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Influencia de la percepción de información prosódica en la regulación de la conducta de cooperación

Perception of prosodic information effects on regulation of cooperation behavior

An analysis of the effects of vocal emotional expressions
on cooperation behavior.

Contents:

Resumen

La importancia de variaciones prosódicas en contextos de interacción social ha sido resaltada, pero sus efectos en la regulación de conductas específicas no han sido abordados. Una de las distinciones prosódicas más abordada en psicología es la prosodia emocional. En términos de percepción, se ha investigado ampliamente la capacidad para identificar emociones a partir de variaciones prosódicas, pero la relevancia de esta habilidad para la interacción social no se ha puesto a prueba. Sin embargo, a partir de modelos teóricos sobre las funciones evolutivas de las emociones y a partir de hallazgos empíricos sobre la influencia de las expresiones emocionales faciales en experimentos que analizan su papel en conductas sociales tales como la cooperación, es posible formular predicciones sobre los efectos de la prosodia emocional en conductas de interacción social. Con este objetivo, en el presente trabajo se abordaron los efectos de la prosodia emocional en la conducta de cooperación y se analizó su interacción con otras pistas sobre intenciones conductuales a través de tres experimentos diseñados con base en metodologías de dilemas sociales. Los hallazgos demuestran que la prosodia influye consistentemente en la conducta de cooperación: las manipulaciones de prosodia emocional mostraron efectos significativos en cada uno de los tres experimentos. Sin embargo, en conjunto con otras pistas sobre intenciones conductuales, los resultados no concuerdan perfectamente con predicciones formuladas a partir de teorías de las emociones. Se discuten posibles explicaciones de los resultados y se sugiere el uso de distinciones lingüísticas más complejas, de analizar otro tipo de distinciones prosódicas, y de tomar en cuenta mecanismos cognitivos, de inferencia, e información contextual en experimentos futuros.

Abstract

The importance of prosodic variations in social interaction contexts has been highlighted but their effects on the regulation of specific behaviors has not been 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 models about the evolutionary functions of emotions and on empirical findings about the influence of facial emotional expressions in experiments that address their role in social behaviors such as cooperation, it is possible to formulate predictions about the effects of emotional prosody in social interaction behaviors. For this objective, in the present work, the effects of emotional prosody on cooperation were addressed, and its interaction with other behavioral intention cues was analyzed in three experiments using the methodology of social dilemmas. The findings show that prosody consistently influences cooperation behavior: emotional prosody manipulations showed significant effects in each of the three experiments. However, their joint effects with other behavioral intention cues do not perfectly agree with predictions based on emotion theories. Possible explanations of results are discussed, and suggestions for future experiments are advanced, such as addressing more complex linguistic distinctions, analyzing other kinds of prosodic distinctions, and taking into account cognitive and inferential mechanisms, and contextual information.

1. Introduction

In oral language, the phoneme domain is referred to as "segmental", whereas the term "suprasegmental" encompasses the properties of phrases that do not belong to any single segment, namely, to a level above the phoneme (Gussenhoven, 2015; Narasimhan, Litha, Shahid, & Rohini, 2010; Snow, 2001). Prosody is defined as all the aspects of speech that do not constitute part of the vowel and consonant articulations (Gussenhoven, 2015; Sidtis & Van Lancker Sidtis, 2003). In other words, it refers to the set of suprasegmental characteristics of language that allow transmitting various distinctions, both linguistic and non-linguistic – in the sense of presence or absence of conventional and discrete contrasts (Caballero, 2011; Gussenhoven, 2015; Ross & Mesulam, 2000; Van Lancker, Pachana, Cummings, Sidtis, & Lancker, 2006; Zakzanis, 1999). Prosody is transmitted by acoustic variables such as fundamental frequency (tone) or *f0*, intensity (amplitude) and the distribution of energy in the spectrum (voice quality), as well as temporal variables such as duration, rhythm and pauses (Gobl & Ní Chasaide, 2003; Thompson & Balkwill, 2006; Van Lancker et al., 2006; Zakzanis, 1999; Zhang, Li, Lo, & Meng, 2010). Variations in tone, intensity and duration are organized in a hierarchic manner, in such a way that the constituents of lower hierarchy are included into those of higher hierarchy (Langus, Marchetto, Bion, & Nespor, 2012; Nespor & Vogel, 2007; Snow, 2001). It has been proposed that the phonological components of languages organize into syllables, feet, phonological words, phonological phrases and intonational phrases, giving rise to different intonation patterns across different languages (Frota & Prieto, 2015; Grosjean & Gee, 1987; Jun, 2014; Ladd, 2001; Selkirk, 2011). Thereby, as an example, phonological phrases would always be included into intonational phrases although the number of phonological phrases in an intonational phrase can vary. The hierarchic organization of prosody has stimulated a

substantial amount of research since it is closely related with the syntactic organization of language, although the precise way in which it relates to syntax is subject to debate (Elordieta, 2008; Langus et al., 2012; Selkirk, 2011).

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 (Belin, 2006; Bestelmeyer et al., 2012; Latinus & Belin, 2011). In this respect, it has been reported that in addition to being able to perceive the emotional state from prosody (Pell, Paulmann, Dara, Alasseri, & Kotz, 2009; Scherer, Banse, & Wallbott, 2001), it is also possible to perceive cues about identity and group membership (DeCasper & Fifer, 1980; Linville, 1996; Munro, Derwing, & Burgess, 2010), personality traits (Nass & Lee, 2001; Smith, Brown, Strong, & Rencher, 1975), physical attractiveness (Bestelmeyer et al., 2012; Zuckerman & Miyake, 1993) and attitudes (Bryant & Fox Tree, 2005; Shochi, Aubergé. V., & Rilliard, 2006) which can be added to a variety of linguistic distinctions for which prosody is fundamental, and that are also relevant in the context of social interaction, a few examples being informational structure (Féry & Krifka, 2008), politeness (Nadeu & Prieto, 2011; Ofuka, McKeown, Waterman, & Roach, 2000; Orozco, 2008), evidentiality and epistemicity (Estellés-Arguedas, 2015; Roseano, González, Borràs-Comes, & Prieto, 2014). 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 had been proposed (Bestelmeyer et al., 2012; Mitchell & Ross, 2013; Sakkalou & Gattis, 2012; Sander et al., 2005; Snedeker & Trueswell, 2003).

Moreover, it has been highlighted that in disorders characterized by difficulties in social interaction such as Asperger's syndrome, and some disorders among the autistic spectrum, abnormal patterns of prosodic production and difficulties in prosody perception are reported; it has even been suggested that the abnormal production patterns may constitute the main obstacle to the social integration of patients as the characteristics of their speech can immediately convey an impression of "oddness" (Paul, Augustyn, Klin, & Volkmar, 2005; Shriberg et al., 2001; Stewart, McAdam, Ota, Peppe, & Cleland, 2013). In Parkinson Disease, where motor abilities are compromised, some alterations in prosodic production (Jaywant & Pell, 2010), and perception (Monetta, Cheang, & Pell, 2008) are observed, which may contribute to social interactions difficulties reported for this population. Finally, in disorders that mainly compromise prosody (but not social interaction directly) such as the *foreign accent syndrome* it is often reported that patients complain of difficulties in social interaction contexts apparently derived from their prosodic production (González-Álvarez, Parcet-Ibars, Ávila, & Geffner-Sclarsky, 2003; Miller, Lowit, & O'Sullivan, 2006; Moen, 2000). In fact, the modern study of the neurobiology of prosody was largely initiated following evaluations of patients in the process of recovery from brain injuries that complained from severe psychosocial difficulties (Ross & Mesulam, 2000; Ross & Monnot, 2008).

Yet, even if prosody is proposed as an important variable for regulating interpersonal interactions, most of the time the influence of prosodic variations on participants' *behavior* is not addressed directly. In effect, the above-cited studies show that it is possible to *recognize* different kinds of attributes in prosody (such as emotions, attitudes, identity, attractiveness, personality traits, among others) and that perceptual judgments of different people tend to agree. Based on those perceptual studies, it is argued that prosody is important because it could have real effects

on interactions but, nevertheless, available studies do not show directly that prosodic variations are capable of influencing behavior in social interactions.

Having direct evidence of the effects of prosody on social interaction behavior is particularly important when considering that some proposals place it as a primitive mode of communication at the basis of human social interaction (Belin, 2006; Bestelmeyer et al., 2012; Latinus & Belin, 2011) and that it has been proposed as an important factor – for which interventions can be developed (Shriberg et al., 2001)– associated with difficulties in social interaction contexts in Asperger and autism spectrum disorders (Paul et al., 2005; Shriberg et al., 2001), Parkinson disease (Jaywant & Pell, 2010); and other alterations (e.g. Dimoska, McDonald, Pell, Tate, & James, 2010).

It is fundamental to have specific data about behavioral regulation effects of prosody in contexts of social interaction because, without them, it is impossible to evaluate the proposal of it being at the basis of human social interaction and also because investing the time, effort and resources required for developing prosody-centered interventions constitutes a risk that would be taken even if prosody effects on a variable of great interest and relevance (social interaction) are not properly established.

Therefore, the main research question of the present work is "Does prosody regulate social interaction?" Nevertheless, considering the wide variety of perceptual effects reported for prosody, it is necessary to restrict the kind of prosodic stimuli for addressing the question.

In this respect, *emotional prosody*, the encoding of emotions in prosody and the corresponding capability to decode them from prosody may be a suitable starting point for addressing the subject. First, it has been observed that it is possible to identify emotions in

prosody both by human perceptual judgments and using automatic classification systems based on acoustic analyses (Pell, Paulmann, et al., 2009). Moreover, it has been reported that it is possible to perceptually classify vocal expressions of emotions even in the absence of propositional contents and in foreign languages (Bänziger & Scherer, 2005; Bryant & Barret, 2008; Dromey, Silveira, & Sandor, 2005; Pell & Skorup, 2008; Scherer et al., 2001). Furthermore, as emotional expressions – not restricted to prosody – had been proposed as an important factor in social interaction (Eckel & Wilson, 2003; Fischer & Mansted, 2008; Keltner & Kring, 1998; Shariff & Tracy, 2011; Van Kleef, De Dreu, & Manstead, 2010), emotional prosody – as a particular way of communicating emotions – provides a mean to test the proposed effects of prosody on social interaction regulation; benefiting from the theoretical background of emotion research and the previous empirical studies on perception of emotional prosody.

In the following, brief outlines are provided about research on emotions and their relation to motivation and behavioral regulation, about research on emotional expression – stressing emotional expression in prosody –, about the social functions of emotions, and about how the influence of emotional expressions on a particular interaction behavior (cooperation) has been studied previously.

1.1 Emotions

The study of emotions has received a considerable amount of interest from psychology because of its important role in behavior as they can modulate it and exert influence in a wide range of psychological processes, such as attention, perception, thinking, motivation, goal-directed behavior, decision-making, among others (Andrade & Ariely, 2009; Clore & Palmer,

2009; Farb, Chapman, & Anderson, 2013; Levenson, 2011; Loewenstein, 1996; Shiv, Loewenstein, & Bechara, 2005; Taylor & Fragopanagos, 2005; Vuilleumier & Huang, 2009).

As a theoretical term in psychology, the word "emotion" has been present since 1884, year in which William James wrote an influencing article in the journal Mind, entitled "What is an emotion?" (Dixon, 2012). Another author whose work has greatly influenced the field is Charles Darwin. Following the ideas developed in *The Expression of the Emotions in Man and Animals*, several authors have highlighted the importance of emotional expressions as an adaptive resource for the individual and their conspecifics in such a way that different vocal, facial, and body behaviors would specialize for communication if the clues that they communicate with regard to behavioral tendencies and emotional states have a survival value for the transmitter, the receiver, or both (Darwin, 1965; Kraut & Johnston, 1979; Nesse, 1990; Russell, 1994; Shariff & Tracy, 2011).

His proposal largely influenced authors interested in emotions as a product of the evolutionary process who proposed sets of emotions considered as *basic* that would be present in every culture and would be associated with unique motivational tendencies and expressions. In the present work, it is precisely in the perspective of basic emotions where the emphasis will be placed.

Among these authors, Tomkins (1970, 1984) considers emotions as a fundamental motivational system. According to him, affect is indeed the primary motivational system. Moreover, he proposed that facial expressions constitute a system that can amplify emotions' intensity. From his perspective, movements of the face and body provide a sensory feedback that influences the subjective experience of emotions. Tomkins extended Darwin's ideas and argued

that a reduced number of basic or fundamental emotions could be conceived as phylogenetically stable *neuromotor programs*. Even though he did not describe those programs in detail, he assumed that specific eliciting conditions exist, and that they could trigger response patterns that ranged from physiological reactions to muscular activation, especially in the face; these ideas greatly influenced authors such as Izard and Ekman, who extended their theoretical proposals and looked for pertinent empiric evidence for supporting them, mainly in the context of muscular patterns of facial expression and their universality (Scherer, 2000).

Differential emotions theory, formulated by Carrol E. Izard emphasizes that basic emotions serve distinct and unique motivational purposes. According to this conception, emotions are the main motivational system in humans, in a manner that resembles Tomkins' proposal, with whom he worked at the beginning of his career. The theory holds that 1) There are 10 discrete emotions that constitute the main human motivation system, 2) each emotion is associated with unique motivational and phenomenological properties, 3) each emotion leads to different behavioral consequences and physiological states, 4) emotions interact between them, so one of them can activate, amplify or weaken another, and 5) motivational processes interact with and exert influence over homeostatic, perceptual, cognitive and motor processes and physiological drives (Izard, 1997). The most important idea within the theory is that it considers that the discrete emotions proposed are essentially motivational systems that prepare the individual for behaving in adaptive ways throughout life (Abe & Izard, 1999; Izard, 1997).

According to Levenson, emotions are psychological and physiological phenomena of short duration that represent efficient ways for adapting to the environmental demands. Following the author's approach, emotions influence attention, increase the priority of certain

behaviors and activate relevant associative networks in memory. Physiologically, emotions organize responses in several biological systems (such as facial expression, muscle tone, tone of voice, and activity in the nervous and endocrine systems). From his point of view, emotions allow regulating interactions with the environment pulling people toward certain stimuli and pushing them away from others. Moreover, only a subset of emotions can be considered basic: those that are associated with specific brain circuits, that allow solving adaptive challenges and that are associated with precise physiological and behavioral characteristics (Levenson, 1999).

In the theory formulated by Frijda, it is assumed that events appraised as relevant for the individual (in the sense of favoring or opposing to their goals motives or sensibilities) produce emotions. Emotions would represent states of action readiness and the physiological reactions associated with them are considered as a support system for those states; which are defined in terms of dispositions or lack thereof for interacting with the environment and perform behaviors. Accordingly, emotions would promote the achievement of goals by a heightened tendency to perform the required behaviors for reaching them (Frijda, 1988; Frijda, Kuipers, & ter Schure, 1989).

Basic emotions notion is a fundamental assumption in several theories of emotion (Ortony & Turner, 1990) such as the previously described theories formulated by Tomkins, Izard, and Levenson. It is considered that basic emotions are a discrete and finite set (Levenson, 2011) and that they are universally present in human beings and due to the process of evolutionary adaptation serve to successfully cope with particular survival challenges (Ekman, 1992; Keltner & Gross, 1999; Levenson, 2011). Also, it is considered that they arise from the same circumstances for all individuals and that they are associated with specific physiological patterns.

As they are considered as innate dispositions present in all human beings independently of their culture, it is considered that their expression should be similar throughout the world. In a related fashion, it has been supposed that emotional expressions can be recognized innately, or, at least, that there exist innate dispositions that foster the development of the capability of recognizing emotional expressions. The antecedents of this notion can be traced back to Darwin and to the theories that highlight the functional component of emotions for the survival of the individual and the species. In this sense, basic emotions are considered part of our biologic/genetic constitution because they have proved to be useful for the species as they permit dealing with particular adaptive challenges (Izard, 1971; Levenson, 2011). While different authors have proposed different necessary and sufficient conditions to consider an emotion as basic and hence have described different sets of basic emotions (Levenson, 2011), there is greater agreement in that at least joy, sadness, anger, fear, and disgust are members of the set (Ekman, 1992; Scherer et al., 2001).

Joy has been associated with events that lead to desirable outcomes and goal accomplishing; it affects behavior promoting the involvement in social activities; also, facial expressions of joy (smiles) have been associated with social interaction facilitation (Frank & Ekman, 1993; Izard, 1991; Van Kleef et al., 2010). Sadness, in contrast, has been associated with experiences of losing and failing, in an indirect fashion facilitates social cohesion as it has been highlighted that expressing sadness can signal the need for help and social support; it is also associated with a lack of behavioral initiative and searching for alternative courses of action (Gray, Ishii, & Ambady, 2011; Niedenthal, Krauth-Gruber, & Ric, 2006; Osen, 2009). In turn, anger has been associated with situations that impede the attainment of goals, and to restriction situations in which it is not possible to behave as one wants; furthermore, it has been related to

situations that are perceived as unfair and has been associated with behaviors directed to beat or correct the situations that elicit it, such as aggression; the exposure to aversive stimuli such as hot or cold temperatures or displeasing odors also can produce anger (Berkowitz & Harmon-Jones, 2004; Canary, Spitzberg, & Semic, 1998; Izard, 1991). Fear is associated with dangerous and threatening situations and would serve the goal of self-protection and defense through behaviors such as avoidance, escape, and even attack, depending on the situation; accordingly, it would increase the capacity to perceive and process perceptual information related to environmental threats, and its expression would inform others about the presence of threats and signal a submissive disposition and the need for help (Bossuyt, Moors, & De Houwer, 2014; Hammer & Marsh, 2015; Izard, 1991; Marks & Nesse, 1994; Marsh, Adams, & Kleck, 2005; Ohman & Mineka, 2001; Susskind et al., 2008). Lastly, disgust has been associated with behaviors of aversion, avoidance, and rejection of undesirable stimuli, it arises mainly in response to potentially harmful biological stimuli (as rotten food, feces, and diseases), but in the course of development it can be elicited also by learned stimuli, such as observing behavior considered as morally unacceptable, such as physical abuse, cheating, and injustice (Chapman, Kim, Susskind, & Anderson, 2009; Izard, 1991).

Maybe the most important source of evidence regarding the universality of basic emotions has been research on intercultural recognition of emotional expressions.

As mentioned previously, since Darwin's proposal and after researchers such as Tomkins, Izard, and Ekman drawing attention to the idea that facial expressions of emotion should be universal, the notion gave rise to specific hypotheses regarding encoding and decoding of emotional expressions. First, if emotions are universal, then people throughout the world should

exhibit the same facial expressions when experiencing emotions. Second, if emotions are universal, people of different cultures should interpret facial expressions of that emotion in the same way, and hence be able to recognize facial expressions of emotion from members of different cultures (Russell, 1994).

Extensive research on the recognition of facial emotional expressions has documented that participants consistently recognize them at higher than chance levels, with correct recognition as high as 90% in literate cultures (western participants), and somewhat lower levels (but still significantly higher than chance) in culturally isolated cultures, (for a review, see Ekman, 1994), that different instructions and contexts have little effect on the findings, and that infants produce facial emotional expressions and are capable of decoding them early in life (Izard, 1994). Although some concerns regarding methodological limitations of the early studies were raised (Russell, 1994), later studies still confirmed that people from different – and often isolated – cultures are able to identify facial expressions of emotion portrayed by members of different cultures at above-chance levels; in addition, they also drew attention to the frequent finding that recognition levels are higher when the emotional expressions are portrayed by members of the same culture, which has been termed *in-group advantage,* and that some emotions, such as joy, are easier to recognize while others, such as fear and disgust, are harder (Elfenbein & Ambady, 2002).

Note that the universality hypothesis is not restricted to facial expressions; other kinds of emotional expression had received attention, although in a lesser degree. Those other modalities of emotional expression include whole body movements (Coulson, 2004), touching (Hertenstein, Holmes, McCullough, & Keltner, 2009) and voice modulations (for a review, see Scherer, 2003).

In all these fields, a similar pattern to that reported for facial emotional expressions is observed: emotions can be recognized at above chance levels and there are differences in recognition accuracy for different emotions.

In the specific case of vocal expressions of emotions, the occurrence of numerous vocalizations in non-human species (especially primates) with similar acoustic characteristics and produced in similar situations to those of human vocalizations had been highlighted. Among them, distress calls, and vocalizations emitted during social play, threat situations or in the context of aggressive, affiliative or sexual encounters (Newman, 2007; Snowdon, 2002; Vettin & Todt, 2005). Following this line, it has been reported that even members of isolated communities can identify emotions in human nonlinguistic vocalizations portrayed by members of other cultures (Sauter, Eisner, Ekman, & Scott, 2010). Specifically, Sauter and collaborators presented non-linguistic vocal emotional expressions (such as laughter, moans, sighs and growls) to members of the isolated Himba tribe (in northern Namibia) and to English speakers of the UK and tested whether they were able to recognize the emotions conveyed by them. Both groups were able to recognize vocal expressions at above chance levels, even if portrayed by members of the other culture, suggesting the existence of intercultural (maybe innate) similarities in the way of expressing emotions through non-linguistic vocalizations. In fact, some authors have proposed that prosodic modulations associated with emotions as well as other uses can be rooted in the general vocal behavior that is present in other species (Gussenhoven, 2002, 2004, Ohala, 1984, 1994). Elaborating on Ohala's (1984, 1994) work, (Gussenhoven, 2002, 2004) proposes that prosody and vocal production tend to imply universal “meanings” that are based on the way in which vocal behavior is produced across different species, the associations of vocal cues with body characteristics (e.g. higher pitched vocalizations for smaller animals) and biological

conditions that affect linguistic production. These biological tendencies would give rise to three *biological codes* (*frequency, effort*, and *production*), whose characteristics would be universal and exploited by speakers for communicative purposes. This way, the biological codes would contribute to the communication of affective meanings as well as different pragmatic distinctions (e.g. expressing politeness). Crucially, through repeated use in communicative contexts, prosodic variations may become conventional and be subject to different mechanisms of linguistic variation and change, which would explain cross-linguistic similarities *and* differences in prosodic patterns.

Even if the findings by Sauter et al. (2010) highlight the intercultural similarities of vocal expressions of emotions, in contrast with animals, humans seldom express emotions exclusively by means of devices such as growls and moans. In contrast, they usually express them in the context of language. *Emotional prosody* refers to the more usual situation of expressing emotions through prosodic modulations in the context of linguistic messages. This field has been studied from different perspectives, including neurophysiological studies, acoustic analyses, and perceptual experiments. In the following section, the main findings of perceptual studies of emotional prosody are addressed.

1.2 Emotional prosody

Emotional prosody is defined as the expression of emotions through the manipulation of different suprasegmental attributes, such as tone, intensity and duration (Besson, Magne, & Schön, 2002; Buchanan et al., 2000; Wildgruber, Ackermann, Kreifelts, & Ethofer, 2006). Unlike

prosody defined in a general way, the function that those variations serve is specific, namely, expressing emotions.

Influenced by evolutionary theories of emotions, several studies have tested whether it is possible to recognize prosody associated with basic emotions. Consistently with the notion of universality proposed for basic emotions, it has been observed that it is possible to perceptually identify vocal expression of emotions above chance even if encoded by speakers of an unknown language or in procedures that make stimuli unintelligible, but spare prosody (Bänziger & Scherer, 2005; Bryant & Barret, 2008; Dromey et al., 2005; Pell & Skorup, 2008; Scherer et al., 2001) and may even be greater than 90% when stimuli come from speakers of the same language (Bryant & Barret, 2008; Wildgruber et al., 2005). Moreover, it had been reported effects of *in-group advantage* (a pattern in which participants perform better when evaluating emotions expressed by members of their same culture (Paulmann & Uskul, 2014) and differing recognition accuracies for different emotions (Bryant & Barret, 2008; Juslin & Laukka, 2003; Pell, Monetta, Paulmann, & Kotz, 2009; Scherer, 2003); both findings are similar to the above-described patterns reported for facial emotion recognition (Elfenbein & Ambady, 2002).

Scherer (2003) reviewed emotion recognition in voice experiments and points that recognition levels correspond roughly to 5 or 6 times the expected performance were the subjects responding randomly, that is, approximately 60%. As a means of comparison, the author refers that performance in recognition experiments with facial stimuli are about 75%. Other authors also point out that performance differs between emotions but, in contrast, state that performance in emotion recognition corresponds to approximately 70% stimuli (Juslin & Laukka, 2003), which roughly corresponds to performance in facial emotion recognitions experiments. Moreover, some

studies point that the ability to recognize emotions in prosody may be present early in life (Sauter, Panattoni, & Happé, 2013) and that brain activity patterns differ for different emotions expressed by prosodic means in infants (Grossmann, Striano, & Friederici, 2005) and even in neonates (Cheng, Lee, Chen, Wang, & Decety, 2012; Zhang et al., 2014).

Literature addressing recognition of emotions in prosody is extensive; hence in this section only works addressing emotional prosody recognition in several cultures simultaneously will be addressed. The same pattern of results is observed when evaluating individual cultures.

In one of the studies that have addressed the ability to recognize prosody in several cultures simultaneously, Scherer et al., (2001) conducted an experiment in nine countries, seven in Europe, as well as the United States and Indonesia. They presented their participants a set of stimuli encoded by professional German-speaking actors conveying anger, fear, joy, sadness and a neutral expression. Stimuli were nonsense utterances composed of syllables of different European languages. Among their results, they found that emotions are recognized above chance; that the better performance was that of German speakers (in-group advantage); a gender effect, in which women performed better and differing performance depending on particular emotions, being better for anger and relatively low for joy. They also report an effect of the language spoken by participants and interpreted it as reflecting cultural differences. They found that the confusion patterns were similar across groups and interpret this finding as suggesting a common process for emotion perception.

In another study which addresses emotion recognition in different cultures, Pell et al., (2009) presented nonsense utterances conveying anger, disgust, fear, sadness, pleasant surprise, and a neutral expression. Stimuli were encoded by native speakers of English, German, Hindi and

Arab with non-professional experience in acting or in public speaking. Nonsense phrases were developed by a native speaker of each language in such a way that they did not violate phonetic or phonotactic rules but conveyed no meaning. Previously validated stimuli were presented to groups of native speakers of each language included in the study. They addressed the ability to perceptually recognize stimuli coming from the same or a different language and made an acoustic analysis focusing on variables at the whole utterance level (speech rate and f0 mean and range). They found that emotional prosody can be correctly recognized above chance within each language. Performance differed according to participants' native language and the particular emotion: In English, Hindi and Arab speakers, the best performance was in identifying sadness, anger and fear, in addition, Arab speakers were also good at identifying neutral expressions. In German speakers, the best performance was for anger and neutral expressions, followed by disgust, sadness, and fear. Overall, across participants, anger and sadness were easier to recognize, followed closely by fear and neutral expressions, while joy and disgust were harder to recognize.

1.3 Social functions of emotions

In addition to preparing the organism for action and adaptive responses, emotions play an important role in the context of social interaction (Andersen & Guerrero, 1998; Andrew, 1963; Keltner & Haidt, 1999; Keltner & Kring, 1998; Shariff & Tracy, 2011; Van Kleef et al., 2010). As emotions are associated with adaptive behavioral tendencies and recognizable universal expressions, they allow others to quickly (or even automatically) identify them, predict likely courses of action and behaviorally react in adaptive ways (Alguacil, Tudela, & Ruz, 2015;

Andersen & Guerrero, 1998; Keltner & Haidt, 1999; Shariff & Tracy, 2011). Accordingly, emotions allow: 1) communicating emotional states and likely courses of action to other people, 2) influencing the way in which other people interact with one, 3) facilitating social interaction, and 4) maintaining relationships (Keltner & Haidt, 1999; Keltner & Kring, 1998)

Concretely, the following social functions have been proposed for basic emotions: For anger, eliciting change in the behavior of others, signaling that it is desired to attain a degree of control over the people towards it is expressed and threat, and hence instigating submission, or forcing others to interrupt the current course of action. In negotiation contexts, it has been reported that it can lead to higher concessions from others; in addition, it has been observed that it is perceived that people expressing anger are less cooperative, offer less support and that it is harder to work with them. Accordingly, expressions of anger had been related to attempts to maintain or recover a status of dominance and power (Fischer & Mansted, 2008; Stouten & de Cremer, 2010; Wubben, Cremer, & van Dijk, 2011; Wubben, Cremer, & Dijk, 2009). In contrast, sadness is considered as an expression of helplessness and search for help, social support, and willingness to engage in behaviors that facilitate interactions and make possible to keep social relationships. This emotion is presented mainly in presence of people with whom intimate relationships already exist, as it is more likely to attain support from the than from strangers; moreover, it has been reported that sad expressions increase empathy and helping behavior in observers (Bandstra, Chambers, McGrath, & Moore, 2011; Eisenberg et al., 1989; Fischer & Mansted, 2008; Gray et al., 2011; Izard, 1991; Osen, 2009; Vigil, 2009). Joy has been related mainly to the establishment and maintenance of relationships, with openness to social contact and approaching, with the establishment and increase of mutual confidence and trust, and with the formation of attachment bonds in early infancy; experiencing positive affect is related to an

increased behavioral tendency to cooperate and help others; moreover, people displaying joy are perceived as higher in traits such as gentleness, humor, intelligence, honesty, reliability and tendency to cooperate (Fischer & Mansted, 2008; Izard, 1991; Kraut & Johnston, 1979; Lyubomirsky, King, & Diener, 2005; Stouten & de Cremer, 2010). Fear, in contrast, has been associated with a heightened search for social contact and support from others; fear expressions would signal the presence of environmental threats and could promote helping behavior of others; in addition, when presented in the context of social interaction, they would signal submissiveness and a non-threatening intention; therefore, fear expressions can serve as a signal of an affiliative, non-threatening disposition and invite approach from others in contexts of social interaction (Fischer & Mansted, 2008; Hammer & Marsh, 2015; Izard, 1991; Marsh, Ambady, & Kleck, 2005; Niedenthal et al., 2006; Tracy, 2014). In the case of disgust, it has been associated also with signaling in social interaction contexts: disgust expressions in other people allow avoiding stimuli without requiring a first-hand experience for learning, thus, allowing risk avoidance and the contact with undesirable stimuli. In addition, it has been pointed out that in interaction situations that are perceived as unfair, disgust is associated with that perception. It has been highlighted that, as it is possible to experience disgust caused by contact with another people (not only because of biological hazard, as in diseases, but also in face of people who are associated with morally unacceptable behavior), it is associated with lack of disposition to keep contact with people who cause this emotion, as well as a tendency towards rejection and withdrawal, consistent with disgust-related behavioral tendencies in a broad sense. Moreover, it has been argued that some problems related to social interaction – such as ethnic discrimination – could be mediated by disgust, as a response to a perceived contamination or to a perceived possibility of infection (Izard, 1991; Rozin, Haidt, & McCauley, 2008).

1.4 Effects of facial emotional expressions on cooperation

The influence of facial emotional expressions on social interaction has been addressed experimentally through methodologies derived from game theory that allow studying cooperation behavior: social dilemmas (for additional details on game theory and social dilemmas, see Annex A). Those works are based on the perspective that emotional expressions are a fundamental mean for communicating intentions and an important mechanism for regulating social interactions (Erickson & Schulkin, 2003; Marneweck, Loftus, & Hammond, 2013; Schmidt & Cohn, 2001), particularly relevant for solving interpersonal challenges such as cooperation (Wubben et al., 2009).

Eckel and Wilson (2003) proposed that humans can read others' intentions through different cues such as facial expressions, body language, and tone of voice. However, in the context of social dilemmas, they believe that not every possible cue about intentions is reliable because players could display fake signals for strategic considerations. Therefore, ideal cues should be credible, easy to interpret and hard to fake, and people to whom signals are directed should be able to imagine the mind state of the person that produces them. A set of signals that meet those criteria, according to the authors' view, are emotional expressions. Accordingly, they tested the hypothesis that emotional expressions influence cooperation behavior in two experiments that compared the effects of pairs of faces conveying joy (smiles) or a neutral expression on perceptual judgments and behavioral measurements of cooperation. In the first experiment, they presented photographs of 60 individuals displaying either a smiling or neutral expression and asked their participants to rate them according to several dimensions. The authors report only results for a scale measuring trustworthiness, for which smiling faces were perceived

as more trustworthy than those displaying a neutral expression. Afterwards, they presented a randomly selected photograph from the set described above to a second group of participants and told them that it depicted a real participant against whom they would play. In this second experiment, a factorial design of 2 (sex of participant) X 2(sex of the model in the photograph) X 2 (smiling or neutral expression) was used. They report significant effects of facial expression indicating that participants cooperated more when presented with faces displaying smiling expressions. They interpret their results as indicating that facial expressions allow inferring intentions and that participants consider these inferences in order to take decisions, supporting the view that emotions regulate social interactions.

Reed et al., (2012) explored if positive emotional expressions allow predicting future behaviors of cooperation using the prisoner's dilemma. In their experiment, they randomly paired participants for playing a single turn of the prisoner's dilemma. Participants were recorded while interacting during 10 minutes. When promises of cooperation were observed in any or both partners, positive (genuine and social smiles) and negative (contempt and anger) facial expressions that participants displayed during the following 10 seconds were coded using the Facial Action Coding System (Sayette, Cohn, Wertz, Perrott, & Parrott, 2001). After that, the dyads played the prisoner's dilemma. The authors analyzed whether it was possible to predict the decision in the game based on emotional expression observations. They report that positive emotional expressions allow predicting a higher probability of cooperation and that, among the negative emotional expressions, contempt allow predicting a lower probability of cooperation. They also explored whether emotional expressions allowed to predict not only the behavior of people displaying them but also the one of the people against whom they played. Authors report that positive emotional expressions did not allow to predict the behavior of opponents (except in

a marginally significant way), but that among negative ones, the expression of contempt allowed to predict a lower probability of cooperation in opponents.

Scharlemann, et al., (2001) also addressed the hypothesis that the emotional expression of joy could signal a cooperative intention and that therefore smiles increase cooperation. They presented photographs depicting neutral or smiling expressions to their participants that represented opponents with whom they should play a one-shot "trust" game (although is not the same formulation of the prisoner's dilemma the possible actions were also cooperating or defecting). They report a higher proportion of cooperation when participants played against smiling opponents as compared to neutral expression opponents and interpret their results as consistent with the hypothesis that smiles convey a cooperative intention.

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). An important limitation of Stouten and de Cremer's 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, those details do not allow drawing clear conclusions from this study.

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. Counterbalancing task order can address this kind of limitation.

Tortosa et al., (2013), interested in the communicative function of emotions, wanted to determine if facial emotional expressions exert an influence on cooperation in repeated interaction scenarios. In a series of 3 experiments they addressed 1) whether facial expressions of joy and anger influence cooperation in a repeated interaction scenario although they weren’t predictive of the opponent’s tendency to cooperate, 2) whether those effects are maintained when the social meaning of expressions is removed and 3) whether it is easier to learn associations between emotional expressions with their “natural” than with “artificial” consequences. In the

first experiment, they exposed their participants to a "trust game" against 3 different players, in a sequential fashion, varying facial expressions displayed by opponents (joy, anger or neutral) trial by trial. Participants were informed that although the opponents were represented by photographs on the screen selected by an algorithm, their actions would follow behavioral patterns of real people (but the actual opponents' probability of cooperation was 0.5 regardless of displayed facial expression). The authors report higher cooperation rates for joy as compared to anger expressions, higher cooperation rates for neutral than for anger expressions and a marginally significant difference favoring joy over neutral expressions; they also highlight that the effects of emotional expressions on cooperation were stable even though they did not predict opponents' behavioral tendencies. In the second experiment the same methodology of the previous one was used except for a difference in instructions: they indicated that in each trial a photograph depicting different emotional expressions would be randomly chosen, the manipulation was introduced with the objective of making explicit that the particular emotional expression had nothing to do with the behavior of opponents. This difference in instructions made the effect of emotional expression disappear; the authors interpret this pattern of results as evidence indicating that the effects observed in Experiment 1 are due to the communicative function of emotions and not to a more general effect such as *priming*. In the third experiment, the general methodology of the first one was used but dividing participants into two groups for which cooperation probabilities differed according to the emotions displayed. In the "consistent" group, when joy was displayed, the probability of cooperation was 0.8; for neutral expressions was 0.5; and for anger it was 0.2. In the "inconsistent" group the probabilities were 0.2 for joy expressions, 0.5 for neutral and 0.8 for anger expressions. An interaction effect of emotional expression, order and group is reported. In the "consistent" group a main effect of emotional expression was detected,

involving higher cooperation rates for joy as compared to neutral and anger, as well as a difference between anger and neutral; namely, the same pattern reported in Experiment 1. In the "inconsistent" group a main effect of emotional expression is reported: higher cooperation rates for anger than for joy expressions and higher cooperation rates for neutral than for joy expressions, in addition, an interaction effect of order and the kind of emotion displayed is reported for this group: in the first block, cooperation levels were equivalent across expressions, whereas starting from the second block the effects of the displayed emotion were increasingly pronounced. The authors interpret their results as indicating that learning associations of emotional expressions and their consequences was harder for the "inconsistent" group given that consequences were contrary to the expected ones. It's noteworthy that although participants were explicitly told that they would play against computer-generated opponents the same pattern of other experiments is observed, namely, positive effects of joy expressions and negative effects of anger expressions on cooperation.

Melo et al., (2014) report a series of five experiments in which they test whether facial emotions displayed by computer simulated opponents can influence cooperation. Note, however, that their experiments have important differences from previous ones. First, the authors did not test the effects of individual expressions of emotions but of "cooperative" or "competitive" opponents, as defined by displaying different emotions after a certain outcome of the experimental game has occurred. For example, the cooperative opponent would express joy when there was a mutual benefit and regret when he exploited the participant, in contrast, the competitive opponent would express joy when he exploited the participant and regret when there was a mutual benefit. Across the experiments, they report that cooperation behavior and judgment measures favored cooperative over competitive opponents. While the analyses and

reported effects are not based on the presentation of individual emotions, it is noteworthy that their work shows that cooperative and competitive opponents (which differed only in terms of the situations where they displayed the facial emotional expressions) have differential effects on cooperation even when it was clear that the opponents were computer-generated.

It can be appreciated how the emphasis has been put on joy and anger expressions; hence, knowledge about the effects of expressions of other basic emotions is limited. Notwithstanding, there are some studies that indirectly suggest the possible effects of fear, disgust, and sadness expressions.

Kugler et al., (2012) explored the effects of anger and fear in several tasks related to decision making, including an experiment that uses the stag hunt dilemma described previously. In their experiment, they induced fear or anger to their participants and after that a single turn of the assurance dilemma against an anonymous opponent was played. After deciding whether cooperating or defecting they were asked how many people out of 100 they thought that would cooperate if faced with the situation as a measure of perceived probability of cooperation. Cooperation rates were significantly different depending on the induced emotion: the fear group cooperated 80% of the time while the anger group cooperated 45.2% of the time. There were no statistically significant differences in the number of people (out of 100) that the participants considered that would cooperate if faced with the situation (57.2 for fear and 56.7 for anger) but a statistically significant difference was found in this measure between the participants that choose to cooperate (63.5) and those that choose to defect (45.9). The authors highlight that although there were no differences in the perception of the possible behavior of players facing the situation depending on the induced emotion, differences in the behavioral measure itself were indeed

detected; in addition, they point to the limitation of studying only the influence of two emotions on decision making in game contexts. Similarly, Nelissen et al. (2011) found that people to whom fear is induced tend to cooperate more as compared to participants in neutral emotional states in the ultimatum game. In this game, the participants receive an amount of money and propose how to split it with a second player, who can accept the offer (in which case the split is done) or reject it (in which case both players receive nothing). In this situation, higher proposed splits are considered more cooperative.

Considering results of Kugler et al's. (2012) study, the behavioral tendency of players to whom anger was induced was indeed to cooperate less. A finding that is consistent with studies described in previous paragraphs showing that people exposed to anger expressions display lower cooperation rates and tend to perceive people expressing anger as less cooperative. If fear expressions also convey the behavioral intention (in this case, a higher probability of cooperation, as suggested by the studies of Kugler et al., 2012, and Nelissen et al., 2011), it is possible that people facing fear expressions would perceive the heightened propensity to cooperate and hence tend to cooperate more. However, as effects of emotional expressions on cooperation behavior have only been addressed for joy and anger, this is an open question.

Chapman et al., (2009) conducted a series of experiments in which disgust was induced to their participants through different stimuli. In one of their experiments, they used the ultimatum game for inducing disgust to their participants. In that game, a quantity of money is to be divided between two players. One of them makes a proposal for the division and the second one may accept or reject the offer. If the second player accepts, the money is divided as proposed, if rejects, no player receives anything. Participants always played the role of the second player and

were exposed to two kinds of proposals; some of them were "fair" (e.g. 50% for each player in all cases) and other "unfair" (e.g. 90% for the proposer and 10% for the participant in all cases), among varying levels of split "fairness" between those extremes. The researchers measured facial muscular activity related to disgust in each turn and participants rated after each turn how well 6 photographs depicting different emotions represented their reactions to the proposal. It is reported that every "fair" offer was accepted and that the rejection proportion increased as the difference in percentages proposed for both players increased, namely, as the offer was more unfair. Moreover, disgust (measured through self-report and facial muscular activity) tended to increase as the offers were more unfair. The authors argue that the general function of disgust related to rejection and avoidance of stimuli may be used and extended to reject unpleasant stimuli in the social domain. In Chapman et al.'s work, it is observed that disgust is related to an increased probability to reject offers in an experimental game and that its intensity increases as the situation is perceived as more unfair, however, the possible effects of expressions of that emotion on cooperative tendencies of other people are still an open question.

Lastly, Tan and Forgas (2010) conducted a series of experiments in which they addressed the effects of joy and sadness on decisions taken on the "Dictator game". In their experiments, participants played the role of the "Dictator", who has to decide how to split a given quantity of resources between him and the second player. The authors induced joy or sadness to their participants and compared the effects of this manipulation on the splits they made. They report that it was consistently observed across their experiments that participants to whom joy was induced gave fewer resources to opponents in contrast with those to whom sadness was induced, suggesting that joy produced lower levels of cooperation than sadness. In Tan and Forgas' study, the effects of joy appear to be inconsistent with the way in which the facial expression of that

emotion is perceived: although people displaying smiles are perceived as more cooperative (Krumhuber et al., 2007; Stouten & de Cremer, 2010), in Tan and Forgas' the behavioral tendency appears to be the opposite. It is worth to note, however, that in the Dictator game a key characteristic of games used in previous experiments is lacking; namely, the consequences for participants did not depend on the joint decisions with their opponents, but only on their own decisions. Moreover, the authors did not include a control condition with neutral affect; in consequence, it is not possible to discard that although resources given to opponents were lower for the joy group than for the sadness group, the quantity could nevertheless be higher when compared with a neutral emotional state. The influence of sadness expressions had not been addressed in experimental games. Hence the question of whether they influence cooperation tendencies of other people and, if so, whether they increase or decrease cooperation are still open questions.

Until now, the effects of expressions of other basic emotions on cooperation behavior had not been addressed. However, following the perspective proposing that basic emotions are associated to several social functions, it is possible to make some predictions.

Specifically, it can be expected that sadness and fear expressions increase cooperation and disgust expressions decrease it.

For sadness, increases in cooperation can be expected because it has been associated with keeping social relationships and to the signaling of need for social support and disposition to engage in behaviors that facilitate social interaction) (Gray et al., 2011; Osen, 2009), it has been proposed that sadness expressions allow to signal a disposition to behave in a reciprocal manner in response to behaviors of social support (Vigil, 2009) and it has been reported in experimental

games that participants to whom sadness is induced display high levels of cooperation (Tan & Forgas, 2010).

In the case of fear, it has been proposed that fear expressions signal a non-threatening disposition and promote affiliation and approach behaviors in others (Hammer & Marsh, 2015; Marsh, et al., 2005) Moreover, it has been reported that people to whom this emotion is induced display high levels of cooperation in experimental games (Kugler et al., 2012; Nelissen et al., 2011). Considering the role of fear in promoting affiliation and if emotional expressions communicate behavioral intentions it can be expected that when exposed to stimuli depicting fear expressions, participants would be able to grasp the tendency to high levels of cooperation and cooperate more in response; particularly in a game such as the assurance dilemma because the best choice is to cooperate if the other player also does.

Lastly, disgust has been associated with behavioral tendencies of withdrawal and rejection; it has also been reported that in the ultimatum game, intensity of disgust measured both via self-report and facial muscle activity is associated with a higher proportion of responses of "rejecting the offer" that, in the ultimatum game, would be the most similar response to the "defecting" option in games such as the assurance dilemma (Chapman et al., 2009; Farb et al., 2013; Rozin et al., 2008).

1.5 Objectives

Summarizing the previous sections, even if the importance of prosody for social interaction has been highlighted, the subject is rarely addressed directly; that emotional prosody has been widely researched in psychology, and that emotions had been associated with influences

on motivation, behavioral tendencies, and specific expressions that play a regulating role in social behavior, particularly on cooperation.

As it has been proposed that the function of emotional expressions is the communication of intentions and interpersonal behavior regulation, the effects described for facial expressions of emotions on cooperation behavior should also be present for other modalities, in other words, they should not be confined to facial expressions.

Hence, to address the main research question "Does prosody influence regulation of social interactions?" the effects of emotional prosody on cooperation behavior will be addressed. This particular choice is made because emotional prosody has received more attention in psychological research as compared to other kinds of prosodic uses, because there is plenty of evidence about perceptual recognition of this kind of prosody and because there is an empirical background regarding the influence of (facial) emotional expressions on cooperation behavior as well as a theoretical framework regarding the social functions of emotions that predicts similar effects for vocal expressions of emotion as those observed for facial expressions.

In view of this, the present work aims to contribute the following: 1) addressing directly the proposed effects of prosody on interaction regulation, 2) extending research on emotional expressions to vocal expressions. Additionally, as will be argued in Experiment 3, it is important to address the effects of other basic emotions on cooperation; hence, the present work also aims to 3) extend research of the effects of emotional expressions on cooperation to other basic emotions.

2. Experiment 1: Influence of anger and joy prosody on cooperation behavior.

The objective of the first experiment was addressing whether prosody expressing anger and joy had similar effects on cooperation as the corresponding facial expressions of emotion. The main reason for focusing on those two emotions is that previous research exploring the effects of facial emotional expressions on cooperation has mainly addressed them, which does not imply that those two emotions and their prosodic expressions are fundamentally different from other basic emotions. In Experiment 3, reported below, the effects of additional basic emotions are addressed.

In line with literature regarding social functions of emotions (Andersen & Guerrero, 1998; Keltner & Haidt, 1999; Shariff & Tracy, 2011; Van Kleef et al., 2010), and previous experiments addressing the effects of facial emotional expressions (Reed et al., 2012; Scharlemann et al., 2001; Stouten & de Cremer, 2010; Tortosa et al., 2013), the main hypothesis was that emotional prosody would influence cooperation behavior.

More specifically, it was expected that anger expressions decrease cooperation behavior in accordance with the results of Tortosa et al., (2013) and Kugler et al., (2012) and reports showing that people displaying anger expressions are perceived as less cooperative and supporting (Stouten & de Cremer, 2010). Moreover, it has been proposed that anger promotes aggression and allows to influence others' behavior, instigating submission or causing other people to change their courses of action (Berkowitz & Harmon-Jones, 2004; Canary et al., 1998; Fischer & Mansted, 2008; Wubben et al., 2009).

In the case of joy, it has been proposed that it plays an important role in social interaction, allowing to establish and maintain social relationships, signal openness to social contact and build trust (Fischer & Mansted, 2008; Izard, 1991). However, some studies addressing the effects of joy expressions on cooperation have failed to find effects of joy expressions on cooperation (Reed et al., 2012; Tortosa et al., 2013), while others have found that joy expressions increase cooperation, but suffer from limitations such as the use of high levels of alpha for statistical decisions, lack of stimuli validation (Eckel & Wilson, 2003; Scharlemann et al., 2001), and lack of task order counterbalancing (Krumhuber et al., 2007), which made difficult to advance a specific prediction for the effect of joy in this experiment.

2.1 Method

2.1.1 Participants

In the present experiment, 48 students ranging from 18 to 25 years old (mean age = 19.15; SD= 1.81; 11 male) participated for course credit. To make results as comparable as possible with previous research on the subject, the inclusion criteria were being undergraduate students between 18 and 26 years old. Additionally, participants were required to be native Spanish speakers without hearing or language disabilities.

2.1.2 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).

For each emotion, the stimuli with the highest recognition rates among a set of valid stimuli obtained in a previous validation procedure were used (see Annex B for additional details on the validation procedure).

2.1.3 Apparatus

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

2.1.4 Procedure

Upon arrival at the laboratory, participants were explained that they would voluntarily participate in an experiment regarding social interaction and that they were free to abandon it at any moment. No participant abandoned the study. Afterwards, data regarding sex and age were recorded, and participants' name was registered to assign the course credit once they completed the experiment. After that, a sound test was conducted and participants adjusted the volume at a comfortable hearing level. Subsequently, instructions were presented on the screen and participants completed three practice trials; any doubts or questions regarding the experimental procedure were answered at this point.

An experimental game task and a perceptual judgment task were presented according to a counterbalanced design, where each participant was randomly assigned to a task-order group:

game first and judgment later or the opposite task order. Accordingly, 24 participants were assigned to each task-order group.

In both blocks, each of the 60 stimuli was presented once in a pseudorandom order, avoiding to present stimuli depicting the same emotion more than twice in a row. Therefore, 60 trials were presented in each task (3 emotions x 20 recordings).

The experimental game task consisted on an implementation of the assurance dilemma (Kollock, 1998) depicted as a hypothetical bets situation with the options *cooperate* ("cooperar") and *defect* ("traicionar"). The hypothetical payoff matrix is shown in Table 2.1.

Table 2.1. 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 specify the consequences for Player 1 and Player 2 depending on the combination of their choices; each player could either Cooperate or Defect. The first number of the pair refers to the consequence for Player 1 and the second number refers to the consequence for Player 2. The $ sign represents Mexican pesos.

Before starting the experimental game task, participants were informed that they would play a single turn against each opponent, that in each trial they would listen to a short recording

of the opponent's voice, that the objective was to maximize hypothetical benefits, and that opponents' behavior would mimic the patterns observed in real people (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 specifically inform participants that opponents were simulated as it was judged that making them believe that they were sequentially playing against 60 different real opponents in different emotional states was unrealistic. Note that previous experiments have detected effects of emotional expressions on cooperation even when the participants are aware that the opponents are fictitious (de Melo et al., 2014; Tortosa et al., 2013).

In each trial of the experimental game block the following events occurred: First, a prosodic stimulus reflecting an emotion (joy, neutral or anger expression) was presented; afterwards, the payoff matrix was presented and the participant decision of cooperating or defecting (by pressing the keys "1" or "2" respectively) was recorded; lastly, feedback depending on the participant's and opponent's responses was displayed (see the upper panel of Figure 2.1 for a display of the sequence of events in a trial).

For the perceptual judgment task, the event sequence for each trial was as follows: First, a prosodic stimulus reflecting a joy, neutral or anger expression was presented; afterwards, the participant was asked how likely it was that the opponent would cooperate and had to respond using a 7-point Likert scale (by pressing the keys "1" to "7", with higher numbers representing higher perceived probability of cooperation). Finally, the participant was asked how likely he was to cooperate if he was to play versus that opponent and had to respond using a 7-point Likert scale (by pressing the keys "1" to "7", with higher numbers representing a higher intention to cooperate). The lower panel of Figure 2.1 displays the sequence of events in a trial.

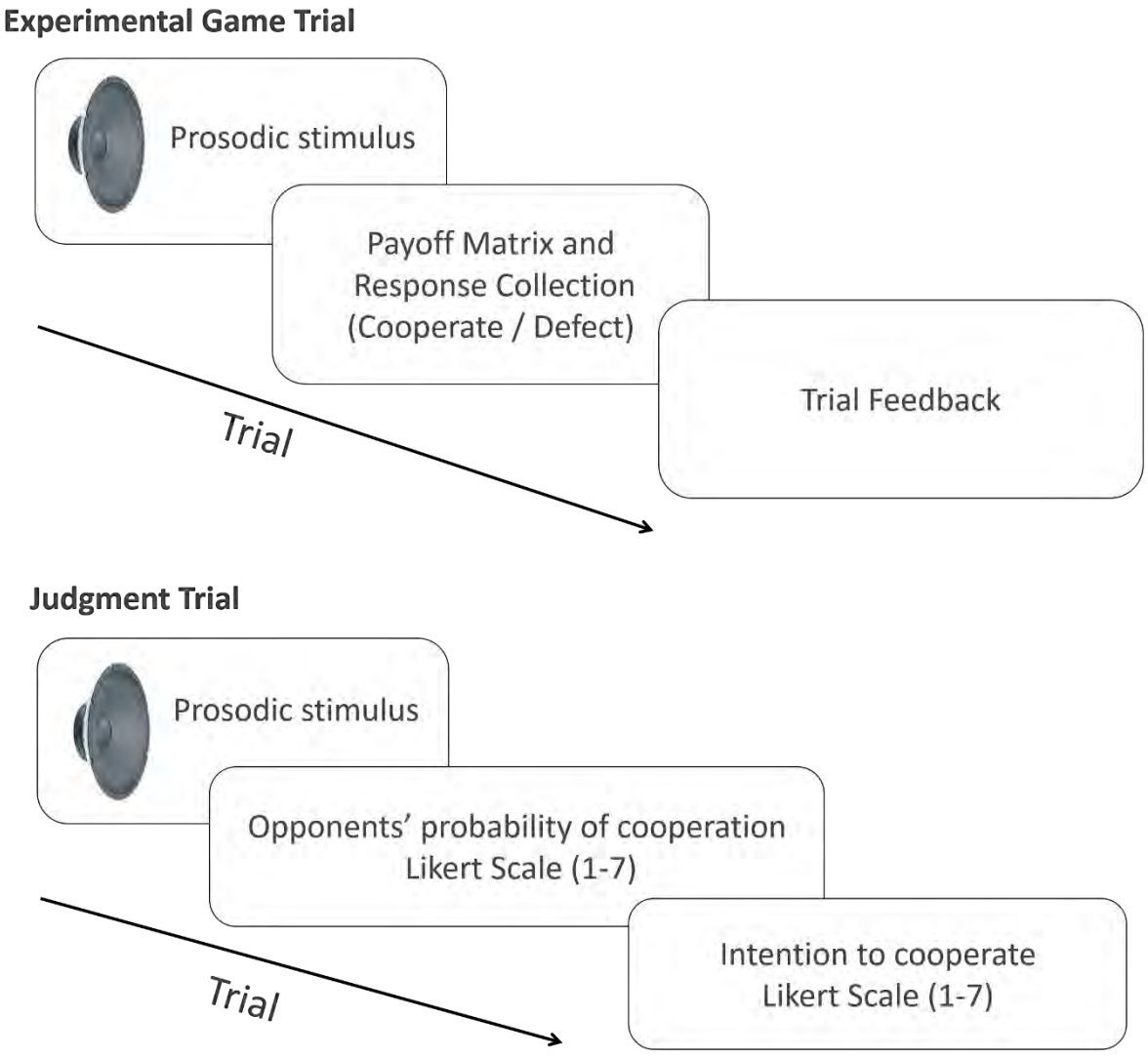

Figure 2.1 Sequences of trial events

2.2 Results

Three dependent measures were obtained from the experiments: “cooperation behavior”, “opponent’s probability of cooperation” (OPC) and “intention to cooperate” (IC).

The main dependent measure was Cooperation Behavior. To compute it, for each participant, the proportion of turns in which he cooperated out of the 20 stimuli depicting each emotion was calculated. Proportions were submitted to an arcsine transformation before analysis to suit better the normality assumption. Hence, each participant provided three data points, one for each emotion.

The perceptual judgment measures were obtained from the Likert punctuations provided for questions 1 (“How likely to cooperate is this opponent?”) and 2 (“How likely would you be to cooperate if you were playing versus this opponent?”) in the judgment task block detailed in the previous section.

The first perceptual judgment, “opponent’s probability of cooperation” (OPC), was obtained by calculating the median Likert punctuation provided to question 1 for the 20 stimuli depicting each emotion. Hence, each participant provided three data points, one for each emotion, in an analogous way to the behavioral measure.

The second perceptual judgment measure, “intention to cooperate” (IC), was obtained by calculating the median Likert judgment that the participant provided to question 2 for the 20 stimuli depicting each emotion was calculated. Hence, each participant provided three data points, one for each emotion.

The resulting dependent measures were individually 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. Post-hoc analyses were performed using the Bonferroni adjustment to keep a global alpha level equal to 0.5.

2.2.1 Behavioral Measure

As 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 $\eta^2 = 0.005$ were detected, the data from the two different task-order groups were collapsed and analyzed using a repeated measures ANOVA with the within-subjects factor "emotion". Results showed a main effect of emotion, $F(1.66, 77.85) = 50.2$, $p < .01$**, partial $\eta^2 = 0.52$.

Post-hoc analyses revealed a significant difference between 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 2.2 illustrates this pattern of results.

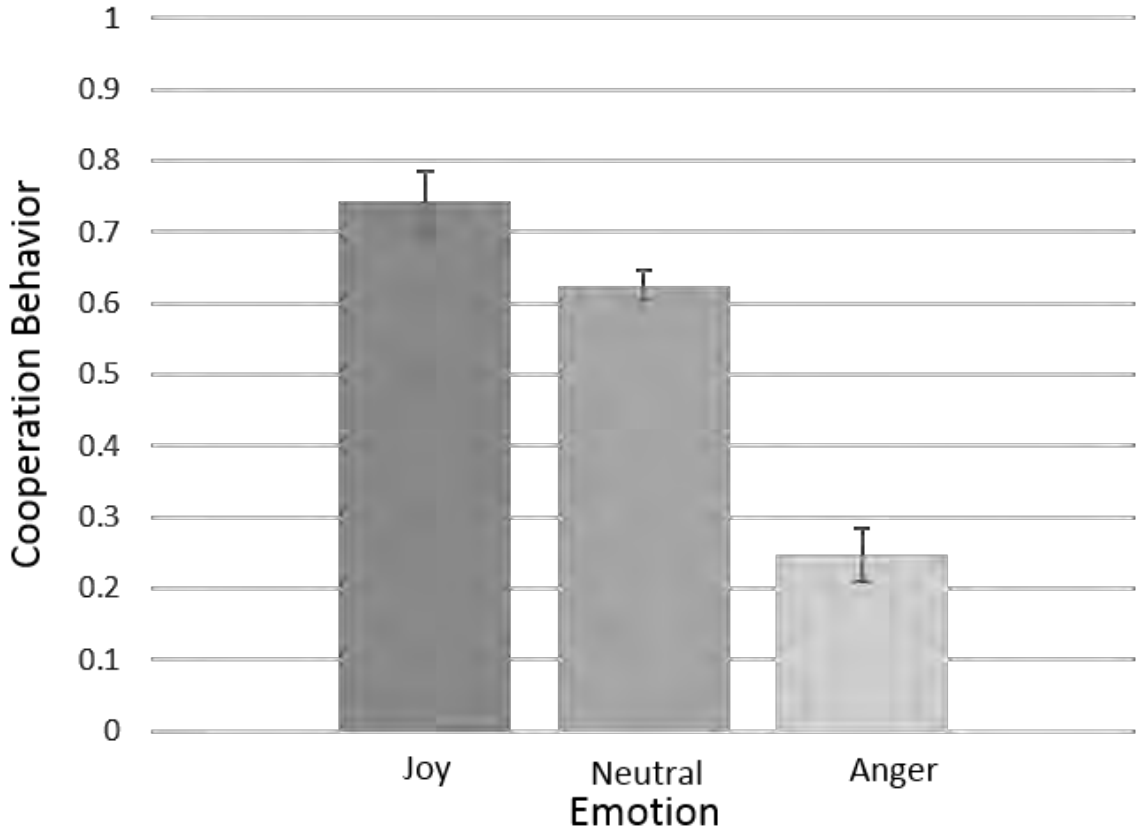

Figure 2.2 Cooperation behavior is plotted vs. each emotion.

2.2.2 Judgment Measures

For OPC, no effect of the "task order" factor, $F(1, 46) = 1.08$, $p = .3$, partial $\eta^2 = 0.023$, nor a significant interaction effect, $F(1.64, 75.23) = 1.4$, $p = .25$, partial $\eta^2 = 0.029$ were detected. Accordingly, both task-order groups were collapsed and data were analyzed using a repeated measures ANOVA with the factor "emotion". Results showed a main effect of emotion $F(1.62, 75.97) = 96.2$, $p < 0.001$***, partial $\eta^2 = 0.67$.

Post-hoc tests showed a significant difference in OPC 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. Figure 2.3 illustrates the results of this analysis.

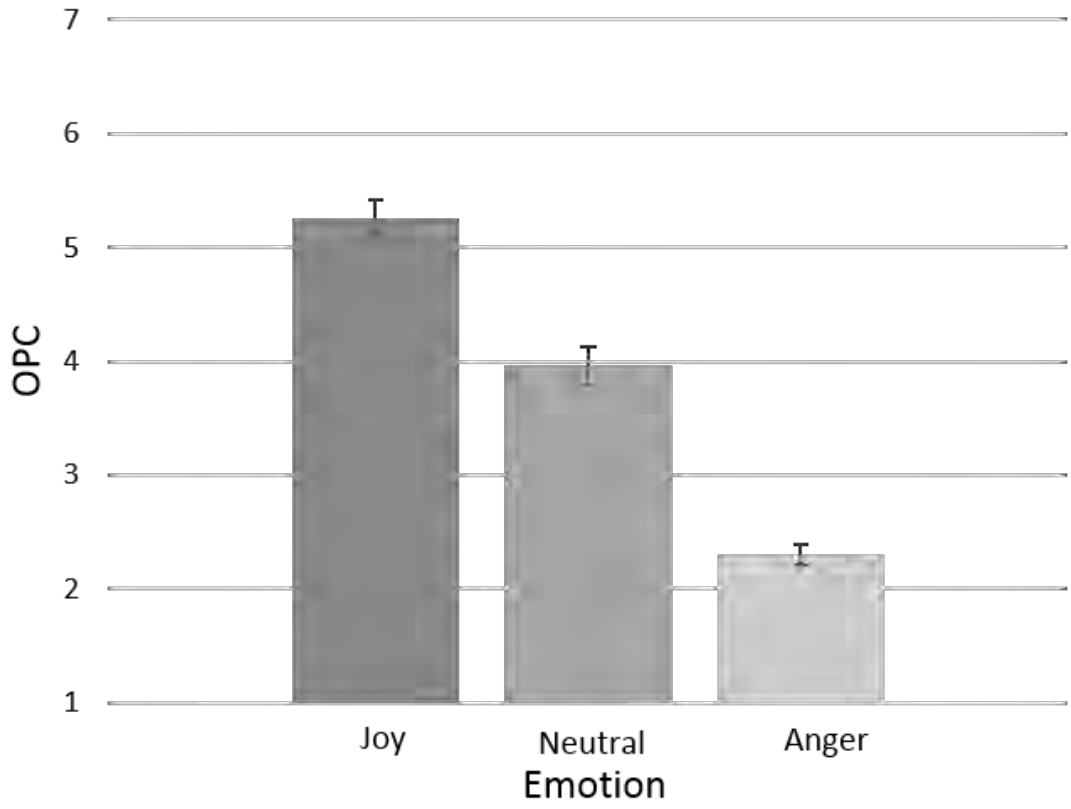

Figure 2.3. Opponent's probability of cooperation (OPC) is plotted versus each emotion. All pairwise comparisons are significantly different.

For IC, results revealed a main effect of the factor "emotion", $F(1.73, 79.7) = 81.52$, $p < .01$**, partial $\eta^2 = 0.64$, a main effect of the "task order" factor (higher probability of cooperation for the judgement-game task order group), $F(1, 46) = 5.49$, $p < .05$*, partial $\eta^2 = 0.11$, and a significant interaction effect, $F(1.73, 79.7) = 3.94$, $p < .05$*, partial $\eta^2 = 0.08$.

Post-hoc analyses for the "emotion" factor revealed that IC was different in each pairwise comparison: higher for joy than anger, $t(1, 47) = 10.35$, $p < .01$**, higher for neutral than anger, $t(1, 47) = 8.09$, $p < .01$**, and higher for joy than neutral expressions, $t(1, 47) = 5.23$, $p < .01$**.

Analyses of the effect of "task order" for each emotion separately revealed a significant difference restricted to joy expressions, $t(46) = 3.11$, $p < .05$* (higher IC for the judgment-game task order group). In contrast, no differences due to "task order" were detected for neutral, $t(46) = 1.76$, $p = .09$, or anger expressions, $t(46) = 0.91$, $p = .37$.

Analyses of the effect of "emotion" for each task order group revealed the following:

For the judgment-game group, all emotion pairs revealed significant differences on IC: 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, $t(23) = 6.08$, $p < .01$**. Note that this pattern of results corresponds to that observed for OPC. Figure 2.4 illustrates results.

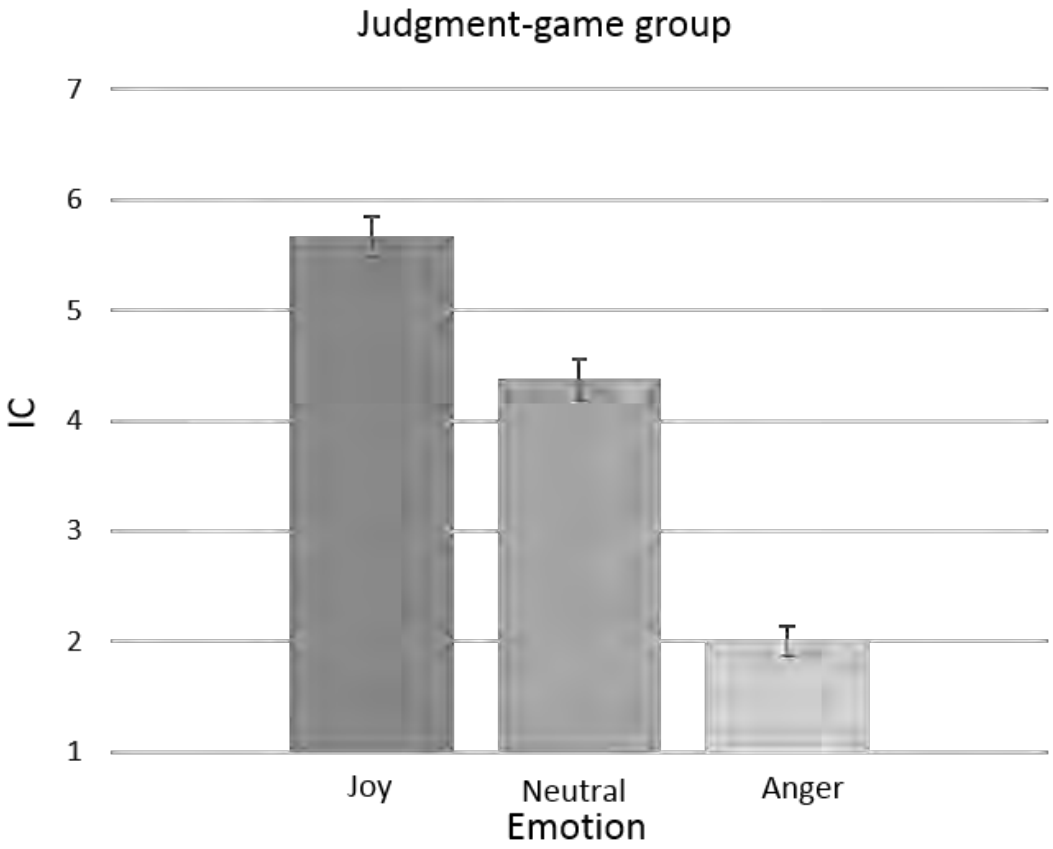

Figure 2.4. Intention to cooperate (IC) is plotted versus each emotion for the judgment-game group. All pairwise comparisons are significantly different.

In contrast, for the game-judgment group, IC differed between joy and anger, $t(23) = 5.99$, $p < .01$** and neutral and anger expressions, $t(23) = 4.27$, $p < .01$**, but no difference was found between joy and neutral expressions, $t(23) = 2.32$, $p = 0.03$; showing a similar pattern of results

to that observed for Cooperation Behavior: joy and neutral expressions being associated with a higher probability of cooperation than anger expressions, and higher probability of cooperation for joy than for neutral expressions that fails to reach significance. Results are shown in Figure 2.5.

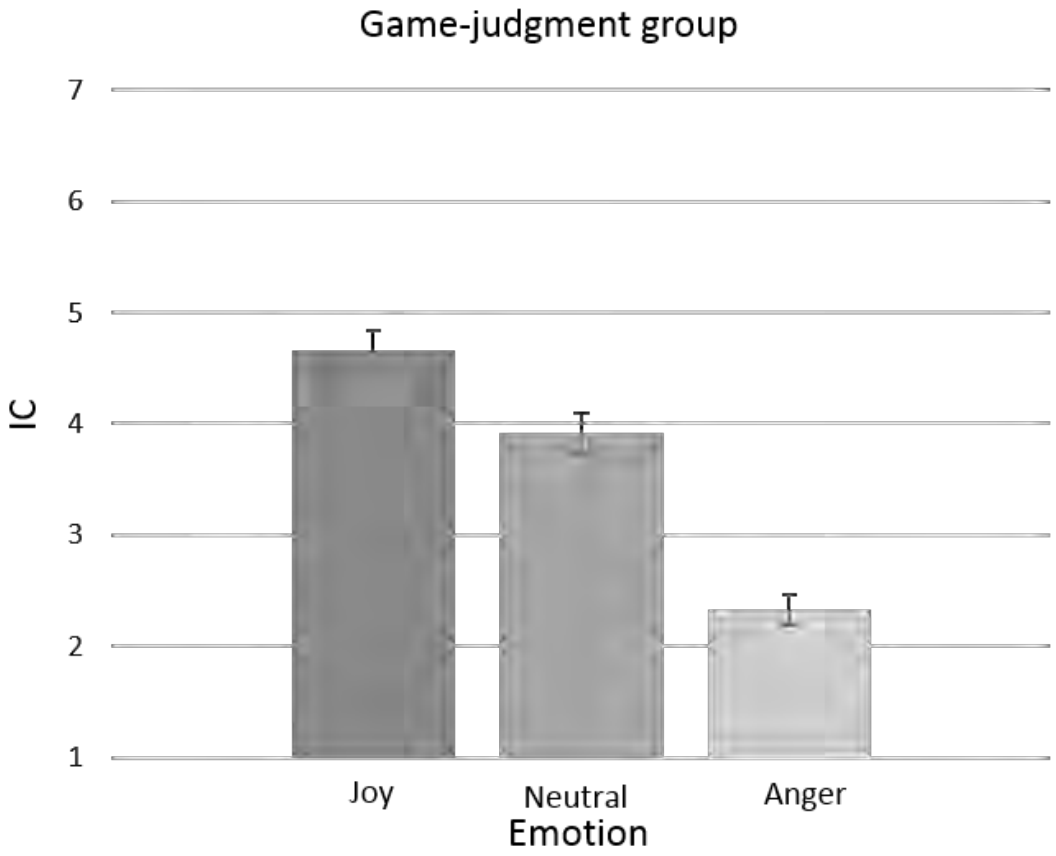

Figure 2.5. Intention to cooperate (IC) is plotted versus each emotion for the game-judgment group.

2.3 Discussion

The main hypothesis of this experiment was that emotional prosody would influence cooperation. Results supported this hypothesis: the emotion factor had effects on all dependent variables. The fact that effects of emotional prosody were detected 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).

It is noteworthy, however, that although differences in Cooperation Behavior associated to joy vs. anger, and neutral vs. anger expressions were detected, no clear difference was detected between joy and neutral expressions (see Figure 2.2).

There is some controversy regarding this pattern of results from previous studies; whereas in some of them joy is reported to increase cooperation (Eckel & Wilson, 2003; Krumhuber et al., 2007; Scharlemann et al., 2001), other studies have failed to find this pattern and report no effects of joy expressions on cooperation (Reed et al., 2012; Tortosa et al., 2013). In the current experiment, joy expressions were associated with higher cooperation proportions than neutral expressions but still failed to reach significance. In comparison, the tests for both the joy vs. anger and neutral vs. anger comparisons showed significant differences.

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 formulate 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 stimuli validation procedure 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 shown were included in this experiment.

The judgment measure of OPC (see Figure 2.3) also suggests that explanation "b" is not the case: Results for this variable showed differences between all pairs of emotions. Participants expected that opponents displaying joy expressions were more cooperative than those displaying neutral expressions and also 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 OPC judgment measure suggest that participants were able to distinguish stimuli and did perceive differences in intention.

However, results of the second judgment measure (IC) suggest that although differences in opponent’s intention were perceived, that was not the only information used to take a decision. This point deserves further elaboration:

The results for IC 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 2.4). 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 acting, their intentions mirrored the perceived intentions of opponents, as revealed by the results presenting the same pattern as that observed for the OPC judgment measure (compare Figures 2.3 and 2.4).

In contrast, results for IC in the game-judgment group showed a different pattern: the same observed for Cooperation Behavior (compare Figures 2.2 and 2.5). 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 cooperation of the opponents, but from other sources, most likely prior experience.

Specifically, by being exposed to a cooperation probability (0.5) that likely was below to what the participants expected for joy expressions, they may have adjusted their 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 has been made (De Houwer & Beckers, 2002; Fiser, Berkes, Orbán, & Lengyel, 2010; Sternberg & McClelland, 2012), in the particular case of probabilistic outcomes paired to emotional expressions, 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 et al., 2015; Averbeck & Duchaine, 2009)

In everyday life, however, there are multiple cues of behavioral intentions in addition to emotional expressions. This subject is addressed in Experiment 2.

3. Experiment 2: Influence of multiple cues of intention on cooperation

The objective of the second experiment was addressing the influence of emotional prosody on cooperation in a context where other cues of intention were available.

In everyday interaction, emotional expressions are not the only way of communicating intentions. In speech, the specific phrases can convey cues about behavioral intentions (in which case, they can be considered *commissive* speech acts, (Searle, 1975). If prosody influences interaction only in contexts in which it is the only available cue for behavioral intentions, its role in social interactions would not reflect the fundamental importance that has been suggested.

Previously, only a single work has addressed the joint influence of emotional expressions (in faces) and phrases (written messages) on cooperation behavior. Stouten and de Cremer, (2010) explored the effects of anger and joy facial expressions and written messages expressing a cooperative or non-cooperative intention and reported interaction effects. However, they did not include control stimuli such as neutral emotional expressions or written messages unrelated with the intention to cooperate; which would allow having an adequate baseline to compare cooperation levels.

In the present experiment, it was explored whether emotional prosody and verbal cues of intention influence cooperation and whether interaction effects involving both means of signaling behavioral intentions play a role in this context.

As in Experiment 1, the effects of emotional prosody reflecting anger, joy, and a neutral expression were assessed. Additionally, three different utterances conveying cues about the

behavioral intention were used: one of them, "I will cooperate" (*"Voy a cooperar"*) transmitted a high probability of cooperation; a second one, "I will defect" (*"Voy a traicionar"*), a low probability of cooperation; and a third one, "Let's play" (*"Vamos a jugar"*), provided no specific cue regarding the behavioral intention.

3.1 Method

3.1.1 Participants

For this experiment, an independent group of 48 students ranging from 18 to 25 years old (mean age = 19.81; SD= 1.79; 13 male) participated for course credit. Inclusion criteria were the same as in Experiment 1.

3.1.2 Stimuli

Short recordings of the phrases "Let's play" ("*Vamos a jugar*"), "I will cooperate" (*"Voy a cooperar"*) and "I will defect" (*"Voy a traicionar"*) said with 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 recordings of the phrase "Let's play" (said with joy, anger or in a neutral way) were the same as in Experiment 1.

Regarding the additional stimuli included for this experiment, for each combination of emotion (joy, anger and neutral expression) and phrase ("I will cooperate" / "I will defect") the 20 stimuli with the highest recognition rates among a set of valid stimuli obtained in two previous

validation procedures were used (see Annex B for additional details on the validation procedures).

3.1.3 Apparatus

The experimental apparatus was the same as in Experiment 1.

3.1.4 Procedure

The procedure was the same as in Experiment 1. The only difference was that 180 stimuli (the combination of 3 Emotions x 3 Phrases x 20 Recordings) were presented in the present experiment while in Experiment 1 only 60 stimuli (1 Phrase x 3 Emotions x 20 recordings) were presented. Half of the participants (24) took part in each task-order group.

3.2 Results

As in Experiment 1, three dependent measures were obtained: "cooperation behavior", "opponent's probability of cooperation" (OPC) and "intention to cooperate" (IC). They were obtained in the same way as in Experiment 1, except that they were based on the 9 different stimuli types of this experiment represented by the combination of the 3 emotions (joy, anger and neutral) and 3 phrases (I will cooperate, I will defect and Let's play). Accordingly, each participant provided 9 data points for each variable.

Each dependent measure was individually analyzed using a factorial ANOVA including the within-subjects factors "emotion" (comparing joy, anger, and neutral expressions) and "phrase" (comparing the cooperative, uncooperative and neutral phrases) and the between-

subjects factor “task order” (whether the participant completed the game task first and the judgment task second or the reverse order). Sphericity tests, adjustments to degrees of freedom and Bonferroni adjustments for multiple comparisons were performed as in Experiment 1.

3.2.1 Behavioral Measure

As the main analysis did not reveal a main effect of the “task-order” factor $F(1,46) = 1.97$, $p = .17$, partial $\eta^2 = 0.04$, nor any interaction effects involving it (All contrasts $F < 1$, $p > 0.05$), the groups from the two different task-order groups were collapsed and data were analyzed with a factorial ANOVA including the within-subjects factors “emotion” and “phrase”.

Results for this analysis showed a main effect of the “emotion” factor, $F(2,94) = 60.26$, $p < .01$**), partial $\eta^2 = 0.56$. As in Experiment 1, joy and neutral expressions produced higher cooperation proportions than anger expressions, while the difference between joy and neutral expressions was not significant (see Figure 3.1).

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 proportions than uncooperative (“I will defect”) phrases; cooperation behavior did not differ between cooperative and neutral phrases, though (see Figure 3.2).

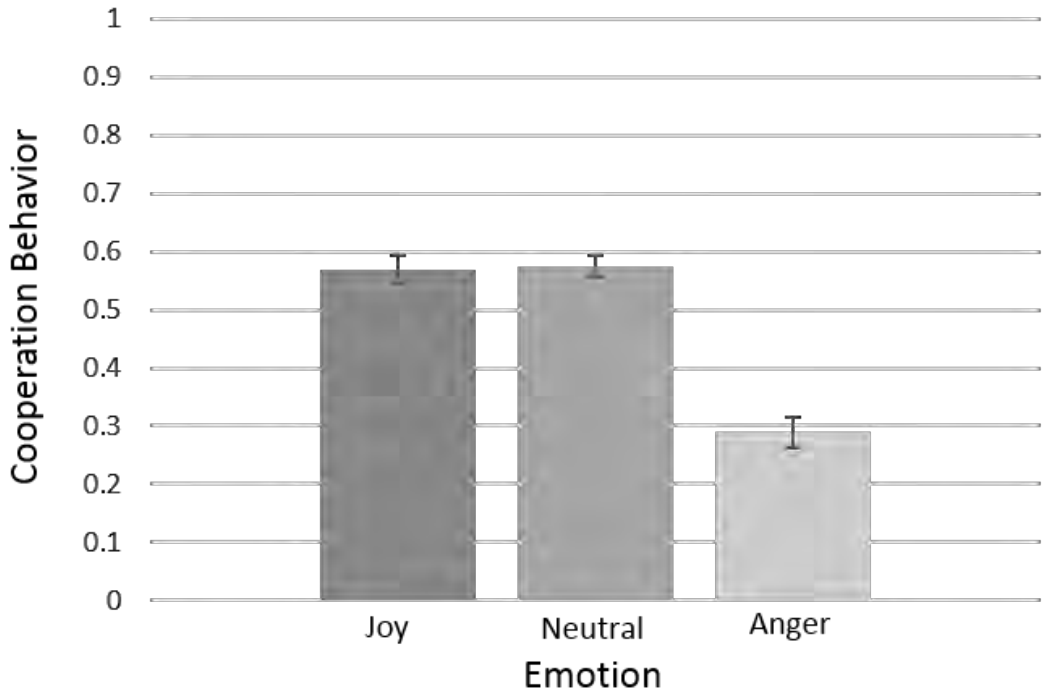

Figure 3.1. Main effect of Emotion on Cooperation Behavior.

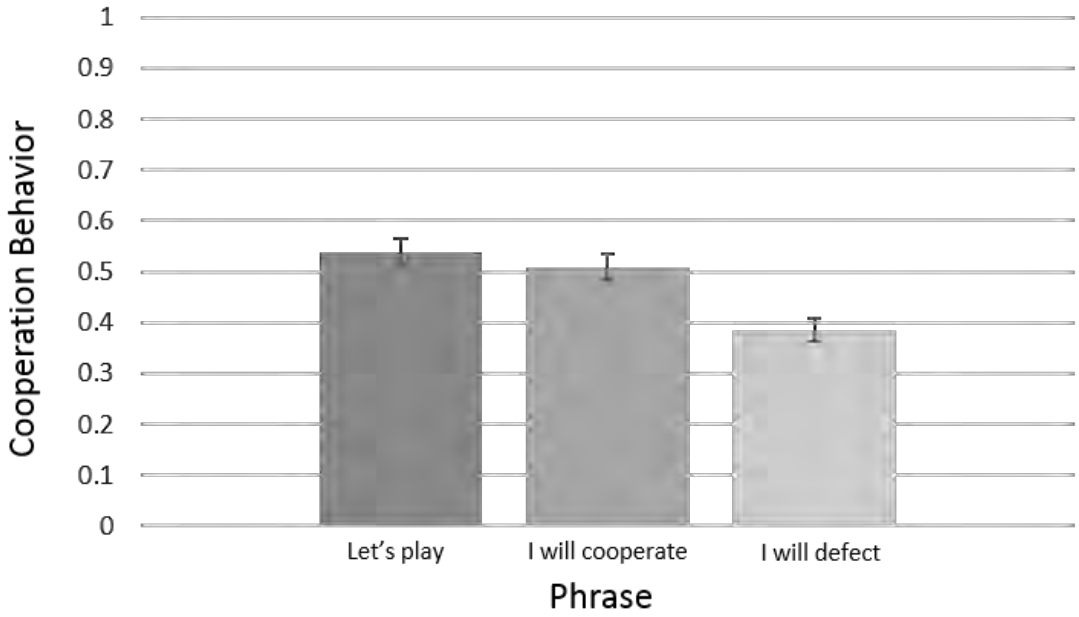

Figure 3.2. Main effect of Phrase on Cooperation Behavior.

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 3.3 and Table 3.1

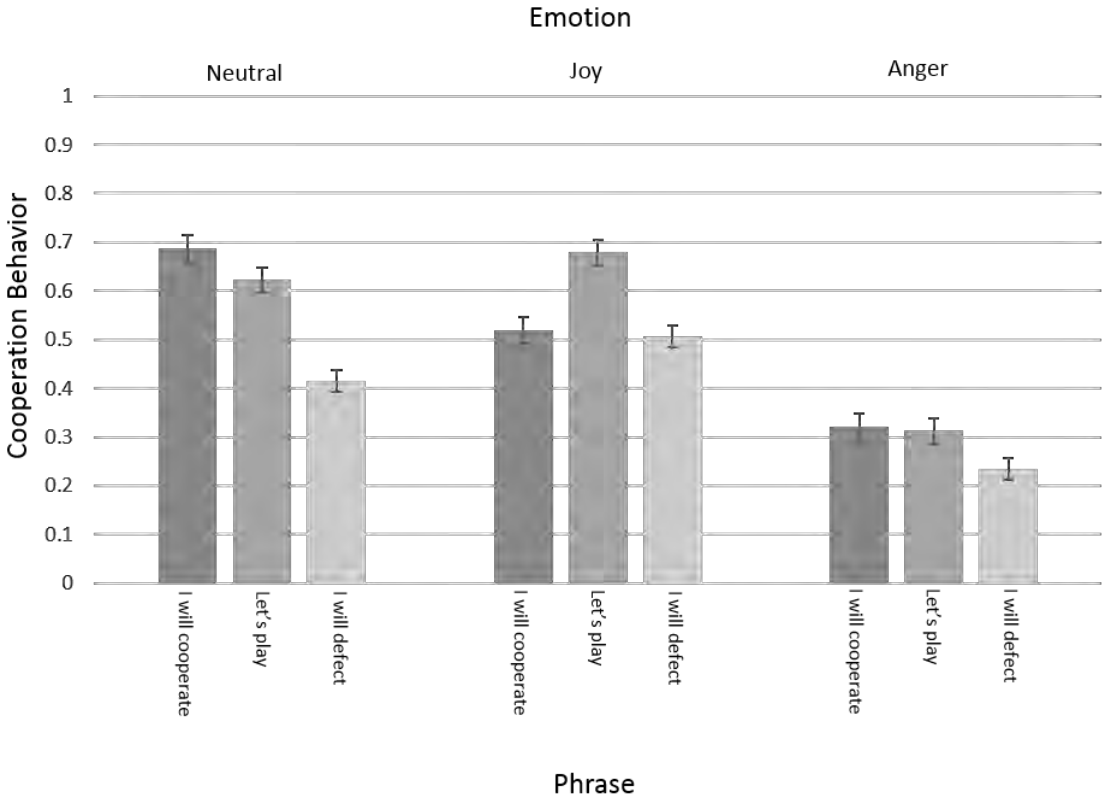

Figure 3.3. Interaction of Emotion and Phrase on Cooperation Behavior.

As it was expected to find the same pattern of results of Experiment 1 for the subset of stimuli comprising only the "Let's play" phrase, data for this subset was analyzed using a repeated-measures ANOVA including the emotion factor. Results were significant $F(2,94) = 37.09$, $p < .001$***, partial $\eta^2 = 0.44$, and revealed the same pattern of results of Experiment 1; cooperation proportions were higher for joy and neutral expressions than for anger expressions, but no difference was found between joy and neutral expressions.

Table 3.1. Pairwise comparisons for Cooperation Behavior for each emotion.

Emotion	**Phrase**		**Cooperate**	**Play**	**Defect**
		Mean	0.69	0.62	0.41
	Cooperate	0.69	X	n.s.	*
Neutral	**Play**	0.62	n.s.	X	*
	Defect	0.41	*	*	X

Emotion	**Phrase**		**Cooperate**	**Play**	**Defect**
		Mean	0.52	0.68	0.5
	Cooperate	0.52	X	*	n.s.
Joy	**Play**	0.68	*	X	*
	Defect	0.5	n.s.	*	X

Emotion	**Phrase**		**Cooperate**	**Play**	**Defect**
		Mean	0.32	0.31	0.23
	Cooperate	0.32	X	n.s.	n.s.
Anger	**Play**	0.31	n.s.	X	n.s.
	Defect	0.23	n.s.	n.s.	X

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 $\alpha=0.05$ with a Bonferroni correction for multiple comparisons was used, * 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.

3.2.2 Judgment Measures

For OPC, the main analysis did not reveal a main effect of the "task-order" factor $F(1,46) = 0.84$, $p = .37$, partial $\eta^2 = 0.02$, nor any interaction effects involving it (All contrasts $F < 2$, $p > 0.05$). Accordingly, the two different task-order groups were collapsed and data were analyzed with a factorial ANOVA including the within-subjects factors "emotion" and "phrase".

Results for this analysis showed a main effect of the "emotion" factor, $F(1.4,65.68) = 76.1$, $p < .01$**), partial $\eta^2 = 0.62$. All pairwise comparisons revealed significant differences; OPC was higher for joy expressions, moderate for neutral and lower for anger expressions; revealing the same pattern of Experiment 1 (see Figure 3.4).

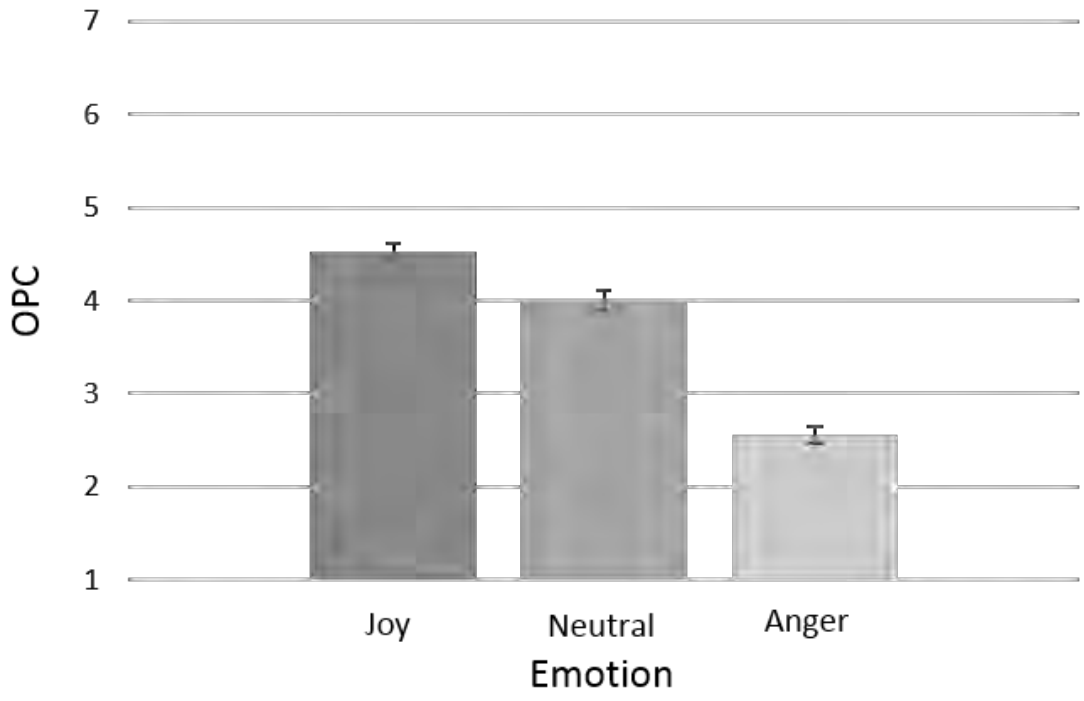

Figure 3.4. Main effect of emotion on OPC.

Additionally, a main effect of the "phrase" factor was detected, $F(1.4,65.64) = 25.46$, $p < .01$**, partial $\eta^2 = 0.351$. OPC was higher for "I will cooperate" and "Let's play" phrases than for "I will defect", but did not differ between the first two phrases (see Figure 3.5). This pattern is the same as the observed for the behavioral measure. The interaction of emotion and phrase was not significant $F(2.76,129.63) = 2.49$, $p = 0.069$, partial $\eta^2 = 0.05$.

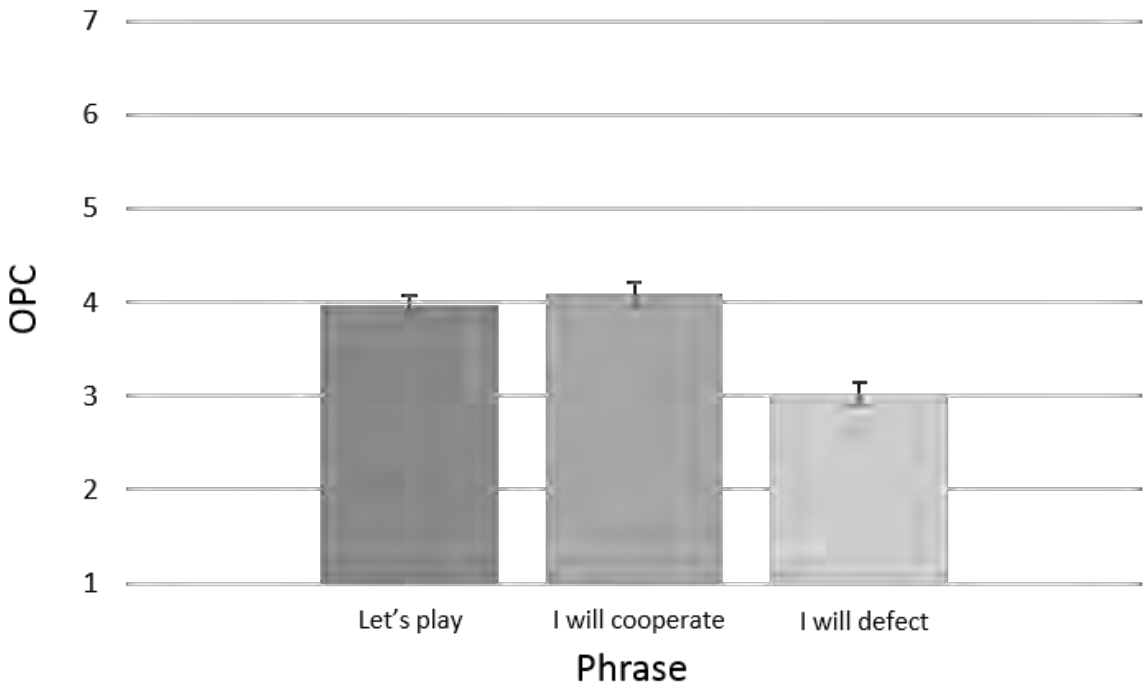

Figure 3.5. Main effect of Phrase on OPC.

As it was expected to find the same pattern of results of experiment 1 for the subset of stimuli comprising only the "Let's play" phrase, OPC data for this subset was analyzed using a repeated-measures ANOVA including the emotion factor. Results were significant $F(1.44, 67.44)$

= 46.64, $p < .001$***, partial $\eta^2 = 0.5$, and revealed the same pattern of results of Experiment 1: all emotion pairs were significantly different.

For IC, the main analysis did not reveal a main effect of the "task-order" factor $F(1,46) = 1.06$, $p = .3$, partial $\eta^2 = 0.02$, nor any interaction effects involving it (All contrasts $F < 1$, $p > 0.05$). Accordingly, the two different task-order groups were collapsed and data were analyzed with a factorial ANOVA including the within-subjects factors "emotion" and "phrase".

The analysis revealed a main effect of the "emotion" factor, $F(1.57,73.98) = 100.9$, $p < .01$**, partial $\eta^2 = 0.68$. Pairwise comparisons revealed that IC was higher for joy and neutral expressions than for anger expressions, but the difference between joy and neutral expressions was not significant (see Figure 3.6).

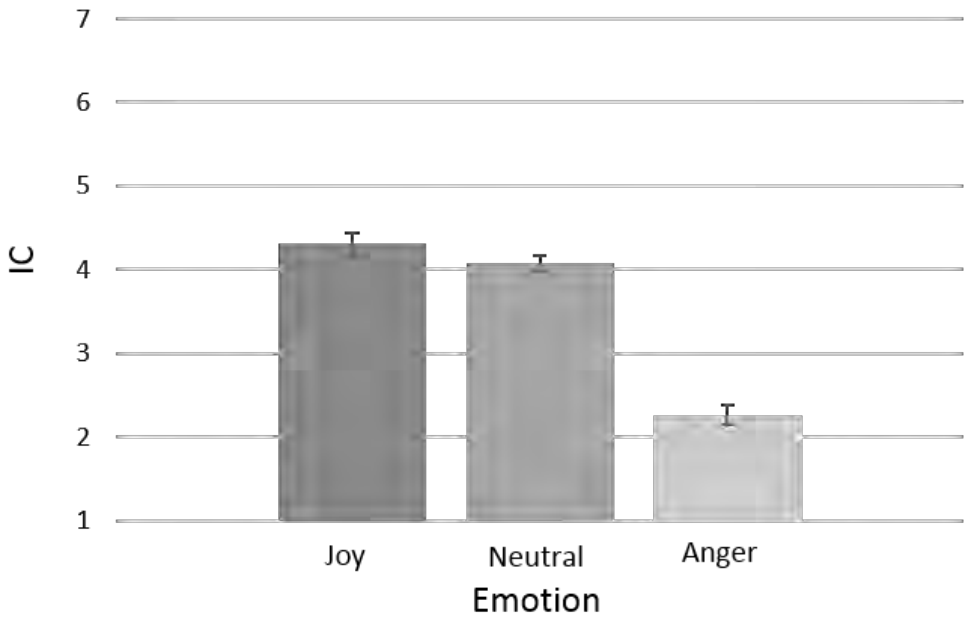

Figure 3.6. Main effect of Emotion on IC.

A main effect of the "phrase" factor was also detected, $F(1.4,65.65) = 22.61$, $p < .01$**, partial $\eta^2 = 0.325$. IC was higher for cooperative ("I will cooperate") and neutral ("Let's play") phrases than for uncooperative ("I will defect") phrases but the difference between cooperative and neutral phrases did not reach significance (see Figure 3.7). This pattern is the same as the observed for the behavioral measure and the OPC judgment measure.

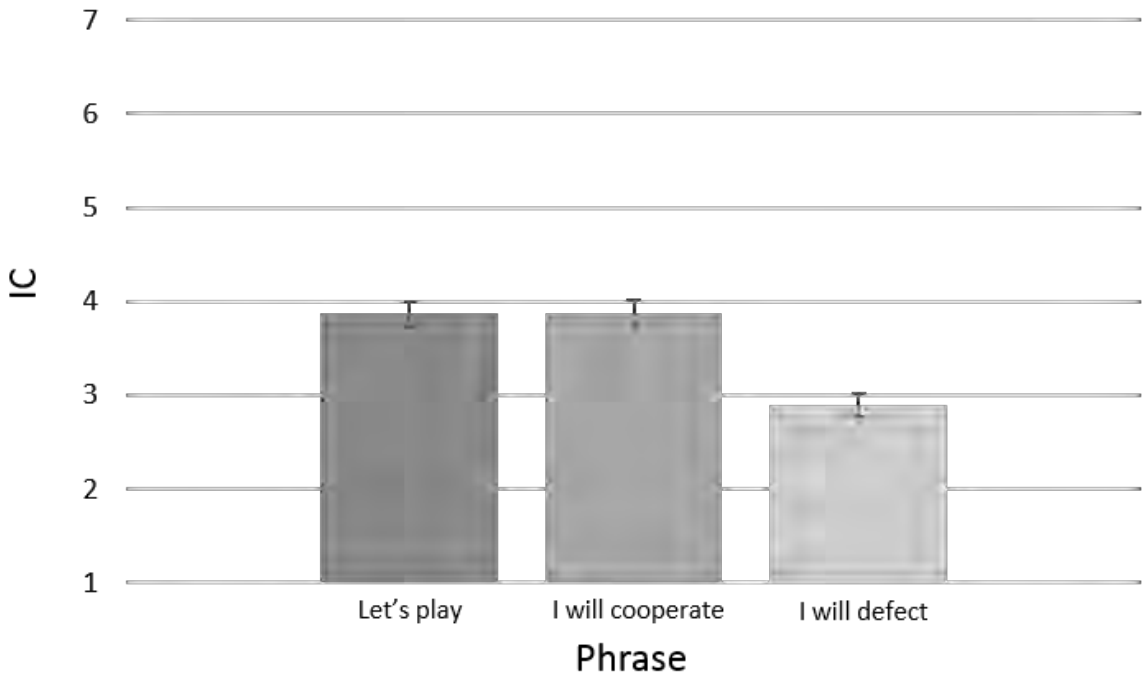

Figure 3.7. Main effect of Phrase on IC.

Lastly, the interaction of emotion and phrase was also significant, $F(2.32,109.24) = 3.78$, $p < .05$*, partial $\eta^2 = 0.074$. This effect is shown in Figure 3.8 and Table 3.2.

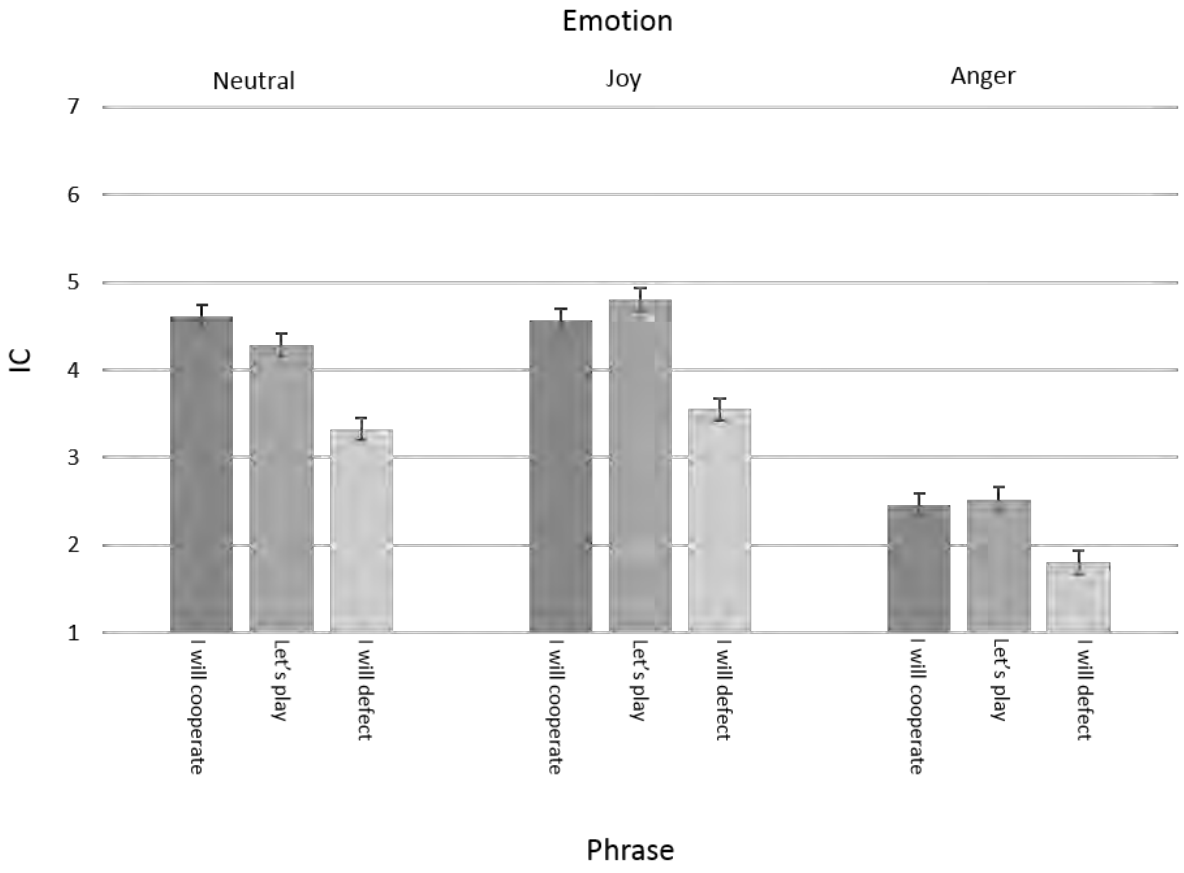

Figure 3.8. Interaction of Emotion and Phrase on IC.

Table 3.2. Pairwise comparisons for IC for each emotion.

Emotion	**Phrase**		**Cooperate**	**Play**	**Defect**
		Mean	4.62	4.28	3.32
	Cooperate	4.62	X	n.s.	*
Neutral	**Play**	4.28	n.s.	X	*
	Defect	3.32	*	*	X

Emotion	**Phrase**		**Cooperate**	**Play**	**Defect**
		Mean	4.56	4.8	3.55
	Cooperate	4.56	X	n.s.	*
Joy	**Play**	4.8	n.s.	X	*
	Defect	3.55	*	*	X

Emotion	**Phrase**		**Cooperate**	**Play**	**Defect**
		Mean	2.46	2.52	1.8
	Cooperate	2.46	X	n.s.	*
Anger	**Play**	2.52	n.s.	X	*
	Defect	1.8	*	*	X

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, * 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.

As it was expected to find the same pattern of results of Experiment 1 for stimuli comprising only the "Let's play" phrase, IC data for this subset was analyzed independently for the two task-order groups using repeated-measures ANOVAs including the emotion factor. The pattern of results was the same of Experiment 1. For the judgment-game group the emotion effect was significant $F(1.52, 34.9) = 43.99$, $p < .001$***, partial $\eta^2 = 0.66$ and revealed differences between all emotion pairs. For the game-judgment group, the emotion effect was also significant $F(1.3, 30.03) = 24.05$, $p < .001$***, partial $\eta^2 = 0.51$, and differences between joy and neutral expressions versus anger expressions were detected, but the difference between joy and neutral expressions was not significant. This pattern of results mirrors the observed pattern of Experiment 1.

3.3 Discussion

The main objective of this experiment was testing whether emotional prosody had effects on cooperation in contexts where other cues of intention were available. Experimental results supported this hypothesis: all variables revealed significant effects of the emotion factor.

In the case of Cooperation Behavior, participants cooperated more when exposed to joy or neutral expressions than when exposed to anger expressions but no differences were found between joy and neutral expressions. Pairwise comparisons of the different emotions on the "intention to cooperate" (IC) judgment measure revealed the same pattern of results.

In contrast, "opponent's probability of cooperation" (OPC) revealed differences between all emotion pairs. Together with results of Experiment 1, this observation suggests that

participants considered other variables in addition to the probability of cooperation perceived in opponents (captured by OPC) for taking their decisions (as revealed by IC and Cooperation Behavior).

The phrase factor also revealed significant effects for all variables. Nonetheless, effect sizes suggest that emotional prosody produced much stronger effects than phrases as evidenced by partial η^2 values being about two to three times larger for the emotion factor than for the phrase factor for all variables. Note that this pattern of results was observed even though two out of the three phrases (I will cooperate / I will defect) signaled a specific behavioral intention.

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 take decisions and adjust their behavior. Therefore, no single cue overrides the influence of the other. And more importantly, the joint effect may not be easy to predict, as suggested by the "I will cooperate" phrase leading to lower rates of cooperation than "Let's play" in the context of joy prosody (see Table 3.1).

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 (Lindner & Rosén, 2006; Stewart et al., 2013).

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 (Holtgraves, 1986; Searle, 1969, 1975, 1979). Correctly understanding indirect meanings requires the successful integration of diverse cues, including prosody, gestures, context, semantics and syntax (Papagno, 2001; Pell, 2006; Pell et al., 2014; Pexman, 2008; Rothermich & Pell, 2015), 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 (Pell et al., 2014; Pexman, 2008; Rothermich & Pell, 2015; Varga et al., 2013, 2014) that involve diverse brain areas (McNamara, Holtgraves, Durso, & Harris, 2010; Papagno, 2001; Pell, 2006; Pell et al., 2014; Pexman, 2008; Varga et al., 2013).

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 (Cardoso, Silva, Maroco, De Mendonca, & Guerreiro, 2014; Golan, Baron-Cohen, Hill, & Rutherford, 2007; McNamara et al., 2010; Paul, Van Lancker-Sidtis, Schieffer, Dietrich, & Brown, 2003; Pell, 2006; Pell et al., 2014; Pexman, 2008; Rutherford, Baron-Cohen, & Wheelwright, 2002; Varga et al., 2014; Wang, Lee, Sigman, & Dapretto, 2006).

A better understanding of the way in which prosody and other cues affect the perception of indirect meanings and behavioral responses in healthy populations would allow to better understand how the perceptual deficits in clinical populations relate to their social interaction

difficulties. Moreover, including behavioral measures on future studies may enhance our current understanding of the subject, especially considering that results of the present experiment revealed that behavioral and judgment measures do not necessarily show exactly the same pattern.

Lastly, it is worth to note that analysis restricted to the “Let’s play” phrase revealed the same pattern of results of Experiment 1 for all variables. In the case of IC, even though the main analysis, which included all phrases and emotions did not reveal interaction effects involving task-order, conducting a separate analysis for both task order groups including only the “Let’s play” stimuli, revealed the same pattern of results observed in Experiment 1, which was to be expected as it was the same stimuli subset.

4. Experiment 3: Influence of basic emotion expressions on cooperation.

The main objective of the present experiment was testing whether effects of vocal expressions of basic emotions are in accordance with their proposed social functions.

Most of the works that have addressed the effects of emotional expressions on cooperation are based on the theoretical framework proposing that emotions allow communicating behavioral intentions. In line with this framework, basic emotions promote particular behavioral tendencies and their associated universal expressions allow observers to predict them and adapt their behavior accordingly (Alguacil et al., 2015; Andersen & Guerrero, 1998; Keltner & Haidt, 1999; Keltner & Kring, 1998; Shariff & Tracy, 2011; Van Kleef et al., 2010). In line with this framework, effects of joy and anger facial expressions on cooperation (Reed et al., 2012; Scharlemann et al., 2001; Stouten & de Cremer, 2010; Tortosa et al., 2013), are usually interpreted to reflect the social functions of those emotions; for joy, signaling openness to social contact and helping to establish and keep relationships, mutual confidence and trust (Fischer & Mansted, 2008; Izard, 1991; Stouten & de Cremer, 2010); and for anger, attaining or maintaining a status of dominance by instigating submission in others or forcing them to change their courses of action through different means, such as threat and aggression (Berkowitz & Harmon-Jones, 2004; Canary et al., 1998; Fischer & Mansted, 2008; Stouten & de Cremer, 2010; Wubben et al., 2009).

However, previous findings do not allow determining whether the effects of emotional expressions are due to their proposed social functions or whether they are due to a simpler distinction: positive vs. negative emotions. An alternative interpretation is that expressions of

positive emotions increase cooperation while expressions of negative emotions decrease it, regardless of their proposed social function.

Therefore, this experiment aimed to address the influence of other basic emotions on cooperation: sadness, fear, and disgust; and to compare them with the effects of joy, anger and neutral expressions used in previous experiments.

It has been proposed that sadness signals helplessness and the need of social support, and that sadness expressions promote empathy and helping behavior in observers (Bandstra et al., 2011; Eisenberg et al., 1989; Fischer & Mansted, 2008; Gray et al., 2011; Izard, 1991; Osen, 2009; Vigil, 2009); fear is thought to increase search for social support, and its expressions would promote observers' helping behavior by signaling an affiliative, non-threatening disposition and inviting approach (Fischer & Mansted, 2008; Hammer & Marsh, 2015; Izard, 1991; Marsh, Ambady, et al., 2005; Niedenthal et al., 2006; Tracy, 2014). Moreover, sadness and fear have been reported to increase cooperation in experimental games (Kugler et al., 2012; Nelissen et al., 2011; Tan & Forgas, 2010). Disgust, in contrast, promotes avoidance, withdrawal and rejection, and it has been reported that it correlates negatively with cooperation in experimental games (Chapman et al., 2009; Rozin et al., 2008).

Accordingly, if the effects of emotional expressions are determined by their social functions, it can be expected that joy, sadness, and fear expressions increase cooperation while anger and disgust decrease it. In contrast, if effects on cooperation depended on a distinction of positive vs. negative emotions, joy was expected to increase it while the rest of them (sadness, anger, fear, and disgust) to decrease it.

This experiment aimed to test the theoretical framework that has guided research on the subject and to extend the set of emotions for which the hypotheses were tested.

4.1 Method

4.1.1 Participants

For this experiment, an independent group of 46 students ranging from 18 to 26 years old (mean age = 19.33; SD= 1.9; 38 female) participated for course credit. Inclusion criteria were the same as in Experiments 1 and 2.

4.1.2 Stimuli

Short recordings of the phrase "Let's play" ("*Vamos a jugar*"), said with joy, sadness, anger, fear, disgust, or a neutral expression were used. For each emotion, 20 recordings were included; therefore, a total of 120 stimuli were used in the experiment (6 Emotions x 20 recordings).

Recordings of joy, anger, and neutral emotional expressions were the same as in Experiment 1. Regarding the additional emotions included for this experiment (sadness, fear, and disgust), the 20 stimuli with the highest recognition rates among a set of valid stimuli obtained in two previous validation procedures were used (see Annex B for additional details on the validation procedures).

4.1.3 Apparatus

The experimental apparatus was the same as in Experiments 1 and 2.

4.1.4 Procedure

The procedure was the same as in Experiment 1. The only difference was that 120 stimuli (the combination of 6 Emotions x 20 Recordings) were presented in the present experiment while in Experiment 1 only 60 stimuli (3 Emotions x 20 recordings) were presented. Half of the participants (23) took part in each task-order group.

4.2 Results

As in Experiment 1, three dependent measures were obtained: "cooperation behavior", "opponent's probability of cooperation" (OPC) and "intention to cooperate" (IC). They were obtained in the same way as in Experiment 1, except that they were based on the 6 emotional expressions of this experiment (joy, sadness, anger, fear, disgust, neutral). Accordingly, each participant provided 6 data points for each variable, one data point for each emotion.

Each dependent measure was individually analyzed using a factorial ANOVA including the within-subjects factor "emotion" and the between-subjects factor "task order" (whether the participant completed the game task first and the judgment task second or the reverse order). Sphericity tests, adjustments to degrees of freedom and Bonferroni adjustments for multiple comparisons were performed as in Experiment 1.

4.2.1 Behavioral Measure

As the main analysis did not reveal a main effect of the "task-order" factor $F(1,44) = 1.46$, $p = .23$, partial $\eta^2 = 0.03$, nor an interaction with "emotion" $F(5,220) = 1.85$, $p = .105$, partial $\eta^2 = 0.04$, the data from the two different task-order groups were collapsed and analyzed using a repeated-measures ANOVA including the within-subjects factor "emotion".

Results for this analysis showed a main effect of "emotion", $F(3.5,157.39) = 42.85$, $p < .01$**), partial $\eta^2 = 0.49$. As the main objective of the present experiment was comparing the effects of each emotion versus the neutral expression, individual t-tests for related samples were conducted for the pairs formed between neutral expressions and each of the emotions (additional pairwise comparisons are summarized in Table 4.1; Bonferroni-adjusted alpha for this and later analysis reported in the section was 0.003). Results revealed that cooperation behavior was higher for joy than neutral expressions, but failed to reach significance ($t(45) = -2.18$, $p = 0.035$); in contrast, cooperation behavior was lower for all emotions as compared to neutral expressions (for all tests, $t(45) > 3$, $p < 0.001$***). Note that the pattern of results for joy, anger, and neutral expressions resembles results from Experiments 1 and 2. Figure 4.1 illustrates results.

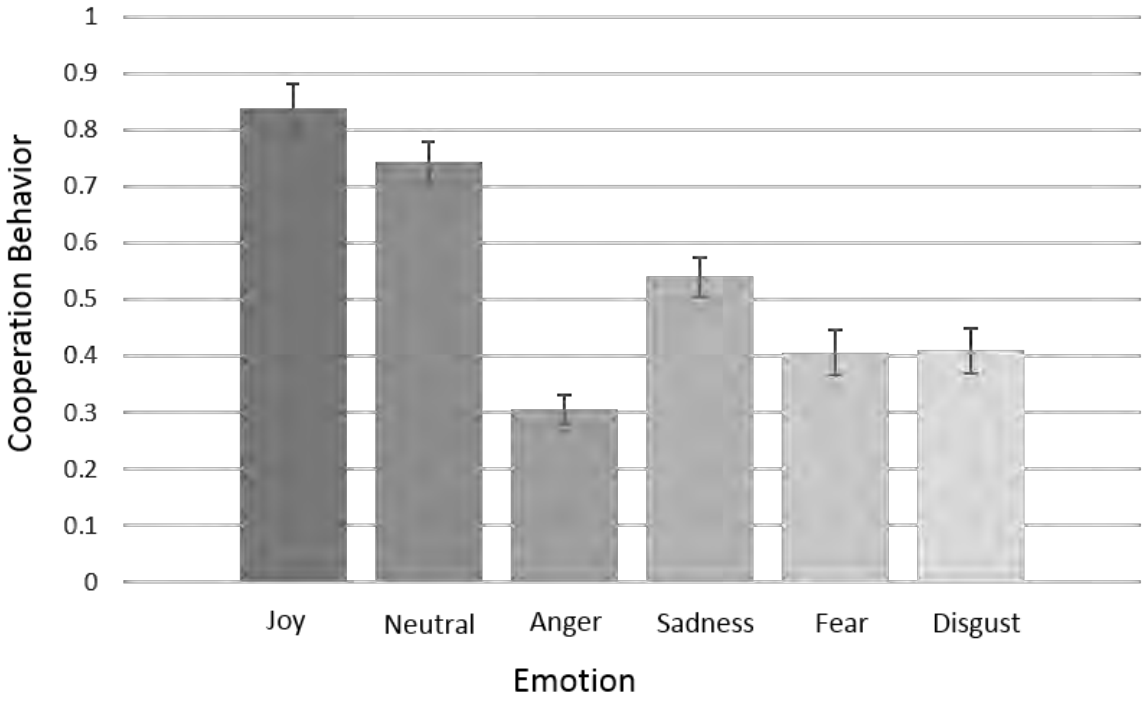

Figure 4.1. Cooperation behavior is plotted vs. each emotion.

Table 4.1. Pairwise comparisons for Cooperation Behavior.

Emotion		**Joy**	**Sadness**	**Anger**	**Fear**	**Disgust**	**Neutral**
	Mean	0.84	0.54	0.3	0.4	0.41	0.74
Joy	0.84	X	*	*	*	*	n.s.
Sadness	0.54	*	X	*	*	n.s.	*
Anger	0.3	*	*	X	n.s.	n.s.	*
Fear	0.4	*	*	n.s.	X	n.s.	*
Disgust	0.41	*	n.s.	n.s.	n.s.	X	*
Neutral	0.74	n.s.	*	*	*	*	X

Note. The table summarizes pairwise comparisons in Cooperation Behavior for all emotion pairs. A global level of α=0.05 with a Bonferroni correction for multiple comparisons was used, * 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.

4.2.2 Judgment Measures

For OPC, the main analysis did not reveal a main effect of the "task-order" factor $F(1,44) = 0.39$, $p = .54$, partial $\eta^2 = 0.009$, nor an interaction with "emotion" $F(5,220) = 1.76$, $p = .12$, partial $\eta^2 = 0.038$. Accordingly, the two different task-order groups were collapsed and data were analyzed using a repeated-measures ANOVA including the within-subjects factor "emotion".

Results for this analysis showed a main effect of "emotion", $F(5,225) = 37.67$, $p < .001$***), partial $\eta^2 = 0.46$. Individual t-tests for related samples were conducted for the pairs formed between neutral expressions and each of the emotions (additional pairwise comparisons

are summarized in Table 4.2). Results revealed that OPC was higher for joy than neutral expressions ($t(45) = -4.89$, $p < 0.001$***), that there was no difference between sadness and neutral expressions ($t(45) = 2.23$, $p = 0.031$), and that OPC was lower for anger, fear and disgust as compared to neutral expressions (for all tests, $t(45) > 3$, $p < 0.001$***). Note that the pattern of results for joy, anger, and neutral expressions resembles results from Experiments 1 and 2. Figure 4.2 illustrates results.

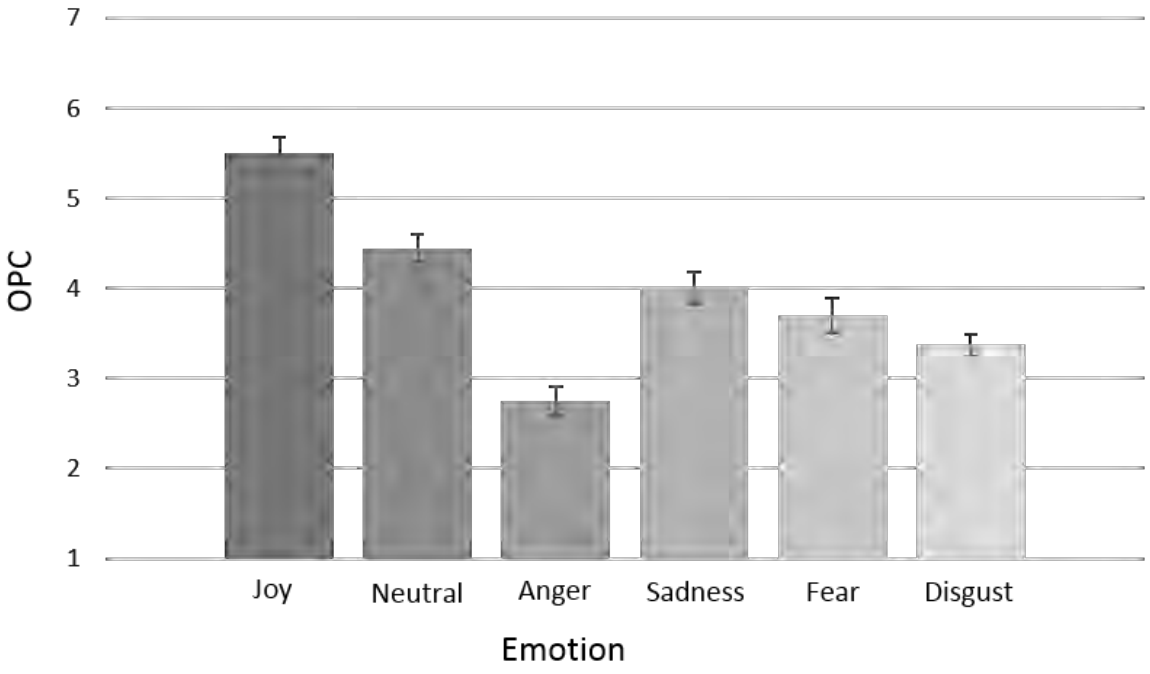

Figure 4.2. Opponent's probability of cooperation (OPC) is plotted versus each emotion.

Table 4.2. Pairwise comparisons for OPC.

Emotion		**Joy**	**Sadness**	**Anger**	**Fear**	**Disgust**	**Neutral**
	Mean	5.5	4.0	2.8	3.7	3.4	4.4
Joy	5.5	X	*	*	*	*	*
Sadness	4.0	*	X	*	n.s.	*	n.s.
Anger	2.8	*	*	X	*	n.s.	*
Fear	3.7	*	n.s.	*	X	n.s.	*
Disgust	3.4	*	*	n.s.	n.s.	X	*
Neutral	4.4	*	n.s.	*	*	*	X

Note. The table summarizes pairwise comparisons in OPC for all emotion pairs. A global level of α=0.05 with a Bonferroni correction for multiple comparisons was used, * 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.

For IC, the main analysis did not reveal a main effect of the "task-order" factor $F(1,44) = 2.8$, $p = .1$, partial $\eta^2 = 0.06$, nor an interaction with "emotion" $F(5,220) = 1.27$, $p = .12$, partial $\eta^2 = 0.028$. Accordingly, the two different task-order groups were collapsed and data were analyzed using a repeated-measures ANOVA including the within-subjects factor "emotion".

Results for this analysis showed a main effect of "emotion", $F(5,225) = 33.45$, $p < .001$***, partial $\eta^2 = 0.43$. Individual t-tests for related samples were conducted for the pairs formed between neutral expressions and each of the emotions (additional pairwise comparisons are summarized in Table 4.3).

Results revealed that IC was higher for joy than neutral expressions, but failed to reach significance ($t(45) = -1.67$, $p = 0.102$); in contrast, IC was lower for all emotions as compared to neutral expressions (for all tests, $t(45) > 3$, $p < 0.001$***). Figure 4.3 illustrates results.

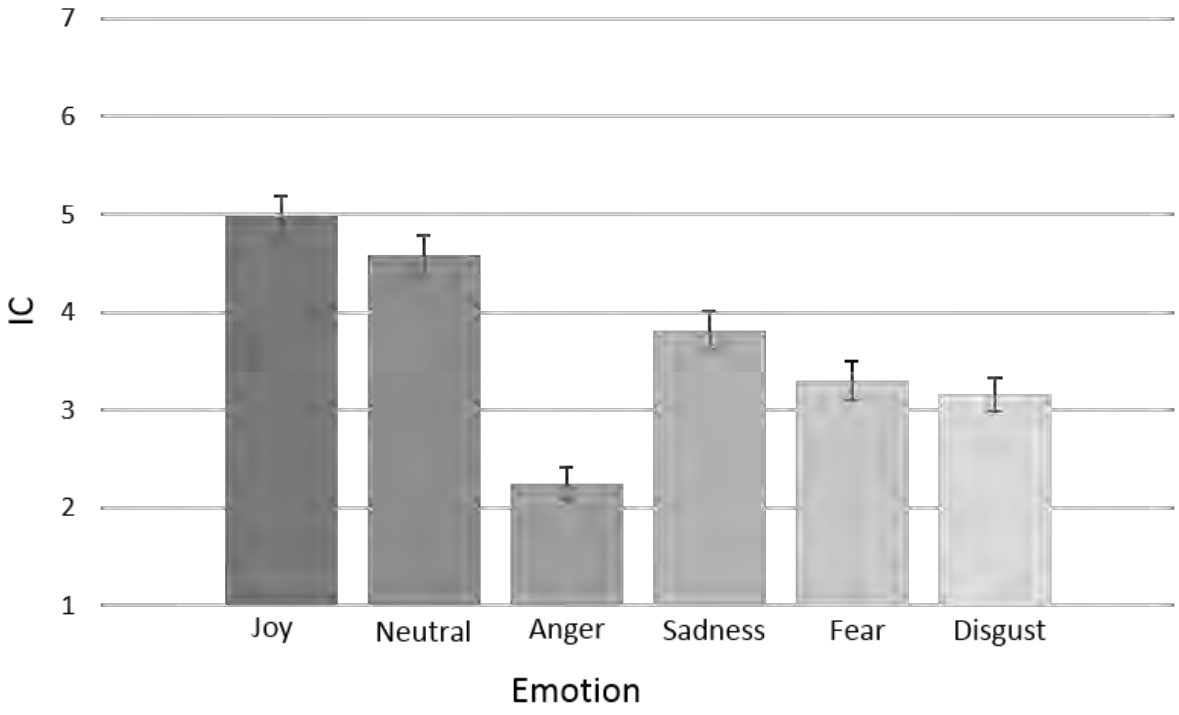

Figure 4.3. Intention to cooperate (IC) is plotted versus each emotion.

Table 4.3. Pairwise comparisons for IC.

Emotion		**Joy**	**Sadness**	**Anger**	**Fear**	**Disgust**	**Neutral**
	Mean	5.0	3.8	2.3	3.3	3.2	4.6
Joy	5.0	X	*	*	*	*	n.s.
Sadness	3.8	*	X	*	n.s.	n.s.	*
Anger	2.3	*	*	X	*	*	*
Fear	3.3	*	n.s.	*	X	n.s.	*
Disgust	3.2	*	n.s.	*	n.s.	X	*
Neutral	4.6	n.s.	*	*	*	*	X

Note. The table summarizes pairwise comparisons in IC for all emotion pairs. A global level of α=0.05 with a Bonferroni correction for multiple comparisons was used, * 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.

Lastly, as it was expected to find the same pattern of results of Experiment 1 for the subset of stimuli comprising only joy, anger and neutral expressions, IC data for this subset was analyzed independently for the two task-order groups using repeated-measures ANOVAs including the emotion factor. The pattern of results was the same of Experiment 1. For the judgment-game group the emotion effect was significant $F(2,44) = 53.01$, $p < .001$***, partial $\eta^2 = 0.71$ and revealed differences between all emotion pairs. For the game-judgment group, the emotion effect was also significant $F(2,44) = 36.97$, $p < .001$***, partial $\eta^2 = 0.63$, revealing differences between joy and neutral expressions versus anger expressions, but no difference

between joy and neutral expressions. This pattern of results mirrors the observed pattern of Experiment 1 and of the analysis conducted for the same stimuli subset in Experiment 2.

4.3 Discussion

Results of the present experiment extend research beyond joy and anger expressions and showed that sadness, fear, and disgust also influenced cooperation. This result was expected as it has been proposed that prosody constitutes an important influence on social interaction and thus it should not be limited to contexts in which it conveys joy and anger.

An important objective of this experiment was to test whether the effects of emotional expressions corresponded with their proposed social functions or to a distinction between positive and negative emotions. For cooperation behavior and IC, the pattern of results for joy and anger expressions was the same of Experiments 1 and 2; however, either framework could explain it. For disgust, decreases in cooperation were found, which could, as well, be explained by either framework. Nonetheless, according to their proposed social functions, sadness and fear should have increased cooperation, but they decreased it instead. This observation fits more with an explanation suggesting that the distinction between positive and negative emotions determines effects on observers' behavior.

It is important to note, however, that cooperation levels were not the same for all negative emotions. Among them, sadness always produced the highest levels of cooperation. Moreover, results for OPC revealed that inferred probabilities of cooperation for sadness expressions were as high as for neutral expressions. While those observations do not invalidate the previous

interpretation, they call into attention that not all negative emotional expressions may produce the same effects.

In contrast with joy and anger expressions, no experiment has addressed the effects of facial (nor vocal) expressions of sadness, fear and disgust on cooperation. However, since it has been proposed that observing emotional expressions allows predicting behavioral intentions and adapt behavior accordingly (Alguacil et al., 2015; Andersen & Guerrero, 1998; Keltner & Haidt, 1999; Shariff & Tracy, 2011), previous studies addressing the effects of *induced* emotions may give a clue about what to expect.

For disgust, Chapman et al. (2009) have reported a negative correlation between disgust measures and cooperation, which suggests that emotional expressions of disgust should decrease cooperation in observers. This was exactly the observed pattern of results.

In the case of fear, Kugler et al (2012) and Nelissen et al (2011) reported that inducing fear to their participants increased cooperation. In the case of Kugler's work, however, they only compared cooperation levels with those of participants to whom they induced anger. As they have not included a neutral emotional condition, it is unclear whether the observed levels of cooperation for both emotions could be lower than those of participants in neutral emotional states. Nelissen et al., in contrast, reported increased cooperation for fear as compared with a neutral emotional condition. In present data, cooperation behavior for fear and anger did not differ, and both revealed lower levels as compared to neutral expressions.

In the case of sadness, Tan and Forgas (2010), compared the effects of inducing joy or sadness in an experimental game. Unexpectedly, they found that participants to whom sadness was induced cooperated more than those to whom joy was induced. In the present experiment,

even though sadness produced the highest levels of cooperation among the negative emotions, none of the variables revealed higher levels of sadness as compared to joy. Note, however, that the experimental game methodology used by Tan and Forgas' lacks a fundamental characteristic of other experimental games, including ours. Namely, in their methodology, consequences depend entirely on the participant's decision, and hence it involves no risk as in other games. As our experiment was different in methodological details such as the use of emotional expressions versus induced emotions and the use of a risky vs. a no risky game, it is hard to advance an explanation for the different results between the present experiment and Tan and Forgas'.

Somehow unexpectedly, studies addressing the effects of emotional expressions and of induced emotions do not appear to necessarily show the same patterns of results, and while there is evidence that emotional states (Chapman et al., 2009; Kugler et al., 2012; Nelissen et al., 2011; Tan & Forgas, 2010) and emotional expressions (Eckel & Wilson, 2003; Reed et al., 2012; Scharlemann et al., 2001; Tortosa et al., 2013) influence cooperation, current studies do not support clearly that they do so in accordance with their proposed social functions. Future studies would benefit of comparing the effects of induced emotions and emotional expressions using the same experimental games, of including control neutral conditions, and of considering other possible explanations for results and do not assume *a priori* that social functions of emotions determine their influence on behavior.

Nonetheless, it is important to note that it is possible that the observed cooperation levels for neutral emotional expressions used in this experiment did not reflect a completely unbiased baseline. In Experiment 2, no difference was found between the "Let's play" and "I will cooperate" phrases. While "Let's play" does not directly announce a particular behavioral

intention in the game (in comparison to “I will cooperate” and “I will defect”), if participants perceived the phrase as intrinsically cooperative, it may be the case that our analyses have overestimated baseline cooperation levels (which were based on “Let’s play” phrases with a neutral emotional expression). As prosody and the phrases of the design form a unified whole, it is not possible to fully comprehend what was the contribution of prosody, and the phrases, and how they interacted to promote different inferences in participants. However, future studies may control this by presenting filtered speech, by presenting stimuli to non-Spanish speakers, or by comparing the effects with emotional expressions in other modalities (e.g. faces, body movement), as those manipulations should reduce or remove the contribution of the specific phrase into participants’ behavior; in a complementary fashion, written texts can be presented in order to address the effects of the phrases, controlling, or removing the effects of prosody. This way, a better understanding of their joint effect may be possible.

Lastly, note that results for joy, anger, and neutral expressions mirror results for the same subset of stimuli from previous experiments. For Cooperation Behavior, joy and neutral expressions were associated with higher levels of cooperation than for anger expressions, without differing among themselves. For OPC, all the pairwise comparisons revealed differences. And for IC, conducting a separate analysis for both task order groups revealed differences between all emotion pairs for the judgment-game group, and differences between joy and neutral expressions versus anger expressions, but no difference between joy and neutral expressions for the game-judgment group.

5. General discussion

It has been proposed that prosody plays an important role in the context of social interactions (Belin, 2006; Bestelmeyer et al., 2012; Latinus & Belin, 2011), as it is capable of transmitting different cues related to the emotional state, identity, personality, group membership, attractiveness and attitudes (Bestelmeyer et al., 2012; Bryant & Fox Tree, 2005; DeCasper & Fifer, 1980; Linville, 1996; Munro et al., 2010; Nass & Lee, 2001; Pell, Paulmann, et al., 2009; Scherer et al., 2001; Shochi et al., 2006).

In contrast with previous studies that have focused on how people perceive different cues through prosody, in the experiments reported hereby the actual behavioral effects of prosody were tested, extending research beyond perception. Specifically, the effects of emotional prosody on cooperation behavior were addressed.

The pattern of results supports the position that prosody can influence the behavioral outcomes of social interactions. Across the three experiments, participant's cooperation behavior and related perceptual measures revealed significant effects of emotional prosody. The significance and implications of these results are discussed in detail below.

5.1 The importance of emotional expressions on interaction

In contrast with other social cues transmitted by prosody, the perception of emotions in prosody has been widely researched. It is known that emotional prosody can be recognized at above chance levels across a variety of situations (Bänziger & Scherer, 2005; Bryant & Barret, 2008; Dromey et al., 2005; Juslin & Laukka, 2003; Pell & Skorup, 2008; Scherer, 2003; Scherer et al., 2001).

This was the main reason it was decided to focus on emotional prosody for the present experiments; not only there is evidence that emotional prosody can be accurately recognized at above chance levels, but the very fact that it transmits emotional cues allow expecting that it should influence social interactions. Specifically, emotional expressions should allow observers to quickly identify them, predict likely courses of actions and react behaviorally in adaptive ways (Alguacil et al., 2015; Andersen & Guerrero, 1998; Keltner & Haidt, 1999; Shariff & Tracy, 2011). Moreover, previous experiments have found that participants' behavior is affected by observing different facial emotional expressions (Alguacil et al., 2015; Averbeck & Duchaine, 2009; Krumhuber et al., 2007; Reed et al., 2012; Scharlemann et al., 2001; Tortosa et al., 2013).

Accordingly, it was expected that emotional prosody should affect behavior, as the effects of emotional expressions should not be restricted to facial expressions. In accordance with this hypothesis, emotional prosody influenced cooperation, as reflected by the main effect of emotion in all dependent variables across the three experiments.

In Experiment 1, it was found that Joy, Anger, and Neutral emotional expressions lead to different and orderly (Joy>Neutral>Anger) perceptions of probability of cooperation (as measured by OPC). However, the actual behavior of the participants did not differ between Joy and Neutral expressions, although both led to higher cooperation levels than Anger expressions. Moreover, it was found that experience had an influence on the judgment measure of Intention to Cooperate (IC), as reflected by a task order effect in which the pattern of results for this measure was similar to the OPC measure in the judgment-game group (where participants judged *before* having any behavioral experience in the game), and similar to the Behavioral measure in the game-judgment group (where participants judged *after* having completed the behavioral task).

In Experiment 2, it was found that emotional prosody plays a role in regulating cooperation behavior even in the presence of other cues of behavioral intention (defined as phrases about the intended behavior in the game). Moreover, it was found that OPC was independently influenced by both manipulations (as revealed by the lack of interaction effect), while both IC and the Behavioral measure revealed interaction effects of emotional prosody and phrases, suggesting that participants integrate different cues in complex and not necessarily easy-to-predict ways.

In Experiment 3, it was found that the effects of emotional prosody are not restricted to joy and anger expressions, as expressions of sadness, fear, and disgust influenced cooperation too. As in Experiments 1 and 2, the patterns of results of Cooperation Behavior and IC were similar among themselves, while OPC differed slightly. In the case of the first two measures, joy and neutral expressions did not differ, while the rest of emotions decreased cooperation (with respect to the neutral expression); in contrast, for OPC, joy lead to higher levels of cooperation than neutral expressions, cooperation levels did not differ between neutral and sadness expressions, and the rest of emotions decreased cooperation. Additionally, it is worth to note that the effects of the different emotions on the three variables were not in accordance with their proposed social functions. Instead, they seem to be dependent on a simpler distinction between positive and negative emotions.

Note that, among additional stimuli, Experiments 2 and 3 included all stimuli of Experiment 1 (joy, anger, and neutral emotional prosody with the phrase “Let’s play”). Because of this, analysis restricted to this subset of stimuli were conducted in Experiments 2 and 3 to test whether the results pattern corresponded with that observed in Experiment 1. Indeed, the pattern

was the same for all dependent variables across the three experiments. For OPC, all emotions lead to significant differences (Joy>Neutral>Anger); for Cooperation Behavior, joy, and neutral lead to higher cooperation proportions than anger, but did not differ among themselves; and for IC, in the judgment-game group the pattern of results corresponded with that for OPC, while in the game-judgment group it corresponded with the pattern for Cooperation Behavior. Accordingly, at least for this subset of data, evidence for the replicability of results was obtained.

As mentioned earlier, much of the work that suggests that prosody is important for social interaction is mainly based on perceptual studies, many of them in the context of studying clinical populations known to have difficulties to correctly interpret non-verbal cues, which are important for a healthy social interaction. However, as suggested by the current series of experiments, the effects on behavior may not fully correspond to the patterns observed for perceptual judgment measures. Accordingly, future studies addressing the impact of prosody on perception may want to include behavioral measures in their designs if the main interest for conducting research has to do with the potential consequences of the stimuli in the context of actual behavioral outcomes.

While evidence of the influence of emotional prosody on cooperation was found across the three experiments, it is not clear why the behavioral and judgment measures differ. 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, 1988; Frijda et al., 1989), 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 (Experiments 1-3), to phrases regarding behavioral intentions (Experiment 2), and to the experienced cooperation probabilities (as reflected by the pattern of results for IC differing depending on the task-order group); which suggest a rather flexible process that integrates different cues in order to make decisions.

Other proposed mechanisms for explaining the influence of emotional expressions on observers' behavior assume that affective processes drive the effects (e.g. social appraisal; de Melo et al., 2014; Manstead & Fischer, 2001; and emotional contagion de Melo et al., 2014; Van Kleef et al., 2010); or that emotional stimuli prime behavior through memory processes and associative pathways (Janiszewski & Wyer, 2014) without the need to actively make inferences; and thus may be less flexible than reverse appraisal. It is important to note, however, that the present experiments were not designed to pinpoint the underlying mechanisms. Future studies should address this subject more closely.

5.2 Beyond social functions of emotion.

While results of the experiments indeed show that emotional prosody influenced a particular kind of social behavior, the specific pattern of results did not fully correspond with predictions based on the framework of social functions of emotions.

In part, this could be because Cooperation Behavior and IC may have required participants to integrate more cues in order to take a decision than those required for OPC, as

reflected by the finding of OPC always showing a different pattern of results than the other two measures. In Experiment 1, an orderly pattern of results for all emotions was found (Joy>Neutral>Anger) for OPC, while the other two measures failed to reveal differences between Joy and Neutral expressions. In Experiment 2, OPC reflected independent contributions of the emotion and phrase manipulations, while the other two measures revealed interaction effects, suggesting that participants integrated these cues for guiding their own decisions but not for judging the probability of cooperation of opponents. In Experiment 3, a closer correspondence between the pattern of results for Cooperation Behavior and IC was detected once more. Lastly, task order effects were found for IC in each experiment focusing on the subset of stimuli comprising the phrase "let's play" said with joy, anger, and neutral expressions. Together, these results suggest that participants integrate available cues and experience in order to guide their decisions, but not for predicting the likely behavior of opponents.

However, it is not completely clear whether participants did perceive stimuli exclusively as emotional expressions. While all stimuli were previously validated to accurately reflect the intended emotions, in the reported experiments participants were not asked to respond what emotion they perceived. Anecdotally, when participants made comments about stimuli, they described them with different terms, some of them related to emotion such as "angry", "joyful", or "sad", but some of them not specifically related to emotion, such as "sarcastic", "ironic" and "mocking", especially for Experiment 2, in which emotional prosody and phrases were simultaneously manipulated. It may be the case that in the absence of a forced choice paradigm such as the one used in the validation procedure, and in the context of a more complex task such as the one used in the present experiments, participants do not spontaneously perceive stimuli exclusively as reflecting emotions.

Recently, it has been found that people are able to identify different intentions in the voice, and that doing so is related to the perception of the emotional significance of the stimuli, but that the emotional component does not fully account for results (Hellbernd & Sammler, 2016). Also, it has been suggested that processing pragmatic stimuli may involve affective processing as it has been observed that brain areas that have been previously related to emotional processing also are active in the processing of indirect meanings (Rigoulot, Fish, & Pell, 2014). Moreover, clinical populations that experience difficulties with perceiving emotions also tend to experience difficulties with understanding non-literal meanings in language (Cardoso et al., 2014; McNamara et al., 2010; Paul et al., 2003; Pell, 2006; Pell et al., 2014; Rutherford et al., 2002; Varga et al., 2014; Wang et al., 2006).

Taken together, those findings suggest that effects of emotional expressions in everyday interactions may be more complex and more flexible than a set of specific social functions of discrete emotions, and that they may constitute a social cue that must be integrated with others and framed in the context of particular situations and previous experience in order to influence behavior. Such a perspective would indeed allow more flexibility, and likely would be more adaptive in the long run than a set of predefined, fixed tendencies of response that fail to take into account additional relevant cues.

This interpretation also fits well with a recent series of experiments inspired by the reverse appraisal framework, which shows that the effect of particular emotional expressions can be moderated or even reversed by manipulating contextual cues in which they are presented (de Melo et al., 2014). However, reverse appraisal represents an inferential process that can only be applied to emotional expressions. Nevertheless, in everyday interaction, several social cues are

available and not all are necessarily emotional. For example, it has been shown that prosody is able to convey cues regarding identity and group membership (DeCasper & Fifer, 1980; Linville, 1996; Munro et al., 2010), personality traits (Nass & Lee, 2001; Smith et al., 1975), attractiveness (Bestelmeyer et al., 2012; Zuckerman & Miyake, 1993) and attitudes (Bryant & Fox Tree, 2005; Shochi et al., 2006), as well as playing an important role in distinctions such as informational structure (Féry & Krifka, 2008), politeness (Nadeu & Prieto, 2011; Ofuka et al., 2000; Orozco, 2008), evidentiality and epistemicity (Estellés-Arguedas, 2015; Roseano et al., 2014). which can also impact social interaction.

A full account of the mechanisms that allow prosody to influence social behavior should be able to explain the effects of both emotional and non-emotional prosodic distinctions. In this sense, it has been suggested that different psychological processes may impact abilities for decoding emotional and pragmatic distinctions (such as indirect speech acts and dimensions such as politeness). Namely, Theory of Mind, Executive functions, cue integration, and the detection of unexpected patterns, have been proposed as important processes for achieving it (Golan et al., 2007; Martin & McDonald, 2003; Paul et al., 2003; Pell, 2006; Pell et al., 2014; Pexman, 2008; Rutherford et al., 2002; Varga et al., 2013; Wang et al., 2006).

Not surprisingly, it has been found that areas related to Theory of Mind are active during the processing of indirect meanings (Spotorno, Koun, Prado, Van Der Henst, & Noveck, 2012), that brain damage in areas that play a role in experimental game tasks affects the comprehension of indirect meanings (McNamara et al., 2010), and that areas related to the processing of emotional prosody are active in tasks involving the perception of indirect meanings (Wang et al., 2006).

Future research should aim to pinpoint underlying mechanisms for the influence of emotional and non-emotional cues on social perception and behavior. And to address to which extent emotional and cognitive mechanisms play a role in those instances. Ultimately, it may be the case that depending on situational and task variables, different mechanisms contribute to perceptual and behavioral outcomes.

5.3 Limitations and future directions.

As important as pointing out the implications of the present research, it is to point the limitations, and consequently the areas of opportunity and future directions that may allow to address them in future studies.

A first limitation, arising from the particular experimental design and, consequently, from the choice of independent variables, dependent variables, and the particular methodology concerns the generalizability of results and the need to contextualize the potential implications of the findings. A second one has to do with the prosodic and acoustic description of stimuli. A third one, regarding the interaction effects between prosody and phrase that were found in Experiment 2, is the difficulty to fully explain the pattern of results through emotion theories. In addition, a fourth one has to do with potential subtle gender differences that remain unexplored.

In what follows, each one will be developed, and ways to address them in future studies will be suggested.

5.3.1 Domain restriction and need for contextualization

In order to address the research question of the present project ("Does prosody influence regulation of social interactions?"), several methodological decisions were made, which restricts

the context in which this general question can be addressed. Specifically, by using the Assurance Dilemma as a model of social interaction, we restricted "social interaction" to cooperation behavior, and furthermore, to binary choices available in this particular experimental situation (cooperating or defecting). This allowed to operationalize the construct, and ultimately to perform the different comparisons and statistical analyses needed to test the hypothesis. Of course, this does not mean that social interaction in everyday life restricts to cooperation, nor to binary decisions; its complexity, both in terms of the different factors that influence it and in terms of the available response options and ways in which social behavior develops is very far from the particulars of the present experimental methodology and can be studied using a wide spectrum of methodologies which capture different subtle aspects of human social interaction.

Moreover, in the present series of experiments, analyses were restricted to the effects of emotional prosody. This allowed to obtain evidence of its importance in the context of social interaction, but it does not necessarily mean that prosody is important in all instances of social interaction, nor that it is the most important factor.

It is important to keep in mind that emotional distinctions are only a restricted subset of the wide array in which prosody plays a role. Choosing emotional prosody as a starting point was based on the rich theoretical background of the role of emotion expressions on social interaction (Andersen & Guerrero, 1998; Andrew, 1963; Keltner & Haidt, 1999; Keltner & Kring, 1998; Shariff & Tracy, 2011; Van Kleef et al., 2010), on research findings about the accurate perception of emotions in prosody (Juslin & Laukka, 2003; Scherer, 2003; Scherer et al., 2001), and on the availability of previous research results showing that facial expressions of emotion can influence

behavior in methodologies for the study of cooperation (e.g. Krumhuber et al., 2007; Reed et al., 2012; Scharlemann et al., 2001; Tortosa et al., 2013) such as the one used for the present project.

Note, however, that research on prosody is far wider. It can transmit other distinctions that, as emotional prosody, can be perceived even when using filtered speech or in intercultural contexts, like attractiveness, attitudes, as well as identity and personality cues (Bestelmeyer et al., 2012; Bryant & Fox Tree, 2005; Linville, 1996; Munro et al., 2010; Nass & Lee, 2001; Shochi et al., 2006). Focusing on emotional distinctions is also a consequence of the interest in testing proposals of the processing the social information of some prosodic variations as a non-linguistic, more primitive mode of communication that would be basic for human social interaction (Belin, 2006; Bestelmeyer et al., 2012; Latinus & Belin, 2011).

However, this may give the inaccurate impression that prosody is always universal, has no differences across languages, and is independent, or accessory, to language. This is not the case. Prosody is central to language (Frazier, Carlson, & Clifton Jr, 2006). It plays a fundamental role in complex distinctions such as informational structure (Féry & Krifka, 2008; Gutiérrez Bravo, 2008; Hirschberg, 2002), phrasing and syntactic disambiguation(Fitzpatrick, 2000; Frazier et al., 2006; Shah, Baum, & Dwivedi, 2006), politeness (Nadeu & Prieto, 2011; Ofuka et al., 2000; Orozco, 2008), evidentiality and epistemicity (Estellés-Arguedas, 2015; Roseano et al., 2014), which are important for social interaction as they provide real-time information and cues about how different utterances should be interpreted, and consequently, go beyond the pure truth-value and semantics of the utterances.

Moreover, prosody does show interlinguistic variation, and the prosodic structure relates to the syntactic structure of particular languages (Frota & Prieto, 2015; Jun, 2014; Ladd, 2001;

Selkirk, 2011); taken together, the observations highlight that, at least for some distinctions, it cannot be studied using methodologies such as filtered speech.

But how to reconcile these two apparently opposed views of prosody? It has been suggested that prosodic distinctions can be conceived in several continua between linguistic and paralinguistic uses; categorical/discrete vs. graded distinctions, among others (Grice & Baumann, 2007; Gussenhoven, 1999; Wilson & Wharton, 2006). While acknowledging the existence of both kind of distinctions, Gussenhoven (2002, 2004) had suggested that even discrete prosodic distinctions may be based on universal, biological tendencies in vocal behavior production, which constitutes an effort to bring together those differences under a unified approach.

The conclusion is that there is a wide area of opportunity to study the influence of prosody (and its role in different prosodic distinctions) on social interaction. The present research has only started to address the subject, and to do so, has focused on a limited subset of stimuli that aligns to a more graded/universal subset of prosodic distinctions. Future research should also explore the effects of other – more discrete/categorical – prosodic distinctions on social behavior.

5.3.2 Prosodic cues of emotion

For the present experiments, all stimuli were previously submitted to a validation study (see Annex B) to ensure that prosodic variations accurately reflected the intended emotions. However, the perceptual validation does not allow knowing which prosodic cues were ultimately responsible for the observed behavioral effects. As the present work emphasized perception and behavioral outcomes, providing a detailed description of the stimuli in terms of acoustic analyses

and prosodic patterns was beyond the objectives; however, future studies may benefit to perform such analyses and to relate prosodic variations to perceptual and behavioral effects.

Understanding what approach to the analysis of prosody may be best suited to this endeavor is not an easy task, though. Some authors have attempted to describe which sets of cues allow distinguishing between discrete emotions, usually emphasizing basic emotions. This approach has led to varying degrees of success, and to automatic classification systems that can perform at similar levels than humans, which mostly rely on global acoustic variables (such as the mean, variability, and range) of variables such as tone (f0), intensity, or duration (Banse & Scherer, 1996; Juslin & Laukka, 2003; Pell, Paulmann, et al., 2009).

Other authors have related prosody to continuous dimensions of emotions, such as arousal and valence. Such efforts have been generally better at relating arousal with acoustic measures, while acoustic markers of valence have proved difficult to find (Bänziger, Patel, & Scherer, 2014; Belyk & Brown, 2014; Laukka, Juslin, & Bresin, 2005); these approaches also tend to rely on global acoustic variables.

Moreover, other authors have approached this issue by analyzing prosody through intonation models, and emphasizing local patterns instead of global variables, decomposing prosodic variations into discrete units (Martín Butragueño, 2015; Prieto & Rigau, 2011). In this regard, it has been noted that while spontaneous and uncontrolled emotional expressions occur in speech, most of the time speakers intentionally modulate prosody with the intention to produce particular communicative effects in the listeners (c.f. Caffi & Janney, 1994). Given that, in contrast to the approaches described in the previous paragraphs, these studies part from the assumption that prosodic variations involved in communicating emotions are conventional and

discrete, and hence analyses using sophisticated linguistic approaches (such as the Autosegmental Metric Model and Optimality Theory) are used. In this sense, cues such as a higher initial tone height, lengthening of syllables, phrasing patterns, and the characteristics of prenuclear and middle peaks would be particularly relevant to signal emotional expressivity and may be affected by variables such as syntactic structure and concurrent speech acts (Martín Butragueño, 2015). Also, it has been emphasized that listeners' impressions do not depend exclusively on prosodic variations, and that contextual cues play an important role in creating them (Nadeu & Prieto, 2011; Prieto & Rigau, 2011). Note that the contribution of variables such as syntactic structure, speech acts, and contextual cues, are often left out of the analyses in other research approaches; also note that, as the works described here pay close attention to the hierarchical organization of prosody (Nespor & Vogel, 2007), they emphasize local prosodic events and their contribution to listeners' impressions, rather than global cues. Taken together, the characteristics of these works highlight that a fuller account of how prosody relates to the perception of emotions may benefit from detailed analyses of local patterns and of considering other variables that have an influence on prosody (such as the syntactic structure). Note, however, that the use of emotional terms on these works does not fully correspond with psychological descriptions of emotions, and that they are mainly involved with the description of prosodic patterns of pragmatic categories, not with patterns associated with particular *emotions.* Nonetheless, they have the advantage of emphasizing that speakers can purposefully use prosody for communicative ends and that the context in which they are uttered plays an important role.

Given that results of Experiment 3 were not completely in accordance with the predictions made based on discrete emotion models, and seemed to fit better with a dimensional account of emotions instead, it seems that analyzing prosody in terms of arousal and valence may prove

more fruitful. However, results of Experiment 2 draw attention to cue interaction and suggest that effects may not be driven exclusively by prosodic variations. Ultimately, it may prove hard to relate prosodic variations to behavioral outcomes without considering the context in which they are presented, the particularities of the experimental tasks, and additional cues that participants may take into account to guide their decisions. Accordingly, future studies may want to look into pragmatic models to inform research on the field, a subject that will be further elaborated in the following subsection.

5.3.3 Explaining interaction effects

A third limitation, regarding the interaction effects between prosody and phrase that were found in Experiment 2, is the difficulty in explaining the pattern of results. An explanation based on reverse appraisal was offered, but it is not clear whether it allows to fully explain the pattern because the framework intends to describe the effects of emotional expressions on observers' behavior, but does not make specific predictions about the effects of other cues and how do they interact with emotional expressions.

Alternatively, linguistic accounts may be useful for explaining the effects. In linguistics, there is consensus and a wide body of research showing that phrase meaning (what is said), and speaker meaning (what is intended by saying something) often do not correspond, and that the most important component for interpersonal communication is speaker meaning, rather than phrase meaning (Bach, 2012; Hellbernd & Sammler, 2016; Holtgraves, 1986; Searle, 1969, 1975, 1979). For example, although a phrase such as "can you reach the salt?" taken at face-value is a question about the capability of the interlocutor to perform an action, its intended speaker meaning would most likely be to request the interlocutor to actually perform the action;

accordingly, an appropriate response would be to pass the salt rather than just answer the question. Comprehending this kind of *indirect speech acts* and reacting appropriately to them would require a shared common knowledge between speakers (or, more technically, "common ground", Clark & Brennan, 1991; Féry & Krifka, 2008; Kecskes & Zhang, 2009; Krifka, 2007) , and an inferential process from the part of the listener. Moreover, it has been proposed that in normal social interaction, interlocutors are expected (and assumed) to be truthful, relevant, to make their contributions as clear as possible, and to avoid providing insufficient or excessive detail in their interventions (Grice's "Cooperative Principle"); and that when an utterance fails to comply with those premises, the listener assumes that the speaker is trying to convey an indirect meaning, and actively tries to infer it (Grice, 1975). Those accounts, the Speech Acts Theory and the Cooperative Principle, respectively, have been successful at inspiring research – not only in the field of linguistics, where it has been extensive – but also psychological and neurophysiological studies (see Hellbernd & Sammler, 2016; McNamara et al., 2010; Noveck & Reboul, 2008; Okanda, Asada, Moriguchi, & Itakura, 2015; Regel, Gunter, & Friederici, 2011), and as far as they are concerned with how people infer indirect meanings and react to them, may be useful for addressing interaction effects such as the one found in Experiment 2, as well as to better understand how the experimental context plays a role in constraining the expected and inferred meanings.

For example, a possible explanation of why cooperation levels for joy and neutral phrases with the phrase "Let's play" did not differ across the three experiments may be because participants inferred that the phrase intrinsically conveyed a cooperative intention, as it's intended effect (speaker meaning) can be interpreted as a proposal, or, more specifically, a *commissive speech act* (Searle, 1975, 1979). If it was the case, recordings of this phrase said with

neutral prosody may have promoted high cooperation levels, and may not truly constitute neutral stimuli.

It is hard to determine whether this was the case, though. Although the neutral stimuli in our experiments were based on the neutral emotional facial expression used as a control condition in previous experiments, facial expressions of emotion are devoid of the additional complexity of the linguistic stimuli used in the present experiments. Moreover, previous experiments have found mixed results regarding the contrasts between joy and neutral facial emotional expressions. Among 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 specifically 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 experiments, 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.

Future studies addressing the effects of emotional prosody on social behavior may benefit to include conditions that allow disentangling the effects of prosody and phrases; for example, presenting written texts (and hence eliminating prosody), and acoustically filtered stimuli (to

preserve prosodic information while making phrases unintelligible) may constitute a way to separate the effects of prosody and phrases. Note, however that this approach may not be useful for addressing all kinds of prosodic distinctions: as many of them are discrete and present interlinguistic variations and a close relation with the syntactic structure (see section 5.3.1), presenting them as filtered speech stimuli may simply disrupt the relation with other cues that is necessary for them to convey distinctions.

An additional issue that is important to consider, is that not all prosodic distinctions have a facial equivalent. In the case of emotional prosody, it is possible to take into account predictions of theories of emotion about the influence of emotional expressions on social behavior (Andersen & Guerrero, 1998; Andrew, 1963; Keltner & Haidt, 1999; Tracy, 2014; Van Kleef et al., 2010), which make no reference to the modality of expression (e.g. facial, vocal, etc.) and the available evidence for the recognition of emotion in faces, non-linguistic emotional vocalizations, prosody, body movements and touch (Coulson, 2004; Elfenbein & Ambady, 2002; Hertenstein et al., 2009; Juslin & Laukka, 2003; Sauter et al., 2010). But such a specific theoretical background and close relations between the face and prosodic expressions cannot be expected for all distinctions that prosody transmits. Some research in linguistics has addressed the relation between gestures (both facial and manual) and prosody in the context of distinctions such as evidentiality, epistemicity, informational structure, among others (Abner, Cooperrider, & Goldin-Meadow, 2015; Biau, Morís Fernández, Holle, Avila, & Soto-Faraco, 2016; Guellaï, Langus, & Nespor, 2014; Prieto, Puglesi, Borràs-Comes, Arroyo, & Blat, 2015; Roseano et al., 2014); however, while there is evidence for a tendency of prosody and gestures to synchronize, the relationship is not perfect and the expression and perception of gestures in those instances cannot be considered universal nor independent of context.

All of this does not mean that research on psychology and linguistics is not compatible. As stated above, the participation of cognitive mechanisms and brain areas which are relevant for perceiving emotions in processing indirect meanings has been highlighted in psychological research (Spotorno et al., 2012; Wang et al., 2006) for one side, and the importance of cognitive mechanisms and inference processes for understanding the process of human communication has also been developed by language scholars in theoretical approaches such as Langackers's "Cognitive Grammar" (Langacker, 2008), and Givón's view on "Context as other's minds" (Givón, 2005) for the other. Again, the categories of both fields do not completely correspond (linguistic notions often being relatively simple or variables such as context ignored in psychological research, and notions about cognitive mechanisms being sometimes outdated or not supported by psychological empirical research in linguistic proposals), but certainly they offer a fertile ground for cross-disciplinary research in domains that fall under the scope of both disciplines (especially Givón's perspective, which extensively develops notions of theory of mind, and addresses the way we predict and understand others' minds in the context of communication).

This kind of synergetic approaches could be illustrated by the work of Wichmann (2000, 2002) in the field of politeness; who considers that only emotions (e.g. anger) can be directly reflected in the speech signal (i.e., through prosody), but that, in conjunction with the choice of words, the context, and inference, emotions in prosody can lead to pragmatic implicatures or indirect meanings. Note that under such a perspective, emotional prosody could be universal, but nonetheless play a role, along with contextual cues, to convey indirect meanings; and, more specifically, politeness impressions (for which, not surprisingly, the contribution of prosody has been highlighted Culpeper, Bousfield, & Wichmann, 2003; Ofuka et al., 2000; Orozco, 2008).

The conclusion is that there are many areas of opportunity for researching the cognitive mechanisms that allow prosody to influence social interaction that go beyond the theories that deal with the effects of emotional expressions on others' behavior such as reverse appraisal (de Melo et al., 2014). A proper understanding of the effects of prosody on social behavior should be able to explain the effects of emotional and non-emotional contrasts in prosody. And addressing them appropriately may require to expand psychological categories and take into account linguistic distinctions such as speech acts, common ground, informational structure, and additional variables, especially contextual ones (Clark & Brennan, 1991; Féry & Krifka, 2008; Kecskes & Zhang, 2009; Krifka, 2007; Searle, 1969, 1975, 1979).

5.3.4 Gender differences

Last, but not least, it is important to point out that in the present experiment, gender differences were not explored. According to theories of emotion, the effects of emotional expressions on social behavior affect humans in a general fashion, not in a differentiated way depending on the gender of the observer (or hearer, in the context of our experiments).

However, there is some evidence of gender differences in emotional research. Maybe a finding which appears to be more in line with popular knowledge is that females tend to be more emotionally expressive than men; however, this does not necessarily mean that they experience more intense emotions as compared to males in everyday life, and may reflect only a different tendency to spontaneously express them, as well as the contribution of different social expectations for different genders (Kret & De Gelder, 2012a). This gender difference may not seriously impact the interpretation of the current experiments because emotional expressions were encoded by actors (as opposed to untrained individuals) and because all included stimuli

were perceptually validated in a previous step, ensuring that all of them were consistently recognizable well above chance.

On the other side, there is also evidence that females tend to have an advantage in recognizing others' emotional expressions and perceiving them as more intense than men do; however it is not clear whether this is the case in all situations and across all emotions, as some findings qualify this tendency by showing a male advantage for recognizing emotions such as anger, and some studies fail to show a female advantage (Biele & Grabowska, 2006; Kret & De Gelder, 2012b).

Note that most research on this subject is based on facial emotional expressions. In the case of sex differences for perceiving prosody, the pattern is less clear. In this field, some researchers have pointed out gender differences during the time course of emotional prosody processing, males being slower to process prosodic emotional cues than females, but without necessarily displaying differences at the behavioral level (Besson et al., 2002; Schirmer, Kotz, & Friederici, 2002). Evidence for a female advantage in recognition of emotional prosody is, at most, scarce (Szymanowski, Kotz, Rotte, & Dengler, 2007), and negative evidence is available from research comparing emotion recognition in prosody and sex differences in healthy subjects and patients with schizophrenia, with no sex differences detected among healthy subjects in both cases (Campellone & Kring, 2013; Ramos-Loyo, Mora-Reynoso, Sánchez-Loyo, & Medina-Hernández, 2012).

The final composition of the samples used for the present experiments does not allow to accurately compare behavioral responses between male and female participants: in our three experiments, most participants were females. However, we have no reason to expect that the

effects of emotional expressions should affect males and females in qualitatively different ways, according to emotion theories. At most, assuming a better emotion recognition by females (which is not widely supported in emotional prosody research), the effects of emotional expressions may be of a larger magnitude in females (but keep in mind that no explicit emotion recognition task was used for the present experiments, see section 5.2). The time course of the processing – which was not addressed in the experiments – may reveal some differences if addressed in future studies.

As the main purpose of the present project was to test a hypothesis for which no previous empirical evidence was offered (the effects of prosody on social interaction using a behavioral paradigm), the samples for the experiments were not planned to look for gender differences at this point. The issue, however, constitutes an interesting area of opportunity for future research.

5.4 Conclusions.

Across three experiments, it was shown that emotional prosody can influence a particular instance of social interaction, specifically, cooperation behavior. This work extends previous studies of the effects of emotional expressions on social interaction to vocal expressions of emotion. Moreover, results provide direct evidence that prosodic variations play a role in social interaction, and that they are able to influence it even in contexts where other cues to intentions are available (Experiment 2).

However, the pattern of results does not appear to be fully explained by theoretical accounts about the social functions of emotions. In contrast, it seems that once emotional

expressions are presented in the context of particular tasks that require certain responses, and when other cues of intention are present, they are not perceived as signaling specific and fixed action tendencies, and instead promote complex inferences that result on flexible responses from listeners. Ultimately, this may be more appropriate to function in adaptive ways in complex social environments.

An appropriate understanding of the psychological mechanisms that drive the influence of emotional prosody in social behavior awaits further studies. Moreover, future research may benefit from taking into account proposals of how humans infer indirect meanings (Givón, 2005; Grice, 1975; Holtgraves, 1986; Langacker, 2008; Searle, 1979), and test whether the psychological mechanisms that have been proposed to underlie their comprehension, such as Theory of Mind, semantic processing, cue integration, and executive functions (Papagno, 2001; Pell, 2006; Pell et al., 2014; Pexman, 2008; Rothermich & Pell, 2015; Varga et al., 2013, 2014) also play a role in the processing of emotional stimuli. As such mechanisms are more general than those proposed for explaining the influence of emotional expressions on observers' behavior (de Melo et al., 2014; Janiszewski & Wyer, 2014; Manstead & Fischer, 2001; Van Kleef et al., 2010), they may be good candidates to explain the effects of both kinds of stimuli.

Although there is evidence that people can perceive different cues in prosody such as identity and group membership (DeCasper & Fifer, 1980; Linville, 1996; Munro et al., 2010), personality traits (Nass & Lee, 2001; Smith et al., 1975), physical attractiveness (Bestelmeyer et al., 2012; Zuckerman & Miyake, 1993) and attitudes (Bryant & Fox Tree, 2005; Shochi et al., 2006) it is important to address whether those cues can influence social behavior, and if so, how. Moreover, addressing prosodic distinctions such as informational structure (Féry & Krifka,

2008), politeness (Nadeu & Prieto, 2011; Ofuka et al., 2000; Orozco, 2008), evidentiality and epistemicity (Estellés-Arguedas, 2015; Roseano et al., 2014) is also an important future direction that will require to take into account other variables (such as the context, common ground, and syntactic structure), insofar as they cannot be as readily studied by methods such as filtered speech and forced recognition.

Such an endeavor may prove fruitful and eventually lead to practical applications, specially taking into account that several populations that experience social interaction difficulties also display difficulties for perceiving emotions and indirect meanings (Cardoso et al., 2014; Golan et al., 2007; McNamara et al., 2010; Paul et al., 2003; Pell, 2006; Pell et al., 2014; Pexman, 2008; Rutherford et al., 2002; Varga et al., 2014; Wang et al., 2006). A better understanding of how the perception of such social cues influences behavior in healthy populations may contribute to eventually developing interventions for impaired populations.

In conclusion, the present work represents an effort to extend research on the perception of different social cues in prosody and to address the role that those cues play in regulating actual behavior. Results provided evidence that emotional prosody can regulate cooperation behavior, the mechanisms that may underlie that influence have been discussed, and future directions of research have been suggested.

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Annex A: Game theory

A particular kind of interpersonal behavior is cooperation. The influences of emotional expressions on that behavior had been studied mainly through game theory. This section provides a brief outline of game theory and how it has been used in psychology for the study of cooperation.

Participation in joint activities that allow achieving mutual benefits is considered cooperation (Bowles & Gintis, 2011). It has been proposed that cooperation is fundamental for social behavior and that its study is of great importance for practical problems, ranging from training in social skills to interventions against prejudice among groups. Historically, cooperation has been studied by different disciplines, including psychology, anthropology, sociology and economics. Cooperation research was driven mainly using *games*, such as the "prisoner's dilemma". The theoretical basis of the methodology is found in *game theory*, a branch of mathematics whose development has been motivated in great part by questions about economics (Argyle, 1991).

Game theory is a branch of applied mathematics focused on modeling situations that involve conflicts of interest. Specifically, game theory is interested in mathematically describing behavior in strategic situations, in which the success of a decision maker depends on other's decisions and, in addition, participants (or players) are aware that their actions affect others. Even though theoretical developments in game theory have been motivated by the study of problems in economics, methodologies developed in the field have been applied to other disciplines such as biology and psychology. In fact, the prisoner's dilemma and participants' responses in that methodology have been used as an operational definition of cooperation and it has been the most

broadly used methodology in cooperation research (Argyle, 1991; Camerer, 2003; Pavel, 2012; Rasmusen, 1989)

Some important elements of a game are players, actions, strategies, payoffs and equilibriums (Rasmusen, 1989).

Decision-making individuals are called players. The goal of each player is to maximize earnings through their decisions.

An action or move is a decision that can be taken in the game. A combination of actions is defined as the set of movements that players have made, one action for each player.

A strategy is a rule that a player uses to choose their actions in every instant of the game, according to his knowledge about the game structure. A set of strategies or space of strategies is referred to all possible strategies for a player. A combination of strategies is referred to the strategies that players use, one strategy for each player. In situations where there is only one turn in the game, the space of strategies and the set of all possible actions are equivalent.

Payoffs are referred to two concepts: 1) consequences obtained once the game has been played and 2) expected consequences given the actions of the player and other players. Those two meanings can be distinguished by using the terms actual payoff and expected payoff, respectively. Although in literature the two terms are used in an indistinct fashion, it is useful to make the distinction

Finally, the term equilibrium is referred to a combination of strategies in which every player chooses the best strategy for himself. However, here is important to define what “best strategy” means. In addition, given that there are different ways to find equilibriums and the

structure of games differs, in some occasions, there are not unique equilibriums or no equilibrium exists.

Regarding strategies, there is an important distinction depending on their relationship with other strategies. A *dominant strategy* is a strategy whose expected payoff is strictly more than that of any other strategy independently of the actions of the rest of the players. A *dominated strategy* is any strategy whose expected payoff is strictly less than that of another strategy (Camerer, 2003). A *Nash equilibrium* is defined as a combination of strategies in which the strategy of every player is the best response to the actions of every other player (Fudenberg & Tirole, 1991). Every dominant strategy is a Nash equilibrium but the converse is not true, given that some games can have multiple Nash equilibriums or not have any single one (Rasmusen, 1989). Finally, the term *deficient equilibrium* is a term referred to an equilibrium for which there is another combination of strategies that yields better payoffs for every player; however, it is an equilibrium because no player has incentives for changing his behavior (Kollock, 1998).

A particular class of games that has been used for studying cooperation behavior is called *social dilemmas.* Situations in which individual rationality leads to collective irrationality are considered social dilemmas. In this sense, in social dilemmas, if everyone follows the most rational behavior, everyone will be in a worst situation than the one that would result if everyone acted otherwise (Kollock, 1998). In every social dilemma, however, a *deficient equilibrium* exists, hence there is at least another combination of actions in which everyone would be better, but no player has incentives for changing his behavior (Kollock, 1998). The best known social dilemma is called prisoner's dilemma and has been one of the most widely used in empiric research and one that has greatly influenced the theoretical development in cooperation studies.

In prisoner's dilemma, there are 2 players, each with two possible choices: cooperating or defecting, each one must take a decision without knowing what the other player will do. Regardless of the other player's decision, defecting leads to a better outcome than cooperating. The dilemma is that, if both players defect, consequences for both would be worse than if they had cooperated (Axelrod, 1984). A particular formulation of the prisoner's dilemma is exemplified by Davis (1986):

> Two suspects of having committed a crime in complicity are arrested by police and secluded in separate cells. Each suspect may confess or keep silent. The possible alternatives are the following: 1) If a suspect confesses and his accomplice keeps silent, the first serves as a witness and its declaration will be used to imprison the other, who will be sentenced to 20 years, whereas the first will be immediately released. 2) If both confess, both will be sentenced to 5 years. 3) If both keep silent, both will be sentenced to 1 year because of illegal possession of weapons – a minor charge.

It can be observed how the above-mentioned properties of the game are maintained, there are two players and each one has 2 possible choices: cooperating (C) or defecting (D), without knowing what the other player will choose. For any player, confessing (defecting) leads to a better result than keeping silent (cooperating) because if he defects and the other cooperates, is immediately released, whereas if the other suspect also defects the sentence will be of only 5 years (which is better than the 20 years that would result if he cooperated but the other suspect defected), but nonetheless, if both defect, their consequence is worst (5 years) than if both had cooperated (1 year).

Usually, these situations are represented in payoff matrices: charts in which in each axis the movements of a player are represented in such a way that the combinations of actions are represented by cells. In the cells, the consequences associated with the particular combination of actions are represented as ordered pairs. In the case of the prisoner's dilemma, as formulated above, the payoff matrix is the following:

		Player 2	
		Cooperate	Defect
Player 1	Cooperate	1,1	20,0
	Defect	0,20	5,5

In each cell, ordered pairs represent years of jail. In each ordered pair, the first number corresponds to the consequence for player 1 and the second to the consequence for player 2.

Hence, from the point of view of any player, player 1 for example, the best possible consequence occurs if he defects while the other cooperates, which can be denoted as DC; the second best result is both players cooperating (CC), followed by both defecting (DD) and at least, the worst result is to cooperate while the other defects (CD); thus, the order of preferences is DC>CC>DD>CD. In situations where only a single interaction occurs, rational decision would be defecting, as there is no possibility of retaliation (Axelrod, 1984), however, researchers have found that even in situations in which a single turn of the prisoner's dilemma is played participants display cooperation (Chater, Vlaev, & Maurice, 2008; Cooper, DeJong, & Forsythe, 1996; Pothos, Perry, Corr, Matthew, & Busemeyer, 2011). This tendency allows pinpointing the

influence of different variables through experiments that expose subjects to the prisoner's dilemma in a single occasion (Reed et al., 2012) or to sequences of single turns, for example by repeatedly pairing participants in a random fashion (Chater et al., 2008).

Another game, characterized by a different preference order, is called *Assurance dilemma* or *Stag hunt dilemma.* In this game, the preference order is CC > DC > DD> CD (Kollock, 1998) and its associated payoff matrix can be represented as follows:

		Player 2	
		Cooperate	Defect
Player 1	Cooperate	3,3	0,2
	Defect	2,0	2,2

It can be noted how, in contrast to the prisoner's dilemma, in this game defection is not the best possible choice regardless of others' actions; instead, the best possible action depends on the other player's choice. The game's name derives from the fact that, in principle, each player would be willing to cooperate as long as he is assured that the other player will cooperate too: if the opponent cooperates, it is better to cooperate, while if defects it is better to defect too; in other words, the game does not have a unique equilibrium. Put another way, in the assurance dilemma, the best possible action is to do the same as the opponent (Kollock, 1998). This kind of game, in addition to its status as a social dilemma, is also referred to as a "coordination game" because, as

it exhibits multiple equilibriums, coordination is required for picking one among them (Camerer, 2003).

Several variables that affect cooperation in this and other games have been identified. Some of them are referred to the structure of the situation, such as payoff matrices, whether games are presented repeatedly or in a single turn, the inclusion of the possibility of choosing with whom one is to play, among others (Kollock, 1998; Van Lange, Joireman, Parks, & Dijk, 2013).

Regarding non-structural variables, the influence of several psychological variables have been researched, including priming and framing effects, group identity, individual differences in personality traits and communication effects (Camerer, 2003; Curry, Chesters, & Viding, 2011; Hirsh & Peterson, 2009; Kollock, 1998; Mulford, Orbell, Shatto, & Stockard, 1998; Van Lange et al., 2013). The frequent finding of high levels of initial cooperation (in iterated games and in one-shot games) is a subject that has drawn the attention of several researchers. A finding that may be even more surprising is that in situations in which participants know beforehand that the other player has cooperated, they tend to cooperate too, even while they know with certainty that by defecting a better outcome would be obtained, a proposal for explaining this kind of findings is based on emotions and gave rise to the study of the effects of emotional expressions and induced emotional states on cooperation behavior (Bowles & Gintis, 2011; Cooper et al., 1996; Eckel & Wilson, 2003).

Annex B: Validation procedures

All stimuli for the experiments reported in this work were obtained from a set of valid stimuli coming from two rounds of recording and validation. Details of those procedures are provided in this annex.

First round of recording and validation

Recording

Participants

Twenty individuals (10 male and 10 female) between 18 and 26 years old, native Spanish speakers with non-professional experience in acting participated in the recording procedure. In previous studies there has been a large variation in the characteristics of stimuli encoders, ranging from individuals without any experience in acting to professional actors, and although it has been suggested that acted emotions depict normal patterns of expression, in the case of professional actors it has been argued that because of having extensive experience and practice in the way of expressing emotions their portrayals may reflect cultural biases of the way in which emotions should be expressed (Johnstone & Scherer, 2000; Scherer, 2003). Because of this, recordings of people with experience in acting, but not professionals, were used for the experiments.

Procedure

Each actor was recorded in an individual session. Recordings were made in a quiet room using Praat (Boersma & Weenink, 2011). Each recording was saved in an individual wav file (44000 Hz sampling frequency) and consisted on a short phrase said with a particular emotion. The phrases were "*Vamos a jugar"* (Let's play), *"Voy a cooperar"* (I will cooperate) and *"Voy a*

Traicionar" (I will defect), and differed according to the behavioral intention they announced. The emotions were joy, anger, sadness, fear and disgust, and a neutral emotional expression as a control.

At the beginning of the recording session, actors were instructed to wear an earphone/microphone wireless headset (Logitech H600), and were explained that they would record several utterances with different emotional expressions. They were provided with a set of cards depicting the name of each emotion on top and followed by the description of a short situation in which the emotion typically occurs (the card for the "neutral" emotion read "Please say the phrase as naturally as possible, trying not to convey any particular emotion", instead of depicting any situation). Situations were taken from Scherer, et al. (1991) and constitute short scenarios based on intercultural research on emotion-eliciting situations. Then they were instructed that before each recording they would be told which phrase had to be recorded and what emotion had to be portrayed; that they had to consult the card corresponding to that emotion and that they would be recorded once they were ready. After the recording was made, they were allowed to listen to it and decide whether they were satisfied with it. If not, they were allowed to repeat the recording until they were satisfied with the result.

Immediately after, the recording session started. Before each recording, the specific combination of phrase and emotion was informed by the experimenter. The recording order was random. Overall, 840 recordings were obtained in this phase. Before starting the validation procedure, each recording was individually inspected, 30 of them were found to contain noise or acoustic artifacts and were discarded.

Validation

Recordings obtained in the last phase were submitted to a perceptual validation procedure as detailed below

Participants

An independent group of participants took part in the validation procedure for course credit. It consisted of 20 individuals (14 female) between 18 and 26 years old, native Spanish speakers without experience in acting, and with no history of language or hearing impairments.

Stimuli

Recordings obtained in the previous step were submitted to a low-band pass filter which allows disrupting segmental information (phonemes) but spare prosodic information (Bryant & Barret, 2008; Lakshminarayanan et al., 2003; Nazzi, Bertoncini, & Mehler, 1998). Previous experiments using this manipulation report that it is still possible to reliably identify emotional prosody (Bryant & Barret, 2008; Lakshminarayanan et al., 2003). It was decided to present filtered recordings in the validation procedure to avoid the influence of any variable other than prosody in participants' responses. This procedure was chosen because the main interest was validating the emotion transmitted by stimuli's prosody, regardless of the phrase.

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, participants were explained that they would complete an emotion recognition task and that the stimuli would not be intelligible. After that, a sound test was conducted and participants adjusted the volume at a comfortable hearing level. Subsequently, instructions were presented on the screen, indicating that in each trial they would listen to a voice sample and that they had to decide which of the six emotions (joy, sadness, anger, fear, disgust, neutral) it represented by pressing the keyboard numbers 1 to 6, respectively. Participants completed three practice trials, and any doubts or questions regarding the experimental procedure were answered at this point. After this, the experimental task started. Participants were offered three breaks during the experimental procedure, after completing 200, 400 and 600 trials. Stimuli were presented in a pseudorandom order avoiding the presentation of stimuli depicting the same emotion more than twice in a row.

Results

For each stimulus, the proportion of times in which it was correctly recognized was obtained. Adopting the criterion used in Pell et al., (2009), stimuli were considered valid if they were correctly recognized as the originally intended emotion at least 3 times the expected proportion by chance.

According to this criterion, a pool of 249 valid stimuli was obtained. The following table illustrates the distribution of valid stimuli per combination of phrase and emotion.

	JOY	SADNESS	ANGER	FEAR	DISGUST	NEUTRAL
LET'S PLAY	29	22	25	9	1	26
I WILL COOPERATE	15	24	19	2	0	15
I WILL DEFECT	8	25	14	3	0	12

All required stimuli for Experiment 1 were obtained in this validation round. However, given that some valid stimuli required for Experiments 2 and 3 were lacking, a second validation round was conducted as detailed in the following section.

Second round of recording and validation

Recording

Participants

Twenty individuals (10 male and 10 female) between 18 and 26 years old, native Spanish speakers with non-professional experience in acting, dubbing, or opera singing participated in the recording procedure.

Procedure

The recording procedure was the same of the first round of recording. Except for two minor procedure changes. First, the order of the emotion recordings was random, but all recordings depicting a given emotion were made consecutively, whereas in the previous round

the recording order was fully random. This change of the procedure was implemented based on comments made by the actors that took part in the previous round, who remarked that preparing to portray the emotions to be depicted required effort, and that quickly switching to other emotions immediately was difficult at times. Additionally, only stimuli for which valid exemplars were lacking were recorded. Overall, 502 recordings were obtained in this phase, 1 of them was found to contain noise and was discarded.

Validation

Recordings obtained in the last phase were submitted to a perceptual validation procedure as detailed below.

Participants

An independent group of participants took part in the validation procedure for course credit. It consisted of 20 individuals (11 female) between 18 and 26 years old, native Spanish speakers without experience in acting, and with no history of language or hearing impairments.

Stimuli

Recordings obtained in the previous step were submitted to a low-band pass filter (Bryant & Barret, 2008; Lakshminarayanan et al., 2003; Nazzi et al., 1998).

Apparatus

The experimental apparatus was the same as in the previous validation round.

Procedure

The experimental procedure was the same as in the previous validation round. The only difference was that breaks were offered after completing 125, 250 and 375 trials.

Results

For each stimulus, the proportion of times in which it was correctly recognized was obtained. Stimuli were considered valid if they were correctly recognized as the originally intended emotion at least 3 times the expected proportion by chance.

According to this criterion, a pool of 189 valid stimuli was obtained. The following table illustrates the distribution of valid stimuli per combination of phrase and emotion. The empty cells represent combinations of phrase and emotion that were not recorded because no valid stimuli for that combination were lacking.

	JOY	SADNESS	ANGER	FEAR	DISGUST	NEUTRAL
LET'S PLAY		42		19	19	
I WILL COOPERATE	19		18			27
I WILL DEFECT	14		13			18

The additional valid stimuli obtained in the second recording and validation procedure allowed to complete the required stimuli set needed for all the experiments reported in the present work.