Psicológica (2015), 36, 309-335.

Ignoring facial emotion expressions does not eliminate their influence on cooperation decisions

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Whereas the automaticity of emotion processing has been investigated in several cognitive domains, its mandatory influence on cooperative decision-making is still unexplored. We employed an interference-task to evaluate whether explicit instructions to ignore the emotions of others during alleged interpersonal interactions override their behavioral effects. Participants played a Trust Game multiple times with eight cooperative or non-cooperative partners, who displayed facial expressions of happiness or anger. Emotions were non-predictive regarding the partners' cooperation. In Experiments 1 and 2 participants were explicitly asked to ignore the emotions, and the uncertainty about the partners' behavior varied. We found an effect of emotional interference; whereas happy partners speeded cooperative decisions, angry ones speeded non-cooperative choices. This was replicated in Experiment 3, where the request of ignoring emotions was removed. Our results show the inevitable influence of the emotional displays of others during cooperation decisions, which fits with theories that contend for a tight link between emotions and social context.

We live in environments crowded with multiple stimuli. For a successful navigation that fulfills current goals and allows optimal decision-making, humans rely on selection mechanisms that enhance the processing of relevant information whilst keeping distracting events out of the attentional focus (Egner, Etkin, Gale & Hirsch, 2008; Posner, 2011; Squire, Noudoost, Schafer & Moore, 2013). However, certain types of salient stimuli escape control mechanisms and reach decision and response stages

* Acknowledgements: We would like to thank Sonja Kotz for many useful discussions about the studies reported in the paper. This work was supported by the Spanish Ministry of Science and Innovation by a F.P.U. scholarship (AP-2010-4858) to S.A., and by a 'Ramón y Cajal' research fellowship (RYC-2008-03008) and grant PSI2013-45567-P to M.R. Corresponding Author: María Ruz. Departamento de Psicología Experimental. Campus de Cartuja s/n. Granada, Spain. E-mail: mruz@ugr.es

even when they are explicitly ignored (e.g. Pourtois, Schettino & Vuilleumier, 2013). This is taken as proof that such information is processed in an automatic or mandatory, non-volitional fashion. Affective events are among the most salient types of stimuli, and they have the potential to modulate decision-making. The studies reported in this paper evaluate whether the influence of emotional facial expressions on alleged social interactions can be controlled by explicit instructions, and the temporal distribution of these effects.

Some theories contend that the constant interplay between internal and external affective environments impacts how emotional states, beliefs, behaviors and decisions arise (Augoustinos, Walker & Donaghue, 2006; Fischer & Manstead, 2008). In line with this, social context seems essential for emotions to have meaning and function (Barrett, 2012; Keltner & Gross, 1999; Parkinson, Fischer & Manstead, 2004; Parrott & Schulkin, 1993). According to Fischer and Manstead (2008), emotions are decisive elements for social survival and help us deal with the challenges that interpersonal environments pose. They facilitate adaptation by readying, automatically and efficiently, context-appropriate behavioral responses, and making the individual more likely to engage in efficient action (Frijda, 1988; Frijda & Mesquita, 1994; Tooby & Cosmides, 1990). At the *intrapersonal* level emotions provide relevant information about social events, and prepare us to act as needed (Keltner & Haidt, 1999). During *interpersonal* interactions, the emotional displays of others yield clues about their internal states and their most likely behavior (see for example, Ekman & Friesen, 2003). Thus, emotional displays help the agent gather information about the emotions, beliefs and future intentions of others, as well as their appraisal of the current situation, and serve as tools for coordinating interactions among people (Keltner & Haidt, 1999). Such interpersonal interactions depend on the affiliation and distancing functions of emotions. Whereas the former would help to form and maintain relations with others, the latter would lead the agent to differentiate from others and compete with them. In this way, emotions help to balance the social goals of cooperation and competition to an optimum compromise (Fischer & Manstead, 2008). Action tendencies of cooperation and competition are mainly built on social judgments (Forgas, 1991). These appraisals are affected by quick, automatic evaluations, which are strongly grounded on emotional information (Haidt, 2001). The accuracy and efficiency of judgments are of critical relevance for our private life and especially for an effective interpersonal behavior (Forgas, 1991).

Economic games are useful paradigms to study how emotions, in addition to other factors, impact our behavior when cooperation and

competition tendencies emerge during interpersonal interactions (Camerer, 2003). Emotions have an impact on decisions during negotiation scenarios (e.g. Kopelman, Gewurz & Sacharin, 2007). For example, the experience of positive affect is associated with a higher number of cooperative behaviors and joint gain seeking, whereas negative feelings have the opposite effect (Forgas, 1998; Kopelman et al., 2007). The negative reactions generated by unfair offers in the Ultimatum Game (UG) provoke punishment behaviors, even when people have to sacrifice their future benefits (Sanfey, 2009; Sanfey, Rilling, Aronson, Nystrom & Cohen, 2003).

The modulation of cooperation and competition tendencies as a consequence of emotional information is also crucial at the interpersonal level. Communicated anger can promote different patterns of behavior. For example, in the UG, expressions of anger can increase the amount of rejections of offers (Kopelman, Rosette & Thompson, 2006). But they also foment generous behavior in participants if they are encouraged to consider the opponent's emotions (see for example Van Kleef, De Dreu & Manstead, 2004) or such emotional states are directly linked to the offer of the proposer (Lelieveld, Van Dijk, Van Beest, Steinel & Van Kleef, 2011). In the Trust Game (TG), on the other hand, happy facial expressions generate higher levels of initial and sustained trust even in contexts in which they lack predictive value (Eckel & Wilson, 2003; Scharlemann, Eckel, Kacelnik, & Wilson, 2001; Tortosa, Strizhko, Capizzi & Ruz, 2013; see also Averbeck & Duchaine, 2009; Campellone & Kring, 2013).

Although the field of economic bargaining has mostly stressed the role of strategic factors on decisions (Camerer, 2003; Lee & Harris, 2013), judgments of trust also seem to be guided by the *non-volitional* processing of facial features (Oosterhof & Todorov, 2008). Several studies have shown that facial dimensions guide judgments of trustworthiness of unfamiliar people (e.g. Todorov, Baron & Oosterhof, 2008; Todorov, Mandisodza, Goren & Hall, 2005). The evaluation of emotionally neutral faces in terms of trustworthiness seems to be an over-generalization of functionally adaptive systems for detecting emotions in others, which appear to be based on basic facial features that resemble emotional expressions signaling approach/avoidance tendencies (Todorov et al., 2008). In this over-generalization model, faces at the negative extreme of the trustworthiness dimension are related to the expression of anger, whilst those at the positive extreme are linked to happiness features (Todorov, Said, Engell & Oosterhof, 2008). Angry faces arise avoidance tendencies whereas happy faces signal the opposite (Todorov et al., 2008). In this line, structural features in faces resembling happy expressions are associated with

judgments of trustworthiness whereas those characteristics similar to anger are linked to judgments of untrustworthiness (Todorov et al., 2008).

The effect of emotions on our social judgments can be controlled (e.g. Ruz & Tudela, 2011; Satpute, Badre & Ochsner, 2013), although the extent of this control has not yet been established. We are endowed with the ability to flexibly regulate our emotions, and on many occasions we are able to effectively induce or suppress emotional reactions through a variety of tactics (Gross, 1999). We can thus modulate the impact of emotions, felt and perceived, when interacting with other people in bargaining scenarios (Kopelman et al., 2006). This ability can be particularly useful during competition, where other people may conceal or fake their true dispositions (Dawkins & Krebs, 1978; Fridlund, 1994; Krebs & Davies, 2009). However, emotion regulation demands cognitive control to manage the behavioral reactions that emotions from others generate in us, and to avoid being misled. An example of the deployment of cognitive control in interpersonal scenarios comes from the use of situations in which emotions conflict with the expectations they generate, which leads to a marked increase in decision times (Ruz, Madrid & Tudela, 2013; Ruz & Tudela, 2011). Previous studies on this respect, however, instructed participants to use the emotional expression of the partner as a cue to predict their future behavior, and thus our capacity to actively ignore emotions and their ability to intrude our decisions has not yet been tested.

Hence, the extent of top-down control guided by explicit instructions over the approach-avoidance reactions that emotions generate during interpersonal interactions is an open question. In our series of experiments, we investigated whether the influence of fully non-informative emotions on interpersonal decisions could be completely eliminated by explicitly instructing participants to ignore them. Along the series, we employed an adaptation of the Trust Game (Berg, Dickhaut & McCabe, 1995) where participants decided if sharing or not their money with trustworthy and untrustworthy partners in a multi-round setting. Game partners displayed emotional expressions that participants were asked to ignore. We manipulated the type of partner, their emotional display, the validity of the personal information, and the explicit instruction of ignoring the affective information.

In addition, we explored how the putative effect of emotions on decisions changed depending on the speed of responses, following the model proposed by Ridderinkhof (2002). This model poses that the amount of mental resources and the time taken to respond influence the mental strategies in operation during conflict resolution. According to the

activation–suppression model, stimuli directly linked to responses (S-R) do not require a large amount of mental resources, as they take place in a mostly ballistic manner. However, when such S-R connections lead to incorrect responses, they are followed by the online engagement and implementation of suppression mechanisms of cognitive control (Ridderinkhof, 2002). By this logic, more automatic reactions would occur at the shortest response times whereas controlled responses would take place at the slowest RTs. Thus, automatic and controlled strategies would influence the distribution of behavioral performance (i.e. accuracy and reaction times, RTs). The strategy to implement a distributional analysis is based on the division of the full range of data into several temporal intervals, which are named 'bins'. These 'bins' are included in the general statistical analysis with the aim of obtaining a detailed description of the influence of selective suppression mechanisms on choices made at different speeds (see Ridderinkhof, 2002; Ridderinkhof, van den Wildenberg, Wijnen & Burle, 2004, for a similar strategy).

Given the biological relevance of affective stimuli (LeDoux, 2001), their rapid evaluation and privileged processing (Barrett & Bliss-Moreau, 2009; Reeck & Egner, 2011), we expected to find an effect of conflict on decision times (Ruz & Tudela, 2011), driven by the action tendencies generated by the ignored emotions, in the social setting. Based on the over-generalization of trustworthiness features theory by Todorov (Todorov et al., 2008), and in line with previous studies in the same field (see for example Ruz & Tudela, 2011), we employed expressions of happiness and anger in order to maximize the emotions' avoidance-approach tendencies aroused by the partners' facial expressions. These two emotions also share characteristics, such as transmitting an elevated sense of certainty and personal control while keeping opposite valences (see for example Han, Lerner & Keltner, 2007; Lerner & Keltner, 2000). We hypothesized that happy expressions of partners would generate trustworthy evaluations in participants and thus expectations of cooperation, whereas the opposite would occur for angry facial expressions. We expected that these expectations would be reflected on the speed of choices made in relation to cooperative vs. non-cooperative partners in an interactive fashion. Happy cooperative and angry non-cooperative partners would generate faster choices than angry cooperative and happy non-cooperative ones. Also, given the hypothesized automatic nature of this effect, we predicted that its size would be larger in the fast decisions (bins), compared to the slow decisions (bins), as the cognitive control required for its suppression would demand additional resources and time to operate (Ridderinkhof, 2002; Ridderinkhof et al., 2004).

EXPERIMENT 1

Participants. Twenty-six right-handed healthy volunteers (13 men, mean age: 23), with normal or corrected-to-normal vision, were recruited from the University of Granada and received course credits in exchange for their participation. They all signed a consent form approved by the local Ethics Committee.

Stimuli, Apparatus and Procedure. Participants played the Trust Game multiple times with 8 different partners. They were instructed that in every trial they had to decide whether to share or not a sum of fictional money (€1; received at the beginning of each game round) with a partner. If they chose to share, the amount was multiplied by five and passed to the partner, who decided next whether to cooperate or not with the participant. If s/he reciprocated the participant's trust, each would earn €2.5. However, if the partner did not cooperate, s/he would get €5 and the participant €0. The participant's goal was to achieve as much money as possible with each partner. In addition, they were instructed about the cooperative or non-cooperative patterns of the partners and about their identity. Participants were also told to retain and learn the behavioral pattern of each of their partners and use this information during the experimental task. Half of them most likely cooperated with them and the other half most likely did not. This information was valid in 70% of the trials for each partner, and invalid in the remaining 30%. That is, trustworthy partners cooperated on 70% of the occasions, whereas untrustworthy ones only did so on 30% of the exchanges. Hence, the identity of the partner operated as a trustworthiness cue that participants could use to guide their decisions. In addition, participants were told that partners would display happy and angry facial emotional expressions, but that they were not relevant to the partner's choices or any other aspect of the game, and thus they had to be ignored. Participants were instructed to respond as quickly as possible, to enhance the sensitivity of reaction times to the manipulations. If their response was too slow (> 1500 ms) a text reminded them to respond faster. This reminder did not appear for responses shorter than 1500 ms. Afterwards, an asterisk or a hash symbol (either purple or blue) provided feedback. Participants were instructed about the meaning of these symbols, which informed about the decision that the partner had made (in trials in which the participant cooperated) or would have made (in trials in which the participant decided not to cooperate).

Sixteen facial stimuli (8 identities, 4 females and 4 males) displaying happy or angry (50%) emotional expressions were taken from the NimStim set (Tottenham, Tanaka, Leon, McCarry, Nurse, Hare et al., 2009). These faces were used as partners in the game. Emotional expressions were orthogonal to the partner types and their cooperation rates; hence, emotions were not predictive of the partners' cooperative behavior.

The trustworthiness of the identities (cooperative or non-cooperative), the association between hand and response key and the feedback symbols (and their ink color) were fully counterbalanced across participants. The task was created and displayed using E-Prime 2.0 Professional software (Schneider, Eschman and Zuccolotto, 2002). Trials were presented in a random order, and the stimuli were displayed on a silver background. Each trial comprised the following sequence (see Figure 1): A symbol of 1 Euro (**€;** 1.9° x 2.39°) displayed for 200 ms at the center of the screen, followed by a fixation point (+; 0.57°) of 500 ms on average (random 250-750 ms). Next, the face of the partner for the trial appeared during 1500 ms (6.20° x 7.15° on average), followed by another fixation point identical to the first one. Afterwards a feedback symbol ('*', 0.67° x 0.7°, or '#', 0.57° x 0.95°; displayed in blue or purple ink) was displayed for1000 ms, and finally a third fixation point with the same characteristics as the previous ones ended the trial. Participants were instructed to respond during the time the partner's face was present on the screen by pressing one of two buttons with their left or right index fingers. On average, a trial lasted 4200 ms.

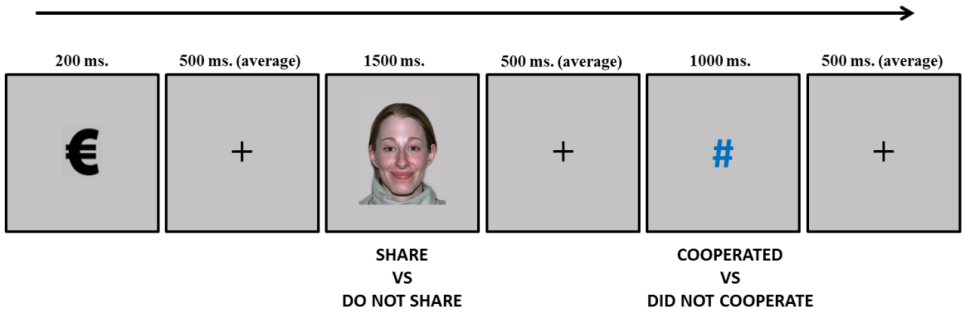

Figure 1: Sequence of trial events in all experiments.

Before the main task, participants performed a training block of 40 trials to familiarize themselves with the procedure. The stimulus set and

instructions about face and feedback were the same in practice and experimental phases. The only difference was that, during practice trials, the cooperation of the partners was 100% consistent, to increase learning about their cooperation tendencies. The experiment was composed of 4 blocks of 80 trials each (320 in total), separated by 3 brief breaks. The approximate duration of the task was 22 minutes. When the task ended, participants completed a short questionnaire (10 point-Likert scale ranging from 0 to 10) in which they indicated the approximate percentage of cooperation of each of their game partners. All participants included were able to indicate the cooperation patterns of all their partners.

Data analysis. Following procedures already published (e.g. Ridderinkhof et al., 2004), the percentage of cooperation rates and the mean RTs were rank-ordered per condition and split up in three equivalent RT speed tercils (bins), and the average in each condition submitted to an ANOVA with the factors displayed Emotion (happy, angry), Partner Trustworthiness (cooperative, non-cooperative) and Bin (tercils 1, 2, 3). Trials without a response (i.e. sharing or not the money) were eliminated from the bin selection and subsequent analyses. All of the remaining trials, regardless of whether the choice (sharing or not) corresponded to the type of partner (cooperative, non-cooperative), were included in the analyses[1]. The inclusion of the bin factor afforded the consideration of additional information in our design, which allowed us to explore the automatic vs. more controlled effect of emotions on social decisions. This is also of interest to compare the current results with similar results from non-social interference paradigms (Ridderinkhof, 2002; Ridderinkhof et al., 2004). The removal of the bin factor did not change any of the other findings in the studies reported below. In any case, we kept the bin factor in the design given the additional information this variable provides. In addition, in all Experiments we performed an additional ANOVA including the factor of Block, to account for potential practice or learning on bin effects (given that slower responses may take place in earlier initial trials compared to late trials in the experiments). We did not observe any main effect of block or interaction with the Bin factor, which rules out interpretations of the Bin in terms of practice with the task.

[1] Including only choices congruent with the type of partner (cooperating only with cooperative partners and not doing so with non-cooperative ones) did not change the general pattern of results.

RESULTS

Only trials in which participants did not respond were discarded from the analyses (1.14 %). On average, participants cooperated on 52 % of the trials. The ANOVA of the mean cooperation rates showed a main effect of Emotion, F (1, 25) = 5.99, $p < .05$, $\eta p^2 = .19$, as cooperation rates were higher for partners displaying happy, M = 55 %, SD = 6 %, than angry, M = 49 %, SD = 7 %, emotional expressions. Partner Trustworthiness was also significant, F (1, 25) = 258.70, $p < .001$, $\eta p^2 = .91$. Participants shared their money more frequently with cooperative, M = 89 %, SD = 12 %, than with non-cooperative, M = 15 %, SD = 11 %, partners. In addition, there was an interaction between the three factors in the design, F (1, 25) = 4.74, $p < .05$, $\eta p^2 = .28$. This was because whereas the interaction between Emotion and Partner Trustworthiness was not significant in the first two bins, all *ps* > .118, it reached significance in the third one, F (1, 25) = 9.96, $p < .01$, $\eta p^2 = .28$. Subsequent analyses in this third bin showed an effect of the emotional display close to significance levels for cooperative partners, F (1, 25) = 3.90, $p = .059$, $\eta p^2 = .13$, and significant for non-cooperative partners, F (1, 25) = 17.07, $p < .001$, $\eta p^2 = .41$. Participants shared more money with happy than with angry non-cooperative partners, M = 18 %, SD = 14 % vs. M = 9 %, SD = 8 %; the tendency for cooperative partners was in the same direction.

The ANOVA of the mean RTs revealed a main effect of Emotion, F (1, 25) = 6.68, $p < .05$, $\eta p^2 = .21$, as participants' responses were faster for happy, M = 596.82, SD = 118.61, than for angry partners, M = 599.49, SD = 117.06. Partners' Trustworthiness was also significant, F (1, 25) = 9.83, $p < .01$, $\eta p^2 = .28$, as decisions were slower for non-cooperative, M = 613.36, SD = 124.47, than for cooperative partners, M = 582.95, SD = 113.37. Crucially, these two factors interacted, F (1, 25) = 4.52, $p < .05$, $\eta p^2 = .15$. Decisions were slower for angry, M = 595.71, SD = 119.03, than for happy, M = 570.26, SD = 109.05, cooperative partners, F (1, 25) = 25.46, $p < .001$, $\eta p^2 = .50$, whereas this pattern was reversed for non-cooperative ones, F (1, 25) = 5.03, $p < .05$, $\eta p^2 = .17$, as responses were faster for angry, M = 603.28, SD = 120.61, than for happy, M = 623.43; SD = 132.11, partners (see Figure 2). The bin factor did not interact with any other variable, all *ps* > .159.

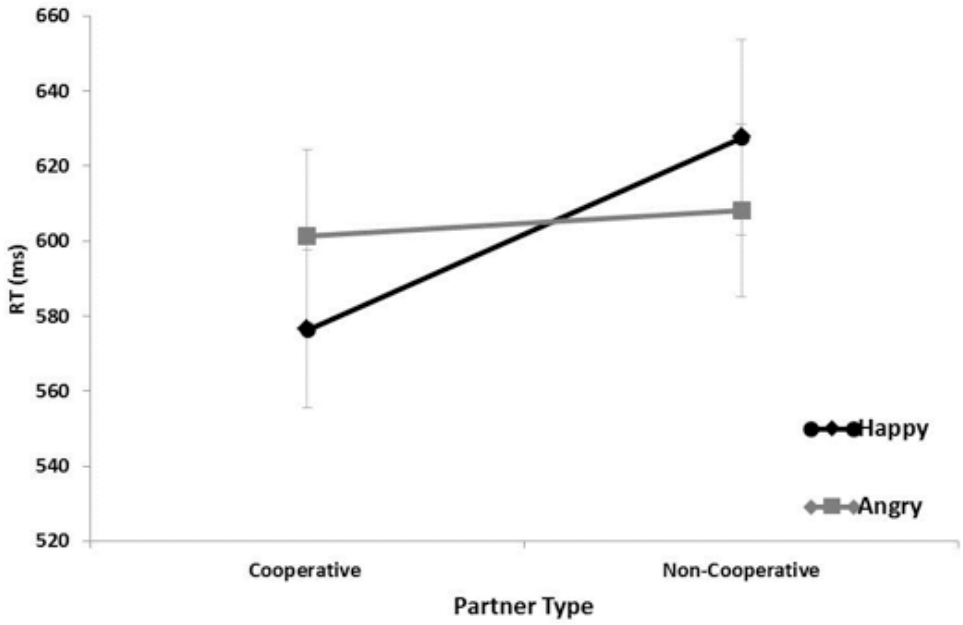

Figure 2: Interaction of Emotion and Partner Trustworthiness on the speed of choices in Experiment 1.

DISCUSSION

Data from Experiment 1 support the existence of an affective bias driven by the emotions that participants were explicitly asked to ignore. In the first place, the percentage of trials in which they shared money was modulated by emotional displays, as reflected in larger concessions for happy than for angry partners. In the second place, results from this first experiment showed a clear delay in decisions due to the influence of emotional displays. On this respect, regardless of the speed of responses (i.e. the temporal moment, or bin, in which they occurred), participants took longer to make a choice when they were playing with a partner with a facial display opposite to their cooperative tendencies. In situations where participants chose whether sharing or not their money with a partner described as mostly cooperative but displaying a negative emotion, or with a happy non-cooperative partner, the decision-making process slowed down. As the emotional facial information was not predictive of the partners' cooperation rates and participants were told explicitly that it was irrelevant for the task and that they should ignore it, its influence on participants' decisions points to a failure in the full implementation of

control mechanisms. In addition, the interference was equal across the whole distribution of response speeds (or bins). Thus, results suggest that affective stimuli are processed in a mandatory or non-volitional manner during the current interpersonal setting.

However, it could be the case that the uncertainty associated to the inconsistent behavior of the partners of the game (who only followed their trustworthiness pattern on 70% of the trials) led participants to pay attention to the emotions as an additional source of information, which could have generated the conflict effect observed. Contextual uncertainty entails risk and can modulate choices (see for example Gaertig, Moser, Alguacil & Ruz, 2012; Ruz, Moser & Webster, 2011). The greater the amount of perceived risk and uncertainty, the larger the influence of other contextual factors on decisions (Kopelman et al., 2007). Therefore, in Experiment 2 we increased the validity of the personal information by having partners behaving in a cooperative or non-cooperative fashion in all trials (that is, personal information was 100% valid). Thus, participants had all the information relevant for their trust choices in the identity of their partners. Obtaining an interference effect due to the emotional displays would be stronger evidence for the mandatory processing of facial emotional expressions during interpersonal choices.

EXPERIMENT 2

Participants. Twenty-six healthy volunteers (5 left-handed, 13 men, mean age: 23.4), with normal or corrected-to-normal vision, were recruited from the University of Granada and participated in exchange for course credits. They all signed a consent form approved by the local Ethics Committee.

Stimuli, Apparatus and Procedure. All details were the same as in Experiment 1 with the exception of the validity of the partner's trustworthiness in the experimental task. In the current experiment, each partner behaved according to his/her cooperation type in all trials. That is, cooperative partners reciprocated on 100% of the game rounds and non-cooperative partners never cooperated. The ANOVAs for the cooperation rates and mean RTs were carried out including the same factors as in the Experiment 1 (Emotion, Partner Trustworthiness and Bin).

RESULTS

Trials without response were eliminated from the analyses (1.02 %). Participants shared their money on 50 % of the trials. The ANOVA of the mean cooperation rates showed a main effect of Partner Trustworthiness, F (1, 25) = 2956.97, $p < .001$, $\eta p^2 = .99$. Participants shared more with cooperative, $M = 96$ %, $SD = 4$ %, than with non-cooperative, $M = 3$ %, $SD = 3$%, partners. This analysis also revealed a significant interaction between Partner Trustworthiness and Bin, F (1, 25) = 16.39, $p < .001$, $\eta p^2 = .58$. Cooperation rates increased along with bin for cooperative partners, F (1, 25) = 11.50, $p < .001$, $\eta p^2 = .49$; participants shared more money with them during the second, $M = 98$ %, $SD = 5$ %, and third bins, $M = 98$ %, $SD = 2$ %, than during the first one, $M = 92$ %, $SD = 9$ %, $p < .001$ and $p = .001$ respectively. There were no significant differences between the second and third bins, $F < 1$. In contrast, the main effect of Bin for non-cooperative partners, F (1, 25) = 8.76, $p = .001$, $\eta p^2 = .42$, was explained by a higher cooperation rate during the first bin, $M = 6$ %, $SD = 8$ %, which was larger than in the second, $M = 2$ %, $SD = 4$ %, $p < .001$, and third bins, $M = 2$ %, $SD = 3$ %, $p < .01$.

The analysis of the RTs revealed a significant interaction between Emotion and Partner Trustworthiness, F (1, 25) = 5.05, $p < .05$, $\eta p^2 = .17$. The effect of Emotion only reached significance for cooperative partners, F (1, 25) = 15.03, $p = .001$, $\eta p^2 = .38$, non-cooperative, $F < 1$, as participants were faster responding to happy, $M = 566.98$, $SD = 84.00$, than to angry, $M = 580.60$, $SD = 90.82$, partners (see Figure 3). No other effect or interactions, including the bin factor, were significant, all $ps > .102$.

DISCUSSION

As in Experiment 1, participants were unable to avoid processing the emotional facial expressions of their partners despite their irrelevance and the full predictability of the cooperation behavior. The increase of contextual certainty was not enough to fully remove the bias that affective information exerted on the time needed to make cooperative decisions. Unlike Experiment 1, there were no effects of emotional information on sharing rates. Choices now were fully guided by the personal information, as reflected by larger sharing rates with cooperative than with non-cooperative partners, and this tendency was most extreme at the slowest decisions (third bin). Thus, longer time windows reflected the behavioral tendencies associated with each partner type better than the shortest ones.

This suggests that the implementation of personal information about trustworthiness takes time, and is mostly effective at the longest choices.

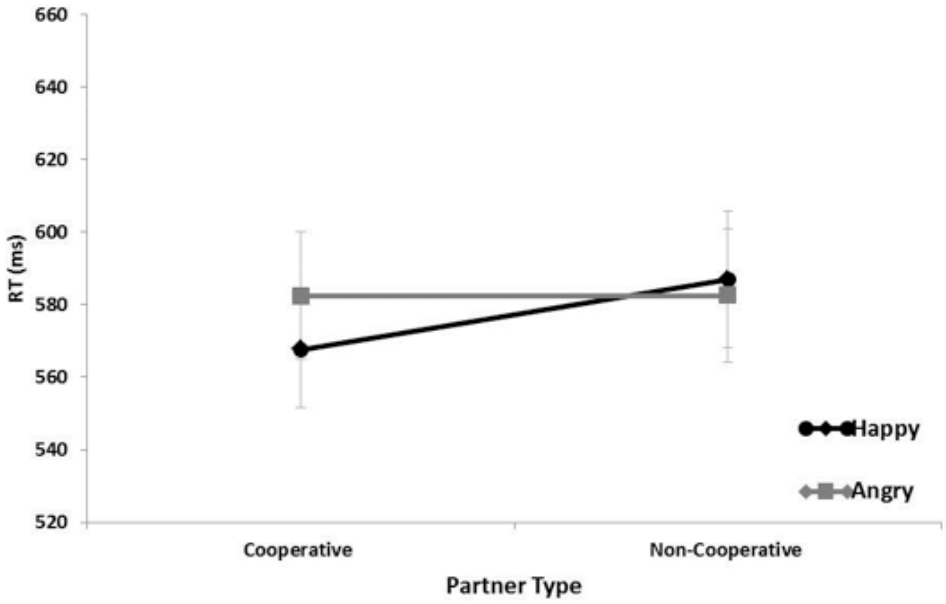

Figure 3: Interaction between Emotion and Partner Trustworthiness on the speed of choices in Experiment 2.

In this experiment, the identity of the partners was fully predictive of their cooperative tendencies, and thus participants had no motive to look for additional information to guide their choices. Even though, making rational cooperative decisions in accordance with the trustworthiness of the partner took them longer when this conflicted with their facial displays, which they were told to ignore. In agreement with Experiment 1, the distributional analyses showed that the interference took place both in fast and slow responses, which suggests that suppression of affective information was equally effective in all bins. On the other hand, the reason why the interference effect was now restricted to cooperative partners is not fully clear, and we will return to it in the General Discussion section. In any case, results reinforce the argument that facial emotional expressions are processed in a mandatory way during interpersonal choices.

It could also be the case, though, that the explicit instructions to ignore the emotional expressions of the partners had the opposite effect and led participants to focus on them (e.g. Wegner, Schneider, Carter & White, 1987). Results in the field of paradoxical thought suppression suggest that trying to suppress a thought sometimes leads to a rebound, opposite effect, in which the thought receives increased processing. In the current scenario, trying to avoid paying attention to the emotional expression of the partners could have funneled their bias on behavioral responses. To test this alternative hypothesis we performed Experiment 3, where we removed the explicit instructions regarding the facial affective information of partners.

EXPERIMENT 3

Participants. Twenty-six right-handed healthy volunteers (13 men, mean age: 21.4), with normal or corrected-to-normal vision, were recruited from the University of Granada and participated in exchange for course credits. They all signed a consent form approved by the local Ethics Committee.

Stimuli, Apparatus and Procedure. All details were the same as in Experiment 2, except that participants received no instructions regarding the emotional displays that the game partners would display. Cooperation rates and mean RTs were submitted to an ANOVA including the same factors as in Experiments 1 and 2 (Emotion, Partner Trustworthiness and Bin).

RESULTS

Trials without a response (i.e. sharing or not the money) were eliminated from the analyses (0.75 %). The average sharing rate was 50 %. The analysis of mean cooperation rates yielded a main effect of Partner Trustworthiness, F (1, 25) = 124.04, $p < .001$, $\eta p^2 = .83$. Participants shared more with cooperative, M = 97 %, SD = 4 %, than with non-cooperative, M = 3 %, SD = 5 %, partners. This effect was qualified by its interaction with the Bin factor, F (1, 25) = 6.23, $p < .01$, $\eta p^2 = .34$. Follow-up analyses showed that cooperation rates increased along with bin for cooperative partners, F (1, 25) = 3.42, $p < .05$, $\eta p^2 = .22$, and decreased for non-cooperative ones, F (1, 25) = 4.56, $p < .05$, $\eta p^2 = .27$. Participants shared more money with cooperative partners in the second, M = 94 %, SD = 20 %, and third, M = 94 %, SD = 19 %, $p = .645$, bins than in the first one, M =

90 %, *SD* = 20 %, both *ps* < .05. This pattern was opposite for the non-cooperative partners, as cooperation rates were higher during the first bin, *M* = 12 %, *SD* = 22 %, than during the second, *M* = 6 %, *SD* = 19 %, *p* < .01, and third ones, *M* = 5 %, *SD* = 19 %, *p* < .01.

The ANOVA of the mean RTs showed a main effect of Partner Trustworthiness, *F* (1, 25) = 8.32, *p* < .01, ηp^2 = .25; participants took longer to respond to non-cooperative, M = 567.88, SD = 66.03, than to cooperative partners, *M* = 552.62, *SD* = 66.81. This factor interacted with Emotion and Bin, *F* (1, 25) = 4.42, *p* < .05, ηp^2 = .269, and thus each bin was analyzed separately. Whereas in the first bin the only significant effect was the type of partner also mentioned above, in the second and third bins this effect was qualified by its interaction with the emotional display, *F* (1, 25) = 9.19, *p* < .01, ηp^2 = .27, and *F* (1, 25) = 11.45, *p* < .01, ηp^2 = .314, respectively. Follow-up analyses showed that in the second bin only the emotion of non-cooperative partners affected speed of decisions, Happy *M* = 529.51, *SD* = 52.33 vs. Angry, *M* = 518.90, *SD* = 52.33, *F* (1, 25) = 13.23, *p* = .001, ηp^2 = .346; cooperative, *F* < 1. However, this factor affected responses to both cooperative and non-cooperative partners in the third bin, *F* (1, 25) = 4.28, *p* < .05, ηp^2 = .15, and *F* (1, 25) = 12.42, *p* < .01, ηp^2 = .33, respectively, in opposite directions depending on whether Partner Trustworthiness was cooperative, Happy *M* = 619.20, *SD* = 79.75 vs. Angry *M* = 631.69, *SD* = 96.12, or not, Happy *M* = 656.01, *SD* = 89.26 vs. Angry *M* = 629.75, *SD* = 88.54; see Figure 4.

DISCUSSION

In the current experiment, in which we eliminated the explicit instructions about the emotional displays of the partners, we still observed an emotional interference effect on decision times. This suggests that results in the previous experiments were not due to the unintended attention to the emotions driven by the instructions to ignore them, but to their mandatory processing during interpersonal interactions.

In contrast to Experiment 1 and 2, however, in Experiment 3 the interaction between emotion and personal information was mediated by the bin factor. At the fastest choices (first bin) only Partner Trustworthiness modulated the speed of responses, whereas this factor interacted with emotion in the other two bins. Whereas in previous studies the interaction was present in all temporal bins, results from the present experiment suggest that now the emotional conflict moved to the longer responses (second and third bins). Emotions began to affect responses to non-

cooperative partners in the second bin, and they did so for both types of partners in the third one. This progressive behavioral adjustment along the three bins could reflect a natural strategy to integrate emotional information in a context in which participants did not know whether the facial expressions were relevant or not. From this perspective, longer responses would allow more time to ponder emotions as potential relevant factors, which would be reflected on their heightened effect on slower choices. We will return to this point in the following and last section.

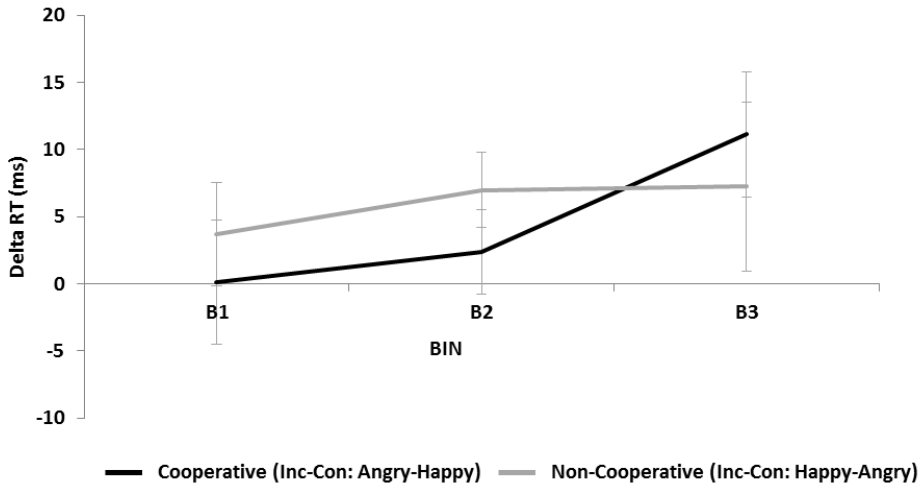

Figure 4: Delta plots for the conflict effect on RTs in Experiment 3. Display of effect size (Delta RT; incongruent-congruent conditions) as a function of response speed (RT tercil scores).

GENERAL DISCUSSION

With the present series of experiments we show that emotions that should be ignored are still processed and influence cooperative responses in alleged social scenarios, and that this takes place in a fairly constant manner across the whole distribution of response speeds (i.e. bins). Behavior during social decision-making, mostly guided by personal identity information, was impacted by emotional irrelevant information from faces. Such effect appeared in a consistent manner across the experiments, as reflected by the interaction between the cooperative tendencies of the partners and their

emotional expression, observed on the speed of choices across the 3 studies. This was also true even in a context devoid of risk where the personal information was fully predictive of the partners' behavior. In addition, the instruction of ignoring irrelevant emotional information was not the cause of the results obtained in Experiment 1 and 2. Thus, emotional contradictory information during social decision-making generates conflict that is unavoidable by cognitive control mechanisms. Our results stress the pivotal importance of emotions in interpersonal interactions and provide further support for theories that contend for a tight link between emotions and social environment (Barrett, 2012; Keltner & Gross, 1999; Parkinson et al., 2004; Parrott & Schulkin, 1993).

In our studies we measured behavioral indexes of cooperation choices and their speed, and obtained evidence of their permeability by irrelevant emotional expressions. Across the three experiments, these indices were affected by the emotional information to a different extent. The temporal profile of the effect also varied depending on the trustworthiness of the partners. Participants' cooperation rates were adjusted to the identity and the expected behavior of the partners across experiments. Crucially, cooperative choices were biased by ignored emotions when the context was uncertain (Experiment 1). This result resonates with previous evidence showing that cooperation decisions are biased by information not predictive in the task setting but that has previous associations with cooperative or non-cooperative behaviors, both in terms of social and moral information (Delgado, Frank & Phelps, 2005; Gaertig et al., 2012; Moser, Gaertig & Ruz, 2014; Ruz et al., 2011) and also emotional expressions (Campellone & Kring, 2013; Tortosa et al., 2013; Tortosa, Lupiáñez & Ruz, 2013). However, in previous studies participants were not explicitly asked to ignore the information provided, and thus the effects observed could be at least partially explained by experimenter bias. In the current study, however, participants received such instructions, and still the uncertainty of the task setting made cooperation choices vulnerable to preexisting associations between irrelevant emotional expressions and behavioral tendencies. Our results thus provide novel evidence that in ambiguous social settings, in the low certainty conditions of Experiment 1, emotions that we actively try to ignore bias our cooperation choices in an expression-congruent manner. This bias on choices disappeared on Experiments 2 and 3. One compelling approach that could help to explain the presence of emotional bias on uncertain choices is the Affect Infusion Model by Forgas (AIM; 1994; 1995). Although this theory is mainly oriented to intrapersonal affect and its consequences during social judgments, it may be relevant to the current findings. The AIM states that the more elaborate the

construction of a social judgement, the greater the influence of affect. From this logic, it is reasonable to assume that in the first experiment, where the uncertainty of the context was high, the risk in the situation promoted seeking for other factors to construct a judgment and make a decision. Participants would go beyond personal information to build inferences about the partners' affective state based on prior knowledge (Forgas, 1995). Under the same rationale, the reduction of contextual uncertainty in the other two experiments could have helped participants to simplify the process and, as consequence, their choices would have been be guided mostly by a preexisting motivational goal (i.e. maximize their benefit by employing personal information) without the inclusion of other irrelevant elements in the actual choices (i.e. facial emotional expressions).

In contrast to choices, the speed of responses was affected by emotions in the three experiments, regardless of the game uncertainty and also of the instructions. However whereas in the first experiment this conflict appeared for both types of partners, the reduction of the uncertainty in Experiment 2 limited the scope of the effect to cooperative partners. The reasons for this are unclear, although previous studies suggest that people rely on theory of mind processes with others who engage in cooperative behavior (Fehr & Camerer, 2007; Frith & Frith, 2007; McCabe, Houser, Ryan, Smith & Trouard, 2001), and that these mechanisms may be partially different for cooperative and non-cooperative partners (Lissek et al., 2008; Ruz & Tudela, 2011). It could also be the case that participants were much more focused in their strategy with cooperative partners as they were expecting larger gains from their interaction than with non-cooperative ones, and that this strengthened the effect of their emotions. On the other hand, supposing that the interference effect is driven by the incongruent happy expressions for cooperative partners and for the angry expression in the case of the non-cooperative ones, a complementary explanation for this asymmetry in the interference effect could be derived from the 'broaden theory' (Fredrickson & Branigan, 2005). This theory posits that positive and negative emotional events engage available attentional resources to a different extent. As a consequence, emotions would either narrow or broaden the attentional focus deployed to the task. Whereas negative emotions tend to narrow action tendencies, positive ones would lead to wider variability in behavior. As such, negative emotions in the case of cooperative partners would lead to a more effective interference than positive emotions for non-cooperative ones, which would lend cooperative partners more prone to interference. In any case, and regardless of the explanation, our results suggest that responses to cooperative partners are more prone to emotional interference that responses to non-cooperative

ones, although further research is needed to replicate this effect and elucidate its potential causes. In any case, the removal of the request of ignoring emotions in Experiment 3 did not eliminate the conflict, which was again apparent for both types of partners at the slowest temporal window.

The analysis of the temporal profile of the decisions offered additional relevant information. Choices in situations of interpersonal uncertainty (Experiment 1) were affected by irrelevant emotional displays only in the slowest responses. In these, participants tended to cooperate more with happy than with angry partners. Removing the uncertainty of the partners' behavior in Experiments 2 and 3 eliminated the effect of emotion on actual choices. However, their cooperation tendencies interacted with bins showing that slower decisions were more adjusted to the cooperative or non-cooperative tendencies of the partners. Overall this suggests that the longer participants took to decide, the better they responded according to the type of partner. This is in line with a higher degree of control in slow response-time windows (Ridderinkhof, 2002), and provides support for the usefulness of exploring the profile of choices with different temporal distributions.

Results regarding the distribution of the emotional conflict on RT indices, on the other hand, contrast with our initial predictions following the model proposed by Ridderinkhof (2002). Whereas previous results in this line suggest that automatic interference effects are stronger when responses are fast and that control mechanisms need more time to develop and thus are mostly reflected in the slowest responses, we observed emotional conflict in both fast and slow bins (Experiments 1 and 2) or only in full in the slowest bin (Experiment 3). It is well-known that emotions carry important information for survival and are processed in a fast and efficient manner (see for example Fischer & Manstead, 2008), which leads to their prioritized processing (Vuilleumier, 2005). The finding that emotional expressions interfere with responses even in the slowest bins suggests that control mechanisms are not fully operative even in this time window. This pattern persists in Experiment 3, although the lack of explicit instructions regarding emotions in this case leads to a disappearance of the effect in the fastest responses. This temporal pattern is puzzling, and it suggests that instructions may change the speed with which affective information captures resources. Whereas most of the studies applying the Activation-Suppression model (Ridderinkhof, 2002) employ non-emotional materials in interference tasks devoid of social content (e.g. Ridderinkhof, 2002; Ridderinkhof et al., 2004), our experiments measure the extent of emotional conflict in interpersonal social contexts, which hinders comparisons. In the Stroop paradigm the nature of the specific conflict seems to be a critical

element as it seems to determine which control mechanisms are implemented and how conflict is dealt with (see for example, Egner, 2008; Funes, Lupiáñez & Humphreys, 2010; Loose, Kaufmann, Tucha, Auer & Lange, 2006; Van Veen & Carter, 2005). In a complementary way, another factor that may affect the pattern of results is the rather stringent limit on response speed that our task imposed, as participants were not allowed to take longer than 1500 ms to decide. In any case, further studies should compare the temporal course of interference from emotional material in different kinds of contexts with variable temporal constrains.

Empathic reactions to the affective nature of the partners may in part explain our results, as the perception of a happy expression enhances subjective positive feelings (Van Kleef, 2009) and these increase cooperation tendencies (see for example, Kopelman et al., 2007), and the opposite may happen for anger (Forgas, 1998; Kopelman et al., 2006). Note, however, that empathic reactions in our experiments had to be context-dependent, as emotions did not influence explicit choices in Experiments 2 and 3, in which the behavior of participants was fully certain (see for example Frith & Frith, 2007; Ikezawa, Corbera & Wexler, 2013; Kadosh, Henson, Kadosh, Johnson & Dick, 2010). In addition, it could also be argued that priming mechanisms may have driven the obtained results. The mere presentation of happy facial expressions could promote cooperative (positive) behavior while anger could lead participants to the opposite (negative) reaction, regardless of the inferences or expectations of cooperative or non-cooperative action tendencies. To rule out such possibility it would be helpful to carry further experiments in which participants are warned that facial expressions are chosen at random and have nothing to do with the game partners. Although similar manipulations in previous studies ruled out the priming explanation (Gaertig et al., 2012), this effect may be relevant for the current paradigm.

Despite the conflict effect observed on RTs was present throughout the three experiments, it showed larger variability than it may be expected. Such variability could be reflecting individual differences in the resolution of emotional interference during interpersonal interactions. Bearing in mind that the temporal dynamics of responses were modeled based on each participant's pattern of response speed (i.e. bins), our results include a richer description of individual behavioral patterns. Indeed, the activation-suppression model (Ridderinkhof, 2002) has understanding individual variability by employing a distribution analysis as one of its goals (Forstmann, van den Wildenberg & Ridderinkhof, 2008). In addition, in the current paradigm conflict is measured by an interaction between two types of cooperation patterns and two emotional expressions, happiness and

anger, which share some characteristics (Han et al., 2007; Lerner & Keltner, 2000), but also differ in many others (see for example, Todorov et al., 2008; Van Kleef et al., 2004). These differences could add variability to the data, which together with individual differences could lead to a more variable pattern of results. In any case, there is a consistent pattern of results on the core finding of the paper, that is, the interaction between the cooperation tendencies of the partners and their non-predictive emotional expression, which strongly suggests that ignoring emotional expressions is not sufficient to override their effect on the speed of cooperation responses.

The current experiments contain limitations that, although do not invalidate the results, should be tackled in future studies. In the first place, the game was played in a somehow artificial and iterative setting, which does not fully correspond to social interactions in daily life (e.g. Schilbach et al., 2013). This, however, was driven by the purpose of exploring the mandatory processing of salient emotions in an interference paradigm similar to those employed in the field of selective attention to study the automaticity of stimulus processing (see for example, Driver, 2001). The experimental approach allowed the use of faces previously rated in terms of the appropriateness of their emotional expressions (Tottenham et al., 2009), and also higher experimental control to measure subtle differences in the speed of responses. On the other hand, people nowadays engage in frequent social interactions that are artificial but still social in its nature (e.g. Facebook, WhatsApp; see Fischer & Reuber, 2011; Van Cleemput, 2010). In addition, humans display a natural propensity to interpret and represent stimuli in relation to their social content (e.g. Castelli, Happé, Frith & Frith, 2000; Sebanz, Knoblich & Prinz, 2003). To stress this, our cover story was conceived to match real social settings, in which the behavior of individuals displays different levels of trustworthiness. Furthermore, the artificial features of the design may have in fact reduced rather than increased the impact of facial expressions of emotions. These acquire full meaning in social contexts and thus it is reasonable to argue that their impact should be largest in live face-to-face situations (Barrett, 2012; Keltner & Gross, 1999; Parkinson et al., 2004; Parrott & Schulkin, 1993). In the second place, certain features of our task depart from the classic Trust Game, such as the lack of real payment to participants. Instructions, on the other hand, aimed at stressing the cooperative and non-cooperative tendencies of the partners, and thus asked participants to maximize benefits with each of them. Of note, previous studies in similar lines of research show that including small payments and/or omitting the instruction of benefits do not change the pattern of results (e.g. Gaertig et al., 2012). Future studies could incorporate videos with dynamic facial expressions, and also extend the range of

emotions tested and the nature of the social settings. It would be interesting to explore whether the interference from ignored emotions also takes place in more natural settings, as well as the contextual dependency of the effects. In addition, it would be worth studying the extent of mandatory interpersonal emotional processing in people with deficits in emotional and/or social processing (e.g. alexithymia).

CONCLUSIONS

Overall, our findings are in line with social-emotional theories about how social constructs and emotions lead to different expectations about the proximal behavior of others (Fischer & Manstead, 2008; Haidt, 2001; Keltner & Haidt, 1999; Oosterhof & Todorov, 2008). In agreement with evolutionary claims about the existence of a specific *module* for judging trustworthiness (see for example Oosterhof & Todorov, 2008), the non-volitional processing of facial features aids in the prediction of what people are going to do next and other important social outcomes (Oosterhof & Todorov, 2008). The inconsistency between personal predispositions of cooperation and emotional facial information leads to opposite expectations and increases demands on decision-making, which are reflected in slower response times. Thus, in the same manner in which reading words cannot be avoided when attending to hue color in the classic Stroop task (Stroop, 1975), our results show for the first time that explicitly ignored emotions influence responses in a mandatory manner during interpersonal interactions.

RESUMEN

Ignorar las emociones de otros no evita su efecto en nuestras decisiones cooperativas. Pese a que la influencia ejercida por el procesamiento de las emociones ha sido estudiada en diferentes dominios cognitivos, el papel de estas durante la toma decisiones en contextos sociales queda aún por explorar. Utilizamos una tarea de interferencia con el fin de estudiar en qué grado es posible evitar la influencia de las emociones de otras personas cuando nos encontramos en interacción con ellas. Los participantes jugaron, en múltiples rondas, al Juego de la Confianza con ocho compañeros que podían ser de tipo cooperativo o no cooperativo, y cuya expresión facial podía ser de felicidad o de enfado. Las emociones de los compañeros de juego no eran predictivas, en ningún caso, de su grado de cooperación. Tanto en el Experimento 1 como en el Experimento 2 los participantes fueron instruidos de manera explícita que debían ignorar las expresiones emocionales de sus compañeros. La validez de la información personal (el grado de cooperación) fue manipulada entre ambos experimentos. Los

resultados revelaron un efecto de interferencia emocional; las expresiones de felicidad redujeron el tiempo necesario para tomar la decisión de cooperación, mientras que las expresiones de enfado acortaron las decisiones de no cooperación. Este efecto de interferencia fue replicado en el Experimento 3, en el que la instrucción explícita de ignorar las emociones de los compañeros había sido eliminada. Nuestros resultados muestran que las emociones de otros nos influyen de manera inevitable durante nuestra interacción con ellos. Esta evidencia es coherente con las teorías que defienden la existencia de un estrecho vínculo entre emociones y contexto social.

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(Manuscript received: 12 January 2015; accepted: 14 May 2015)