University of Porto
Faculty of Psychology and Educational Sciences

INDIVIDUAL DIFFERENCES IN EMOTIONAL CONTAGION AND EMPATHY PREDICT DETECTION OF LAUGHTER AUTHENTICITY

Teresa Leonor Araújo Neves

October 2015

Dissertation presented for the Integrated Master course in Psychology, Faculty of Psychology and Educational Sciences of the University of Porto, supervised by Doctor ***César F. Lima*** (FPCEUP and University College London).

LEGAL NOTICES

Acknowledgements

Now approaching the end of this stage, it is inevitable to thank to several people that, in different ways, have been helping me to grow and build my path.

To my supervisor, Doctor César F. Lima, for the methodic and incessant orientation. It was a privilege to work with one of the most qualified and professional people I have had the honor of meeting. Thank you for believing in my work and make me fall in love with research.

To Professor São Luís Castro, for receiving me in the Neurocognition and Language Research Group of the Centre for Psychology at University of Porto, and for making this project possible.

To all Speech Laboratory members, especially to Tiago, Paulo and Bárbara, for the accompaniment and concern.

To Carolina, for being such a good and helpful colleague.

To Francisco, for all the support and unconditional love. Thank you for believing in me and being by my side in difficult times. There are not enough words to describe what you mean to me.

To Isabel, always and forever my righ-hand person.

To Catarina, for believing in me and supporting me incessantly at any time, like no one else could. Thank you for showing me the beauty of friendship. You are still my role model (until a better one shows up).

To Filipa and Andreia, for all the moments where we could be ourselves and do not think in anything else. Thank you for the patience and preoccupation.

To André, for being so patient and teaching me how to mediate the relationship between work and leisure time.

To Joana, my childhood friend, for showing me true friendship. I will cherish all the moments that we have been living together. Thank you for your clarity when I was making a mountain out of a molehill.

To my beloved brother, for showing me the research world. Thank you for the inspiration and motivation when I was worrying too much.

To my parents, unconditionally present and who give me all possible conditions to be more and better.

Resumo

A gargalhada é uma expressão emocional social poderosa. No decorrer das interações sociais, expressamos a gargalhada numa larga variedade de intensidades e com diferentes funções, dependendo do contexto. Por exemplo, a gargalhada pode refletir uma resposta espontânea, enquanto sinal de afiliação e de experiência de emoções positivas. Por outro lado, a gargalhada poderá estar associada a uma ação mais voluntária, de maneira a evitar possíveis conflitos sociais ou a exprimir uma intenção comunicativa deliberada (e.g., concordância). A capacidade de detectar a autenticidade das gargalhadas possui um papel importante nas interações sociais. Não obstante, existem notáveis diferenças entre as pessoas no que diz respeito a esta capacidade. No presente estudo, investigamos se diferenças individuais na predisposição para o contágio emocional e na empatia explicam diferenças individuais na deteção de autenticidade de gargalhadas. Adicionalmente, exploramos se a possível relação entre suscetibilidade ao contágio emocional e a deteção da autenticidade de gargalhadas é mediada pelas respostas de contágio às gargalhadas. Os resultados mostraram que os participantes com maior predisposição para o contágio de emoções negativas e maior suscetibilidade a preocupação empática apresentam um melhor desempenho na deteção de autenticidade de gargalhadas. Adicionalmente, uma análise de mediação revelou que a associação entre a tendência para o contágio emocional e a deteção de autenticidade em gargalhadas é significativamente mediada pelo nível de diferenciação das avaliações de contágio das gargalhadas. Estes resultados são consistentes com a proposta de que mecanismos sensorimotores estão envolvidos no processamento de vocalizações emocionais.

Palavras-chave: gargalhadas; autenticidade emocional; contágio emocional; empatia; diferenças individuais; simulação sensorimotora.

Abstract

Laughter is a powerful social emotional expression. In the course of social interactions, we produce laughter in a wide range of intensities and with different functions, depending on the context. For instance, laughter might reflect a spontaneous response, as a signal of affiliation and experience of positive emotions. On the other hand, laughter may be associated to a more voluntary act, in order to avoid possible social conflicts or to express a deliberated communicative intention (e.g., polite agreement). The capacity to detect laughter authenticity plays an important role in social interactions. Nevertheless, there are remarkable individual differences regarding this capacity. In the present study we investigated if individual differences in predisposition to emotional contagion and empathy explain individual differences in laughter authenticity detection. Additionally, we explored if the possible relationship between susceptibility to emotional contagion and laughter authenticity detection was mediated by the perceived contagiousness of laughter. Results showed that participants with higher predisposition to contagion of negative emotions and higher susceptibility to empathic concern demonstrated a better performance on laughter authenticity detection. Additionally, a mediation analyses showed that the association between the tendency to emotional contagion and laughter authenticity detection is significantly mediated by the level of differentiation regarding the evaluation of contagiousness in laughter. These results are consistent with the notion that sensorimotor mechanisms are involved in emotional vocalizations processing.

Keywords: laughter; emotional authenticity; emotional contagion; empathy; individual differences; sensorimotor simulation.

Introduction

In social interactions, a wide range of signals coexist with the purpose of communicating intentions and emotions to others, such as facial, body and vocal cues (Lavan & Lima, 2014; Lavan, Lima, Harvey, Scott & McGettingan, 2015; Sauter, Eisner, Ekman & Scott, 2010). Considering that most of our time we are producing, listening to, and interpreting voices, it is reasonable to claim that the human voice plays a central role in communication (e.g., Liu et al., 2012a). In addition to linguistic information, voices convey varied emotional nonverbal vocalizations, for example screams or sobbing, that are significant sources of emotional information (Lavan & Lima, 2014; Sauter & Scott, 2007) and cannot be easily ignored, even when they are not task-relevant (Liu et al., 2012b). Over the past decades, the scientific community has focused mainly on the processing of basic emotion categories, such as fear (e.g., Schaefer, Larson, Davidson & Coan, 2014) and joy (e.g., Raila, Scholl & Gruber, 2015). However, there are nuanced distinctions that can be made within categories that are also relevant for communication, namely laughter emotional authenticity. That is, laughter might be an emotionally driven reaction, or rather a more volitional communicative act (Scott, Lavan, Chen & McGettigan, 2014). Despite the growing interest in laughter as a relevant scientific topic of research, investigation in this field remains sparse and there is a bias towards the research of negative emotions, maybe due to their relationship with the occurrence of social conflicts (Fredrickson, 1998; Lavan & Lima, 2014; McGettigan et al., 2015).

1. Laughter Authenticity

Laughter can be described as a primitive communicative signal, present in various mammal species, emerging spontaneously at an early age (Bryant & Aktipis, 2014). In humans, laughter is often considered to be exclusively the product of humor (Scott et al., 2014). However, in standup comedy scenarios, for instance, only 10 to 15% of pre-laughter comments are remotely humorous. Moreover, the social nature of laughter stands out: laughter occurs 30 times more frequently in social than solitary situations (Provine, 2004). In fact, laughter constitutes a fundamental social play vocalization. Therefore, we mostly laugh with people we are close to, and we not only use laughter as a signal of humor appreciation but also as a social indicator of desire to remain affiliated (McKeown, Sneddon & Curran, 2015).

Although laughter is an universal an easily recognizable communicative signal (Sauter et al., 2010), it is not invariant (Provine, 2004) and it needs to be taken into account how it is elicited. On one hand, spontaneous laughter occurs uncontrollably, conveying a genuine emotional expression; laughter is mainly linked to enjoyable emotions and situations that we seek to maintain. On the other hand, frequently we mask our emotions behind a different emotional expression, using voluntary laughter to ensure that negative impressions are not communicated, to avoid misunderstandings or to fulfill cultural norms (e.g., polite agreements). The capacity to successfully discriminate between spontaneous and voluntary laughter has a crucial role for effective social interactions, preventing, for example, people from being deceived, avoiding social embarrassment or being inappropriate (Manera, Grandi & Colle, 2013). It is therefore relevant to understand the human capacity to detect laughter authenticity. Laughter not only manifests itself in a wide range of intensities, as it appears to have many more functions than simply signalling appreciation of humour (McKeown et al., 2015). Furthermore, it would be relevant to explore the factors that determine inter-individual differences in laughter authenticity detection, that is, why some people excel in this ability while others struggle.

2. Mechanisms underlying vocal emotional processing

One way to derive hypotheses about this question is by considering the neurocognitive mechanisms underlying vocal emotional processing. In this regard, Schirmer and Kotz (2006) highlighted a multistage model of vocal emotional processing, based mostly on research on emotional prosody. This model proposes three interdependent stages of processing: after the emotional utterance, the bilateral auditory areas mediate the sensory processing of the perceived emotional signals; the integration of emotionally significant acoustic cues occurs immediately after, following a pathway from the superior temporal gyrus (STG) to the superior temporal sulcus (STS); and cognitive evaluation of the emotional meaning of vocal emotional cues takes place afterwards, linked to frontal structures in both cerebral hemispheres, namely the dorsolateral prefrontal and orbitofrontal cortices. As it progresses towards the anterior STS, this processing is believed to become increasingly complex and integrative (Bruck, Kreifelts & Wildgruber, 2011;

Schirmer & Kotz, 2006). These stages are reciprocally connected, in the sense for example that sensory stages have an impact on higher order processes (Pinheiro et al., 2013). Research on nonverbal vocalizations has explored higher order cognitive processes during vocal emotional processing, also highlighting the role of sensorimotor (Warren et al., 2006) and mentalizing systems (McGettigan et al., 2015).

2.1. The role of sensorimotor systems: mirroring

Several studies have provided evidence for a mirror-neuron system in humans, which is possibly involved in the understanding of others (Rizzolatti & Craighero, 2004). Mirroring refers to a mechanism such that when we observe another person experiencing an emotion, the same brain areas are activated as if we experience that emotion ourselves, promoting our emotional functioning (e.g., Frith & Frith, 2006). In a functional magnetic resonance imaging (fMRI) study, Warren et al. (2006) investigated cortical regions modulated both by the perception of human vocalizations as well as by voluntary generation of facial expressions, showing that a network of premotor cortical regions activated during the production of facial movements are also involved in auditory processing of affective nonverbal vocalizations. The identified regions demonstrating combined auditory and motor effects (i.e., “mirror” properties) were: left and right lateral premotor cortices, posterior border of the left inferior frontal gyrus (IFG), and medial premotor cortex. Moreover, the degree of activation of some specific areas was determined by positive emotional valence (left posterior inferior frontal region, linked to the representation of prototypic actions) and arousal properties of the affective vocal stimuli (pre-supplementary motor area, involved in higher order motor control). Hence, Warren et al., (2006) found evidence for distinct functional subsystems within the auditory motor mirror network. Furthermore, the passive perception of nonverbal vocalizations (positive or arousing emotions) automatically engaged preparation of the appropriate orofacial gestures. Therefore, this study highlighted a fundamental mechanism for mirroring the emotional states of others. However, being able to experience the same emotion as another is not sufficient to fully understand others’ intentions and emotions. Thus, mirroring can be seen as a first step for other higher order processes, namely mentalizing (Frith & Frith, 2006).

2.2. Mentalizing system

Within social interactions, the human capacity to infer others' mental states is often called mentalizing. Recently, McGettigan et al. (2015) provided further support for the role of sensorimotor systems during vocal emotional processing, and they further identified a role for mentalizing. By means of functional MRI, this study revealed that neural responses to spontaneous laughter, as compared to voluntary laughter, were greater in bilateral superior temporal gyrus (STG) and Heschl's gyrus (HG); by contrast, neural responses to voluntary laughter were greater in anterior medial prefrontal cortex (amPFC), anterior cingulate gyrus and left thalamus. One possible explanation for neural responses to voluntary laughter is that participants were spontaneously attempting to determine others' mental states, as laughter was perceived as less genuine. Thus, these results plausibly reveal that the social emotional ambiguity of voluntary laughter leads to a stronger engagement of mentalizing processes (Lavan & Lima, 2014). Moreover, the magnitude of neural responses during passive listening to laughter in amPFC, as well as various sensorimotor cortex regions, predicted greater accuracy on a post-hoc test regarding authenticity judgments. Thus, the engagement of sensorimotor system and mentalizing processes may be positively related to successful judgments of emotional stimuli. In short, different cortical areas were identified regarding the perception of spontaneous and voluntary laughter; these findings corroborate the social role of both types of laughter, once these neural differences reflect the automatic interpretation of intentions associated with the perception of laughter. Although there was no significant enhancement in sensorimotor responses to the more contagious spontaneous laughter, these findings suggest that there may be a benefit associated with recruiting sensorimotor cortex regarding the accuracy in evaluating laughter authenticity (McGettigan et al., 2015).

3. Sensorimotor Simulation

One possible interpretation of the aforementioned brain activation profiles is that they reflect the engagement of simulation processes, in that interpreting social signals like laughter would involve some level of sensorimotor simulation (supported by sensorimotor systems), and then attributing it to others (supported by mentalizing systems). Based on this idea, we can hypothesize that individual predispositions to engage sensorimotor processes in response to observed emotional expressions (i.e., emotional contagion) might be associated with the capacity to detect emotional authenticity in laughter. In the visual domain, Manera et al. (2013) reported an association between inter-individual differences in self-report predispositions to experience others' emotions (emotional contagion) and detection of authenticity in smile. The predisposition to emotional contagion was measured through the Emotional Contagion Scale (ECS; Doherty, 1997). The results revealed that predisposition to negative contagion was positively correlated with the capacity to discriminate between voluntary and spontaneous smiles; and predisposition for contagion of positive emotions was negatively correlated with this ability. Manera et al. (2013) proposed that people more susceptible to negative emotions were especially sensitive to negative emotions cues, thus, the focus on negative emotions may have lead to a better performance in relation to detect voluntary smiles. People who were more prone to positive emotions may have overestimate happiness cues in others, or even being easily deceived by voluntary smiles, once they focused on positive emotion cues. Moreover, this novel finding was discussed in relation to embodied simulation processes of smile, advanced by Niedenthal, Mermillod, Maringer and Hess (2010). This model posits that when the observer perceives a smile, an embodied simulation develops, resulting in the activation of the facial configuration associated with the observed emotion (mimicry), and this, in turn, induces in the observer the physiological activations and the subjective experience of the emotion (emotional contagion). Based on this theory, Korb, With, Niedenthal, Kaiser and Grandjean (2014) used facial EMG to demonstrate that stronger smiles were judged as being more authentic; importantly, participants spontaneously mimicked the perceived smiles, and this mimicry predicted ratings of smile authenticity. Although no significant mediation effect was found, these findings highlighted the role of sensorimotor simulation and its' importance regarding social interactions.

4. Emotional Contagion and Empathy

Emotional contagion can be defined as the tendency to automatically mimic and synchronize emotional expressions with those of another person. Eliciting stimuli arise from one individual, act upon one or more others, and produce emotional responses that are congruent or complementary to the initially stimuli (Doherty, 1997). Wide variations across individuals are encountered in self-report measures of emotional contagion. For instance, correlations were found between emotional contagion and measures of emotionality, reactivity, social functioning, among other individual differences. Furthermore, susceptibility to emotional contagion was strongly associated with emotional empathic responding, especially regarding empathic concern (Doherty, 1997), suggesting a link between contagion responses and empathy. In fact, through emotional contagion we share what other people are currently feeling, thus, it facilitates the predisposition to empathy (Frith & Frith, 2006). Davis (1983) proposed a multidimensional view of empathy, describing it as a reaction of one individual to an observed experience of another. Emotional empathy, contrary to cognitive empathy, was characterized as a more automatic and unconscious reaction (Davis, 1983), and it facilitates somatic, sensory, and motor representations of others' mental states, resulting in more vigorous mirroring of the observed mental states than cognitive empathy (Nummenmaa, Hirvonen, Parkkola & Hietanen, 2008). Furthermore, Banissy and Ward (2007) demonstrated a correlation between higher scores regarding empathic ability and mirror touch synesthesia, as well as that variability in different components of empathy relates to differences in brain structures, suggesting that multiple mechanisms are associated with increases in specific empathic skills (Banissy, Kanayi, Walsh & Rees, 2012). Using fMRI, Gazzola, Aziz-Zadeh and Keysers (2006) demonstrated that the left hemispheric temporo-parieto-premotor circuit was activated by both motor execution and when participants listened to action sounds; thus, it suggests the existence of a human auditory "mirror" system. Moreover, ratings for interpersonal reactivity measured through the IRI were associated to a stronger engagement of the mirror system: specifically, ratings for the perspective taking subscale. Therefore, there is evidence for a human auditory "mirror" sensorimotor system, which is positively associated to empathy.

5. Current Study

As discussed in the previous paragraphs, there is evidence for the existence of an auditory mirror sensorimotor system in the human brain that is important for understanding others, as it provides a mechanism for simulating their actions onto one's own sensory-motor representations (Gazzola et al., 2006). Interpreting social signals like laughter may involve some level of sensorimotor simulation (supported by sensorimotor systems) and then attributing it to others (supported by mentalizing systems). Furthermore, the activation of the auditory mirror system is related to higher scores of empathy (Gazzola et al., 2006). More recently, McGettigan et al. (2015) have demonstrated that there might be a benefit associated with the recruitment of sensorimotor cortex considering the ability to evaluate laughter authenticity detection. Therefore, the recruitment of sensorimotor cortex suggests that simulation processes may support laughter evaluations. Nevertheless, these were findings obtained through neuroimaging; the precise underlying cognitive processes regarding the ability to infer laughter authenticity still remain, as far as we know, underexplored. Manera et al. (2013) provided evidence regarding this matter, that is, these authors demonstrated that, in the visual domain, individual differences in susceptibility to emotional contagion for negative emotions is associated with improved detection of smile authenticity. If activations observed in sensorimotor systems in neuroimaging studies do reflect an emotional contagion process, it is plausible to expect that individual differences regarding emotional contagion are associated to a better ability to infer laughter authenticity.

In the present study we aimed to explore if individual differences in susceptibility to emotional contagion and empathy can account for individual differences regarding the ability to infer laughter authenticity in the auditory domain.

Method

2.1. Participants

A total of 101 participants took part in this study (83 women) [1]. Their average age was 42.78 years (*SD* = 22.27, range = 19 – 79 years)[2]. All participants had a minimum of 9 years of education (*M* = 15.07, *SD* = 2.59, range = 10 – 25 years). Most participants were recruited through the subject database of the Neurocognition and Language Group, Centre for Psychology at the University of Porto; the others were recruited through several local communities such as senior universities. Exclusion criteria included psychiatric and neurological illnesses, current or recent intake of psychotropic medications, cognitive decline, brain damage, as well as hearing difficulties. Participants received course credits or a small financial compensation for their time. Written informed consent was obtained from all participants.

2.2. Background Measures

In order to quantify aspects related to the exclusion criteria, we measured hearing thresholds and general cognitive status. To evaluate participants' hearing levels, an audiogram based on pure-tone audiometry was conducted (Amplivox 116 manual screening audiometer). We determined hearing levels (dB HL) for frequencies ranging between 500 Hz and 4000 Hz. Hearing acuity was summarized for each participant by averaging thresholds across the covered frequency range, separately for each ear. Participants' hearing thresholds in the better ear ranged from -1.67 to 17.50 dB HL (*M* = 4.57, *SD* = 4.13). Thus, all participants had normal hearing, i.e., average thresholds ≤ 25 dB HL (Hall & Muller, 1997; Peelle, Troiani, Grossman & Wingfield, 2011); hearing thresholds for right ear ranged from -1.67 to 55 (*M* = 13.53, *SD* = 10.35), and for the left ear they ranged from -.83 to 43.33 (*M* = 13.57, *SD* = 10.27). The Montreal Cognitive

[1] Four participants of the initial 105 recruited were not included in our final sample: one due to a high number of missing values (regarding hearing acuity and MoCa), one due to a self-reported psychiatric illness (Major Depression) and the remaining two because there was a suspect of cognitive decline, based on their MoCA performance.

[2] The participants' age range was wide because these data were collected as part of a larger ongoing project on ageing.

Assessment test was used to exclude possible cognitive decline (MoCA; www.MoCAtest.org; Portuguese version, Simões, Firmino, Vilar & Martins, 2007). This instrument evaluates distinct dimensions of cognition, namely executive functions, naming, memory, attention, language, capacity of abstraction, delayed recall and orientation. All participants scored ≥ 21 (*M* = 27.24, *SD* = 1.55, range = 23 – 30), which is congruent with the normative range for the Portuguese population (Freitas, Simões, Alves & Santana, 2011).

2.3. Experimental Measures

2.3.1. Emotional Contagion

The Emotional Contagion Scale (ECS) was used to assess the susceptibility of individuals to experience emotional contagion (Doherty, 1997; Portuguese version, Rueff-Lopes & Caetano 2012). The ECS is a self-report scale consisting of 15-item covering five emotion categories: love, happiness, sadness, anger and fear (3 items per category). Therefore, this scale separately evaluates the susceptibility to emotional contagion for positive emotions (happiness and love) and for negative emotions (fear, anger and sadness). Participants were asked to rate their degree of agreement with each item, on a 5-point scale, from 1 (never) to 5 (always). For example, "Being around happy people fills my mind with happy thoughts"; "Watching the fearful faces of victims on the news makes me try to imagine how they might be feeling". In Rueff-Lopes and Caetano (2012) study, Cronbach's Alpha for both ECS subscales were found to be reliable (susceptibility to emotional contagion for positive emotions: α = .77; susceptibility to emotional contagion for negative emotions: α = .80). Therefore, internal consistency of the ECS was good.

2.3.2. Empathy

The Interpersonal Reactivity Index (IRI) was used to assess empathy (Davis, 1980, 1983; Portuguese version, Limpo, Alves & Castro, 2010). This measure is a 28-item self-report questionnaire answered on 5-point scales, ranging from 0 ("Does not describe me well") to 4 ("Describes me well"). The IRI includes 4 subscales, each consisting of 7 items: perspective taking, personal distress, emphatic concern, and fantasy. The Portuguese IRI includes 24 items only; the remaining 4 of the original American scale were not included in order to enhance the factorial validity of this version (6 items for each subscale) Examples of items are: “I sometimes feel helpless when I am in the middle of a very emotional situation”; “I am often quite touched by things that I see happen”. In Limpo and colleagues (2010) study, Cronbach’s Alpha for the four IRI subscales were found to be reliable (perspective taking: $\alpha = .73$; personal distress: $\alpha = .80$; empathic concern: $\alpha = .76$; fantasy: $\alpha = .84$). Thus, internal consistency of the IRI was good.

2.3.3. Laughter Stimuli

Seven different speakers (4 women) produced the laughter stimuli used here in a soundproof anechoic chamber at University College London. These nonverbal emotional vocalizations can be differentiated between voluntary and spontaneous laughter. In order to record voluntary laughs, the speakers were asked to simulate laughter in the absence of external stimulation, i.e., they produced laughter expressions on command, without experiencing genuine feelings of amusement or happiness. They were encouraged to make the expression sound natural and credible; this approach is typically used to obtain acted emotional portrayals (e.g., Scherer, 2003). Regarding spontaneous laughter, each speaker was shown video clips, which they identified beforehand as finding amusing and that would easily cause them to laugh aloud, i.e., an amusement induction situation was created (for details, see McGettigan et al., 2015). The speakers reported genuine feelings of amusement during and after recording spontaneous laughter. The final set of laughter stimuli used here was selected after a perceptual validation study ($n = 40$; Mage = 23.6; $SD = 4.8$) on a large set of laughs (80 tokens, 40 voluntary laughs and 40 spontaneous). Separate files per laughter event were created based on the original recordings (sampled at a rate of 44 100 Hz to mono.wav files with 16-bit resolution), and all vocalizations were normalised for root-mean-square (RMS) amplitude using Praat software (www.praat.org) to control for the wide dynamic range of the raw recordings.

A total of 54 vocalizations were included in the experimental task (18 voluntary laughs, 18 spontaneous laughs and 18 distractors stimuli). Considering a seven-point rating scale, the results showed that average duration for voluntary laugh was 2.48s ($SD = 0.39$), while for spontaneous laugh was 2.44s ($SD = 0.26$; $F[1,34] = 0.18$, $p = .67$). Both spontaneous and voluntary laughs were perceived as positively valenced (voluntary laughter, $M = 5.23$; $SD = .47$; spontaneous laughter, $M = 5.58$; $SD = .60$; $F[1,34] = 3.85$, p

= .06). Importantly, spontaneous laughs were rated as more authentic (M = 4.85; SD = .82) than voluntary laughs (M = 3.43; SD = .82; $F[1,34] = 13.28, p < .001$). Therefore, it was ensured that these stimuli differed regarding the degree to which they are considered to reflect a genuine emotional state. In order to prevent that the main experimental manipulation of the study could be easily detected by the participants, distractor stimuli were intermixed with the laughter stimuli. Distractors consisted of 18 nonverbal emotional vocalizations, including sounds of achievement, pleasure, relief and sadness (these results were not analyzed). These stimuli elicited high emotion recognition accuracy in a forced choice task (86% on average) and were consistently rated as communicating the intended emotions in a rating task (Lima, Castro & Scott, 2013). Stimuli were randomized and presented twice to each participant, as separate blocks of trials. In one presentation participants evaluated the vocalizations concerning authenticity, and in the other presentation they evaluated the vocalizations concerning emotional contagion. The order of the evaluations was counterbalanced across participants. Regarding authenticity, before starting the task, the experimenter explained to participants that they would hear a set of vocalizations, and that some of them would consist of posed (acted) expressions, while others would consist of spontaneous (genuine) expressions (these instructions were also presented on the computer screen). On each trial participants heard a vocalization and rated how much it reflected a genuinely felt emotion on a 7-point scale, ranging from 1 (*the person is acting out the expression*) to 7 (*the person is genuinely feeling the emotion*). Regarding emotional contagion, participants were asked to rate how much each vocalization was contagious, from 1 (*it does not make me feel like mimicking or feeling the emotion*) to 7 (*it makes me feel like mimicking or feeling the emotion*).

2.4. Procedure

This study involved a single individual experimental session in a quiet room, lasting about one hour. Stimuli were presented via high-quality headphones and loudness was individually adjusted to a comfortable hearing level. Before starting the experimental task, participants completed a brief practice block, in order to familiarize them with the rating scale and stimuli. SuperLab 5 (www.superlab.com) was used to control stimulus presentation and data collection. Short breaks were allowed between each block of trials to minimize potential effects of fatigue. There was no time limit; however, participants were encouraged to respond as intuitively and as fast as possible. After each block of trials, participants also indicated how confident they were in the accuracy of their responses. As part of another study, participants also evaluated the vocalizations regarding arousal, emotional category membership and perceived control (these results are not presented here).

2.5. Data Analysis

In the present study, we conducted descriptive statistics regarding the measures of emotional contagion, empathy, and evaluations of authenticity and contagion in laughter. Afterwards, in order to investigate links between individual differences in laughter perception, emotional contagion, and empathy, we computed Pearson's correlations: we conducted correlations between both subscales of the ECS, as well as among IRI subscales, and laughter perception (authenticity and contagion). Furthermore, we aimed to understand if the perceived contagiousness of laughter was a mediator of the relationship between emotional contagion and perceived laughter authenticity; for this purpose, we conducted a mediation analyses (Hayes & Preacher, 2014). To ensure that the reported results cannot be attributed to possible confounds related to age or sex, all significant results were confirmed on residual values, after having excluded variability associated with these variables.

Results

3.1. Individual differences in self-report emotional contagion and empathy

For ease of interpretation and consistency across scales, the ECS results were transformed from 1 – 5 to a 0 – 4-point scale, similarly to the IRI. For positive contagion, ratings ranged between 1.33 and 4 ($M = 3.16$, $SD = .52$), while for negative contagion they ranged between 0.78 and 3.67 ($M = 2.47$, $SD = .58$). A paired sample t-test confirmed that ratings were significantly higher for positive than for negative contagion ($t\,[100] = 11.304$, $p < .001$). A Pearson correlation analysis revealed a positive correlation between positive and negative contagion ($r = .398$, $p < .001$).

Regarding the IRI, ratings for the perspective taking subscale ranged between 2 and 4 ($M = 3.13$, $SD = .45$), while for empathic concern they ranged between 0.83 and 3.67 ($M = 2.45$, $SD = .57$); for personal distress ratings ranged between 0.83 and 4 ($M = 2.42$, $SD = .56$), and for fantasy they ranged between 0.83 and 3.33 ($M = 2.22$, $SD = .59$). A paired sample t-test demonstrated that the difference between these variables was significant, namely between empathic concern and perspective taking, ($t\,[100] = 12.23$, $p < .001$), and between empathic concern and fantasy ($t\,[100] = 4.06$, $p < .001$). The difference was also significant between personal distress and perspective taking ($t\,[100] = 13.37$, $p < .001$), and between personal distress and fantasy ($t\,[100] = 3.35$, $p < .001$), as well as between fantasy and perspective taking ($t\,[100] = 14.44$, $p < .001$). No significant differences were found between empathic concern and personal distress ($t\,[100] = .655$, $p = .514$).

A Pearson correlation demonstrated that positive correlations were found across all subscales of the IRI (between empathic concern and perspective taking, $r = .416$, $p < .001$; between empathic concern and personal distress, $r = .602$, $p < .001$; between empathic concern and fantasy, $r = .546$, $p < .001$; between personal distress and perspective taking, $r = .450$, $p < .001$; between personal distress and fantasy, $r = .504$, $p < .001$; between fantasy and perspective taking, $r = .286$, $p = .004$).

Correlation analyses across the ECS and IRI indicated that negative contagion correlated positively with perspective taking ($r = .585$, $p < .001$), empathic concern ($r = .530$, $p < .001$), personal distress ($r = .427$, $p < .001$), as well as with fantasy ($r = .319$, $p =$

.001). Positive contagion was also positively correlated with perspective taking (r = .376, p < .001) and empathic concern (r = .237, p = .017). However, no significant correlations were found between positive contagion and personal distress (r = .167, p = .096), as well as fantasy (r = .090, p = .369).

3.2. Individual differences in laughter perception

We examined two dimensions related to how laughter was perceived: authenticity and contagion.

3.2.1. Evaluations of laughter authenticity

Considering ratings for authenticity, spontaneous laughs were rated as more authentic (M = 4.71, SD = 0.71, range = 2.33 - 6.22) than voluntary laughs (M = 3.74, SD = 0.77, range = 1.78 to 5.78; t[100] = 16.87, p < .001). Therefore, participants successfully detected laughter authenticity, i.e., on average, they rated voluntary laughter as less authentic than spontaneous laughter.

To examine associations between predisposition to emotional contagion, empathy, and authenticity perception in laughter, we first computed an index of authenticity detection, consisting of the difference between average ratings provided to spontaneous laughter minus average ratings provided to voluntary laughter; higher values indicate better ability to infer authenticity in laughter (M = 0.97, SD = 0.58, range = - 0.39 – 2.56).

Regarding susceptibility to emotional contagion, a positive correlation was found between negative contagion and better ability to infer authenticity in laughter (r = .309, p < .001). This correlation was in the same direction but did not reach significance for positive contagion (r = .136, p = .176). Two scatterplots show the results regarding the correlations between negative contagion and laughter authenticity detection, as well as between positive contagion and laughter authenticity detection (Figure 1).

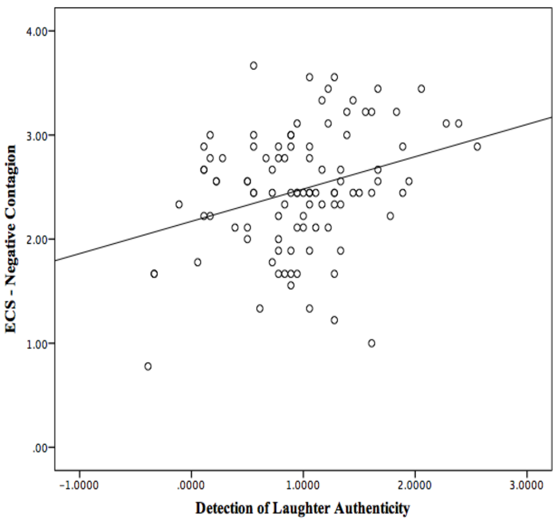
Regarding empathy, a positive correlation was found between empathic concern and better ability to infer authenticity in laughter (r = .308, p = .002). For the remaining subscales of the IRI, no significant correlations were found (perspective taking, r = .129, p

= .199; personal distress, $r = .148$, $p = .140$; fantasy, $r = .100$, $p = .319$)[3]. Four scatterplots show the correlations between laughter authenticity detection and all IRI subscales (Figure 2).

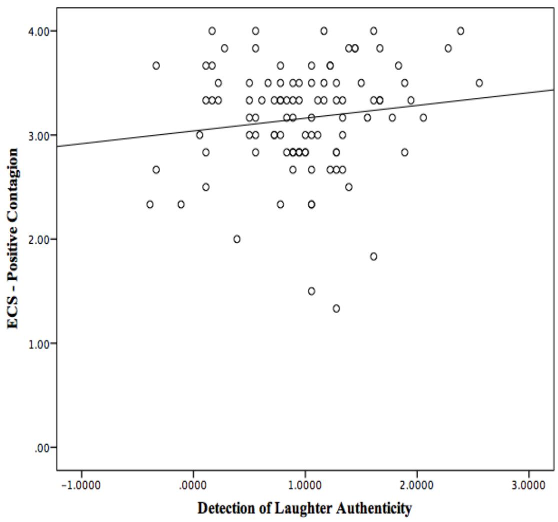
We have also computed correlations between susceptibility to emotional contagion, empathy, and authenticity ratings for voluntary and spontaneous laughter separately, i.e., between negative contagion and authenticity ratings for voluntary laughter, negative contagion and authenticity ratings for spontaneous laughter, and so on and so forth. These results are summarized in Table 1. Apart from a positive correlation between the fantasy subscale and ratings for spontaneous laughter, as well as a negative correlation between empathic concern and voluntary laughter that approached significance, the remaining associations were non-significant.

Figure 1. Scatterplots representing A) the positive correlation between negative contagion and detection of laughter authenticity, and B) the positive correlation between positive contagion and detection of laughter authenticity.

A)



B)



[3] The two significant correlations found (i.e., between negative contagion and laughter authenticity detection, as well as between empathic concern and laughter authenticity detection) cannot be explained by possible age or sex confounds, as they remain significant when these effects are partialled out and the correlations are computed on the residuals (negative contagion and detection of laughter authenticity: $r = .389$, $p < .001$; empathic concern and detection of laughter authenticity: $r = .259$, $p = .009$).

Figure 2. Scatterplots representing A) the correlation between empathic concern and detection of laughter authenticity, B) the correlation between perspective taking and detection of laughter authenticity, C) the correlation between personal distress and detection of laughter authenticity, and D) the correlation between fantasy and detection of laughter authenticity.

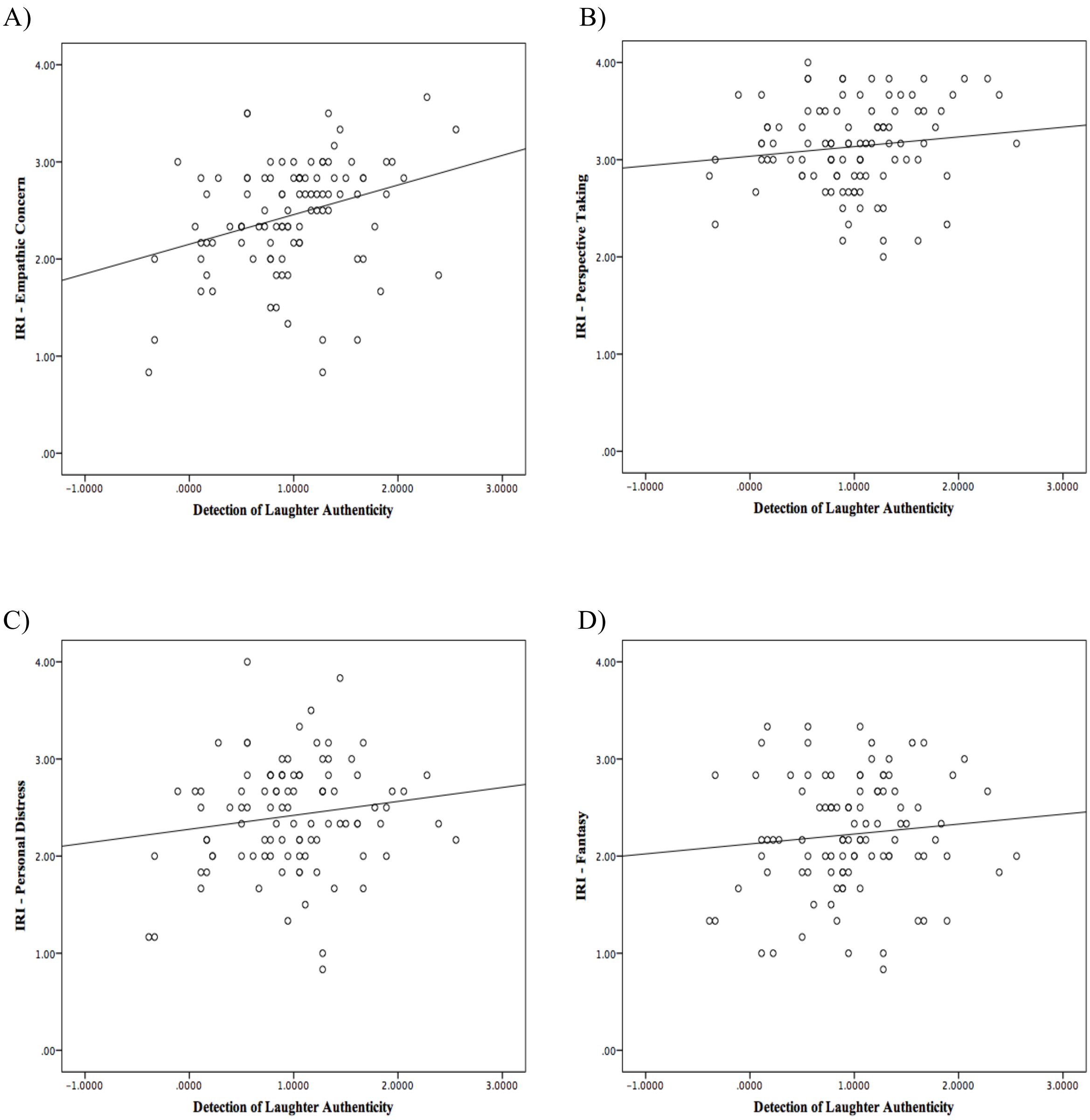


Table 1. Associations between ECS, IRI, authenticity and contagion ratings for voluntary and spontaneous laughter.

	Emotional Contagion Scale		**Interpersonal Reactivity Index**			
	Positive Contagion	Negative Contagion	Empathic Concern	Perspective Taking	Personal Discomfort	Fantasy
Authenticity						
Voluntary Laughter	.065	-.133	**-.205***	-.077	-.075	.160
Spontaneous Laughter	.183	.108	.028	.021	.040	**.258****
Contagion						
Voluntary Laughter	.105	-.043	-.047	.005	.017	.055
Spontaneous Laughter	**.225***	.099	.053	.080	.045	.119

Notes:
values denote Pearson's r coefficients.
**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).

3.2.2. Evaluations of laughter contagiousness

Regarding evaluations of contagiousness, spontaneous laughs were rated as more contagious (M = 4.52, SD = 0.86, range = 1 - 6.22) than voluntary laughs (M = 3.80, SD = .92, range = 1 – 6; $t\,[100] = 15.06$, $p < .001$).

In order to examine associations between predisposition to emotional contagion, empathy and contagion perception in laughter, we computed an index of contagiousness, consisting of the difference between average ratings provided to spontaneous laughter minus average ratings provided to voluntary laughter; higher values indicate more differentiated contagion responses across the two types of laughter (M = 0.72, SD = 0.48, range = -0.56 – 1.83).

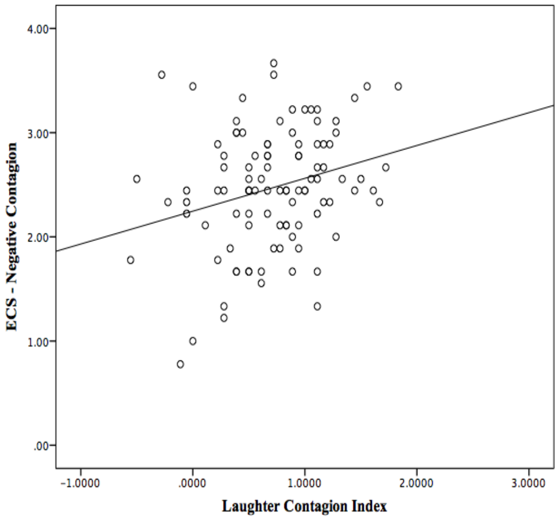
Regarding susceptibility to emotional contagion, a positive correlation was found between predisposition to negative contagion and more differentiated contagiousness distinctions in laughter (r = .259, p = .009). This correlation also reached significance for predisposition to positive contagion (r = .202, p = .043). Two scatterplots show the positive correlations between negative contagion and laughter contagion index, as well as between positive contagion and laughter contagion index (Figure 3) [4].

Considering empathy, no significant correlations were found between laughter contagion index and any of the IRI subscales (perspective taking, r = .132, p = .187; empathic concern, r = .183, p = .067; personal distress, r = .047, p = .638; fantasy subscale, r = .107, p = .287). Four different scatterplots show the correlations between laughter contagion index and all IRI subscales (Figure 4).

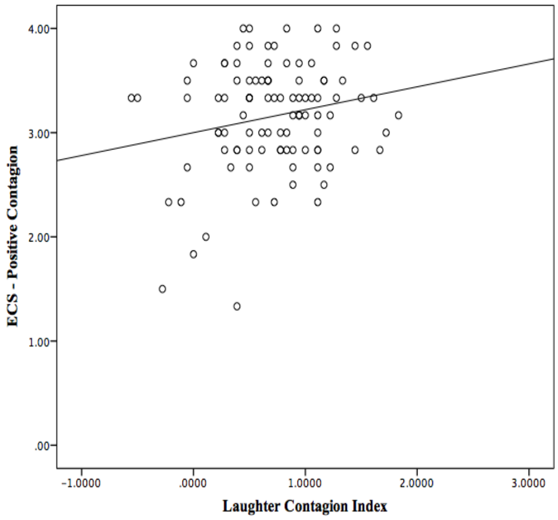
We have also computed correlations between emotional contagion, empathy, and contagion ratings for voluntary and spontaneous laughter separately (these results are summarized in Table 1). Aside from the correlation between positive contagion and ratings for spontaneous laughter, that approached significance, the remaining associations were non-significant.

Figure 3. Scatterplot representing A) the positive correlation between negative contagion and laughter contagion index, and B) the positive correlation between positive contagion and laughter contagion index.

A)

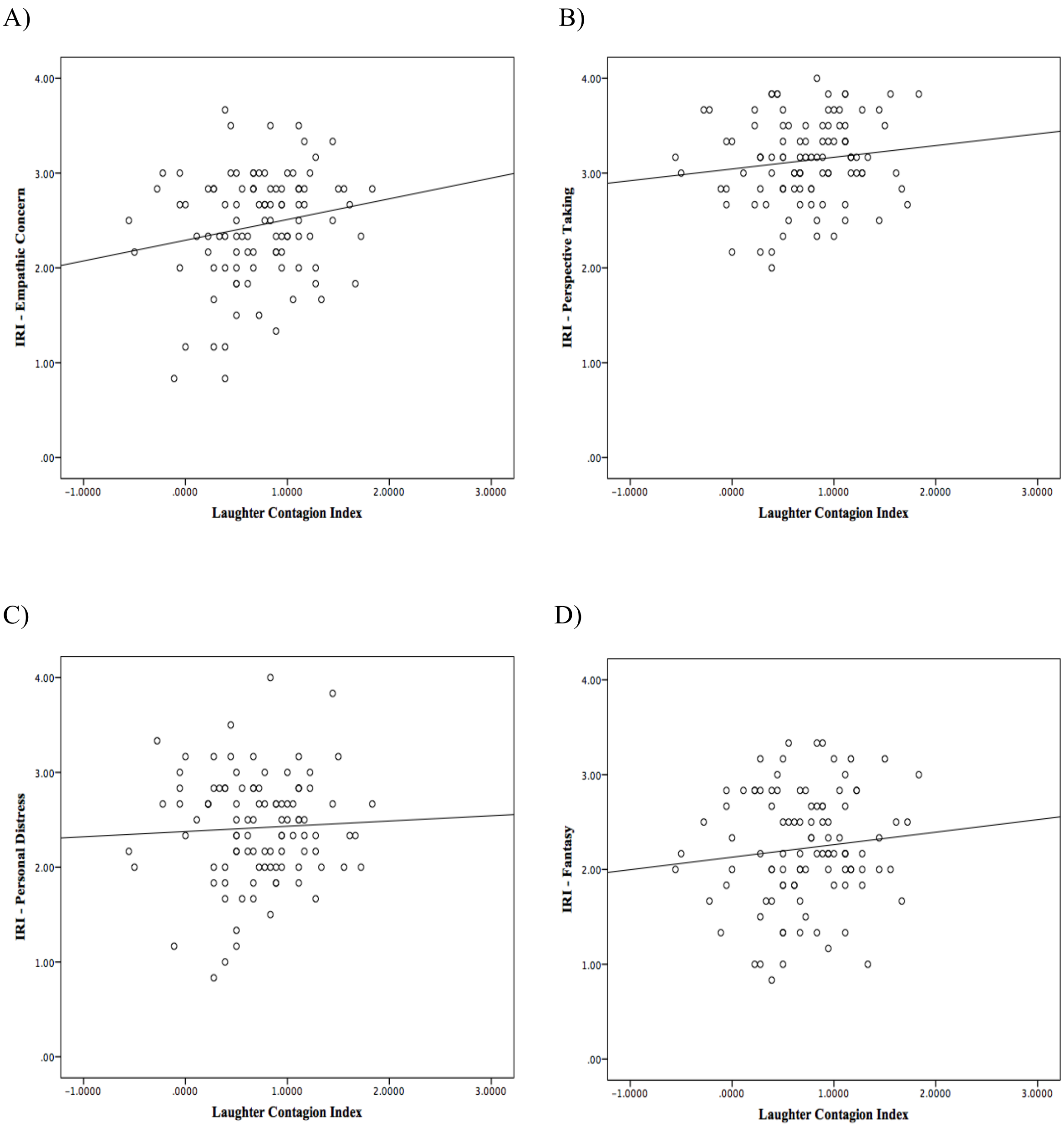


B)



[4] The significant correlations found (i.e., between susceptibility to negative contagion and contagion index, as well as between susceptibility to positive contagion and contagion index), cannot be explained by possible age or sex confounds, as they are also obtained when these effects are partialled out and the correlations are computed on the residuals (negative contagion and perceived laughter contagion index: r = .256, p = .010; positive contagion and perceived laughter contagion index approaches significance: r = .194, p = .052)

Figure 4. Scatterplots representing A) the correlation between empathic concern and laughter contagion index, B) the correlation between perspective taking and laughter contagion index, C) the correlation between personal distress and laughter contagion index, and D) the correlation between fantasy and laughter contagion index.



3.3. The mediating role of perceived laughter contagiousness

Additionally, we aimed to explore if the predisposition to emotional contagion improves laughter authenticity detection via contagion responses to laughter. A statistical mediation analysis (Hayes et al., 2014) was computed in order to test our prediction.

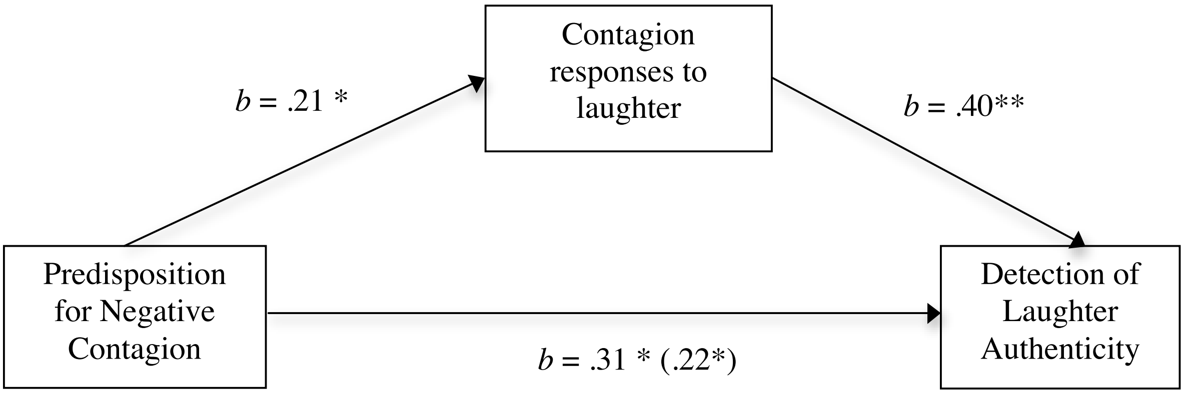
In a first moment, we considered the laughter perceived contagion index as a possible mediator. The results showed that both the total effect (b = .31, p = .002) and the direct effect (b = .22, p = .02) of predisposition to negative contagion on laughter authenticity detection were significant, indicating that susceptibility to negative contagion was significantly associated with laughter authenticity detection, even when the contagion index was controlled for. However, the direct effect of perceived laughter contagiousness on authenticity detection was also significant (b = .40, p < .001), and perceived laughter contagiousness played a significant mediating role on the association between susceptibility to negative emotions and laughter authenticity detection (b = .09, SE = .09, 95% CI = .02 to .21). Thus, as predicted, the association between individual differences in predisposition to negative contagion and laughter authenticity detection was moderated by how differentiated laughter contagion responses were. The mediation model is illustrated in Figure 5.

Afterwards, we considered contagion ratings for voluntary laughter and for spontaneous laughter separately as possible mediators (in separate models). For voluntary laughter, the results demonstrated that the total effect of predisposition to negative contagion on laughter authenticity detection was significant (b = .31, p = .002), as was the direct effect of predisposition to negative contagion on laughter authenticity detection (b = .30, p = .002). The direct effect of contagion ratings for voluntary laughter on laughter authenticity detection was also significant (b = -.14, p = .025). However, it does not play a significant mediating role on the association between predisposition to negative emotions and laughter authenticity detection (b = .01, SE = .03, 95% CI = -.04 to .08).

For spontaneous laughter, the results demonstrated that the total effect of predisposition to negative contagion on laughter authenticity detection was significant (b = .31, p = .002), as was the direct effect of predisposition to negative contagion on laughter authenticity detection (b = .30, p = .002). The direct effect of contagion ratings for spontaneous laughter on laughter authenticity detection did not reach significance (b = -

.038, p = .567). Contagion ratings for spontaneous laughter did not play a significant mediating role on the association between predisposition to negative emotions and Laughter Authenticity Detection (b = .01, SE = .02, 95% CI = -.076 to .015).

Figure 5. Diagram of standardized regression coefficients for the relationship between predisposition for Negative Contagion and Detection of Laughter Authenticity as mediated by contagion responses to laughter.



Notes:
The standardized regression coefficient between predisposition for Negative Contagion and Detection of Laughter Authenticity, controlling for Contagion responses to laughter, is in parentheses.
**. Correlation is significant at the 0.01 level.
*. Correlation is significant at the 0.05 level.

Discussion and Conclusions

The goal of this study was to explore the hypothesis that individual differences in susceptibility to emotional contagion and empathy account for differences in the ability to infer laughter authenticity in the auditory domain. Additionally, we aimed to explore if the perceived contagiousness of laughter mediated the relationship between susceptibility to emotional contagion and laughter authenticity detection. Participants with higher predisposition to negative contagion, and those showing higher empathic concern, performed better on laughter authenticity detection. Also, susceptibility to emotional contagion was associated to more differentiated contagion responses to laughter. Furthermore, a mediation analyses revealed that the association between emotional contagion and detection of laughter authenticity is mediated by contagion responses to laughter, in particular by how differentiated contagion responses are. Overall, the results found in our study supported our hypotheses.

We expected that participants would be able to successfully infer laughter authenticity in the auditory domain, consistently with prior findings with English participants (McGettigan et al., 2015). Therefore, our study extended these findings to a new sample with a different linguistic-cultural background: participants' rated spontaneous laughter as significantly more authentic than voluntary laughter.

Extending the results of Manera and colleagues (2013) to the auditory domain and to laughter, we demonstrated that susceptibility to negative contagion was associated with better ability to detect laughter authenticity. As Manera and colleagues (2013) proposed, it seems that these participants excelled in the laughter authenticity perception task because they made fewer "false positive" mistakes (they demonstrated a tendency to rate voluntary laughter as less authentic). Therefore, it is plausible to think that participants more prone to negative contagion may experience slightly more negative emotions when perceiving voluntary laughter and thus, they perform better regarding detection of laughter authenticity. On the other side, Manera and colleagues (2013) demonstrated that susceptibility to positive contagion reduced sensitivity in smile authenticity detection. In the present study, we did not find any effect of predisposition to positive contagion regarding laughter authenticity detection. Similary to Manera and colleagues (2013), in the present study it seems that once these participants are more prone to positive contagion, they tend to focus their attention on positive emotional signals and overestimate laughter authenticity (they demonstrated a tendency to rate both voluntary and spontaneous laughter as more authentic). Moreover, it is important to note that the ECS covers 9 items for negative emotions and only 6 for positive emotions. So, we could speculate that the results were significant for the negative contagion because this subscale may be more sensitive to individual differences, comparing to positive contagion that may be a subscale slightly less sensitive. Therefore, this bias might explain why people more susceptible to negative contagion were better in detecting laughter authenticity, but people more prone to positive contagion did not particularly excelled or failed in this task.

We showed for the first time that people more susceptible to emotional contagion show more differentiated contagion responses to laughter (that is, participants rated spontaneous laughter as more contagious and voluntary laughter as less contagious). Also, through the mediation analysis, we observed that the general tendency for emotional contagion led to a better ability to perceive laughter authenticity via more differentiated contagion responses. So, it is reasonable to claim that the tendency for emotional contagion is associated to improved detection of laughter authenticity partly because it affects our contagion responses to laughter. Thus, when interpreting an emotional signal, individuals who are more prone to emotional contagion are more susceptible to experience the underlying emotion themselves to a certain extent; that is, they will engage in some level of sensorimotor simulation (supported by sensorimotor systems), and then will be better able to empathize and to understand the emotional meaning of the signal. Thus, experiencing and simulating in ourselves others' expressions culminate in enhanced performance regarding the evaluation of heard emotional vocalizations.

Moreover, higher levels of empathic concern, a specific domain of emotional empathy, were associated with improved performance on laughter authenticity detection. Previously, it was suggested that emotional empathy facilitates somatic, sensory, and motor representations of others peoples' mental states, and results in stronger mirroring of the observed mental states than cognitive empathy (Nummenmaa et al., 2008). Thus, the positive correlation between empathic concern and laughter authenticity detection is consistent with the notion that we empathize with others through a process of simulation, and therefore it facilitates emotional evaluation of heard vocalizations.

Nevertheless, our study has some limitations. We used self-report scales to measure processes that have an unconscious and automatic component, that is, emotional contagion and empathy. Participants may not be totally aware of their own predisposition to these processes and thus, the scores given may not completely reflect the individual predisposition to emotional contagion and empathy. However, using these self-report scales is still the most frequently used way of assessing individual differences regarding emotional contagion and empathy in the literature. Furthermore, the length of the experimental session may have induced fatigue effects and, consequently, influenced the results. With a shorter session, participants could possibly be more focused and give more accurate responses during all the time of the experimental task. However, we made sure that short breaks were allowed when necessary.

As Manera et al. (2013) already proposed, a further challenge would be to investigate if directly manipulating participants' mood would affect their ability to infer laughter authenticity. This could be done by eliciting different moods (e.g. amusement and pessimism) through suitable stimuli (e.g., videos) and by afterwards comparing laughter authenticity evaluations on the same participants (in different mood conditions). Also, it would be interesting to investigate why predisposition to negative emotions correlated to all subscales of the IRI and predisposition to positive emotions correlated with only empathic concern and perspective taking subscales. As mentioned previously, one way to interpret this is by considering that the ECS may be more sensitive to negative contagion comparing to positive contagion. Therefore, it would be relevant to investigate this relationship considering more balanced measures of positive and negative contagion.

In conclusion, in the present study we demonstrated that people are able to successfully evaluate laughter authenticity in the auditory domain. We have seen, for the first time, that people more prone to negative contagion, as well as with higher ratings regarding empathic concern, performed better in laughter authenticity. Moreover, we found that laughter contagiousness perception plays a mediating role regarding the effect of predisposition to negative contagion on laughter authenticity detection. Overall, this study contributes to the understanding of the cognitive processes regarding the evaluation of heard vocalizations. Until now, research on the possible role of sensorimotor processes during vocal emotional processing has mostly focused on neural correlates and on group-level results, not on individual differences. Manera and colleagues (2013) investigated the cognitive processes regarding this ability in the visual domain (smiles). In our study, we extended these results to the auditory domain, that is, considering the evaluation of laughter authenticity. We report findings that demonstrate that emotional contagion plays a role in the evaluation of heard vocalizations and extended the results for empathy. Also, the current models of vocal emotional processing (Brück et al., 2011; Schirmer et al., 2006) do not consider the role of emotional contagion and sensorimotor processes in vocal emotions. Our findings, along with previous neuroimaging data (McGettigan et al., 2015) emphasize the importance of considering these processes in future developments of these vocal emotional processes models. Therefore, the present study contributes to the understanding of the role sensorimotor systems and simulation processes, which plausibly support the automatic emotional evaluation of heard vocalizations.

References

Banissy, M., Kanai, R., Walsh, V., & Rees, G. (2012). Inter-individual differences in empathy are reflected in human brain structure. *Neuroimage,* 62, 2034-2039. doi:10.1016/j.neuroimage.2012.05.081

Banissy, J., & Ward, J. (2007). Mirror-touch synesthesia is linked with empathy. *Nature Neuroscience*, 10, 7, 815-816. doi:10.1038/nn1926

Brück, C., Kreifelts, B., & Wildgruber, D. (2011). Emotional voices in context: A neurobiological model of multimodal affective information processing. *Physics of Life Reviews*, 8, 383-403. doi: 10.1016/j.plrev.2011.10.002

Bryant, G. A., & Aktipis, C. A. (2014). The animal nature of spontaneous human laughter. *Evolution and Human Behavior*, 35, 327-335. doi: 10.1016/j.evolhumbehav.2014.03.003

Davis, M. H. (1983). Measuring individual differences in empathy: evidence for a multidimensional approach. *Journal of Personality and Social Psychology*, 44, 113-126

Doherty, R. W. (1997). The emotional contagion scale: A measure of individual differences. *Journal of Nonverbal Behavior*, 21, 2, 131-154

Fredrickson, B. L. (1998). What good are positive emotions? *Review of General Psychology*, 2, 3, 300-319

Freitas, S., Simões, M. R., Alves, L., & Santana, I. (2011). Montreal cognitive assessment (MoCA): normative study for the portuguese population. *Journal of Clinical and Experimental Neuropsychology*, 33, 989-996. doi: 10.1080/13803395.2011.589374

Frith, C. D., & Frith, U. (2006). The neural basis of mentalizing. *Neuron*, 50, 531-534. doi: 10.1016/j.neuron.2006.05.001

Gazzola, V., Aziz-Zadeh, L., & Keysers, C. (2006). Empathy and the somatotopic auditory mirror system in Humans. *Current Biology,* 16, 1824-1829. doi: 10.1016/j.cub.2006.07.072

Hall, J., & Mueller, G. (1997). Audiologist desk reference. San Diego: Singular.

Hayes, A. F. & Preacher, K. J. (2014). Statistical mediation analysis with a multicategorical independent variable. *British Journal of Mathematical and Statistical Psychology*, 67, 451-470. doi: 10.1111/bmsp.12028.

Korb, S., With, S., Niedenthal, P., Kaiser, S. & Grandjean, D. (2014). The Perception and mimicry of facial movements predict judgments of smile authenticity. *PLoS ONE,* 9, 6, e99194. doi: 10.1371/journal.pone.0099194

Lavan, N., & Lima, C. F. (2014). Neurocognitive mechanisms for vocal emotions: sounds, meaning, action. *The Journal of Neuroscience*, 34, 39, 12950-12952. doi: 10.1523/JNEUROSCI.2988-14.2014

Lavan, N., Lima, C. F., Harvey, H., Scott, S. K., & McGettigan, C. (2015). I though that I heard you laughing: contextual facial expressions modulate the perception of authentic laughter and crying. *Cognition & Emotion*, 29, 935-944. doi: 10.1080/02699931.2014.957656

Lima, C. F., Castro, S. L., & Scott, S. K. (2013). When voices get emotional: a corpus of nonverbal vocalizations for research on emotion processing. *Behavior Research Methods*, 45, 1234-1245. doi: 10.3758/s13428-013-0324-3

Limpo, T., Alves, R. A., & Castro, S. L. (2010). Medir a empatia: adaptação portuguesa do Índice de Reactividade Interpessoal. *Laboratório de Psicologia*, 8, 2, 171-184

Liu, T., Pinheiro, A. P., Deng, G., Nestor, P. G., McCarley, R. W., & Niznikiewicz, M. A. (2012b). Electrophysiological insights into processing nonverbal emotional vocalizations. *Neuroreport*, 23, 108-112. doi: 10.1097/WNR.0b013e32834ea757

Liu, T., Pinheiro, A., Zhao, Z., Nestor, P. G., McCarley, R. W., Niznikiewicz, M. A. (2012a). Emotional cues during simultaneous face and voice processing: electrophysiological insights. *PLoS ONE*, 7, 2, e31001. doi: 10.1371/journal.pone.0031001

Manera, V., Grandi, E. & Colle, L. (2013). Susceptibility to emotional contagion for negative emotions improves detection of smile authenticity. *Frontiers in Human Neuroscience*, 7, 1-7. doi: 10.3389/fnhum.2013.000016

McGettigan, C., Walsh, E., Jessop, R., Agnew, Z. K., Sauter, D. A., Warren, J. E., Scott, S. K. (2015). Individual differences in laughter perception reveal roles for mentalizing and sensorimotor systems in the evaluation of emotional authenticity. *Cerebral Cortex*, 25, 246-247. doi: 10.1093/cercor/bbht227

McKeown, G., Sneddon, I., & Curran, W. (2015). Gender differences in the perceptions of genuine and simulated laughter and amused facial expressions. *Emotion Review*, 7, 1, 30-38. doi: 10.1177/1754073914544475

Niedenthal, P. M, Mermillod, M., Maringer, M., & Hess, U. (2010). The simulation of smiles (SIMS) model: embodied simulation and the meaning of facial expressions. *Behavioral and Brain Sciences*, 33, 417-480. doi: 10.1017/S0140525X1000865

Nummenmaa, L., Hirvonen, J., Parkkola, R. & Hietanen, J. K. (2008). Is emotional contagion special? An fMRI study on neural systems for affective and cognitive empathy. *Neuroimage*, 43, 571-580. doi: 10.1016/j.neuroimage.2008.08.014

Peelle, J. E., Troiani, V., Grossman, M., & Wingfield, A. (2011). Hearing loss in older adults affects neural systems supporting speech comprehension. *The Journal of Neuroscience*, 31, 12638-12643. doi: 10.1523/JNEUROSCI.2559-11.2011

Pinheiro, A. P., del Re, E., Mezin, J., Nestor, P. G., Rauber, A., McCarley, R. W., Gonçalves, Ó. F. & Niznikiewicz, M. A. (2013). Sensory-based and higher-order operations contribute to abnormal emotional prosody processing in schizophrenia: an electrophysiological investigation. *Psychological Medicine*, 43, 603-618. doi:10.1017/S003329171200133X

Provine, R. (2004). Laughing, tickling, and the evolution of speech and self. *Current Directions in Psychological Science*, 13, 6.

Raila, H., Scholl, B. J., & Gruber, J. (2015). Seeing the world through rose-colored glasses: people who are happy and satisfied with life preferentially attend to positive stimuli. *Emotion*, 15, 4, 449-462. doi: 10.1037/emo0000049

Rizzolatti, G., & Craighero, L. (2004). The mirror-neuron system. *Neuroscience,* 27, 169-92. doi: 10.1146/annurev.neuro.27.070203.144230

Rueff-Lopes, R., & Caetano, A. (2012). The Emotional Contagion Scale: factor structure and psychometric properties in a portuguese sample. *Psychological Reports*, 111, 3, 898-904. doi: 10.2466/08.21.28.PR0.111.6.898-904

Sauter, D. A., Eisner, F., Ekman, P., Scott, S. K. (2010). Cross-cultural recognition of basic emotions trough nonverbal emotional vocalizations. *Proceedings of the National Academy of Sciences,* 107, 6, 2408-2412. doi: 10.1073/pnas.0908239106

Sauter, D. A., Scott, S. K. (2007). More than one kind of happiness: Can we recognize vocal expressions of different positive states? *Motivation & Emotion,* 31, 192-199. doi: 10.1007/s11031-007-9065-x

Schaefer, H. S., Larson, C. L., Davidson, J. R., Coan, A. J. (2014). Brain, body, and cognition: neural, physiological and self-report correlates of phobic and normative fear. *Biological Psychology*, 98, 59-69. doi: 10.1016/j.biopsycho.2013.12.011

Scherer, K. R. (2003). Vocal communication of emotion: a review of research paradigms.

Speech Communication, 40, 227-256.

Schirmer, A. & Kotz, S. A. (2006). Beyond the right hemisphere: brain mechanisms mediating vocal emotional processing. *Trends in Cognitive Sciences,* 10, 1, 24-30. doi: 101016/jtcs.2005.11.009

Scott, S. K., Lavan, N., Chen, S., & McGettigan, C. (2014). The social life of laughter. *Trends in Cognitive Sciences, 18*, 618-20. doi: 10.1016/j.tics.2014.09.002

Simões, M., Firmino, H., Vilar, M., & Martins, M. (2007). Montreal Cognitive Assessment (MoCA) – Portuguese version, retrieved from http://www.MoCAtest.org

Warren, J. E., Sauter, D. A., Eisner, F., Wiland, J., Dresner, M. A., Wise, R. J. S., Rosen, S. & Scott, S. K. (2006). positive emotions preferentially engage an auditory-motor "mirror" system. *The Journal of Neuroscience,* 26, 50, 13067-13075. doi: 0.1523/JNEUROSC.3907.06.2006