9th International Conference on Speech Prosody 2018
13-16 June 2018, Poznań, Poland

How to do things with(out) words? Analyzing the effects of vocal emotional expressions on cooperation behavior

Jonathan A. Caballero[1], *Marina Menez Díaz*[2],
Natalia Arias-Trejo[2], *Florente López Rodriguez*[2], *Marc D. Pell*[1]

[1]McGill University, School of Communication Sciences and Disorders, Montreal, Canada
[2]Universidad Nacional Autónoma de México, Facultad de Psicología, Mexico City, Mexico

jonathan.caballeromeneses@mail.mcgill.ca, menez@unam.mx,
nariast@unam.mx, florente@unam.mx, marc.pell@mcgill.ca

Abstract

The importance of prosodic variations in social interaction contexts has been highlighted but their effects on the regulation of specific behaviors are rarely addressed. One of the most widely researched prosodic distinctions in psychology is emotional prosody. In perceptual studies, the capacity for identifying emotions through prosodic variations has been widely addressed, but the relevance of this skill for social interaction has not been tested. However, based on theoretical accounts of emotion and empirical findings of the influence of facial emotional expressions in experiments that address their role in cooperation, it is possible to formulate predictions about the effects of emotional prosody in social interaction behavior. For this objective, in the present work, the effects of emotional prosody on cooperation were addressed, and its interaction with other behavioral intention cues (propositional content) was analyzed. Findings show that emotional prosody influences cooperation behavior but its joint effects with propositional content suggest that a complex inferential process may underlie the integration of contextual and behavioral intention cues to guide behavior. The significance of results and potential for extending future research are discussed.

Index Terms: emotional prosody, social interaction, pragmatics, speech processing, cue integration

1. Introduction

In prosody research, its importance for social interaction contexts is often highlighted. It has been emphasized that prosodic variations allow transmitting socially relevant attributes that are processed as a non-linguistic, more primitive mode of communication that would lie at the basis of human social interaction [1], [2]. In this respect, it is possible to perceive the emotional state from prosody [3]–[5]. Beyond emotions, prosody conveys cues about identity and group membership (e.g. [6]), personality traits [7], and attitudes [8]. On top of that, a variety of linguistic distinctions for which prosody is fundamental such informational structure, politeness, evidentiality and epistemicity [9], [10], [11] complete a wide set of prosodic functions and suggest an important role of prosody in social interaction. Among the proposed effects of prosody for social interaction, inferring intentions from prosody, adjusting behavior in response to others' vocalizations and interpreting behavior as voluntary or accidental have been proposed [8], [12], [13].

As well, different conditions are characterized by concurrent deficits in prosody and social interaction, including autistic spectrum disorders, Asperger´s syndrome, Parkinson disease and some Traumatic Brain Injury patients [14]–[18]. Taken together, these findings highlight the fundamental role of prosody in social cognition and its importance for coping with everyday demands, as basic and ubiquitous as interacting with others.

Yet, even if prosody is proposed as an important variable for regulating interpersonal interactions, and despite concurrent difficulties in prosody and social interaction in diverse populations, most of the time, the influence of prosodic variations on listeners' behavioral responses is not addressed (prosodic entrainment being a notable exception, see [19], [20]). In contrast, based mainly on perceptual data, it is argued that prosody is important for interaction, but studies rarely address directly the role that prosody plays in regulating behavior in social interaction settings.

Emotional prosody – the encoding of emotions in prosody and the corresponding capability to decode them – may be a suitable starting point for addressing more directly the role of prosody in social interaction. In this regard, note that there is extensive evidence about recognition and discrimination of emotions in prosody [3],[5] and emotional expressions in general (i.e. not restricted to prosody) had been proposed as an important factor in social interaction [21]–[23]. Specifically, as emotions are associated with adaptive behavioral tendencies and recognizable universal expressions, observers should be able to predict likely behaviors of people displaying emotions and hence to behaviorally react to the predicted behaviors. In this sense, emotional expressions effectively play a regulatory role in the context of social interaction [22]–[26]. Accordingly, emotional prosody – as a particular way of communicating emotions – provides a means to test the proposed effects of prosody on social interaction regulation, benefiting from previous empirical studies on perception of emotional prosody and from the theoretical background of emotion research.

In the context of facial emotional expressions, methodologies for the study of social interaction in interdependent situations known as social dilemmas have been used to address their effects on cooperation [21], [27], [28]. Since theoretical accounts of emotions predict the same effects of emotional expressions regardless of the modality in which they are transmitted, we decided to address the effects of emotional prosody on cooperation behavior, as results should be similar to those obtained in research using facial emotions. However, as prosody constitutes an integral part of language

10.21437/SpeechProsody.2018-53

which, unlike facial expressions, allows to communicate information accurately and nuancedly through propositional content, the scope of the current research widened to address how prosody *and* propositional content play a joint role in listeners' behavioral responses, as the joint effects of those cues, can lead to very different interpretations (e.g. [29], [30]).

2. Method

2.1. Participants

A group of 48 undergraduate students ranging from 18 to 25 years old (mean age = 19.81; SD= 1.79; 13 male) participated for course credit. Participants were required to be native Spanish speakers without hearing or language disabilities.

2.2. Stimuli

Short recordings of the phrases "Let's play" ("*Vamos a jugar*"), "I will cooperate" (*"Voy a cooperar"*) and "I will betray" (*"Voy a traicionar"*) said with prosody conveying joy, anger or a neutral expression were used. For each combination of emotion and phrase, 20 recordings were included; therefore, a total of 180 stimuli were used in the experiment (3 Emotions x 3 Phrases x 20 recordings). All stimuli were taken from a pool of validated stimuli consisting only on recordings that were recognized at least 3 times the expected rate by chance by independent groups of raters in a forced recognition task (using the same methodology described in [31]), which included recordings of 40 speakers (20 female) with lay experience in acting (theater, opera and dubbing actors).

2.3. Procedure

Participants took part in an experimental game and a perceptual judgment task. For the present report, only the experimental game task will be considered. The scenario was depicted as a hypothetical bets situation where the participant, as well as the simulated opponent, have two possible options in the game: *cooperate* and *betray*. The outcomes for the participant and the opponent depend on the combination of decisions, which are made simultaneously, and without knowing in advance what the other party will do. The payoff matrix is shown in Table 1, with the number pairs representing the consequences for the Participant and Opponent; the first number of each pair represents the consequence for the Participant, while the second number the consequence for the opponent. Note that betraying ensures a small gain regardless of the other party decision, while cooperating leads to a larger gain, but only if the other party also cooperates (hence the name of *Assurance Dilemma* [32]). Participants were informed that they would listen to a short voice recordings at the beginning of the trials, that the objective was to maximize hypothetical benefits, and that opponents' behavior would mimic [27], [31] the patterns observed in real people (although, in fact, the probability of cooperation was fixed to 0.5 regardless of the emotion and phrase).

After the instructions and two practice trials, each of the 180 stimuli were presented in a single trial in a pseudorandom order (avoiding a consecutive presentation of the same emotion more than twice in a row, and of the same phrase more than 5 times in a row). In each trial, first, a recording was presented, immediately after, a matrix with the possible choices for the participant and opponent with their associated outcomes was displayed, the participant had to choose whether cooperating or defecting, and then the feedback for the trial was displayed (participant's and opponent's decisions and monetary outcomes for the trial).

Table 1. Payoff Matrix.

		Opponent	
		Cooperate	Betray
Participant	Cooperate	\$300/\$300	\$0/\$100
	Betray	\$100/\$0	\$100/\$100

3. Results

For each participant, the proportion of turns in which s/he cooperated out of the 20 stimuli depicting each combination of emotion and phrase was calculated. Hence, 9 proportions were calculated for each participant, representing the 9 different stimulus types resulting of the combination of the 3 emotions (joy, anger and neutral) and 3 phrases ("I will cooperate", "I will betray" and "Let's play"). Proportions were submitted to an arcsine transformation and then analyzed using a factorial ANOVA including the within-subjects factors "emotional prosody" (comparing joy, anger, and neutral expressions; hereafter referred to simply as "emotion") and "phrase" (comparing the cooperative, uncooperative and neutral phrases, represented by "I will cooperate", "I will betray", and "Let's play", respectively).

Results showed a main effect of the "emotion" factor ($F(2,94) = 60.26$, $p < .01$, partial $\eta^2 = 0.56$) on cooperation behavior. Where joy and neutral expressions produced higher cooperation than anger expressions, while the difference between joy and neutral expressions was not significant (see Figure 1).

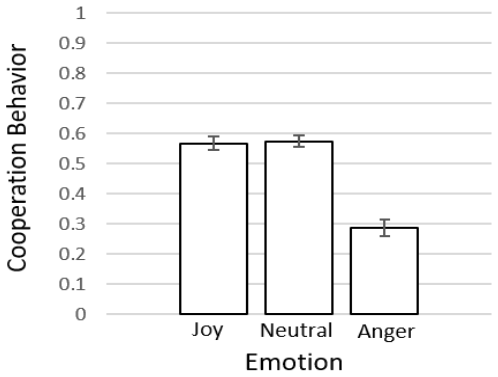

Figure 1. Main effect of Emotion on Cooperation Behavior.

Additionally, a main effect of the "phrase" factor was detected, ($F(1.63,76.48) = 8.88$, $p < .01$, partial $\eta^2 = 0.16$); cooperative ("I will cooperate") and neutral ("Let's play") phrases were associated to higher cooperation than uncooperative ("I will betray") phrases; cooperation behavior did not differ between cooperative and neutral phrases (see Figure 2).

Lastly, the interaction of "emotion" and "phrase" was also significant ($F(4,188) = 11.82$, $p < .01$, partial $\eta^2 = 0.2$). This effect is shown in Figure 3, and Table 2 shows pairwise comparisons.

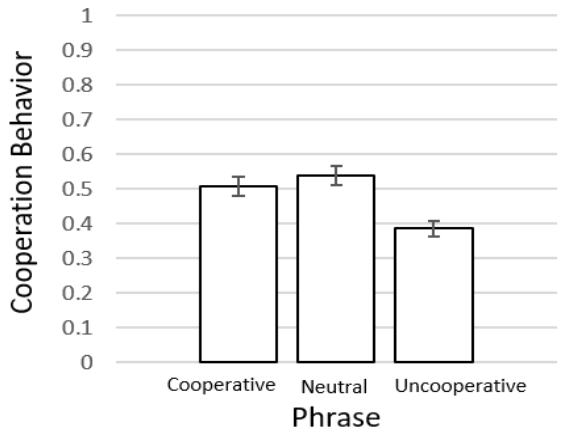

Figure 2. Main effect of Phrase on Cooperation Behavior.

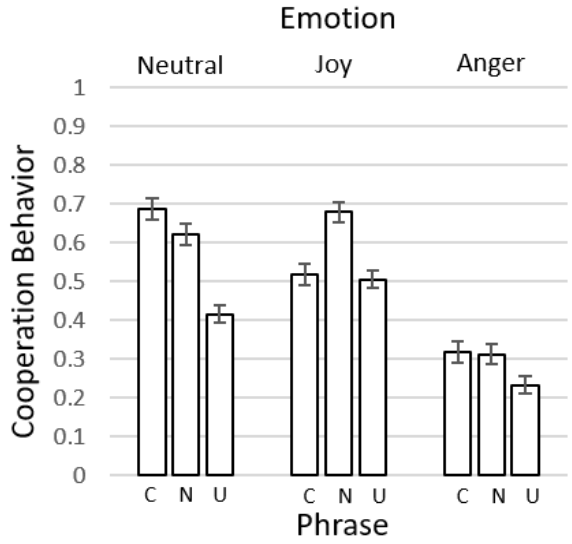

Figure 3. Interaction of Emotion and Phrase. (C: Cooperative phrase "I will cooperate"; N: Neutral phrase "Let's play"; U: Uncooperative phrase "I will betray").

4. Discussion

Using a methodology for the study of cooperation behavior, we addressed how prosody influences one type of social interaction behavior.

The main effect of emotion revealed that in this simulated social situation, listeners were less willing to cooperate when they listened to anger prosody than when listening to joy or neutral prosody. This is consistent with recent findings manipulating emotional expressions through prosody using a similar methodology [31], and with research addressing the effects of facial emotional expressions [27].

The main effect of phrase revealed that participants were less willing to cooperate when the opponent directly announced betrayal ("I will betray"), as compared to when the opponent announced cooperation ("I will cooperate") or simply said ("Let's play"). The lack of differences in cooperation for the last two phrases may indicate a rather positive interpretation of the opponent's intentions when using a phrase related to the signaling of an imminent joint activity: in Spanish, "Vamos a jugar" ("Let's play") can be interpreted as an invitation or proposal (or, more specifically, as a *commissive speech act* [33], [34]).

Table 2. Pairwise comparisons (Emotion x Phrase interaction).

Emotion	***Phrase***	*Cooperate*	*Play*	*Betray*
	Cooperate	-	n.s.	*
Neutral	*Play*	n.s.	-	*
	Betray	*	*	-
	Phrase	*Cooperate*	*Play*	*Betray*
	Cooperate	-	*	n.s.
Joy	*Play*	*	-	*
	Betray	n.s.	*	-
	Phrase	*Cooperate*	*Play*	*Betray*
	Cooperate	-	n.s.	n.s.
Anger	*Play*	n.s.	-	n.s.
	Betray	n.s.	n.s.	-

Note. The table summarizes pairwise comparisons between the three different phrases (I will *Cooperate*, Let's *Play*, I will *Betray*) separately for each emotion (Neutral, Joy, and Anger). A global level of α=0.05 with a Bonferroni correction for multiple comparisons was used, the * symbol means that the difference between the emotion pair conformed by the row and column was significant; n.s. means that the difference was not statistically significant.

Note that Prosody produced a larger effect size than Phrase as suggested by partial η^2 values, a remarkable finding given that two out of the three phrases (I will cooperate / I will betray) signaled a specific behavioral intention in the game context. However, a closer look at the interaction effect suggests that in contexts where different cues of intention are present, such as emotional prosody and phrases announcing possible courses of action, people tend to integrate the sources of information in order to make decisions and adjust their behavior. Note that, for neutral prosody (see leftmost panel of Figure 3), the pattern of results for the different phrases corresponded with the main effect of Phrase (Figure 2); however, for anger prosody (rightmost panel of Figure 3), no differences were detected, participants displayed low levels of cooperation regardless of the phrase used by opponents. And – maybe the most remarkable observation –: for joy prosody (see middle panel of Figure 3), the cooperative phrase ("I will cooperate") not only did not increase cooperation, as compared to "Let's play", but actually decreased it to a comparable level to that observed for the uncooperative phrase ("I will betray").

This joint effect, not necessarily easy to predict, can be interpreted as reflecting inferential processes leading to an indirect meaning, as if too many cues for cooperation ("I will cooperate" + joy prosody) were interpreted as unreliable or even sarcastic in the current experiment (anecdotally, stimuli were described by participants using terms such as "sarcastic", "ironic", or "mocking" in contrast with other experiments, in which the phrases remained constant and only prosody was manipulated [31], [35], where they were usually described using emotion-related terms). Also, if the "Let's play" phrase was interpreted as an invitation, and hence signaling a positive social stance towards the listener, it would represent a perfect match when said using joy prosody, reinforcing an already positive interpretation. Those interpretations should be taken with caution, though, as the experiment was not designed to address these forms of indirect meanings. Future research may help to enlighten how people integrate and interpret in/congruent cues and how they use them to guide behavior, and may as well benefit to consider other ways of describing emotional expressions [36], an idea that already under scrutiny [35].

Coming back to the issue of the importance of prosody in social interaction, note that it has been reported that individuals belonging to populations who experience social interaction difficulties at psychologically clinical levels – such as people with autism spectrum disorders – react differently to utterances that simultaneously vary in emotional prosody and the particular words of the message. As compared with healthy subjects, they tend to base their interpretations mainly on words and tend to disregard or underweight prosodic variations [15], [16].

While this may not be a problem in contexts where cues point to the same interpretation, in everyday interaction, meanings are not always literal; frequently, what is said (*sentence meaning*) and what is intended (*speaker meaning*) by uttering a particular phrase do not fully correspond [34], [37]. Correctly understanding indirect meanings requires the successful integration of diverse cues, including prosody, gestures, context, semantics and syntax [38]–[42], and of cognitive mechanisms such as Theory of Mind (the ability to infer others' mental states and intentions for explaining and predicting their behavior), semantic processing, and executive functions [38], [41]–[44]. Following this line of thought, it is not surprising that different populations with developmental, neurodegenerative, and thought disorders, as well as patients with brain lesions, do not only experience difficulties in the context of emotion perception, but also in social perception tasks and for understanding indirect meanings (c.f. [45], [46]).

A better understanding of the way in which prosody and other cues affect the perception of indirect meanings and subsequent behavioral responses in healthy populations may allow to better understand how the perceptual deficits in clinical populations relate to their social interaction difficulties. For this end, empirical research on prosody as well as classic elaborations in pragmatics [33], [34], [47] have been successful at inspiring research beyond the field of linguistics – where it has been extensive – to recent psychological and neurophysiological studies (see [46], [48]–[51]).

5. Conclusion

Present results show that emotional prosody interacts with lexical cues to influence listeners' social behavior. Specifically, phrases recorded without any emotional intention influenced listeners' behavior in a consistent way with the semantically encoded intention in the context of the Assurance Dilemma, while phrases of angry expressions decreased cooperation regardless of the lexical cues, and recordings of phrases said with joy lead to a pattern of results suggesting nonliteral interpretations.

Exploring the role that prosody plays in social interaction situations allows moving one step forward. By now, scientists have made good progress in understanding how prosody encodes different distinctions (acoustic analysis, intonational phonology), and how people perceive (perceptual and psychological studies) and process (neurobehavioral studies) such distinctions. However, in real life, we go beyond recognizing and decoding information in prosody. We integrate prosody along with other sources of information such as the propositional content and the context in which the utterances are spoken, our own goals and objectives, and we behave in consequence, taking into account complex inferences derived from all these rich information sources.

Using methodologies derived from game theory such as social dilemmas to explore the role of prosody in social interaction opens an interesting avenue of research as it offers simple social interaction situations in which contextual cues, incentives, goals, and possible behaviors can be experimentally controlled, and, despite their simplicity, allow exploring how different cues are integrated and lead to behavioral actions, as opposed to purely perceptual measures and recognition paradigms.

6. Acknowledgements

The experiment described in this paper is part of the first author's doctoral dissertation and was supported by a scholarship from Consejo Nacional de Ciencia y Tecnologia (CONACYT, # 280423) awarded to Jonathan A. Caballero and UNAM-DGAPA PAPIIT RN305412 grant awarded to Marina Menez Díaz.

7. References

[1] P. Belin, "Voice processing in human and non-human primates," *Philos. Trans. R. Soc. Lond. B. Biol. Sci.*, vol. 361, no. 1476, pp. 2091–2107, Dec. 2006.

[2] M. Latinus and P. Belin, "Human voice perception," *Curr. Biol.*, vol. 21, no. 4, pp. R143–R145, Feb. 2011.

[3] M. D. Pell, S. Paulmann, C. Dara, A. Alasseri, and S. A. Kotz, "Factors in the recognition of vocally expressed emotions: A comparison of four languages," *J. Phon.*, vol. 37, pp. 417–435, 2009.

[4] Scherer, "Vocal communication of emotion: A review of research paradigms.," *Speech Commun.*, vol. 40, no. 1–2, pp. 227–256, 2003.

[5] P. N. Juslin and P. Laukka, "Communication of emotions in vocal expression and music performance: different channels, same code?," *Psychol. Bull.*, vol. 129, no. 5, pp. 770–814, 2003.

[6] M. J. Munro, T. M. Derwing, and C. S. Burgess, "Detection of nonnative speaker status from content-masked speech," *Speech Commun.*, vol. 52, pp. 626–637, 2010.

[7] C. Nass and K. Lee, "Does Computer-Synthesized Speech Manifest Personality? Experimental Tests of Recognition, Similarity-Attraction, and Consistency-Attraction," *J. Exp. Psychol. Appl.*, vol. 7, pp. 171–181, 2001.

[8] R. Mitchell and E. Ross, "Attitudinal prosody: What we know and directions for future study," *Neurosci. Biobehav. Rev.*, vol. 37, no. 3, pp. 471–479, 2013.

[9] C. Féry and M. Krifka, "Information Structure : Notional

Distinctions , Ways of Expression," *Unity and diversity of languages*. pp. 123–136, 2008.
[10] E. Ofuka, J. D. McKeown, M. G. Waterman, and P. J. Roach, "Prosodic cues for rated politeness in Japanese speech," *Speech Commun.*, vol. 32, no. 3, pp. 199–217, 2000.
[11] P. Roseano, M. González, J. Borràs-Comes, and P. Prieto, "Communicating Epistemic Stance: How Speech and Gesture Patterns Reflect Epistemicity and Evidentiality," *Discourse Process.*, vol. 53, no. 3, pp. 135–174, 2014.
[12] E. Sakkalou and M. Gattis, "Infants infer intentions from prosody.," *Cogn. Dev.*, vol. 27, no. 1, pp. 1–16, 2012.
[13] J. Snedeker and J. Trueswell, "Using prosody to avoid ambiguity: Effects of speaker awareness and referential context," *J. Mem. Lang.*, vol. 48, pp. 103–130, 2003.
[14] Paul, A. Augustyn, A. Klin, and F. Volkmar, "Perception and Production of Prosody by Speakers with Autism Spectrum Disorders," *J. Autism Dev. Disord.*, vol. 35, pp. 205–220, 2005.
[15] M. Stewart, C. McAdam, M. Ota, S. Peppe, and J. Cleland, "Emotional recognition in autism spectrum conditions from voices and faces.," *Autism*, vol. 17, no. 1, pp. 6–14, 2013.
[16] J. L. Lindner and L. A. Rosén, "Decoding of emotion through facial expression, prosody and verbal content in children and adolescents with Asperger's syndrome," *J. Autism Dev. Disord.*, vol. 36, no. 6, pp. 769–777, 2006.
[17] A. Jaywant and M. D. Pell, "Listener impressions of speakers with Parkinson's disease," *J. Int. Neuropsychol. Soc.*, vol. 16, no. 1, pp. 49–57, Jan. 2010.
[18] L. Monetta, H. S. Cheang, and M. D. Pell, "Understanding speaker attitudes from prosody by adults with Parkinson's disease," *J. Neuropsychol.*, vol. 2, pp. 415–430, Sep. 2008.
[19] S. A. Borrie, N. Lubold, and H. Pon-Barry, "Disordered speech disrupts conversational entrainment: a study of acoustic-prosodic entrainment and communicative success in populations with communication challenges," *Front. Psychol.*, vol. 6, no. 1187, 2015.
[20] Š. Beňuš, "Social Aspects of Entrainment in Spoken Interaction," *Cognit. Comput.*, vol. 6, no. 4, pp. 802–813, 2014.
[21] C. Eckel and R. Wilson, "The Human Face of Game Theory: Trust and Reciprocity in Sequential Games," in *Trust & Reciprocity*, E. Ostrom and J. Walker, Eds. Nueva York: Russel Sage Foundation, 2003, pp. 245–274.
[22] A. F. Shariff and J. L. Tracy, "What are emotion expressions for?," *Curr. Dir. Psychol. Sci.*, vol. 20, no. 6, pp. 395–399, 2011.
[23] G. A. Van Kleef, C. K. W. De Dreu, and A. S. R. Manstead, "An interpersonal approach to emotion in social decision making: The emotions as social information model," *Adv. Exp. Soc. Psychol.*, vol. 42, pp. 45–96, 2010.
[24] D. Keltner and J. J. Gross, "Functional accounts of emotions," *Cogn. Emot.*, vol. 13, no. 5, pp. 467–480, 1999.
[25] S. Alguacil, P. Tudela, and M. Ruz, "Ignoring facial emotion expressions does not eliminate their influence on cooperation decisions," *Psicológica Int. J. Methodol. Exp. Psychol.*, vol. 36, no. 2, pp. 309–335, 2015.
[26] D. Keltner and J. Haidt, "Social functions of emotions at four levels of analysis," *Cogn. Emot.*, vol. 13, no. 5, pp. 505–521, 1999.
[27] M. Tortosa, T. Strizhko, M. Capizzi, and M. Ruz, "Interpersonal effects of emotion in a multi-round Trust Game," *Psicológica Int. J. Methodol. Exp. Psychol.*, vol. 34, no. 2, pp. 179–198, 2013.
[28] E. A. Van Doorn, M. W. Heerdink, and G. A. Van Kleef, "Emotion and the construal of social situations: Inferences of cooperation versus competition from expressions of anger, happiness, and disappointment," *Cogn. Emot.*, vol. 26, no. 3, pp. 442–461, 2012.
[29] D. Laplante and N. Ambady, "On how things are said - Voice tone, voice intensity, verbal content, and perceptions of politeness," *J. Lang. Soc. Psychol.*, vol. 22, no. 4, pp. 434–441, 2003.
[30] N. Vergis and M. Pell, "How prosody guides impressions of speaker im/politeness," *J. Politeness Res., in review*
[31] J. A. Caballero and M. Menez, "Vocal Emotion Expressions Effects on Cooperation Behavior," *Psicológica Int. J. Methodol. Exp. Psychol.*, vol. 38, no. 1, pp. 1–24, 2017.
[32] P. Kollock, "Social Dilemmas: The Anatomy of Cooperation," *Annu. Rev. Sociol.*, vol. 24, pp. 183–214, Aug. 1998.
[33] J. R. Searle, "Indirect speech acts," in *Syntax and semantics (Vol 3): Speech Acts*, P. Cole and J. Morgan, Eds. New York: Academic Press, 1975, pp. 59–82.
[34] J. R. Searle, *Expression and Meaning: Studies in the Theory of Speech Acts*, vol. 49, no. 3. 1979.
[35] J. A. Caballero and J. M. Menez, "Testing social functions of basic emotional expressions on interaction behavior.", in review
[36] L. F. Barrett, "Valence is a basic building block of emotional life," *J. Res. Pers.*, vol. 40, no. 1, pp. 35–55, 2006.
[37] T. Holtgraves, "Language structure in social interaction: perceptions of direct and indirect speech acts and interactants who use them.," *J. Pers. Soc. Psychol.*, vol. 51, no. 2, pp. 305–313, 1986.
[38] K. Rothermich and M. D. Pell, "Introducing RISC: A new video inventory for testing social perception," *PLoS One*, vol. 10, no. 7, 2015.
[39] M. D. Pell, "Judging emotion and attitudes from prosody following brain damage.," *Prog. Brain Res.*, vol. 156, pp. 303–317, 2006.
[40] C. Papagno, "Comprehension of metaphors and idioms in patients with Alzheimer's disease: a longitudinal study.," *Brain*, vol. 124, no. Pt 7, pp. 1450–1460, 2001.
[41] M. D. Pell, L. Monetta, K. Rothermich, S. a Kotz, H. S. Cheang, and S. McDonald, "Social Perception in Adults With Parkinson's Disease.," *Neuropsychology*, vol. 28, no. 6, pp. 905–916, 2014.
[42] P. M. Pexman, "It's fascinating research: The cognition of verbal irony," *Curr. Dir. Psychol. Sci.*, vol. 17, no. 4, pp. 286–290, 2008.
[43] E. Varga *et al.*, "Compensatory effect of general cognitive skills on non-literal language processing in schizophrenia: A preliminary study," *J. Neurolinguistics*, vol. 29, no. 1, pp. 1–16, 2014.
[44] E. Varga *et al.*, "Irony comprehension and context processing in schizophrenia during remission - a functional MRI study.," *Brain Lang.*, vol. 126, no. 3, pp. 231–42, 2013.
[45] A. T. Wang, S. S. Lee, M. Sigman, and M. Dapretto, "Neural basis of irony comprehension in children with autism: The role of prosody and context," *Brain*, vol. 129, no. 4, pp. 932–943, 2006.
[46] P. McNamara, T. Holtgraves, R. Durso, and E. Harris, "Social cognition of indirect speech: Evidence from Parkinson's disease," *J. Neurolinguistics*, vol. 23, no. 2, pp. 162–171, 2010.
[47] P. Grice, "Logic and conversation," in *Syntax and semantics Vol. 3: Speech acts*, P. Cole and J. Morgan, Eds. New York, NY: Academic Press, 1975, pp. 41–58.
[48] N. Hellbernd and D. Sammler, "Prosody conveys speakers' intentions: Acoustic cues for speech act perception," *J. Mem. Lang.*, vol. 88, pp. 70–86, 2016.
[49] I. A. Noveck and A. Reboul, "Experimental Pragmatics: a Gricean turn in the study of language," *Trends in Cognitive Sciences*, vol. 12, no. 11. pp. 425–431, 2008.
[50] M. Okanda, K. Asada, Y. Moriguchi, and S. Itakura, "Understanding violations of Gricean maxims in preschoolers and adults," *Front. Psychol.*, vol. 6, no. July, pp. 1–7, 2015.
[51] S. Regel, T. C. Gunter, and A. D. Friederici, "Isn't it ironic? An electrophysiological exploration of figurative language processing.," *J. Cogn. Neurosci.*, vol. 23, no. 2, pp. 277–293, 2011.