C3, C4, T8, PO3, PO4, O1, Oz and O2) mounted on a cap and placed on the scalp according to the international 10–20 system, plus two sites below each eye to monitor eye movements. Two additional electrodes placed close to Cz—the common mode sense (CMS) active electrode and the driven right leg passive electrode—were used to drive the participant's average potential as close as possible to the AD-box reference potential (Van Rijn et al., 1991). Electrode impedance

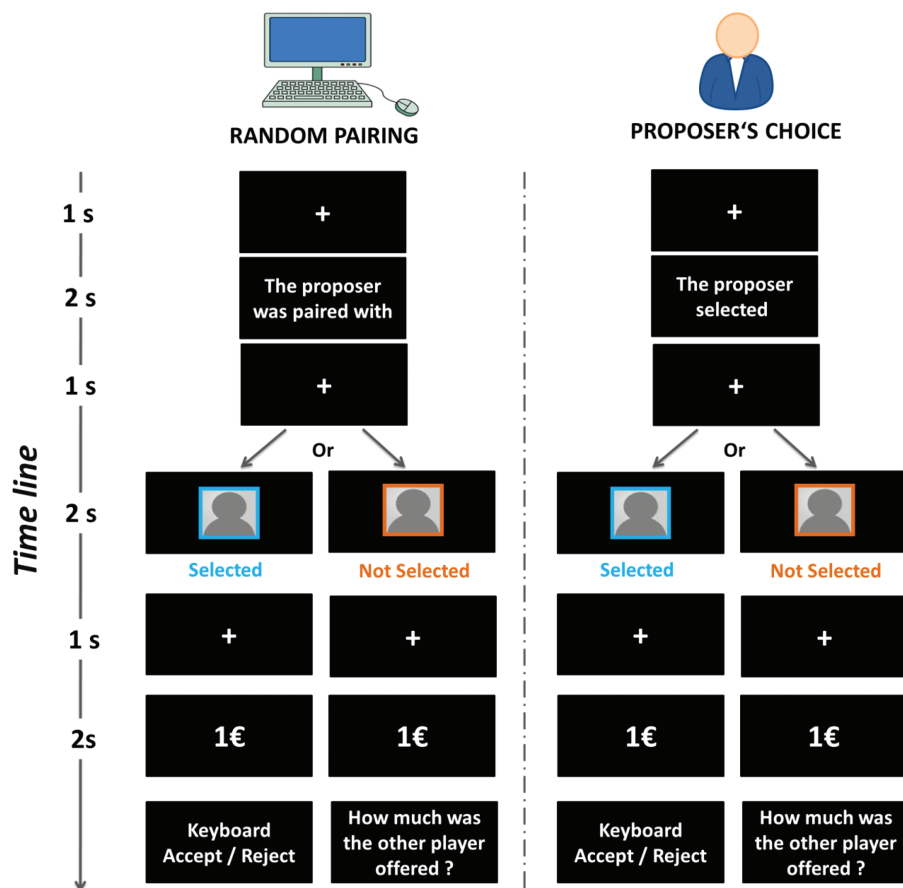


Fig. 1. Illustration of the experimental methodology. Half the participants had their photo framed in blue if they were selected for the economic interaction and in orange if they were not selected. For the remaining half, it was the other way round.

was kept below 5 k Ω for scalp electrodes and below 10 k Ω for the four eye channels. Skin–electrode contact, obtained using conductive gel, was monitored, keeping voltage offset from the CMS below 25 mV for each measurement site. All the signals were DC amplified and digitized continuously at a sampling rate of 512 Hz, using an anti-aliasing filter (fifth-order sinc filter) with a 3 dB point at 104 Hz. No high-pass filtering was applied on line. The triggering signals to each offer onset were recorded on additional digital channels. Data were analyzed with the EEGLAB toolbox (Delorme and Makeig, 2004). EEG data were re-referenced offline to the average activity of the two mastoids and bandpass filtered (0.1–40 Hz, 12 dB/octave), given that the low-pass filter was not effective in completely removing the 50 Hz artifact for some participants. Epochs were time locked to offer onset and extracted for the interval between –200 and 800 ms. Data with excessive blinks were adaptively corrected using independent component analysis. Segments including artifacts (e.g. excessive muscle activity) were eliminated offline before data averaging. A total of 8% of data were lost due to artifacts. A 200 ms pre-stimulus baseline was used in all analyses.

Results

Acceptance rates

A 2 \times 2 analysis of variance (ANOVA) [selection mode (random pairing, proposer's choice)] \times 2 [offer (unfair, fair)] was performed on the percentage of accepted offers. Post hoc comparisons

were performed using Fisher's least significant difference (LSD) corrections for multiple comparisons.

Participants accepted more frequently fair offers [$M = 96.56\%$ (s.d., $\pm 9.60\%$)] than unfair offers [$M = 28.78\%$ (s.d., $\pm 33.80\%$)],

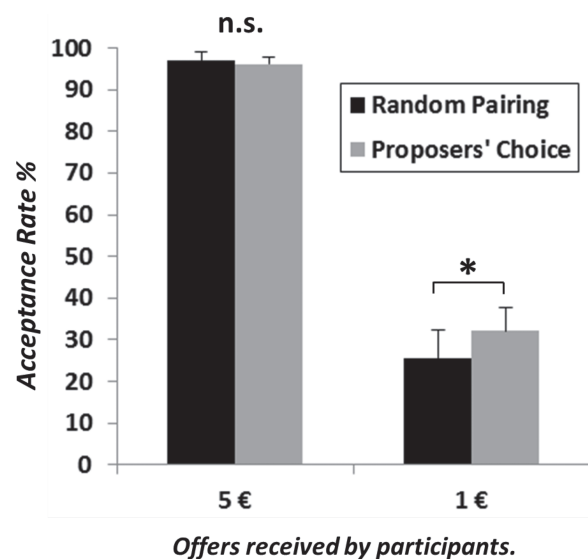


Fig. 2. Acceptance rates for the 5€ and 1€ offers in the random pairing mode and the proposers' choice mode (error bars represent standard errors).

$F(1,29) = 103.52$, $P < 0.001$, $\eta_p^2 = 0.78$]. The ANOVA revealed a significant selection mode–offer interaction [$F(1,29) = 4.36$, $P < 0.05$, $\eta_p^2 = 0.13$]. Participants accepted more frequently unfair offers when they were chosen by the proposer [$M = 32.11\%$ (s.d., $\pm 37.13\%$), $P < 0.05$; see Figure 2] compared to when they were randomly paired [$M = 25.44\%$ (s.d., $\pm 30.37\%$)]. No significant effect was found for fair offers and the selection mode factor. In contrast, participants accepted in the same way fair offers when they were chosen by the proposer [$M = 92.22\%$ (s.d., $\pm 11.13\%$)] and when they were randomly paired [$M = 96.89\%$ (s.d. $\pm 7.97\%$)].

Electrophysiological results

Visual inspection revealed amplitude differences between the experimental conditions for the P200, the FRN and the P300 (e.g. Cohen et al., 2007). The ERP components were assessed in terms of peak-to-peak amplitudes at Fz, Cz and Pz electrodes. Four peak amplitudes were defined in the 90–150 ms, the 180–280 ms, the 280–350 ms and the 310–450 ms time windows. These time windows were chosen after an accurate visual analysis to allow detecting the peak amplitude of all participants (i.e. the peak amplitude of every participant fell into the chosen time window). Peak-to-peak amplitudes were then calculated for the P200, the N200 and the P300 by subtracting the peak

amplitudes measured respectively in the 90–150 ms and the 180–280 ms time windows, the 180–280 ms and the 280–350 ms time windows and the 280–350 ms and 310–450 ms time windows. For each component, a 3 [electrode (Fz, Cz, Pz)] \times 2 [selection mode (random pairing, proposer's choice)] \times 2 [responder (participant, rival)] \times 2 [offer (unfair, fair)] ANOVA was performed. Post hoc analyses were performed using Fisher LSD corrections for multiple comparisons (see Figure 3). Only significant main effects and interactions were reported. See supplementary material for the integrity of results.

P200 component

The analysis revealed a significant electrode–responder interaction [$F(2,58) = 4.19$, $P < 0.05$, $\eta_p^2 = 0.13$; see Figure 3A], with greater P200 responses measured at both Cz and Pz when the rival responders received the offers [Cz: $M = 11.40$ (s.d., $\pm 5.30 \mu V$), $P < 0.01$; Pz: $M = 11.04$ (s.d., $\pm 4.65 \mu V$), $P < 0.001$] compared to when the participants received the offers [Cz: $M = 11.01$ (s.d., $\pm 5.08 \mu V$); Pz: $M = 10.52$ (s.d., $\pm 4.46 \mu V$)]. Moreover, the analysis also revealed a significant responder–offer interaction [$F(1,29) = 5.88$, $P < 0.05$, $\eta_p^2 = 0.17$], with greater responses found when participants received fair offers [$M = 10.92$ (s.d., $\pm 5.14 \mu V$), $P < 0.05$] than unfair offers [$M = 10.15$ (s.d., $\pm 4.76 \mu V$)] and greater responses when unfair offers were offered to rival responders

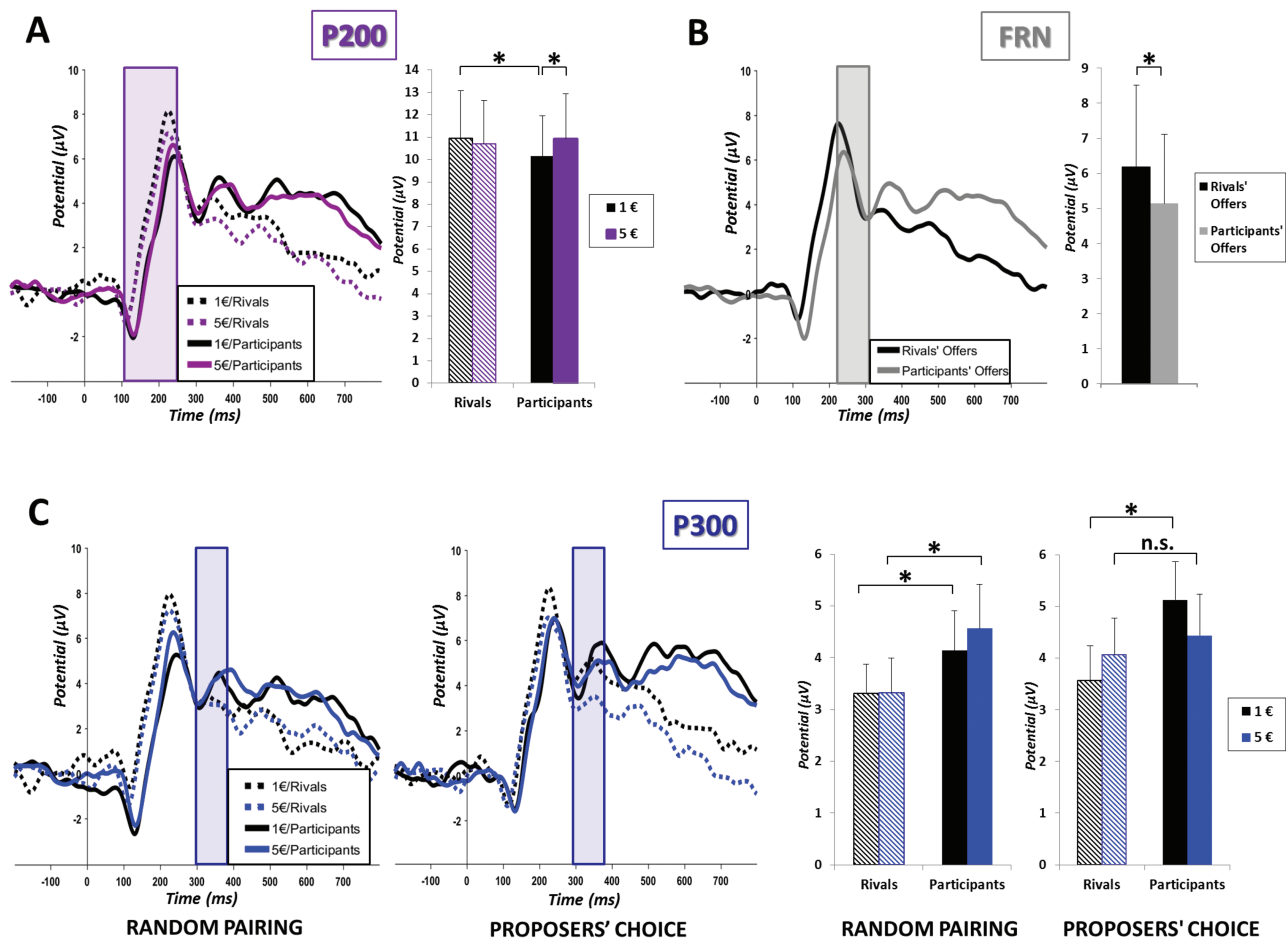


Fig. 3. Grand average ERP waveforms at Cz electrode and graphic charts of peak-to-peak amplitudes for (A) the P200 component for €5 (purple line) and €1 offers (black line) to participants (solid line) and to rival responders (dashed line), (B) the FRN component for the shares offered to participants (gray line) and to rival responders (black line) and (C) the P300 component for €5 (blue lines) and €1 offers (black lines) to participants (solid lines) and to rival responders (dashed lines) for both selection modes (random pairing and proposer's choice).

[$M = 10.93$ (s.d., $\pm 5.57 \mu V$), $P < 0.05$] than to participants [$M = 10.15$ (s.d., ± 4.76)].

FRN component

Greater amplitudes were found when the offers were proposed to rival responders [$M = 6.19$ (s.d., $\pm 4.73 \mu V$), $P < 0.001$] than to participants [$M = 5.14$ (s.d., $\pm 4.22 \mu V$), $F(1,29) = 13.38$, $P < 0.001$, $\eta_p^2 = 0.31$; see Figure 3B].

P300 component

Greater amplitudes were found when the offers were proposed to participants [$M = 4.56$ (s.d., $\pm 2.96 \mu V$)] than to rival responders [$M = 3.57$ (s.d., $\pm 2.41 \mu V$), $F(1,29) = 12.70$, $P < 0.001$, $\eta_p^2 = 0.30$]. The analysis also revealed a significant selection mode–responder–offer interaction [$F(1,29) = 4.44$, $P < 0.05$, $\eta_p^2 = 0.13$]. Greater amplitudes were found (1) when fair offers were proposed to participants [$M = 4.56$ (s.d., $\pm 3.06 \mu V$), $P < 0.01$] than to rival responders [$M = 3.33$ (s.d., $\pm 2.41 \mu V$)] when they were randomly paired and (2) when unfair offers were proposed to participants than to rival responders both when the responders were randomly paired [$M = 4.14$ (s.d., $\pm 2.64 \mu V$) and $M = 3.31$ (s.d., $\pm 2.19 \mu V$), respectively; $P < 0.05$] and when they were chosen by the proposer [$M = 5.13$ (s.d., $\pm 2.83 \mu V$) and $M = 3.57$ (s.d., $\pm 2.47 \mu V$), respectively; $P < 0.001$]. Greater amplitudes were also found when participants received unfair offers in the proposer's choice condition [$M = 5.13$ (s.d., $\pm 2.83 \mu V$)] than in the random pairing condition [$M = 4.14$ (s.d., $\pm 2.64 \mu V$), $P < 0.05$; see Figure 3C].

Discussion

In the present study, participants played a repeated ultimatum game as responder against a new proposer in each trial. The latter interacted either with the participant or with a rival responder. Participants were told that the responder was either randomly selected by the computer or chosen by the proposer. The purpose of this study was twofold: (i) to determine the extent to which being chosen by a human (i.e. social inclusion), rather than being randomly selected by a computer, modulated the responders' reciprocity behavior and (ii) to investigate how participants processed the offers made to them or to the rival responders, depending on the selection mode (i.e. proposer's choice vs randomly paired by the computer). Brain responses to the offers were recorded and analyzed. Based on the results of previous ERP studies, we focused on the analysis of the P200, FRN and P300 components.

Processing of outcomes based on their economic value

In line with the literature, participants were found to reject unfair offers more frequently than fair offers (e.g. Güth et al., 1982; Sanfey, 2009). Greater P200 amplitudes were also found when participants received fair rather than unfair offers. This result is in line with previous studies that found greater P200 in response to high than to low rewards (Rigoni et al., 2010; San Martín et al., 2010).

Impact of selection mode on offer processing

Participants were more likely to accept unfair offers when they had been chosen by the proposer, rather than randomly selected by the computer. In accordance with the theory of reciprocity (Fehr and Gächter, 2000; Falk and Fischbacher,

2006), being chosen by the proposer may have been viewed by participants as a favorable action (i.e. social inclusion), triggering a favorable reciprocal action in the form of accepting unfair shares (Nowak et al., 2000; Seinen and Schram, 2006). Greater P300 amplitudes were also observed in response to unfair offers when participants had been chosen by the proposer, rather than randomly paired. Various studies have shown that social inclusion is a fundamental motivator for individuals (Maslow, 1968; Baumeister and Leary, 1995). The increase in P300 amplitudes observed in response to unfair offers in the proposer's choice mode may reflect a greater motivation among participants to cooperate and behave reciprocally with the proposer after being socially included (Masclet et al., 2003; Cinyabuguma et al., 2005; Kerr et al., 2009; Maier-Rigaud et al., 2010).

Processing one's own vs a rival responder's outcomes

In previous ultimatum game studies, the amplitude of the FRN was found to be modulated by the nature of the offer, with greater FRN amplitudes in response to unfair offers compared to fair offers (Polezzi et al., 2008; Wu et al., 2011; Alexopoulos et al., 2012; Fabre et al., 2015). However, the results of the present study revealed no difference in FRN amplitude in response to unfair shares and fair shares. Interestingly, lower FRN amplitudes were found when the offers were made to the participants than to the rival responders. In the present study, participants did not interact with the proposer in every trial and consequently did not receive a share every time as in a regular ultimatum game (Güth et al., 1982). This modification in the game's structure appears to have changed the benchmark for evaluating the outcomes. The classification of the outcome appeared to no longer depend on the economic value of the offers (i.e. fair or unfair) but on their absence or presence. Greater P200 responses were also found when unfair offers were proposed to the rival responder rather than to participants, independently of selection mode. Greater P200 amplitudes were found in response to high rewards than to low rewards both in previous studies (e.g. Rigoni et al., 2010) and the present study. Moreover, observing the misfortune of a rival was repeatedly found to activate brain areas underpinning reward processing (e.g. Takahashi et al., 2009). This rewarding feeling derived from another's misfortune is known as *schadenfreude* (Heider, 1958; Smith et al., 2009). Taken together, these results could suggest that the increase in P200 amplitude observed in response to the misfortune of the rival responders (i.e. being offered a low share) might reflect a feeling of *schadenfreude* in participants. Further research will be necessary to confirm this hypothesis.

Greater P300 amplitudes were found when unfair offers in both selection modes and fair offers in the random pairing mode were made to participants than to rival responders. Overall, these results show that participants allocated more attentional resources when they received an offer than when their rivals received it, demonstrating the participants' greater interest in the offers made to them compared to those made to the rival responders (Rigoni et al., 2010).

Interestingly, similar P300 responses were found when fair offers were made to either participants or rival responders in the proposer's choice mode. Both individuals with a greater level of possession (Smith and Kim, 2007) and socially included individuals (Leary, 1990) tend to be envied by those with a lower level of possession and those who are socially excluded, respectively. Moreover, the feeling of envy was found to be associated with an increase in attention (Hill et al., 2011; Zhong et al., 2013) and greater P300 responses to advantaged targets (Zhong et al.,

2013). Taken together these results suggest that the similar P300 response to the fair shares offered to the rival responders and to them may reflect a feeling of envy in participants. Interestingly, the feeling of envy occurred only in a social inclusion/exclusion context (i.e. choice mode) but not when the computer was in charge of the selection (i.e. random pairing mode).

These results demonstrate the complexity of the affective and cognitive processes associated with economic decision making in a context inclusion/exclusion.

Conclusion

The present study aimed at investigating the cognitive and affective processes underpinning the decision making of responders playing a modified version of the ultimatum game, simulating a social inclusion/exclusion context. Participants were told that the selection of the responder was either decided by the proposer—based on the physical appearance of the responders—or by the computer. Our results are consistent with a hypothesis that participants interpreted the fact of being selected by the proposer and offered unfair shares not as a strategic move, but as a positive move (i.e. social inclusion). This triggered a positive reciprocal behavior in participants (i.e. increased acceptance rate).

While greater FRN amplitudes are usually found in response to unfair offers, in the present study, greater FRN responses were observed when the shares were offered to rival responders, rather than to the participants. This result calls into question the functional interpretation of the FRN in the ultimatum game, as it appears to vary according to the benchmark against which an outcome is evaluated, and not simply the numerical value of that outcome.

Electrophysiological results also showed interesting affective responses. First, greater P200 responses were found in response to the rival responders' misfortune in both selection modes (i.e. when the rival responders were offered unfair shares). As greater P200 were also found in response to rewarding outcomes (i.e. fair offers), this result suggests that participants may have felt satisfaction while observing their rival's misfortune (i.e. *schadenfreude*). Second, while overall the shares offered to participants elicited greater P300 responses than those offered to the rival responders suggesting a greater interest in their own offers, in the proposer's choice mode participants showed no differences in P300 response to fair offers when they were offered to them or to the responder rivals. This increase in P300 response to the responder rivals' fair offers is likely to reflect participants' envy of their rivals' double reward (i.e. social inclusion and high offer) in the choice mode (i.e. social inclusion) but not when the computer was in charge of the selection (i.e. random pairing mode). Taken together, these results provide new insights into both the cognitive and affective processes associated with economic decision making in a context of social inclusion/exclusion.

Supplementary data

Supplementary data are available at SCAN online.

References

Alexopoulos, J., Pfabigan, D.M., Lamm, C., Bauer, H., Fischmeister, F.P.S. (2012). Do we care about the powerless third? An ERP study of the three-person ultimatum game. *Frontiers in Human Neuroscience*, 6. <https://doi.org/10.3389/fnhum.2012.00059>.

- Barclay, P. (2016). Biological markets and the effects of partner choice on cooperation and friendship. *Current Opinion in Psychology*, 7, 33–8. <https://doi.org/10.1016/j.copsyc.2015.07.012>.
- Baumeister, R.F., Leary, M.R. (1995). The need to belong: desire for interpersonal attachments as a fundamental human motivation. *Psychological Bulletin*, 117(3), 497–529. <http://dx.doi.org/10.1037/0033-2909.117.3.497>.
- Cacioppo, S., Frum, C., Asp, E., Weiss, R.M., Lewis, J.W., Cacioppo, J.T. (2013). A quantitative meta-analysis of functional imaging studies of social rejection. *Scientific Reports*, 3(2027), <https://doi.org/10.1038/srep02027>.
- Carretié, L., Mercado, F., Tapia, M., Hinojosa, J.A. (2001). Emotion, attention, and the 'negativity bias', studied through event-related potentials. *International Journal of Psychophysiology: Official Journal of the International Organization of Psychophysiology*, 41(1), 75–85. [https://doi.org/10.1016/S0167-8760\(00\)00195-1](https://doi.org/10.1016/S0167-8760(00)00195-1).
- Cinyabuguma, M., Page, T., Putterman, L. (2005). Cooperation under the threat of expulsion in a public goods experiment. *Journal of Public Economics*, 89(8), 1421–35. <https://doi.org/10.1016/j.jpubeco.2004.05.011>.
- Cohen, M.X., Elger, C.E., Ranganath, C. (2007). Reward expectation modulates feedback-related negativity and EEG spectra. *NeuroImage*, 35(2), 968–78. <https://doi.org/10.1016/j.neuroimage.2006.11.056>.
- Delorme, A., Makeig, S. (2004). EEGLAB: an open source toolbox for analysis of single-trial EEG dynamics including independent component analysis. *Journal of Neuroscience Methods*, 134(1), 9–21. <https://doi.org/10.1016/j.jneumeth.2003.10.009>.
- DeSteno, D., Valdesolo, P., Bartlett, M.Y. (2006). Jealousy and the threatened self: getting to the heart of the green-eyed monster. *Journal of Personality and Social Psychology*, 91(4), 626–41. <https://doi.org/10.1037/0022-3514.91.4.626>.
- Eisenberger, N.I., Lieberman, M.D., Williams, K.D. (2003). Does rejection hurt? An fMRI study of social exclusion. *Science (New York, N.Y.)*, 302(5643), 290–2. <https://doi.org/10.1126/science.1089134>.
- Fabre, E.F., Causse, M., Pesciarelli, F., Cacciari, C. (2015). Sex and the money: how gender stereotypes modulate economic decision-making. An ERP study. *Neuropsychologia*, 75, 221–32. <https://doi.org/10.1016/j.neuropsychologia.2015.06.013>.
- Falk, A., Fehr, E., Fischbacher, U. (2003). Reasons for conflict: lessons from bargaining experiments. *Journal of Institutional and Theoretical Economics*, 159(1), 171–87. <https://doi.org/10.1628/0932456032974925>.
- Falk, A., Fischbacher, U. (2006). A theory of reciprocity. *Games and Economic Behavior*, 54(2), 293–315. <https://doi.org/10.1016/j.geb.2005.03.001>.
- Falk, A., Fehr, E., Fischbacher, U. (2008). Testing theories of fairness—intentions matter. *Games and Economic Behavior*, 62(1), 287–303. <https://doi.org/10.1016/j.geb.2007.06.001>.
- Fehr, E., Gächter, S. (2000). Fairness and retaliation: the economics of reciprocity. *The Journal of Economic Perspectives*, 14(3), 159–81. <https://doi.org/10.1257/jep.14.3.159>.
- Gintis, H., Bowles, S., Boyd, R., Fehr, E. (2003). Explaining altruistic behavior in humans. *Evolution and Human Behavior*, 24(3), 153–72. [https://doi.org/10.1016/S1090-5138\(02\)00157-5](https://doi.org/10.1016/S1090-5138(02)00157-5).
- Godwin, A., MacNevin, G., Zadro, L., et al. (2014). Are all ostracism experiences equal? A comparison of the autobiographical recall, Cyberball, and O-Cam paradigms. *Behavior Research Methods*, 46(3), 660–7. <https://doi.org/10.3758/s13428-013-0408-0>.

- Goodacre, R., Zadro, L. (2010). O-Cam: a new paradigm for investigating the effects of ostracism. *Behavior Research Methods*, 42(3), 768–74. <https://doi.org/10.3758/BRM.42.3.768>.
- Gray, H.M., Ambady, N., Lowenthal, W.T., Deldin, P. (2004). P300 as an index of attention to self-relevant stimuli. *Journal of Experimental Social Psychology*, 40(2), 216–24. [https://doi.org/10.1016/S0022-1031\(03\)00092-1](https://doi.org/10.1016/S0022-1031(03)00092-1).
- Güth, W., Schmittberger, R., Schwarze, B. (1982). An experimental analysis of ultimatum bargaining. *Journal of Economic Behavior & Organization*, 3(4), 367–88. [https://doi.org/10.1016/0167-2681\(82\)90011-7](https://doi.org/10.1016/0167-2681(82)90011-7).
- Güth, W., Tietz, R. (1990). Ultimatum bargaining behavior: a survey and comparison of experimental results. *Journal of Economic Psychology*, 11(3), 417–49.
- Hartgerink, C.H.J., Beest, I. van, Wicherts, J., Williams, K.D. (2015). The ordinal effects of ostracism: a meta-analysis of 120 Cyberball studies. *PLoS One*, 10(5), e0127002. <https://doi.org/10.1371/journal.pone.0127002>
- Heider, F. (1958). *The Psychology of Interpersonal Relations*, New York, NY: John Wiley Sons. <http://dx.doi.org/10.1037/10628-000>.
- Hill, S., Delpriore, D., Vaughan, W., P. (2011). The cognitive consequences of envy: attention, memory, and self-regulatory depletion. *Journal of Personality and Social Psychology*, 101, 653–66. <https://doi.org/10.1037/a0023904>.
- Kerr, N.L., Rumble, A.C., Ouwerkerk, J.W., Parks, C.D., Gallucci, M., van Lange, P.A.M. (2009). How many bad apples does it take to spoil the whole barrel? Social exclusion and toleration for bad apples. *Journal of Experimental Social Psychology*, 45(4), 603–13. <https://doi.org/10.1016/j.jesp.2009.02.017>.
- Knoch, D., Pascual-Leone, A., Meyer, K., Treyer, V., Fehr, E. (2006). Diminishing reciprocal fairness by disrupting the right prefrontal cortex. *Science*, 314(5800), 829–32. <https://doi.org/10.1126/science.1129156>.
- Leary, M.R. (1990). Responses to social exclusion: social anxiety, jealousy, loneliness, depression, and low self-esteem. *Journal of Social and Clinical Psychology*, 9(2), 221–9. <https://doi.org/10.1521/jscp.1990.9.2.221>.
- Leary, M., Baumeister, R. (2000). The nature and function of self-esteem: sociometer theory. *Advances in Experimental Social Psychology*, 32, 1–62. [https://doi.org/10.1016/S0065-2601\(00\)80003-9](https://doi.org/10.1016/S0065-2601(00)80003-9).
- Lieberman, M.D., Eisenberger, N.I. (2005). A pain by any other name (rejection, exclusion, ostracism), still hurts the same: the role of dorsal anterior cingulate in social and physical pain. In: Cacioppo, J.T., Visser, P., Pickett, C., editors. *Social Neuroscience: People Thinking About People*, Cambridge, MA: MIT Press, 167–87.
- Linden, D.E. (2005). The P300: where in the brain is it produced and what does it tell us? *The Neuroscientist*, 11(6), 563–76. <https://doi.org/10.1177/1073858405280524>.
- Luck, S., Kappenman, E. (2012). *The Oxford Handbook of Event-Related Potential Components*. <https://doi.org/10.1093/oxfordhpb/9780195374148.001.0001>.
- Luck, S.J., Kappenman, E.S., editors (2012). *The Oxford Handbook of Event-Related Potential Components*, Reprint edn, New York, NY: Oxford University Press.
- MacDonald, G., Leary, M.R. (2005). Why does social exclusion hurt? The relationship between social and physical pain. *Psychological Bulletin*, 131(2), 202. <https://doi.org/10.1037/0033-2909.131.2.202>.
- Maier-Rigaud, F., Martinsson, P., Staffiero, G. (2010). Ostracism and the provision of a public good: experimental evidence. *Journal of Economic Behavior & Organization*, 73(3), 387–95. <https://doi.org/10.1016/j.jebo.2009.11.001>.
- Masclat, D., Noussair, C., Tucker, S., Villeval, M.C. (2003). Monetary and nonmonetary punishment in the voluntary contributions mechanism. *American Economic Review*, 93(1), 366–80. <https://doi.org/10.1257/000282803321455359>.
- Maslow, A. (1968). *Toward a Psychology of Being*, New York, NY: Van Nostrand Reinhold.
- Nelson, W. (2002). Equity or intention: it is the thought that counts. *Journal of Economic Behavior & Organization*, 48, 423–30. [https://doi.org/10.1016/S0167-2681\(01\)00245-1](https://doi.org/10.1016/S0167-2681(01)00245-1).
- Nieuwenhuis, S., Aston-Jones, G., Cohen, J.D. (2005). Decision making, the P3, and the locus coeruleus-norepinephrine system. *Psychological Bulletin*, 131(4), 510–32. <https://doi.org/10.1037/0033-2909.131.4.510>.
- Noë, R., Hammerstein, P. (1995). Biological markets. *Trends in Ecology & Evolution*, 10(8), 336–9. [https://doi.org/10.1016/S0169-5347\(00\)89123-5](https://doi.org/10.1016/S0169-5347(00)89123-5).
- Nowak, M.A., Page, K.M., Sigmund, K. (2000). Fairness versus reason in the ultimatum game. *Science*, 289(5485), 1773–5. <https://doi.org/10.1126/science.289.5485.1773>.
- Oldfield, R.C. (1971). The assessment and analysis of handedness: the Edinburgh inventory. *Neuropsychologia*, 9(1), 97–113. [https://doi.org/10.1016/0028-3932\(71\)90067-4](https://doi.org/10.1016/0028-3932(71)90067-4).
- Polezzi, D., Daum, I., Rubaltelli, E., et al. (2008). Mentalizing in economic decision-making. *Behavioural Brain Research*, 190(2), 218–23. <https://doi.org/10.1016/j.bbr.2008.03.003>.
- Rigoni, D., Polezzi, D., Rumiat, R., Guarino, R., Sartori, G. (2010). When people matter more than money: an ERPs study. *Brain Research Bulletin*, 81(4–5), 445–52. <https://doi.org/10.1016/j.brainresbull.2009.12.003>.
- Rotge, J.-Y., Lemogne, C., Hinfrey, S., et al. (2015). A meta-analysis of the anterior cingulate contribution to social pain. *Social Cognitive and Affective Neuroscience*, 10(1), 19–27. <https://doi.org/10.1093/scan/nsu110>.
- San Martín, R., Manes, F., Hurtado, E., Isla, P., Ibañez, A. (2010). Size and probability of rewards modulate the feedback error-related negativity associated with wins but not losses in a monetarily rewarded gambling task. *NeuroImage*, 51(3), 1194–204. <https://doi.org/10.1016/j.neuroimage.2010.03.031>.
- Sanfey, A.G. (2009). Expectations and social decision-making: biasing effects of prior knowledge on Ultimatum responses. *Mind & Society*, 8(1), 93–107. <https://doi.org/10.1007/s11299-009-0053-6>.
- Seinen, I., Schram, A. (2006). Social status and group norms: indirect reciprocity in a repeated helping experiment. *European Economic Review*, 50(3), 581–602. <https://doi.org/10.1016/j.euroecorev.2004.10.005>.
- Smith, R.H., Kim, S.H. (2007). Comprehending envy. *Psychological Bulletin*, 133(1), 46–64. <https://doi.org/10.1037/0033-2909.133.1.46>.
- Smith, R.H., Powell, C.A.J., Combs, D.J.Y., Schurtz, D.R. (2009). Exploring the when and why of schadenfreude. *Social and Personality Psychology Compass*, 3(4), 530–46. <https://doi.org/10.1111/j.1751-9004.2009.00181.x>.
- Stillman, T.F., Baumeister, R.F., Lambert, N.M., Crescioni, A., Dwall, C.N., Fincham, F.D. (2009). Alone and without purpose: life loses meaning following social exclusion. *Journal of Experimental Social Psychology*, 45(4), 686–94. <https://doi.org/10.1016/j.jesp.2009.03.007>.
- Sutter, M. (2007). Outcomes versus intentions: on the nature of fair behavior and its development with age. *Journal of Economic Psychology*, 28(1), 69–78. <https://doi.org/10.1016/j.joep.2006.09.001>.
- Takahashi, H., Kato, M., Matsuura, M., Mobbs, D., Suhara, T., Okubo, Y. (2009). When your gain is my pain and your pain is

- my gain: neural correlates of envy and *schadenfreude*. *Science*, **323**(5916), 937–9. <https://doi.org/10.1126/science.1165604>.
- Walsh, M.M., Anderson, J.R. (2012). Learning from experience: event-related potential correlates of reward processing, neural adaptation, and behavioral choice. *Neuroscience and Biobehavioral Reviews*, **36**(8), 1870–84. <https://doi.org/10.1016/j.neubiorev.2012.05.008>.
- van Damme, E., Binmore, K.G., Roth, A., Samuelson, L., Winter, E., Bolton, G.E., et al. (2014) How Werner Güth's ultimatum game shaped our understanding of social behavior. *Journal of Economic Behavior & Organization*, **108**(C), 292–318. <https://doi.org/10.1016/j.jebo.2014.10.014>.
- van Dijk, W.W., Ouwkerk, J.W., Goslinga, S., Nieweg, M., Gallucci, M. (2006). When people fall from grace: reconsidering the role of envy in *schadenfreude*. *Emotion*, **6**(1), 156–60. <https://doi.org/10.1037/1528-3542.6.1.156>.
- Van Rijn, A.C.M., Peper, A., Grimbergen, C.A. (1991). High-quality recording of bioelectric events. Part 2. Low-noise, low-power multichannel amplifier design. *Medical and Biological Engineering and Computing*, **29**(4), 433–40. <https://doi.org/10.1007/BF02441666>.
- Von Neumann, J., Morgenstern, O. (1947). *Theory of Games and Economic Behavior*, 2nd rev. edn, Princeton, NJ: Princeton University Press.
- Williams, K.D., Forgas, J.P., Hippiel, W.V., editors (2005). *The Social Outcast: Ostracism, Social Exclusion, Rejection, and Bullying*, 1st edn, New York, NY: Psychology Press.
- Wu, Y., Zhou, X. (2009). The P300 and reward valence, magnitude, and expectancy in outcome evaluation. *Brain Research*, **1286**, 114–22. <https://doi.org/10.1016/j.brainres.2009.06.032>.
- Wu, Y., Zhou, Y., van Dijk, E., Leliveld, M.C., Zhou, X. (2011). Social comparison affects brain responses to fairness in asset division: an ERP study with the ultimatum game. *Frontiers in Human Neuroscience*, **5**, 131. <https://doi.org/10.3389/fnhum.2011.00131>.
- Yeung, N., Sanfey, A.G. (2004). Independent coding of reward magnitude and valence in the human brain. *Journal of Neuroscience*, **24**(28), 6258–64. <https://doi.org/10.1523/jneurosci.4537-03.2004>.
- Zhong, J., Liu, Y., Zhang, E., Luo, J., Chen, J. (2013). Individuals' attentional bias toward an envied target's name: an event-related potential study. *Neuroscience Letters*, **550**, 109–14. <https://doi.org/10.1016/j.neulet.2013.06.047>.