Psicológica (2017), 38, 1-24.

Vocal emotion expressions effects on cooperation behavior

Jonathan Azael Caballero Meneses[*] & Judith Marina Menez Díaz

Universidad Nacional Autónoma de México, México.

Emotional expressions have been proposed to be important for regulating social interaction as they can serve as cues for behavioral intentions. The issue has been mainly addressed analyzing the effects of facial emotional expressions in cooperation behavior, but there are contradictory results regarding the impact of emotional expressions on that behavior, particularly regarding the effects of joy expressions. In the present study, we extend research on the influence of emotional expressions on cooperation using vocal emotional expressions and address methodological shortcomings of previous studies. Forty-eight participants were exposed to joy, anger, and neutral emotional expressions before taking part in the "Assurance Dilemma" task, where behavioral and judgment measures were obtained. Behavioral results constitute the first evidence that non-facial emotional expressions influence cooperation behavior in experimental games and suggest that specific emotional expressions may have different effects on cooperation. Judgment measures suggest that experience, in addition to emotional expressions, may also play a role in this context. Theoretical and methodological implications are discussed.

[*] **Acknowledgments**: The experiment described in this paper is part of the first author's doctoral dissertation. This work was supported by a scholarship from Consejo Nacional de Ciencia y Tecnologia (CONACYT, # 280423) granted to Jonathan Caballero and UNAM-DGAPA PAPIIT IN305412 –RN305412 grant awarded to Marina Menez. We thank Dr. Marc D. Pell for valuable comments on an earlier version of this manuscript and Ryan Sanford for support on English revision. **Correspondence** concerning this article should be addressed to Jonathan Caballero. Facultad de Psicología. División de Investigación y Estudios de Posgrado. Cubículo 124, Primer Piso, Edificio D. Universidad Nacional Autónoma de México. Delegación Coyoacán, DF, México, 04510. Tel.:+525556222272. E-mail: j.caballero.m@comunidad.unam.mx

Research on emotion perception has revealed that people can accurately recognize emotional expressions from visual stimuli (facial expressions; see Calvo & Nummenmaa, 2015), vocal stimuli (emotional prosody; see Scherer, 2003), body posture and movement (Coulson, 2004), and even tactile stimuli (Hertenstein, Holmes, McCullough, & Keltner, 2009).

It has been proposed that emotions serve important social functions; influencing behavior of the organism that experiences them, as well as the behavior of other organisms that interact with it through emotional expressions (Fischer & Mansted, 2008; Gray, Ishii, & Ambady, 2011; Keltner & Haidt, 1999; Van Kleef, De Dreu, & Manstead, 2010). Specifically, emotional expressions have been proposed to regulate social interaction by communicating underlying behavioral tendencies to which other members of the species react and adapt their behavior accordingly (Darwin, 1872/1965; Erickson & Schulkin, 2003; Izard, 1997; Marneweck, Loftus, & Hammond, 2013; Schmidt & Cohn, 2001).

Research regarding the effects of emotional expressions on social interaction has relied on diverse approaches and methodologies (Keltner & Haidt, 1999; Van Kleef et al., 2010). A particular instance of social behavior that has received considerable attention is cooperation; several experiments have been conducted in which the effects of facial emotional expressions on cooperation are addressed (de Melo, Carnevale, Read, & Gratch, 2014; Eckel & Wilson, 2003; Krumhuber et al., 2007; Reed, Zeglen, & Schmidt, 2012; Scharlemann, Eckel, Kacelnik, & Wilson, 2001; Stouten & de Cremer, 2010; Tortosa, Strizhko, Capizzi, & Ruz, 2013). In general, previous studies support the hypothesis that emotional expressions influence cooperation by reporting that joy expressions increase cooperation while emotions such as anger and contempt decrease it (Eckel & Wilson, 2003; Krumhuber et al., 2007; Reed et al., 2012; Scharlemann et al., 2001; Tortosa et al., 2013). However, methodological shortcomings such as lack of baseline conditions (Stouten & de Cremer, 2010), lack of stimuli validation as clearly perceptible emotional expressions (Eckel & Wilson, 2003; Scharlemann et al., 2001) and lack of task order counterbalancing (Krumhuber et al., 2007) make difficult to assess if current evidence clearly supports the hypothesis, and more specifically, whether joy expressions increase cooperation or not.

Scharlemann et al. (2001), and Eckel and Wilson (2003) have tested whether differences in cooperation behavior are observed when presenting photographs of faces either smiling or displaying a neutral expression. They report higher levels of cooperation towards smiling faces, but the results

would not be considered significant using conventional levels of alpha as they took their statistical decisions based on an alpha level equal to 0.1. Moreover, they did not validate stimuli as specifically being perceived as emotional expressions (i.e. joy expressions), which further complicates interpretation because smiles are not necessarily perceived as reflecting joy or even as reflecting an emotion (Ambadar, Cohn, & Reed, 2009; Frank & Ekman, 1993).

In a series of experiments, Stouten and de Cremer (2010) addressed the joint influence of emotional expressions (anger or joy) and written messages (reflecting a cooperative or non-cooperative intention) in both cooperation behavior and perception of several attributes of people. The authors report that photographs of people displaying joy are perceived as more reliable and cooperative than those of people displaying anger. Regarding cooperation behavior, they only found interaction effects of facial emotional expressions and written messages, but no main effects. Such a pattern of results is unexpected if one assumes that emotional expressions *per se* regulate social interaction (Fischer & Mansted, 2008; Gray et al., 2011; Keltner & Haidt, 1999; Van Kleef et al., 2010). An important limitation of this study is that authors did not include conditions in which the effects of each variable were independently evaluated nor included control stimuli such as neutral emotional expressions or messages unrelated to the cooperation intention.

In another work, Krumhuber et al. (2007) examined the effects of facial animations of genuine smiles, faked smiles and neutral expressions on behavioral and judgmental measures of cooperation. They report that the type of emotional expression displayed by the opponent influenced perception of trustworthiness, positive emotionality (they derived this measure from a combination of scales evaluating different perceived emotions such as "happy", "afraid", "sad" and "angry"), likelihood to cooperate, and willingness to play again with the same opponent and meet him outside the experimental context: judgment rates and cooperation levels were higher for genuine smiles, medium for faked smiles and lower for neutral expressions. This study has, at least, two limitations. First, while judgment measures of perceived emotions were included, the measures were collapsed, and thus it is not clear whether the composite "positive emotionality" scale implies that participants perceived opponents as expressing joy – as a discrete basic emotion for which specific effects are expected –, or a rather nonspecific combination of emotions for which specific effects on behavior are hard to predict. A second important limitation of this study is that the same sequence of tasks was used for all the participants: ratings prior to the behavioral measure, behavioral

measure, and final ratings. Because of this, it is not possible to discard order effects.

Tortosa et al. (2013), addressed whether facial emotional expressions exert an influence on cooperation in a repeated interactions scenario. They report that emotional expressions indeed influenced cooperation behavior. Joy and neutral expressions were associated with higher cooperation rates than anger expressions, and joy expressions were associated with marginally higher cooperation rates than neutral expressions, but the difference failed to reach significance.

Lastly, Reed and collaborators (2012) took a different approach to exploring the hypotheses that emotional expressions can convey information about intentions and influence social interactions. In their work, they examined people's facial emotional expressions while playing a social dilemma and tested whether those emotional expressions predicted cooperation behavior. The authors randomly paired their participants and recorded videos of them interacting 10 minutes before playing a single turn of the prisoner's dilemma. Then they analyzed their facial expressions using FACS (Facial Action Coding System, a standardized system for classifying emotional expressions; Ekman & Friesen, 1978) to determine whether it was possible to predict game decisions using emotional expression measures. Positive emotional expressions allowed to predict a higher probability of cooperation and, among the negative emotional expressions they coded, contempt allowed to predict a lower probability of cooperation. They also explored whether emotional expressions allow predicting not only the behavior of people displaying them but also the behavior of people against whom they played. According to their analysis, positive emotional expressions did not allow predicting the behavior of opponents, but among the negative ones, contempt allowed to predict a lower probability of cooperation in opponents. Their results suggest that although emotional expressions convey information about behavioral intentions, they may not influence others' behavior effectively. It is unclear whether their participants were able to perceive differences in behavioral intentions of others' based on emotional expressions but did not base their decisions on this information or whether they were unable to draw information about intention from the expressions displayed during the brief interactions, and thus missed those cues to guide their decisions.

In addition to the above-mentioned methodological problems of previous studies, it is important to note that only facial emotional expressions have been tested to the date, but emotional expressions in any modality are supposed to communicate behavioral tendencies associated

with basic emotions. Hence, other kinds of emotional expressions (i.e. vocal emotional expressions) should influence social interaction. It has been reported that vocal emotional expressions conveyed by prosody – variations in tone, rhythm and volume while speaking – are reliably recognized in a wide variety of contexts and both within and between cultures (Bryant & Barret, 2008; Dromey, Silveira, & Sandor, 2005; Pell, Paulmann, Dara, Alasseri, & Kotz, 2009; Scherer, Banse, & Wallbott, 2001; Wildgruber et al., 2005). It has been proposed that prosody influences social interaction by allowing to infer intentions, to adjust behavior in response to others' vocalizations and to interpret behavior as voluntary or accidental (Bestelmeyer et al., 2012; Mitchell & Ross, 2013; Sakkalou & Gattis, 2012; Sander et al., 2005; Snedeker & Trueswell, 2003). Moreover, it has been suggested that it plays an important role in social interaction (Belin, 2006; Bestelmeyer et al., 2012; Jaywant & Pell, 2010; Latinus & Belin, 2011; Monetta, Cheang, & Pell, 2008; Shriberg et al., 2001) and that in populations that simultaneously experience deficits in prosody and social interactions, prosodic impairments may underlie social interaction difficulties (Dara, Monetta, & Pell, 2008; Dimoska, McDonald, Pell, Tate, & James, 2010; Scherer et al., 2001; Stewart, McAdam, Ota, Peppe, & Cleland, 2013).

Prosodic stimuli can be readily incorporated into the same kind of procedures used in the above-described experiments, known as social dilemmas (Kollock, 1998; Van Lange, Joireman, Parks, & Dijk, 2013) because there is extensive evidence for the accurate recognition of emotions in the context of emotional prosody (Juslin & Laukka, 2003; Pell et al., 2009; Scherer, 2003). Furthermore, doing so would allow comparing the effects of vocal emotional expressions with the effects reported for facial emotional expressions: if the effects reported in previous studies are due to emotional expressions communicating underlying behavioral intentions, then the same emotions expressed in other modalities (vocal emotional expressions, in this case) should produce the same effects. Therefore, using vocal emotional expressions allows extending research on the role of emotional expressions in cooperation behavior.

In line with the previous arguments, the objective of the present study is to address whether emotional prosody can influence cooperation in the context of a social dilemma. The effects of joy, anger, and neutral expressions on behavioral measures of cooperation and judgment measures of intention are compared. The main hypothesis is that emotional prosody influences cooperation, and more specifically that anger expressions decrease cooperation behavior and intention measures, and joy expressions increase them (as compared to neutral expressions).

In addition, in the present study, all stimuli were submitted to a previous perceptual validation to ensure that they reflected the intended emotion and hence avoid limitations in the interpretation of results (e.g., Krumhuber et al., 2007; Scharlemann et al., 2001). Neutral expressions were included in order to have a proper baseline to compare cooperation levels in a meaningful way (thereby avoiding limitations like those described for the work by Stouten & de Cremer, 2010). In addition to behavioral measures, judgment measures were included to test directly whether participants perceive differences in opponents' intention according to their emotional expressions (avoiding limitations described for Reed et al. 2012). Finally, the procedures for obtaining behavioral and judgment measures were presented in a counterbalanced way across participants to control order effects (to avoid limitations described for the work by Krumhuber et al., 2007).

METHOD

Participants. Forty-eight undergraduate students ranging from 18 to 25 years old (mean age = 19.81; SD = 1.81; 11 male), native Spanish speakers without hearing or language disabilities participated for course credit. Five additional students were allowed to participate because of the credit offering, but their data were excluded to avoid result interpretation difficulties due to them taking part in the stimuli validation procedure described below. A power analysis using G*Power 3.1.7 (Faul, Erdfelder, Lang, & Buchner, 2007) showed that a total sample of 46 people would be needed to detect medium size effects (partial $\eta^2 = 0.06$) with a power of 0.8 and $\alpha = .05$.

Stimuli. Short recordings of the phrase "Let's play" ("Vamos a jugar") said with joy, anger or a neutral expression were used. For each emotion, 20 recordings were included; therefore, a total of 60 stimuli were used in the experiment (3 emotions X 20 recordings).

The criterion for considering a recording as a valid exemplar of the emotion was to be correctly recognized at least three times the expected recognition rate by chance in the validation procedure described below. For each emotion, the recordings with the highest recognition rates were selected. The 60 stimuli included in the present experiment were correctly recognized on average at 3.94 times chance level (SD = 0.59).

Additional details about stimuli recording and validation are provided in what follows.

Stimuli recording and validation

The stimuli were recorded by 20 individuals (10 male and 10 female) between 18 and 26 years old with experience in acting. Each of them recorded several instances of the phrases "Let's play" ("Vamos a jugar"), "I will defect" ("Voy a traicionar") and "I will cooperate" ("Voy a cooperar") said with joy, anger, sadness, fear, disgust and in a neutral manner, thus obtaining 18 stimuli types (3 Phrases X 6 Emotions). Recordings were submitted to a low-band pass filter in order to remove propositional content for the validation procedure only; low-band pass filters allow removing most segmental information (phonemes) sparing prosodic information (Bryant & Barret, 2008; Lakshminarayanan et al., 2003; Nazzi, Bertoncini, & Mehler, 1998). It was decided to present filtered recordings in the validation procedure to avoid the influence of any variable other than prosody in participants' responses.

A total of 810 filtered recordings were presented to an independent group of 20 individuals, college students between 18 and 26 years old, none of which participated in the recording procedure. Their task was choosing which emotion (joy, anger, sadness, fear, disgust or neutral) represented each recording in a forced-choice procedure. No participant recognized any phrase ("Let's play", "I will defect" nor "I will cooperate"), confirming that the filter was effective for removing phonemic information, and thus participants' responses were based on prosody. Only stimuli that were correctly perceived as the intended emotion at least three times the expected recognition rate by chance were considered as valid, and among them, the ones with the highest recognition rates were used for this experiment.

In the present experiment, recordings were presented unfiltered so that the phrase "Let's play" ("Vamos a jugar") was clearly recognizable (Recordings of the phrases "I will defect" and "I will cooperate" were not included in the present experiment). Among the pool of valid stimuli, the 20 most accurately recognized stimuli representing joy, anger, and neutral emotions were selected for this experiment (stimuli representing sadness, fear and disgust were not used); included stimuli were roughly balanced in gender of the encoder (56% male); stimuli were correctly recognized on average at 3.94 times chance level (SD = 0.59) in the validation procedure.

Apparatus. The experimental procedure took place in a quiet room. The stimuli were presented using professional earphones (Shure SRH940) at a comfortable volume for the participant. Stimuli presentation and response recording were controlled by Psychtoolbox for Matlab (Brainard, 1997; Pelli, 1997) in a Hewlett-Packard a6410la desktop computer.

Procedure. Upon arrival at the laboratory, general demographic data were recorded, participants were informed that their name was only going to be used for giving them course credit and that their responses were anonymous. Afterwards, the instructions were presented on the screen, including three practice trials; subsequently, any doubts or questions were answered. An experimental game block and a perceptual judgment block were presented according to a counterbalanced design, where each participant was randomly assigned to a task order group: game block first and judgment block later or the opposite task order. In both blocks each of the 60 stimuli was presented once, the presentation order was pseudorandom, avoiding the presentation of stimuli depicting the same emotion more than twice in a row. Therefore, 60 trials were presented in each task (3 emotions x 20 recordings).

In the experimental game block, the assurance dilemma (Kollock, 1998), depicted as a hypothetical bets situation was used (participants received no monetary compensation contingent on the game) with the options *cooperate* ("cooperar") and *defect* ("traicionar"). The hypothetical payoff matrix is shown in Table 1.

Table 1. Payoff Matrix. Consequences for players given their combination of choices.

		PLAYER 2	
		Cooperate	Defect
PLAYER 1	Cooperate	\$300/\$300	\$0/\$100
	Defect	\$100/\$0	\$100/\$100

Note. Number pairs represent the consequences for Player 1 and Player 2 depending on the combination of their choices. The first number of the pair represents the consequence for Player 1 and the second number the consequence for Player 2. The \$ sign represents Mexican pesos.

Participants were informed that they were going to play a single turn against each simulated opponent, that they would listen to a short voice recording of the opponent in each trial, that the objective was to maximize hypothetical benefits, and that opponents' behavior would mimic the

patterns observed in real people, but, in fact, the probability of cooperation of each simulated opponent was constant (0.5) regardless of the emotion conveyed by prosodic stimuli. It was preferred to inform specifically that opponents were simulated as it was judged that making participants believe that they were sequentially playing against 60 individual opponents in different emotional states was unrealistic. Note that previous experiments have detected effects of emotions on cooperation even when the participants know that opponents are fictitious (e.g. Tortosa et al., 2013).

In each trial of the experimental game block the following sequence of events occurred: First, a prosodic stimulus reflecting joy, anger or a neutral expression was presented; afterwards, the payoff matrix was presented, and the participant decided whether cooperating or defecting by pressing the keys "1" or "2" respectively; lastly, feedback depending on the participant's and opponent's responses (opponents' probability of cooperation was 0.5 regardless of the emotional expression) was displayed. Participants' decisions in each trial were registered (see the upper panel of Figure 1 for a display of the sequence of events in a trial).

In the perceptual judgment block, the event sequence was as follows: First, a prosodic stimulus reflecting joy, anger, or a neutral expression was presented, afterwards, the participant's judged probability of cooperation for the opponent was registered using a 7-point Likert scale, lastly participant's own intention to cooperate was registered using a 7-point Likert scale (using the keys "1" to "7", with higher numbers representing higher perceived probability of cooperation or intention to cooperate, respectively). The lower panel of Figure 1 displays the sequence of events in a trial.

RESULTS

Three dependent measures were analyzed: cooperation behavior, perception of opponent's probability of cooperation and judged probability of own's cooperation. All statistical tests were performed using $\alpha = 0.05$ using SPSS version 21.0.

Each dependent measure was analyzed using a factorial ANOVA including the within-subjects factor "emotion" (comparing joy, anger, and neutral expressions) and the between-subjects factor "task order" (whether the participant completed the game task first and the judgment task second or the reverse order). Mauchly's W sphericity tests were applied to each analysis. Whenever a significant deviation of the sphericity assumption was detected, the Greenhouse-Geisser adjustment was applied to degrees of

freedom for that test. In those instances, only adjusted degrees of freedom are reported. Because contrasts among all pairs of emotional expressions were tested for each dependent variable, post-hoc analyzes were performed using the Bonferroni adjustment to keep a global alpha level equal to .05. This adjustment allowed to keep a conservative threshold for considering that any particular pairwise comparison was significant. The use of conservative contrasts was considered important because there are conflicting results in previous experiments, particularly regarding the differences of cooperation levels between joy and neutral expressions (Eckel & Wilson, 2003; Krumhuber et al., 2007; Reed et al., 2012; Scharlemann et al., 2001; Tortosa et al., 2013).

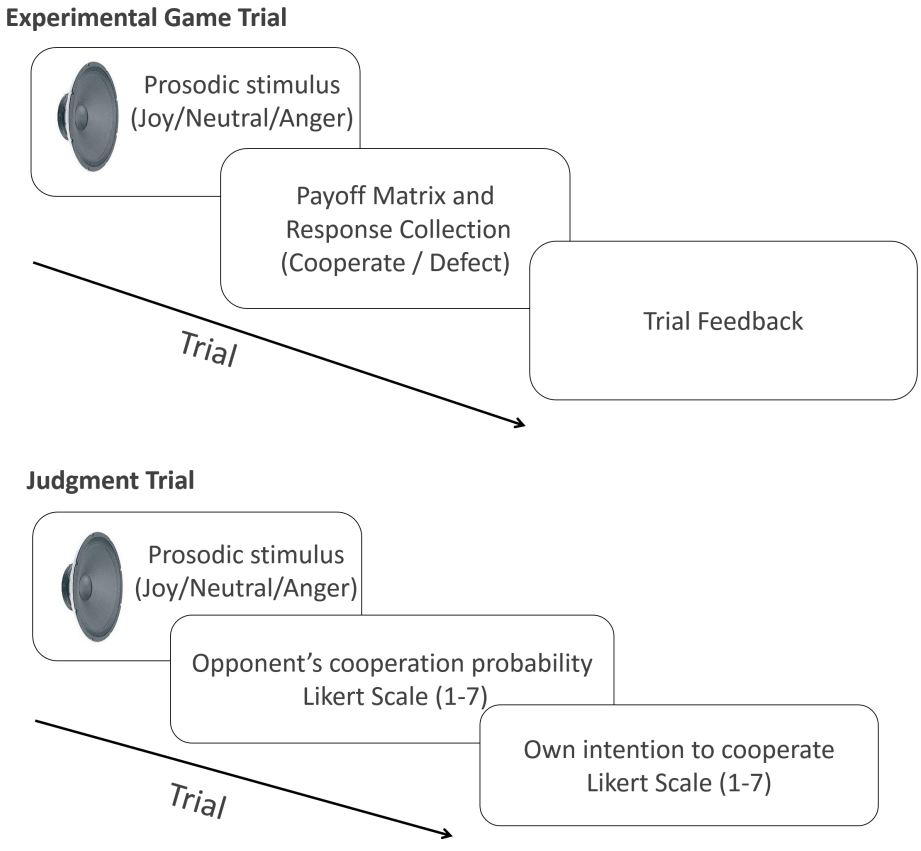

Figure 1. Sequences of trial events

The main dependent measure was cooperation behavior. For each participant, the proportion of turns in which he/she cooperated out of the 20 stimuli depicting each emotion was calculated. Accordingly, a single data point was obtained for each emotion from each participant. Since proportion data were analyzed, all proportions were submitted to an arcsine transformation before analysis. This transformation allows to better suit the normality assumption for statistical tests since crude proportions are by definition non-normal because they are limited to values between 0 and 1; arc-sine transformation allows normalizing proportion data by extending the range of the distribution (Kenny, 1987). Transformed proportions were analyzed using a factorial ANOVA including the within-subjects factor "emotion" and the between-subjects factor "task order". ANOVA's results showed a main effect of the "emotion" factor, $F(1.65, 75.82) = 49.37$, $p < .01$), partial $\eta^2 = 0.52$, and no main effect of the "task order" factor, $F(1, 46) = 2.59$, $p = .12$, partial $\eta^2 = 0.05$, nor a significant interaction effect, $F(1.65, 75.81) = 0.22$, $p = .75$, partial $\eta^2 = 0.005$. As no main effect of task order nor an interaction were detected, the groups from the two different task orders were collapsed into a single group, and data were analyzed using a repeated measures ANOVA. Results showed a main effect of emotion, $F(1.66, 77.85) = 50.2$, $p < .01$, partial $\eta^2 = 0.52$. Post-hoc tests with Bonferroni adjustment for multiple comparisons were performed. Pairwise comparisons showed a significant difference in cooperation proportions for joy vs. anger, $t(47) = 9.25$, $p < .01$, and for neutral vs. anger, $t(47) = 9.65$, $p < .01$, but no difference between joy and neutral expressions, $t(47) = 1.97$, $p = .054$. Joy and neutral expressions were associated with higher cooperation proportions than anger expressions. Moreover, joy expressions were associated with higher cooperation proportions than neutral expressions, as expected, but failed to reach significance. Figure 2 illustrates this pattern of results.

In addition to the behavioral measure of cooperation proportion, two perceptual judgment measures were obtained: "perception of opponent's probability of cooperation" and "own's probability of cooperation". For each of the perceptual measures, the median Likert judgment that the participant provided for the 20 stimuli depicting each emotion in the perceptual judgment task were obtained. Accordingly, for each perceptual measure, a single data point was obtained for each emotion from each participant. The resulting median Likert judgment measures for "perception of opponent's probability of cooperation" and "own's probability of cooperation" were analyzed using a factorial ANOVA including the within-subjects factor "emotion" and the between-subjects factor "task order".

For the perception of opponent's probability of cooperation measure results showed a main effect of the "emotion" factor, F (1.64, 75.23) = 97.02, p < .02, partial η^2 = 0.68, and no main effect of the "task order" factor, F (1, 46) = 1.08, p = .3, partial η^2 = 0.023, nor a significant interaction effect, F (1.64, 75.23) = 1.4, p = .25, partial η^2 = 0.029. Given that neither a main effect of "task order" nor an interaction were detected, groups from the two different task orders were collapsed into a single group, and data were analyzed using a repeated measures ANOVA. Results showed a main effect of emotion, F (1.62, 75.97) = 96.2, p < 0.001, partial η^2 = 0.67. Post-hoc tests with Bonferroni adjustment for multiple comparisons were performed. Pairwise comparisons showed a significant difference in perception of opponent's intention to cooperate between all pairs: joy vs. anger, t (47) = 11.34, p < 0.001, neutral vs. anger, t (47) = 8.93, p < 0.001, and joy vs. neutral expressions, t (47) = 6.97, p < 0.001. The pattern of results suggests that participants inferred different probabilities of cooperation from opponents displaying different emotional expressions, a higher probability of cooperation for those displaying joy, a lower probability of cooperation for those displaying anger, and a moderate probability of cooperation for those displaying neutral expressions. This pattern contrasts with that observed for the behavioral measure. Figure 3 illustrates the results of this analysis.

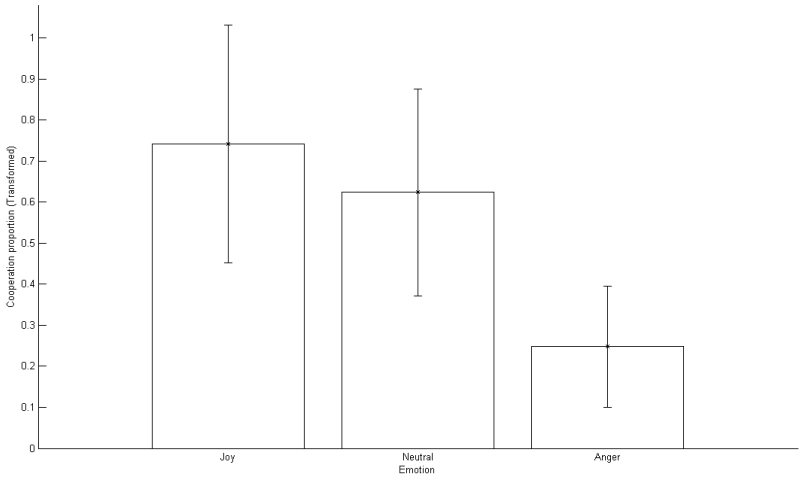

Figure 2. Behavioral Results. Cooperation proportion is plotted versus each emotion. Error bars represent standard deviation.

The pattern for the judged probability of own's cooperation measure showed less order. ANOVA's results revealed a main effect of the "emotion" factor, $F(1.73, 79.7) = 81.52$, $p < .01$, partial $\eta^2 = 0.64$, a main effect of the "task order" factor, $F(1, 46) = 5.49$, $p < .05$, partial $\eta^2 = 0.11$, and a significant interaction effect, $F(1.73, 79.7) = 3.94$, $p < .05$, partial $\eta^2 = 0.08$. Further analyses of the main effect of the factor "emotion" using Bonferroni adjustment for multiple comparisons revealed that own's probability of cooperation was different for all pairs: higher for joy than anger, $t(47) = 10.35$, $p < .01$, higher for neutral than anger, $t(47) = 8.09$, $p < .01$, and higher for joy than neutral expressions, $t(47) = 5.23$, $p < .01$. For the main effect of "task order" own's probability of cooperation was higher in the judgment-game task order group, mean = 4.01, SD = 1.83, than in the game-judgment task order group, mean = 3.64, SD = 1.52.

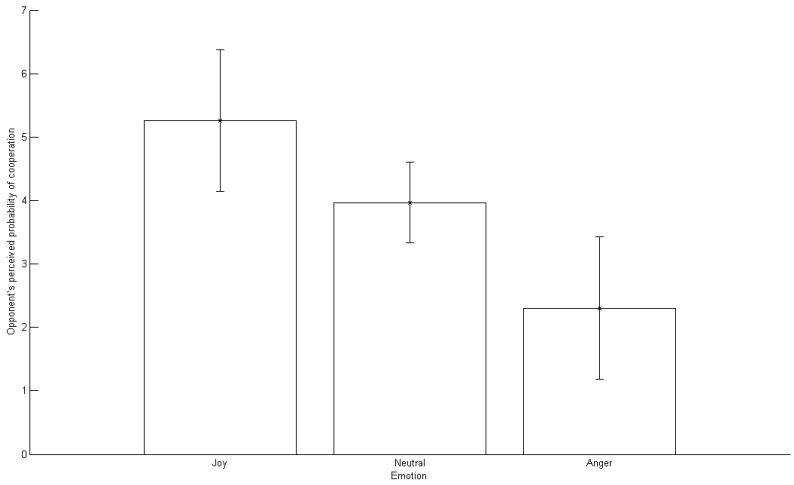

Figure 3. Opponent's perceived probability of cooperation is plotted versus each emotion. Error bars represent standard deviation. All pairwise comparisons are significantly different.

Comparing the effect of "task order" for each emotion separately revealed a significant difference for joy, $t(46) = 3.11$, $p < .05$. Own's probability of cooperation was higher for the judgment-game task order group. There were no differences due to "task order" for neither neutral, $t(46) = 1.76$, $p = .09$, nor anger expressions, $t(46) = 0.91$, $p = .37$.

Tests for the "emotion" factor on own's probability of cooperation for the judgment-game and game-judgment groups were performed separately using Bonferroni-adjusted alpha (0.017). For the judgment-game group all pairwise comparisons were significant: joy higher than anger, $t(23) = 9.38$, $p < .01$, neutral higher than anger, $t(23) = 7.78$, $p < .01$, and joy higher than neutral expressions, $t(23) = 6.08$, $p < .01$, showing a similar pattern of results to that observed for the opponent's probability of cooperation measure. Figure 4 illustrates these results.

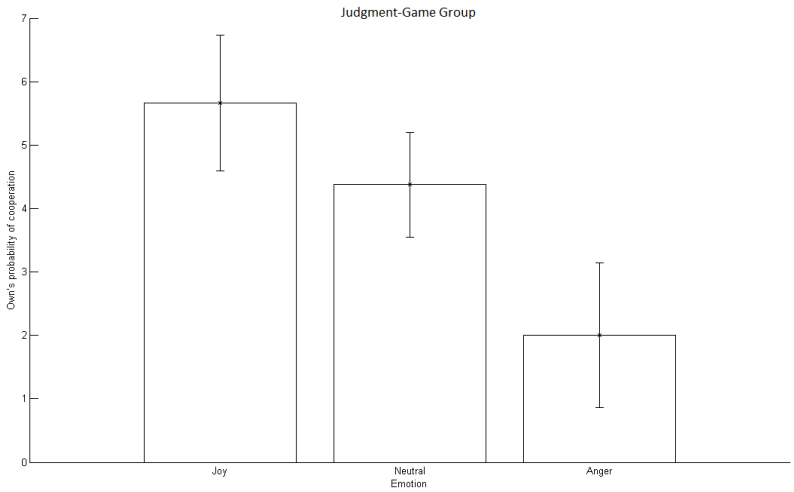

Figure 4. Own's probability of cooperation is plotted versus each emotion for the judgment-game group. Error bars represent standard deviation. All pairwise comparisons are significantly different.

In contrast, for the game-judgment group, own's probability of cooperation differed between joy and anger, $t(23) = 5.99$, $p < .01$, neutral and anger, $t(23) = 4.27$, $p < .01$, but no difference was found between joy and neutral, $t(23) = 2.32$, $p = 0.03$, showing a similar pattern of results to that observed in the behavioral measure: higher probability of cooperation for joy and neutral expressions than for anger expressions, and higher probability of cooperation for joy expressions than for neutral expressions that, nevertheless, fails to reach significance. The results are shown in Figure 5.

DISCUSSION

The purpose of the present study was extending research on the influence of emotional expressions on social interaction by addressing whether emotional prosody can influence cooperation in the context of a social dilemma. Results support the main hypothesis: emotional prosody influenced all dependent measures of cooperation.

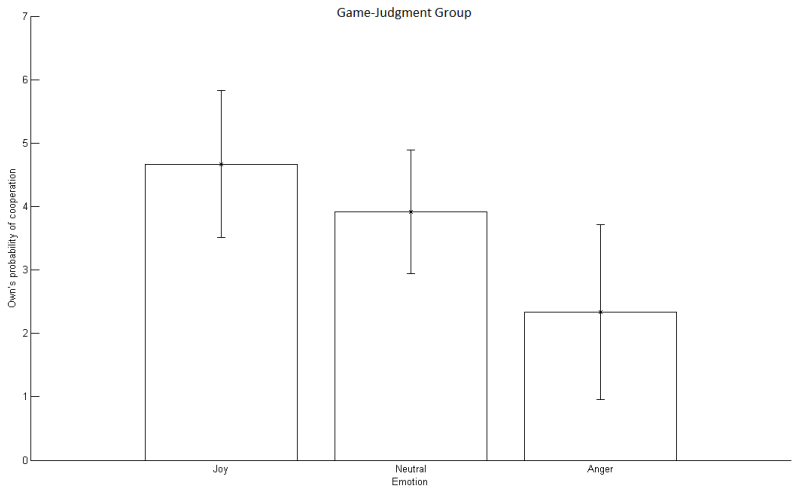

Figure 5. Own's probability of cooperation is plotted versus each emotion for the game-judgment group. Error bars represent standard deviation.

An additional contribution is that vocal emotional expressions were used in the present experiment, whereas only facial stimuli were used in previous studies (Eckel & Wilson, 2003; Scharlemann et al., 2001; Stouten & de Cremer, 2010; Tortosa et al., 2013). The fact that effects on cooperation were observed using those stimuli is in accordance with the proposal that emotional expressions allow regulating social interaction (Eckel & Wilson, 2003; Erickson & Schulkin, 2003; Izard, 1997; Marneweck et al., 2013; Scharlemann et al., 2001; Schmidt & Cohn, 2001), showing that previously reported effects are not restricted to facial expressions and supporting the notion that emotions serve an important social function (Fischer & Mansted, 2008; Gray et al., 2011; Keltner & Haidt, 1999; Van Kleef et al., 2010). Moreover, results are relevant to

prosody research, which has assumed prosody to be important for regulating social interaction (e.g. Belin, 2006; Bestelmeyer et al., 2012; Jaywant & Pell, 2010; Latinus & Belin, 2011; Monetta, Cheang, & Pell, 2008; Shriberg et al., 2001), but whose influence on social behavior has not been addressed using behavioral measures.

Regarding pairwise comparisons for the behavioral measure of cooperation proportion, joy vs. anger, and neutral vs. anger expressions revealed differences, however, it is noteworthy that no differences were detected between joy and neutral expressions (see Figure 2). Although joy expressions were associated with higher cooperation proportions than neutral expressions, still failed to reach significance ($t(47) = 1.97$, $p = .054$) whereas tests for both joy vs. anger and neutral vs. anger comparisons showed clear differences ($p < .01$ in both tests). Among the previous studies that report differences, some have not validated whether stimuli were accurately perceived as the intended emotions and have used rather high levels of alpha (0.1) for taking statistical decisions (Eckel & Wilson, 2003; Scharlemann et al., 2001). In contrast, Krumhuber et al., (2007) did include measures of perceived emotion, but collapsed them into a composite scale to which ratings for different emotions contributed, which makes difficult to assess whether their participants perceived stimuli as reflecting joy. Among the studies that do not report differences between joy and neutral expressions, Tortosa et al. (2013) used previously validated stimuli whereas Reed et al. (2012) made use of a standard system for coding facial expressions. In the present experiment, all stimuli were validated in terms of being perceived as reflecting the intended emotions and results align with those reported by Tortosa et al., (2013) and Reed et al., (2012), suggesting that expressions that are specifically perceived as joy may not increase cooperation; this issue should be addressed more closely in future studies.

An advantage of including neutral expressions as a baseline is that it allows interpreting results as reflecting that anger expressions were associated with reduced levels of cooperation (as compared to neutral expressions) whereas joy expressions did not increase cooperation. This interpretation would be difficult or impossible to conceive if control stimuli (neutral expressions) were not included in the design (one of the limitations in Stouten & de Cremer, 2010).

In face of a behavioral pattern of results such as the one described above, and if the previous stimuli validation and judgment measures were not included in the design, it would be impossible to determine whether a) participants were not able to distinguish stimuli, and thus their behavior did not differ between joy and neutral stimuli, b) participants were able to

distinguish between them, but did not perceive any difference in intention, or c) Participants were able to distinguish stimuli and indeed perceived differences in intention, but did not use this information in order to take their decisions.

The use of previously validated stimuli allows discarding explanation "a": Only stimuli that showed evidence of being distinct in terms of the emotional expression were included in this experiment.

The "perceived opponent's intention to cooperate" judgment measure (see Figure 3) also suggests that explanation "b" is not the case: Results for this variable showed differences between all emotion pairs. Participants in both task order groups expected that opponents displaying joy expressions were more cooperative than those displaying neutral expressions and that those displaying neutral expressions were more cooperative than those displaying anger expressions. This pattern of results also supports the position that explanation "a" can be discarded, as the orderly pattern of results for this judgment measure could not be expected if the stimuli were indistinguishable.

The third explanation, "c", seems more plausible. Results of the behavioral measure and the perceived opponent's intention judgment measure suggest that participants were able to distinguish stimuli and did perceive differences in intention. However, results of the second judgment measure (own's judged probability to cooperate) suggest that although differences in opponent's intention are perceived, it was not the only information that participants used to take decisions. This point deserves further elaboration:

The results for own's probability to cooperate showed that participants' *intention to cooperate* in the group that first judged and then played indeed were different when exposed to the three different emotions (see Figure 4). Participants in this group had higher intention to cooperate when exposed to joy than when exposed to neutral expressions and, in turn, higher intention to cooperate when exposed to neutral than to anger expressions. Hence, when participants were asked about what they would do if they were in the situation, but were not required to act (i.e. to actually decide whether cooperating or defecting) and had no prior experience of the situation, their intentions mirrored the perceived intentions of opponents, as revealed by results presenting the same pattern as that observed for the opponent's probability of cooperation judgment measure (compare Figures 3 and 4).

In contrast, results for own's probability to cooperate in the game-judgment group showed a different pattern: the same observed for the

behavioral measure (compare Figures 2 and 5). Participants in this group first acted (i.e. played versus the different opponents) and then judged. In this context, their intention to cooperate matched the observed pattern of behavior when actually playing. Hence, results suggest that participants' intention to cooperate did not depend only on the perceived probability of the opponent's cooperation, but on other sources, most likely prior experience.

Specifically, by being exposed to a cooperation probability (0.5) that likely was lower than expected for joy expressions, they may have adjusted their judged intention to cooperate when exposed to joy expressions; of course, this only could be done when the behavioral task preceded the judgment task, explaining the order effect. While extensive research on the role of experience in contexts of probabilistic outcomes exist (De Houwer & Beckers, 2002; Fiser, Berkes, Orbán, & Lengyel, 2010; Sternberg & McClelland, 2012), in the particular case of emotional expressions paired to probabilistic outcomes, it has been shown that they affect probability judgments even when they are not predictive of outcomes and even if participants are instructed to ignore them (Alguacil, Tudela, & Ruz, 2015; Averbeck & Duchaine, 2009); which suggests that emotional expressions constitute a hard-to-avoid influence that acts in conjunction with probabilistic consequences in those contexts (Alguacil et al., 2015); the specific way in which experience influences behavior and intention judgment in these contexts should be addressed more closely in the future. Regarding this, the use of judgment measures may provide additional insights that may not be apparent in behavioral measures.

A possible mechanism that may account for the observed results is reverse appraisal. According to appraisal theories of emotion, events that are appraised as relevant for the individual elicit emotions. Since their primary function would be preparing the organism for action, emotions would promote certain behaviors over others (Frijda, Kuipers, & ter Schure, 1989; Frijda, 1988), and their associated emotional expressions would allow observers to infer the eliciting appraisal (how an event is evaluated) and the associated behavioral intentions; a process known as "reverse appraisal" (de Melo et al., 2014). As this mechanism requires the observer to actively make inferences, it represents a process mediated by cognition and may be responsible for the current data, as they reveal that participants were sensitive to emotional expressions as well as to the experienced cooperation probabilities. Other proposed mechanisms for explaining the influence of emotional expressions on observers' behavior such as social appraisal (de Melo et al., 2014; Manstead & Fischer, 2001) and emotional contagion (de Melo et al., 2014; Van Kleef et al., 2010) assume that affective processes

drive the effects and may be less flexible than reverse appraisal. It is important to note, however, that the present experiment was not designed to pinpoint the underlying mechanism. Future studies should address more closely this subject.

Conclusion and Limitations

In short, experimental results showed that vocal emotional stimuli had an effect in a particular instance of social interaction. It does not necessarily mean, however, that they influence all kinds of social interaction nor that they are the most important variable in all situations.

Results also suggest that participants indeed perceived different intentions from prosodic stimuli, but that it was not the only important variable for their decision making (as shown by the order effect in the "own intention to cooperate" judgment measure). It is noteworthy, however, that perceived intentions of the opponents were not affected by previous experience and showed the expected pattern of results (higher expected cooperation for joy than neutral, and higher expected cooperation for neutral than anger expressions), suggesting that emotional expressions induce inferences about intentions that are hard to change, even in the presence of contradicting evidence.

In the present experiment, participants received course credit in exchange for their participation and did not receive monetary compensation related to their performance. While our results are similar to those reported in other experiments, it is not clear whether they may be different if participants received a monetary compensation contingent on performance; even though the best possible choice in the assurance dilemma is to make the same choice as the opponent, defecting ensures a small reward. In the context of real monetary rewards, that could have led to lower rates of cooperation if participants wanted to receive at least a small reward without risk. Note, however, that in experiments addressing the influence of induced emotions on decision-making using real monetary rewards, Kugler et al. (2010) replicated findings of studies that did not offer monetary rewards; which suggests that results may be similar regardless of whether real financial rewards are offered. Another possible effect of real money rewards is that they may discourage responding in a socially desirable fashion (which may distort effects of manipulations; Dodaj, 2012) as offering a concrete financial reward contingent on performance rather than a noncontingent reward (course credit) may motivate more pragmatic decisions. However, it appears that in the particular case of the present experiment, there was little motivation to respond in a socially desirable

way because participants were aware that they were playing against simulated opponents, and therefore, no social consequence could exist. Additionally, they were aware that their responses and personal data were anonymous. This issue could be addressed in following experiments by offering real monetary rewards or other kinds of contingent rewards.

Lastly, it is important to note that a neutral phrase with relation to intention was used: *"let's play"* ("vamos a jugar"). However, in normal social interaction, it is possible to communicate intentions by the phrase meaning itself. It is important to test the effects of emotional prosody in contexts where both meaning and emotion differ as it has been suggested that both emotions (Fischer & Mansted, 2008; Gray et al., 2011; Keltner & Haidt, 1999; Van Kleef et al., 2010) and prosody (Belin, 2006; Bestelmeyer et al., 2012; Latinus & Belin, 2011; Thompson & Balkwill, 2006; Thönnessen et al., 2010) are important for social interaction in a general way, not only in situations where no other cues about behavioral intentions are available.

RESUMEN

Efectos de las expresiones vocales de la emoción en la conducta de cooperación. Se ha propuesto que las expresiones emocionales son importantes en la regulación de la interacción social ya que pueden servir como pistas sobre intenciones conductuales. El tema ha sido estudiado principalmente mediante el análisis de los efectos de expresiones emocionales faciales en la conducta de cooperación pero existen resultados contradictorios sobre los efectos de expresiones emocionales en dicha conducta, particularmente en cuanto a los efectos de las expresiones de alegría. En el presente estudio se extiende la investigación sobre la influencia de expresiones emocionales en la cooperación usando expresiones emocionales vocales y se abordan deficiencias metodológicas de estudios previos. Cuarenta y ocho participantes fueron expuestos a expresiones emocionales de alegría, enojo y neutrales antes de participar en la tarea del "Dilema de la confianza", obteniéndose, en la misma, medidas conductuales y de juicio. Los resultados conductuales constituyen la primera evidencia de que expresiones emocionales no faciales influyen la conducta de cooperación en juegos experimentales y sugieren que expresiones emocionales específicas pueden tener diferentes efectos en la cooperación. Las medidas de juicio sugieren que la experiencia, además de las expresiones emocionales, también puede jugar un papel en este contexto. Se discuten las implicaciones teóricas y metodológicas.

REFERENCES

Alguacil, S., Tudela, P., & Ruz, M. (2015). Ignoring facial emotion expressions does not eliminate their influence on cooperation decisions. *Psicológica*, *36*(2), 309–335.

Ambadar, Z., Cohn, J. F., & Reed, L. I. (2009). All smiles are not created equal: Morphology and timing of smiles perceived as amused, polite, and embarrassed/nervous. *Journal of Nonverbal Behavior*, *33*(1), 17–34.

Averbeck, B. B., & Duchaine, B. (2009). Integration of social and utilitarian factors in decision making. *Emotion*, *9*(5), 599–608.

Belin, P. (2006). Voice processing in human and non-human primates. *Philosophical Transactions of the Royal Society of London. Series B, Biological Sciences*, *361*(1476), 2091–2107.

Bestelmeyer, P. E. G., Latinus, M., Bruckert, L., Rouger, J., Crabbe, F., & Belin, P. (2012). Implicitly Perceived Vocal Attractiveness Modulates Prefrontal Cortex Activity. *Cerebral Cortex*, *22*(6), 1263–1270.

Brainard, D. (1997). The Psychophysics Toolbox. *Spatial Vision*, *10*, 443–446.

Bryant, G. A., & Barret, H. C. (2008). Vocal Emotion Recognition Across Disparate Cultures. *Journal of Cognition and Culture*, *8*, 135–148.

Calvo, M. G., & Nummenmaa, L. (2015). Perceptual and affective mechanisms in facial expression recognition : An integrative review. *Cognition and Emotion*. http://doi.org/10.1080/02699931.2015.1049124

Coulson, M. (2004). Attributing Emotion to Static Body Postures: Recognition Accuracy, Confusions, and Viewpoint Dependence. *Journal of Nonverbal Behavior*, *28*, 117–139.

Dara, C., Monetta, L., & Pell, M. D. (2008). Vocal emotion processing in Parkinson's disease: Reduced sensitivity to negative emotions. *Brain Research*, *1188*, 100–111.

Darwin, C. (1965). *The expression of the emotions in man and animals*. Chicago: University of Chicago Press.

De Houwer, J., & Beckers, T. (2002). A review of recent developments in research and theories on human contingency learning. *The Quarterly Journal of Experimental Psychology: Section B*, *55*(4), 289–310.

de Melo, C. M., Carnevale, P. J., Read, S. J., & Gratch, J. (2014). Reading people's minds from emotion expressions in interdependent decision making. *Journal of Personality and Social Psychology*, *106*(1), 73–88.

Dimoska, A., McDonald, S., Pell, M. C., Tate, R. L., & James, C. M. (2010). Recognizing vocal expressions of emotion in patients with social skills deficits following traumatic brain injury. *Journal of the International Neuropsychological Society*, *16*(2), 369–382.

Dodaj, A. (2012). Social desirability and self-reports: Testing a content and response-style model of socially desirable responding. *Europe's Journal of Psychology*, *8*(4), 651–666.

Dromey, C., Silveira, J., & Sandor, P. (2005). Recognition of affective prosody by speakers of English as a first or foreign language. *Speech Communication*, *47*, 351–359.

Eckel, C., & Wilson, R. (2003). The Human Face of Game Theory: Trust and Reciprocity in Sequential Games. In E. Ostrom & J. Walker (Eds.), *Trust & Reciprocity* (pp. 245–274). Nueva York: Russel Sage Foundation.

Ekman, P., & Friesen, W. V. (1978). *Facial Action Coding System: A Technique for the Measurement of Facial Movement*. California: Consulting Psychologists Press.

Erickson, K., & Schulkin, J. (2003). Facial expressions of emotion: A cognitive neuroscience perspective. *Brain and Cognition*, *52*, 52–60.

Faul, F., Erdfelder, E., Lang, A., & Buchner, A. (2007). G*Power 3: A flexible statistical power analysis program for the social, behavioral, and biomedical sciences. *Behavior Research Methods*, *39*, 175–191.

Fischer, A., & Mansted, A. (2008). Social Functions of Emotion. In *Handbook of Emotions* (3a Edición, pp. 456–467). Nueva York/ Londres: The Guilford Press.

Fiser, J., Berkes, P., Orbán, G., & Lengyel, M. (2010). Statistically optimal perception and learning: from behavior to neural representations. *Trends in Cognitive Sciences*, *14*(3), 119–30.

Frank, M. G., & Ekman, P. (1993). Not all smiles are created equal: The differences between enjoyment and nonenjoyment smiles. *Humor: International Journal of Humor*, *6*(1), 9–26.

Frijda, N. H. (1988). The Laws of Emotion. *American Psychologist*, *43*(5), 349–358.

Frijda, N. H., Kuipers, P., & ter Schure, E. (1989). Relations among emotion, appraisal, and emotional action readiness. *Journal of Personality and Social Psychology*, *57*(2), 212–228.

Gray, H., Ishii, K., & Ambady, N. (2011). Misery Loves Company: When Sadness Increases the Desire for Social Connectedness. *Personality and Social Psychology Bulletin*, *37*(11), 1438–1448.

Hertenstein, M., Holmes, R., McCullough, M., & Keltner, D. (2009). The communication of emotion via touch. *Emotion*, *9*(4), 566–573.

Izard, C. (1997). Differential Emotions Theory. In *Human Emotions* (pp. 43–66). New York: Platinum Press.

Jaywant, A., & Pell, M. D. (2010). Listener impressions of speakers with Parkinson's disease. *Journal of the International Neuropsychological Society*, *16*(1), 49–57.

Juslin, P. N., & Laukka, P. (2003). Communication of emotions in vocal expression and music performance: different channels, same code? *Psychological Bulletin*, *129*(5), 770–814.

Keltner, D., & Haidt, J. (1999). Social functions of emotions at four levels of analysis. *Cognition & Emotion*, *13*(5), 505–521.

Kenny, D. A. (1987). Transformation. In *Statistics for the social and behavioral sciences* (pp. 73–89). Canada: Little & Brown.

Kollock, P. (1998). Social Dilemmas: The Anatomy of Cooperation. *Annual Review of Sociology*, *24*, 183–214.

Krumhuber, E., Manstead, A., Cosker, D., Marshall, D., Rosin, P., & Kappas, A. (2007). Facial dynamics as indicators of trustworthiness and cooperative behavior. *Emotion*, *7*(4), 730–735.

Kugler, T., Connolly, T., & Ordoñez, L. (2012). Emotion, Decision, and Risk: Betting on Gambles versus Betting on People. *Journal of Behavioral Decision Making*, *25*(2), 123–134.

Lakshminarayanan, K., Ben Shalom, D., Van Wassenhove, V., Orbelo, D., Houde, J., & Poeppel, D. (2003). The effect of spectral manipulations on the identification of affective and linguistic prosody. *Brain and Language*, *84*(2), 250–263.

Latinus, M., & Belin, P. (2011). Human voice perception. *Current Biology*, *21*(4), R143–R145.

Manstead, A. S. R., & Fischer, A. H. (2001). Social appraisal: The social world as object of and influence on appraisal processes. In *Appraisal processes in emotion. Theory, methods, research* (pp. 221–232).

Marneweck, M., Loftus, A., & Hammond, G. (2013). Psychophysical measures of sensitivity to facial expression of emotion. *Frontiers in Psychology*, *4*(63). http://doi.org/10.3389/fpsyg.2013.00063

Mitchell, R., & Ross, E. (2013). Attitudinal prosody: What we know and directions for future study. *Neuroscience & Biobehavioral Reviews*, *37*(3), 471–479.

Monetta, L., Cheang, H. S., & Pell, M. D. (2008). Understanding speaker attitudes from prosody by adults with Parkinson's disease. *Journal of Neuropsychology*, *2*, 415–430.

Nazzi, T., Bertoncini, J., & Mehler, J. (1998). Language Discrimination by Newborns: Toward an Understanding of the Role of Rhythm. *Journal of Experimental Psychology*, *24*, 756–766.

Pell, M. D., Paulmann, S., Dara, C., Alasseri, A., & Kotz, S. A. (2009). Factors in the recognition of vocally expressed emotions: A comparison of four languages. *Journal of Phonetics*, *37*, 417–435.

Pelli, D. (1997). The VideoToolbox software for visual psychophysics: Transforming numbers into movies. *Spatial Vision*, *10*, 437–442.

Reed, L., Zeglen, K., & Schmidt, K. (2012). Facial expressions as honest signals of cooperative intent in a one-shot anonymous Prisoner's Dilemma game. *Evolution and Human Behavior*, *33*, 200–209.

Sakkalou, E., & Gattis, M. (2012). Infants infer intentions from prosody. *Cognitive Development*, *27*(1), 1–16.

Sander, D., Grandjean, D., Pourtois, G., Schwartz, S., Seghier, M. L., Scherer, K. R., & Vuilleumier, P. (2005). Emotion and attention interactions in social cognitions: brain regions involved in processing anger prosody. *Neuroimage*, *28*(4), 848–858.

Scharlemann, J., Eckel, C., Kacelnik, A., & Wilson, R. (2001). The value of a smile: Game theory with a human face. *Journal of Economic Psychology*, *22*(5), 617–640.

Scherer, K. R. (2003). Vocal communication of emotion: A review of research paradigms. *Speech Communication*, *40*(1-2), 227–256.

Scherer, K. R., Banse, R., & Wallbott, H. G. (2001). Emotion Inferences from Vocal Expression Correlate Across Languages and Cultures. *Journal of CrossCultural Psychology*, *32*(1), 76–92.

Schmidt, K. L., & Cohn, J. F. (2001). Human facial expressions as adaptations: Evolutionary questions in facial expression research. *American Journal of Physical Anthropology*, *Suppl 33*, 3–24.

Shriberg, L., Paul, R., McSweeny, J., Klin, A., Cohen, D., & Volkmar, F. (2001). Speech and Prosody Characteristics of Adolescents and Adults With High-Functioning Autism and Asperger Syndrome. *Journal of Speech, Language, and Hearing Research*, *44*, 1097–1115.

Snedeker, J., & Trueswell, J. (2003). Using prosody to avoid ambiguity: Effects of speaker awareness and referential context. *Journal of Memory and Language*, *48*, 103–130.

Sternberg, D. a, & McClelland, J. L. (2012). Two mechanisms of human contingency learning. *Psychological Science*, *23*(1), 59–68.

Stewart, M., McAdam, C., Ota, M., Peppe, S., & Cleland, J. (2013). Emotional recognition in autism spectrum conditions from voices and faces. *Autism*, *17*(1), 6–14.

Stouten, J., & de Cremer, D. (2010). "Seeing is believing": The Effects of Facial Expressions of Emotion and Verbal Communication in Social Dilemmas. *Journal of Behavioral Decision Making*, *23*(3), 271–287.

Thompson, W. F., & Balkwill, L. L. (2006). Decoding speech prosody in five languages. *Semiotica*, (158), 407–424.

Thönnessen, H., Boers, F., Dammers, J., Chen, Y.-H., Norra, C., & Mathiak, K. (2010). Early sensory encoding of affective prosody: neuromagnetic tomography of emotional category changes. *NeuroImage*, *50*, 250–259.

Tortosa, M., Strizhko, T., Capizzi, M., & Ruz, M. (2013). Interpersonal effects of emotion in a multi-round Trust Game. *Psicológica*, *34*(2), 179–198.

Van Kleef, G. a., De Dreu, C. K. W., & Manstead, A. S. R. (2010). An interpersonal approach to emotion in social decision making: The emotions as social information model. *Advances in Experimental Social Psychology*, *42*, 45–96.

Van Lange, P., Joireman, J., Parks, C., & Dijk, E. (2013). The psychology of social dilemmas: a review. *Organizational Behavior and Human Decision Processes*, *120*(2), 125–141.

Wildgruber, D., Riecker, A., Hertrich, I., Erb, M., Grodd, W., Ethofer, T., & Ackermann, H. (2005). Identification of emotional intonation evaluated by fMRI. *NeuroImage*, *24*(4), 1233–1241.

(Manuscript received: 15 October 2015; accepted: 9 May 2016)