Social Sciences Faculty
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EMPATHY AND EVOLUTION

Interspecies Emotion Recognition and Facial Mimicry in Humans

2018

By

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Thesis submitted to the Psychology Department at the Pontificia Universidad Católica de

Chile to qualify for the degree of Doctor of Psychology

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Noviembre 2018

Santiago, Chile

**Acknowledgments**

This thesis is doubtless the product of strong and constant collaboration of the Laboratory of Language, Interaction and Phenomenology and Psychophysiology Laboratory research teams. I would like to thank all people who is and was part of these labs for the valuable feedback, critiques and support that allowed me to improve my academic work. I particularly would like to thank Esteban Hurtado, who helped me in data processing and analysis with his uncompromising skepticism and pacience. I deeply appreciate the disposition of my thesis committee who has helped me in the development of my thesis. I want to give special thanks to Vladimir López, who has been close during the whole process giving support and valuable discussions that have helped to give form to this thesis. Of course and above all, I am deeply thankful for the support that my advisor, Carlos Cornejo, has given me during these years. He has not only helped me develop my project, but he has also contributed to improve my critical thinking and research formation, while at the same time providing the necessary space for creativity, innovation and personal growth. Finally, I must thank my partner and parents who have been extremely supportive during this process. Their inconditional support, encouragement and patience have been fundamental to finish this theis, I cannot thank them enough.

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**Abstract**

Empathy is a crucial social phenomenon part of our everyday life. Our ability to access what others are feeling or thinking is essential to the success of every interaction we take part on. Even though lots of scientific interest exists regarding empathy from many different disciplines, no integration of evidence and knowledge between these areas has been achieved. Still no clear definition exist about this central social phenomenon at the foundation of how we interact and understand others. In particular poor integration exist between psychology and evolution still nowadays. The aim of this thesis is to assess the evolutive antiquity of empathy through the exploration of inter-species empathy. Specifically inter-species facial mimicry and emotion facial recognition studies were run to investigate the existence of inter-species empathy and its evolutive origin. Results show only partial support to the hypothesis by showing humans are able to recognize only part of the chimpanzee facial repertoire. Facial mimicry results show no mimicry in the experimental or control condition, possibly due to methodological issues related to contextual modulation. Result from the theoretical manuscript makes visible the benefits of inter-disciplinary integration in the study of empathy by taking together contributions of both evolutive-biology and phenomenology. Finally the present thesis makes a sensible effort, despite mixed experimental results, to integrate different aspects of empathy to study its evolutive origins.

## 1. Introduction

Social encounters play a huge role in our everyday life. We constantly relate with others, when we wake up next to our partners, go shopping for groceries, at work or in a dinner party. Other people surround our lives even when we are alone: social networks consume our time, while movies and series tell others' stories. Every situation or object refers ultimately to other human beings. It is difficult to overstate how relevant social relationships are to us. And therefore the research on how we relate to others and cope with this huge amount of social information is highly relevant to understand the human mind. Different sciences have foregrounded the significance of sociality and studied several social phenomena.

Among these social phenomena, empathy has emerged as a fundamental one, gathering great amounts of resources and interest in scientific research. Empathy has repeatedly been defined by different scientists as a primal skill for building social relationships (Cuff, Brown, Taylor, & Howat, 2014). Empathy is on the basis of our ability to access what others are thinking or feeling as well as our pro-social behaviors. What all different definitions of empathy accomplish is to stress its importance for our social capacities and its immense scope. Empathy is related to many social and interactional phenomena, including "mind-reading" to altruism, that allow us to act as essential social beings. Although authors have tried to separate every aspect of empathy, multiple evidence indicate these are expressions of the same broad and complex phenomena (Coplan, 2011).

Different disciplines have made efforts to study different aspects of empathy. For instance, philosophers have been interested in empathy as a key to the solution of the "problem of other's mind" as well as moral decisions (de Waal, 2010). Are humans originally "solitary wolves" motivated by individualistic needs, where social and moral consciousness is rather a superficial disguise? Or are humans' essentially social beings with innate morality and empathy at the center of our social conformation? Psychologists, on the other hand, have been mainly interested in how are we able to access other's intentions and beliefs, also called "mind-reading" capacity (Michlmayr, 2002). Hence, developmental psychologists have studied when children become able to access other's mental and emotional states (Lohmann & Tomasello, 2003). Cognitive science has studied the many forms in which empathy expresses, investigating emotion recognition, mimicry and emotional contagion (Hatfield, Bensman, Thornton, & Rapson, 2014). Cognitive neuroscience has detected relevant brain areas activated during empathy related tasks, and also discovered the existence of mirror neurons (Rizzolatti, 2005). Finally primatology and evolutionary biology have largely studied altruism in monkeys and apes, in search of the evolutionary origin of empathy (de Waal, 2008; de Waal & Preston, 2017).

Even though relevant knowledge has been generated by all these different disciplines, little integration efforts have been made when it comes to empathy. Disciplines remain mostly encapsulated with scarce or no communication between them. As a proof of this is the fact that still today no clear agreement on its definition has been reached (Cuff et al.,

2014). Every area works with its own definition of what empathy is and built their own theoretical and experimental framework around it (Coplan, 2011). Nonetheless, a proper integration of evidence and knowledge on empathy coming from different disciplines is essential to reach a full comprehension of this relevant social ability. The combination of knowledge and expertise from different areas would contribute to a more robust and complete account of this broad, cross-disciplinary and complex phenomenon. The present thesis approaches this gap by merging evidence, theoretical frameworks, and experimental designs coming from psychology, evolutionary biology and philosophy while studying the evolutionary origin of empathy.

## 1.1. Empathy

As stated above, empathy has almost as many definitions as scientists studying it. A recent article (Cuff et al., 2014) counts at least 43 different definitions of empathy. Usually definitions vary depending on their position concerning some of the controversial issues in the study of empathy, for example if it is either a cognitive or an mainly affective process, whether it is a trait or context-dependent, or whether its automatic or controlled. Trying to reach a wide definition, the social psychologist William Ickes conceives empathy as a "…complex form of psychological inference in which observation, memory, knowledge, and reasoning are combined to yield insights into the thoughts and feelings of others." (Ickes, 1997, p. 2). Through this definition, Ickes stresses the cognitive component of empathy, where reasoning and imagination play a fundamental role. Baron-Cohen and colleagues (Baron-cohen & Wheelwright, 2004, p.

168) deliver a different definition with emphasis on the behavioral consequences of empathy: "The drive or ability to attribute mental states to another person/animal, and entails an appropriate affective response in the observer to the other person's mental state." On a different approach, the ethologist De Waal defines empathy as "the capacity to (a) be affected by and share the emotional state of another, (b) assess the reasons for the other's state, and (c) identify with the other, adopting his or her perspective…This definition extends beyond what exists in many animals, but the term "empathy" applies even if only criterion (a) is met" (de Waal, 2008, p. 281). This definition includes a variety of empathy related phenomena. Finally, the contemporary philosopher Dan Zahavi defines empathy as a "…basic, irreducible, form of intentionality that is directed towards the experiences of others" (Zahavi, 2008, p. 517). This gives empathy a much more basic and motivational form than previous definitions.

All these definitions of empathy have been generated in the last decades. The history of empathy is yet quite older than this. Originally the term was introduced by Robert Vischer in 1873 (Vischer, 1873) —in its German version "*Einfühlung*" ("feeling into") (Mallgrave & Ikonomou, 1994). In 1909, Edward Titchener translated the German "*Einfühlung*" as *empathy* and carried it into modern psychology (Zahavi, 2011). Even though empathy has been a major topic of research and academic discussion for the last century and scientists from all areas agree on its importance, still no agreement has been reached about how empathy works or which phenomena covers (Cuff et al., 2014).

Empirical evidence coming from the study of altruism and pro-social behavior, emotion and facial expression recognition, perspective taking, imitation, mimicry and emotional contagion have nourished the study of this social phenomenon. Empathy and altruism

have been strongly related for many years (de Waal, 2008). As a result many authors have research altruistic and pro-social behaviors in adults (Fehr & Fischbacher, 2003), infants (Warneken & Tomasello, 2009) and non-human animals (de Waal, 2008; Horner, Carter, Suchak, & de Waal, 2011). For humans, a great amount of altruistic or pro-social behavior has been described even outside family relations and with no expectation of future compensation (Brosnan & de Waal, 2002; Preston & de Waal, 2002). While there is agreement about the prevalence of altruism in humans, non-human animals are in a different situation. Although there is evidence of pro-social behavior in different non-human species, especially in apes, there is still debate about result interpretations and the validity of these studies (de Waal, 2010; de Waal & Preston, 2017; Silk, 2006; Silk et al., 2005). It is precisely because of the tight connection between empathy and altruism that many academics refuse to believe non-human animals or apes have truly pro-social behaviors (Penn & Povinelli, 2007). This would open the possibility that non-human animals could empathize, or have access to other's mind, what challenge the dominant paradigm about the radical difference between humans and non-human intellective capacities.

A different approach to study empathy comes from cognitive and developmental psychology, where perspective taking and false belief tasks are the common experimental paradigm (Michlmayr, 2002). Perspective taking tasks are designed to prove our ability to put oneself into another's perspective, spatially or physically speaking (Wapner & Cirillo, 1968). Results in this area show that certain cognitive development is necessary to be able to take the other's perspective. On the other hand, developmental psychology uses the so-called "false belief" tasks to assess when children are able to empathize or

access to what others are thinking (Premack & Woodruff, 1978; Wimmer & Perner, 1983). Results show that children pass this task at 4-6 years old. According to the authors at this age children would be able to theorize about what others are thinking or feeling (Premack & Woodruff, 1978; Wimmer & Perner, 1983). Even though this interpretation collides with more recent evidence that infants younger than 4 years old can under certain circumstances display pro-social behavior (Warneken, Hare, Melis, Hanus, & Tomasello, 2007), is supported by a strong theoretical framework known as "theory-theory of mind" (Michlmayr, 2002; Zahavi, 2010).

In fact, two main approaches dominate the current study of empathy. These two approaches are referred as "theory-theory of mind" (TT) and "simulation theory of mind" (ST), both offering distinct explanations about how we are able to access the inner lives of others (Michlmayr, 2002; Zahavi, 2010). In broad terms, the TT defines empathy as a higher cognitive ability that allows us to generate theories about the other's mental states, which can be confirmed or not by behavioral evidence (Churchland, 1991; Michlmayr, 2002). On the contrary, the ST sustains that empathy is based on imitating the other's state, triggering a matching state in us, and thus making us capable to access the other's mind through projection (Goldman, 1992; Michlmayr, 2002). Even though both theories mainly speak of cognitive processes under voluntary control, different underlying processes are proposed and different sets of evidence are collected by each approach.

On the one hand TT mainly bases on experimental evidence coming from developmental psychology. Results in this area indicate children pass the false belief task only after achieving a cognitive development that allows inferential knowledge (Premack & Woodruff, 1978; Wimmer & Perner, 1983). As a result, empathy is conceived as a mainly

cognitive ability, based on the development of rational thinking and the capacity of making inferences about other's internal states. Although the TT had a wide acceptance for many years and even today references to the first and second-order social inferences can be found in academic articles, this approach has accumulated a series of anomalies (Zahavi, 2007, 2010, 2014). One of these criticisms is the incongruence between the heavy cognitive and time cost required to construct theories for every person we interact with and the pervasiveness, speed and fluidity of our social interactions. Also, as mention above, the cognitive development required by the TT excludes evidence showing social understanding and pro-social behavior in small children and non-human animals.

On the other hand, the ST states that is through imitation, emotional contagion and projection that we humans are able to understand other's mind (Michlmayr, 2002; Zahavi, 2010). This proposal is founded on evidence coming mainly from cognitive psychology and neuroscience. The ST approach is fundamentally based on the pervasiveness of imitation and emotional contagion (Chartrand & Bargh, 1999; Decety & Ickes, 2009). Evidence from different areas has already proved that humans, and other apes, have the tendency to imitate (sometimes covertly) and catch other's emotions easily (Chartrand & Bargh, 1999; Hatfield, Rapson, & Cacioppo, 1994; Hatfield, Rapson, & Yen-Chi, 2009). This tendency to imitate others would allow us to feel what others feel and then project it back to them. Imitation, emotional contagion and the mirror neuron system are considered as evidence of this process by the simulation theory (Decety & Ickes, 2009; Oberman & Ramachandran, 2007). The ST has doubtless taken a big step forward by acknowledging the role that affect —imitation, emotion and contagion— might play in empathy, moving away from the purely cognitive account of TT.

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Nevertheless, this approach has been criticized for the rather voluntary and cognitive profile of the concept of projection, by which the understood mental state is assigned back to others. The voluntary and cognitive features lead to similar criticisms received by the TT fall upon the ST, namely the inconsistency of postulating highly demanding cognitive processes with the requirements of our active social life, as well as the impossibility to explain the presence of empathy and pro-social behavior in babies and non-human primates (Michlmayr, 2002; Zahavi, 2008, 2010).

In brief empathy is a phenomenon of high interest for science, considering its primal importance in understanding human social life. Yet after a century of research, no clear definition has been established. Different areas focus on different aspects of this broad encompassing concept, usually leaving outside other ones. Although two main theories dominate the current research on empathy, none of them has proven to be as robust and satisfactory, meanwhile experimental evidence keeps accumulating and no integration between different disciplines seem to occur.

## 1.2. Empathy, facial expression recognition and mimicry

Relevant experimental evidence supporting empathy comes from the study of emotion recognition. Being able to access the mental and emotional states of others directly relates with the ability to recognize what emotion is behind facial expressions. Studies in this area confirm this by showing that empathic participants display higher rates of emotion recognition (Kosonogov, Titova, & Vorobyeva, 2015). Self-reports of empathy and emotional intelligence show also positive correlation with emotion recognition (Besel &

Yuille, 2010). Starting from this relation, psychometrical instruments to assess empathy have been developed using facial expression recognition (Golan, Baron-Cohen, & Hill, 2006), using the eyes section of facial expressions (Simon Baron-Cohen, Wheelwright, Hill, Raste, & Plumb, 2001). Moreover the study of pathologies associated with low empathy levels like autism, Asperger-syndrome and schizophrenia (Kosonogov et al., 2015) have revealed impairment in emotion recognition tasks. Autism in particular has been related to a deficit in the ability to imitate and grasp other's emotions (Oberman & Ramachandran, 2007; Williams, Whiten, Suddendorf, & Perrett, 2001).

There is robust experimental evidence establishing a strong link between empathy and imitation. Research has showed humans have a natural tendency to imitate or mirror others in a variety of aspects including facial expressions (Chartrand & Bargh, 1999; Niedenthal, Mermillod, Maringer, & Hess, 2010), body posture (Lafrance & Broadbent, 1976), speech and behavior in general (Bernieri & Rosenthal, 1991; Chartrand & Lakin, 2013). This unconscious and non-voluntary form of coordination between people has been labeled *interpersonal coordination* (Cornejo, Cuadros, Morales, & Paredes, 2017). Numerous studies have shown that mirroring is modulated by contextual factors, such as social distance, status, trustworthiness, group membership, trust, friendship and attention (Christov-moore, Simpson, Grigaityte, Iacoboni, & Ferrari, 2014; Cornejo et al., 2018). Evidence shows also a tight relation between mirroring and empathy (Chartrand & Bargh, 1999; Iacoboni, 2005), supporting the idea that imitation plays a fundamental role in our ability to understand others —a core statement defended by the ST. The ability of recognizing emotion in facial expression has also been connected to mirroring, through

studies showing that recognition is impaired when facial movements in the observer are blocked (Hennenlotter et al., 2009; Oberman, Winkielman, & Ramachandran, 2007).

Among the interpersonal coordination and mirroring studies, a particular form of unconscious imitation is reported found, namely facial mimicry. In general terms, facial mimicry consists in the elicitation of congruent facial muscular activity when observing a given facial expression, a tendency that can be measured by means of electromyographic recordings (EMG). This kind of facial coordination has been described as very robust, and has been studied using masked, static, dynamic and even avatar stimuli (Cannon, Hayes, & Tipper, 2009; Wataru Sato, Fujimura, & Suzuki, 2008; Weyers, Mühlberger, Kund, Hess, & Pauli, 2009), using different expression intensities (Fujimura, Sato, & Suzuki, 2010), different experimental tasks (Cannon et al., 2009) and even using more realistic subtle facial expressions (Hess & Blairy, 2001). As a whole, facial mimicry has been described as an automatic process, which occurs spontaneously without conscious attention or effort, and can also be interfered by voluntary processes (Niedenthal et al., 2010). Furthermore facial mimicry has been related to a series of social variables such as perceived similarity, liking and empathy (Seibt, Mühlberger, Likowski, & Weyers, 2015). Facial mimicry, along with other interpersonal coordination phenomena, has been proposed as a fundamental part in the process of understanding others mental states. In particular, facial mimicry through facial feedback and emotional contagion is believed to play a crucial role in facial expression recognition, accessing to other's emotional states (Chartrand & Bargh, 1999; Hatfield et al., 2014, 2009; McIntosh, 1996; Preston & de Waal, 2002).

## 1.3. Empathy and evolution

A largely unknown part of the study of empathy corresponds to the research of its evolutionary origins. Evidence and knowledge coming from evolutionary biology has failed to fully reach psychological circles. Although many authors addressing empathy evolution define themselves as evolutionary or comparative psychologists, they often seem to belong to an encapsulated research area with no communication with the rest of psychology. Research about the evolutive history of empathy has focused, as many others inquiries, on knowing if empathy is a uniquely human ability (Herrmann, Call, Hernàndez-Lloreda, Hare, & Tomasello, 2007; Penn & Povinelli, 2007). As a result, great part of the researchers try to find out whether other non-human animals display empathic behavior, altruism or pro-sociality, what would reveal some understanding at these evolutionary stages of other's minds.

In this venue, researchers have found evidence of pro-social and altruistic behavior in non-human animals, depending on the complexity, from mice to apes (de Waal & Preston, 2017). The work of ethologist Frans De Waal on altruism is remarkable in this aspect. De Waal distinguishes between different types of altruistic behavior, mainly between truly altruistic and selfish ones; while the former is associated with empathy the later implies a more cognitive disposition (de Waal & Suchak, 2010). He also describes different types of altruistic behavior according to their complexity, going from consolation and sympathetic concern to targeted helping and perspective taking (de Waal, 2008). For example, evidence of empathic targeted helping, that is, helping adapted to the

specific need or situation of another congener is found in apes, capuchin monkeys, dolphins and elephants (de Waal, 2008; de Waal & Preston, 2017). Interestingly, this is a behavior motivated by emotional contagion and requires self-regulation and perspective taking.    As mentioned above children and young chimpanzees also show complex altruistic and helping behavior way before they pass the false belief task (Warneken & Tomasello, 2006). Thus, evidence coming from evolutionary biology and psychology shows a clear conflict with the cognitive demanding accounts of empathy provided by Theory-theory and the Simulation theory of mind.

While De Waal's evidence on altruism in non-human animals mostly comes from ethological field observation of wild animals, the studies on pro-social behavior in children and chimpanzee by Felix Warneken are mainly experimental and involve captive apes (de Waal, 2008; Warneken & Tomasello, 2009). Whilst experimental studies show poor empathetic capacities in animals different than humans, including apes (Povinelli & Vonk, 2003, 2004; Silk et al., 2005), field observation presents a different image, in which animals are more than capable of altruistic and pro-social behaviors (de Waal, 2008, 2009b; de Waal & Preston, 2017; Preston & de Waal, 2002). Supporters of behavior observation in the wild argue that experiments always involve humans interacting with the ape and usually implicate artificial and unusual tasks for the animals. Due to these artificial conditions conclusions about empathy from experimental settings could be unfair and their results invalid by methodological reasons. For fieldwork ethologists, observing the animal in its natural environment interacting with their conspecifics is the only way of validly studying animal behavior.

In a different line of research, some authors have undertaken the question from a different perspective. Are non-human animals able to know what others know? Are chimpanzees capable of passing a modified false belief task? These questions have lead to evidence involving different false belief tasks specially designed for apes and the evaluation of how they use different social clues, such as pointing and gaze (Call & Tomasello, 1999; Hare, Call, & Tomasello, 2006; Krachun, Carpenter, Call, & Tomasello, 2009; Tomasello, Hare, Lehmann, & Call, 2007). These experiments show mixed results with a tendency toward finding negative results, that is providing evidence that apes are not able to access other's mind and fail to use social clues usually used by humans like gaze and pointing (Tomasello, Call, & Hare, 2003a). This line of experimental evidence suffers, however, the same naturalistic objections than any experiment in artificial settings (Hare, 2001; Povinelli & Vonk, 2004; Tomasello, Call, & Hare, 2003b). Should apes use the same social clues than humans even tough they live in radically different environmental and social settings? Typically the kind of false belief and social clues tasks fail to take into account the type of life in which apes have evolved. They also fail to take into account what might be relevant to apes in their natural life and that they interact with conspecifics and not with humans. The few studies that try to take these aspects into considerations have surprisingly found positive results (Warneken et al., 2007), opening again the question, are apes' actual capacities to empathy and interpersonal understanding.

Finally cognitive neuroscience has also been interested in the evolutive origin of empathy. In short, these findings show that brain structures related to empathy in humans are largely present since the origin of the mammalian brain (Carter, Harris, & Porges, 2009; Harris, 2003, 2007). This would indicate that empathy is a feature essential for all social mammals —a more rudimental one than thought until now. Empathy could have evolved in the context of offspring care, due it is specially relevant in the context of mammals where babies are born vulnerable, no fully developed and in need of proper care (de Waal, 2002, 2012). Once a trait is selected by natural evolution, it can well serve to other purposes than the one it was originally selected for. Therefore, it can be hypothesized that once empathy was selected, it surely supplied an essential role in social relationships (de Waal, 2012). Another debate in the study of the evolution of empathy relates to what motivates empathy and altruism, i.e., the drive behind it. According to some authors empathic and altruistic behavior is motivated by the expectation of future retribution, mainly directed to other with whom we share genetic material, or motivated by personal distress (Brosnan & de Waal, 2002; de Waal, 2008; de Waal, Leimgruber, & Greenberg, 2008). Researchers arguing for a more ancient origin of empathy argue, nonetheless, that empathy presents motivational autonomy, that is, although it may have been motivated by those reasons when it was selected, those are probably not which *in the present* motivates empathy (de Waal, 2008, 2002; Preston & de Waal, 2002). Empathy is proposed as an originally basic, automatic and emotional process at the root of maternal care that later on served as the foundation to social understanding, altruism and sociality.

In the same line, De Waal proposes a definition and conception of empathy that embraces a variety of phenomena, including from mimicry and emotional contagion until to perspective taking and targeted helping (de Waal, 2008; Preston & de Waal, 2002). He proposes the Russian Doll Model, where more complex and cognitive forms of empathy are built upon more basic, emotional and automatic forms as emotional contagion. In this view empathy is an ancient evolutionary phenomenon at the root of social behavior and the mammalian linage (de Waal, 2008, 2012; de Waal & Preston, 2017; Preston & de Waal, 2002). Taking into account this evidence the present thesis aims to integrate psychological, evolutionary and philosophical perspectives on empathy. More specifically, the present thesis explores the possibility of inter-species empathy by asking if psychological measures of empathy, as emotion recognition and facial mimicry, show evidence of human empathy when they observe other apes.

## 2. Objectives and Hypothesis

In order to study the ancient quality of empathy the present thesis examined the possibility that human empathy, as a basic, automatic and rudimentary feature, is expressed in presence of other evolutionary related species of apes. If empathy is, as proposed, an ancient evolutionary phenomena should be present when people are presented with the face of a closely related species as the chimpanzee. This hypothesis is proved in the more basic and automatic expressions of empathy, namely mimicry and emotion recognitions. The mere presence of a face-like stimulus could elicit empathy,

involving mimicry, contagion and interpersonal understanding. In this way the general aim is to investigate empirically if empathy is present in inter-species relationships.

Even though the present proposal takes into account only one of the possible approaches to the question of evolutionary antiquity of empathy, inter-species relationships, the pertinence of this question has been augmented above. Empathy has been proposed as one of the origins of sociality and maternal care, and being the process in which interpersonal understanding is based (de Waal, 2012; de Waal & Preston, 2017; Preston & de Waal, 2002). Given the pervasiveness of sociality in our lives (Herrmann et al., 2007), its relevance to our success as individuals and species makes the study of human empathy of primal relevance. If inter-species empathy is experimentally confirmed, we will dispose of evidence for the idea that empathy is an earlier evolutive phenomenon that previously thought, shedding light on the extent of its automaticity and scope.

The present thesis formulated the following questions in the preceding project to guide the research:

**Question 1:** ¿Is there evidence of facial mimicry when humans are exposed to pictures of chimpanzee facial expressions of joy (SBT y ROM)?

**Question 2:** If there is positive evidence of facial mimicry in humans in response to chimpanzee facial expressions of joy ¿Are there differences in temporality and intensity

in the facial mimicry in humans evoked by expressions of joy of humans and chimpanzee?

**Question 3:** If there is positive evidence of facial mimicry in humans in response to chimpanzee facial expressions of joy ¿Are there differences in temporality and intensity in the facial mimicry in humans evoked by smiles and laughter expressions? ¿Are there differences in temporality and intensity in the facial mimicry in human evoked by SBT and ROM expressions?

Although the above-presented questions only regard facial mimicry, early in the design of the thesis it was decided that another empathy related phenomena, namely facial emotion recognition, should be also experimentally addressed in case of the facial mimicry study rendered negative results.

## 3. Methodological proposal

To accomplish the objectives proposed two experiments were designed, one regarding facial emotion recognition and another concerning facial mimicry. Methodological details and theoretical framework from each experiment are given in the respective manuscripts. An additional theoretical manuscript is also included indirectly related to the guiding questions in the thesis but exploring the contributions evolutive-biology and phenomenology can make the study of empathy. As a whole, the three manuscripts address the proposed problem of how ancient, in evolutionary terms, is empathy through

the study of inter-species relationships. The two experimental manuscripts tackle the question if humans present empathy in presence of an evolutionary related species as the chimpanzee, by using psychological experimental designs used to study empathy. In its turn, the third manuscript indented to integrate theoretical and empirical knowledge coming from evolutionary biology and phenomenology into the study of empathy in psychology.

The first manuscript presented below corresponds to a classical experimental design about emotion recognition through facial expressions. Pictures of prototypical facial expressions of both humans (Sadness, Anger, Smile, Laughter and Neutral) and chimpanzees (Silent Bared Teeth, Relaxed Open Mouth, Neutral, Pout and Scream) were presented for a short period of time to participants. After each picture presentation participants were asked which emotion they think the facial expressions displayed, as well as to evaluate their intensity, aversion and credibility. Results were analyzed using categorical judgment statistical instruments designed for this specific type of data. Details about the methodology, design and analysis can be found in the manuscript 1"Can humans recognize chimpanzee facial expressions?" attached below (See section 4.1).

The second manuscript (See section 4.2) implies a classical facial mimicry design in which participant observed pictures of facial expressions of both humans and chimpanzees while their facial muscular activity was registered. Pictures were observed by a short period of time followed by black screen, pictures of 4 human expressions (Smile, Laughter, Anger, and Neutral) and 5 chimpanzee expressions (Silent Bared

Teeth, Relaxed Open Mouth, Scream, Pout and Neutral). The activity of four facial muscles was registered by surface electromyography (EMG) to compare their differential activation during picture presentation. The data analysis included variance rates between baseline and stimuli presentation for each muscle and expression presented, repeated measures ANOVA were also used to test the hypothesis.

The last manuscript (See section 4.3) corresponds to a theoretical article that aims to integrate evidence and knowledge from evolutionary biology and phenomenology into the study of empathy in psychology. Even though each of these traditions has studied empathy since long ago, little of them is known in scientific psychology. To achieve the integration a review of several current and past authors in the phenomenological tradition was undertaken. Additionally a review of the work of one of the most prominent authors theorizing empathy from an evolutionary point of view, the ethologist Frans de Waal, was carried out. Finally, the manuscript presents the advantages and contributions that interdisciplinary integration can achieve.

## 4. Attached Manuscripts

Three articles have been developed, two experimental studies —one related to inter-species emotion recognition and the other about inter-species facial mimicry. A third theoretical paper aims to integrate converging approaches from different disciplines on empathy. The facial emotion recognition manuscript will be submitted to the *Journal of Nonverbal Bahavior*. Due to the findings of negative results in the inter-species facial

mimicry manuscript this will not be send to any journal. Finally, the theoretical manuscript has been sent to be to the journal *Phenomenology and Cognitive Science*. Manuscripts were formatted according with journals requirements.

## 1.1. Manuscript 1: "Can humans recognize chimpanzee facial expressions?"

Title: Can humans recognize chimpanzee facial expressions?

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**Abstract**

Facial expression of emotions has been a major subject of scientific research the past decades. Since Darwin, facial expressions of emotions of humans and other primates have been explained assuming a common evolutive origin. Therefore, if facial expressions of other primates share elements with human facial expressions, even inexpert individuals should be able to recognize the emotions behind them. In this study, we address the question of whether naive humans are capable of recognizing the emotions associated to naturally occurring chimpanzee facial expressions. To answer this question, a categorization study was initially conducted using 70 chimpanzee facial expression pictures (SBT, ROM, Neutral, Pout and Scream) and 105 human facial expression pictures (Smile, Laughter, Neutral, Sad and Anger), which were showed to respectively 263 and 280 students. They answered which emotion pictures expressed, and also rated their intensity, credibility and aversion. Our results show participants were capable of relating the correct emotion for three (Neutral, SBT/Smile, ROM/Laughter) of the five chimpanzee facial expressions presented to them. Rates of credibility and aversion showed SBT and ROM where the least credible expressions and their human homologues Smile and Laughter as the more aversive ones. In contrast to previous research, results show participants were able to recognize some of the chimpanzee expressions, in particular the most morphologically similar ones to their human counterparts. Finally we discuss the implication of these results in our knowledge of cross-species facial recognition and the evolutive continuity of primate facial expressions.

*Keywords: facial expressions, recognition, emotion, species comparison.*

**Introduction**

Facial expressions are an essential part of our expressive repertoire in our everyday social interactions. Humans are born with a clear preference for looking faces over objects (Gauthier & Nelson, 2001; Valenza et al., 1996). People are able to distinguish identity or emotion in less than a second of exposure (Junghöfer, Bradley, Elbert, & Lang, 2001; W Sato, Kochiyama, Yoshikawa, & Matsumura, 2001; Wilhelm, Hildebrandt, Manske, Schacht, & Sommer, 2014), to deploy facial expressions even when they are congenitally blind (Galati, Scherer, & Ricci-Bitti, 1997) and to have automatic emotional reactions to them (Dimberg, Thunberg, & Elmehed, 2000). Research has discussed the configural and feature-like way in which faces are processed (Fernandez-Dols, 2013; Mondloch, Le Grand, & Maurer, 2002; Posamentier & Abdi, 2003; Roy, Blais, Fiset, Rainville, & Gosselin, 2015), as well as the categorization of emotional facial expressions (Ekman, 1992) and their presence in different human cultures (Ekman, 1973, 1999). This last issue, mainly addressed by Paul Ekman, has provided evidence in favor of the universal character of facial expressions of emotions (Ekman, 1973, 1999).

The claim that facial expressions are universal goes back to Charles Darwin' book "The expression of the emotions in man and animals" (Darwin, 1872). In this work, Darwin holds two proposals about facial expressions that explain their evolutive relevance and common evolutive origin (Darwin, 1872). First, since facial expressions have a common evolutive root they ought to be similar in all human beings regardless of their cultural group. Second, essential similarities in facial expressions among different species of

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primates are expected given their evolutive connection (Darwin, 1872, p. 361). Since Ekman (Ekman, 1999; Ekman & Friesen, 1986) found evidence in favor of the first of these proposals, by proving the universality of facial expressions across cultures, we will direct our attention to the second one and the evidence surrounding it.

Studies assessing the physical similarity in facial expressions between species have existed since long time (Darwin, 1872), making comparisons between different species of primates (Chevalier-Skolnikoff, 1973; Mehu & Dunbar, 2008; Vick et al., 2007) and non-primates (Waller & Micheletta, 2013) even at the muscular level (Gaspar, 2006; Parr, Waller, Vick, & Bard, 2007). As a result, parallels between facial expressions in humans and other primates have been established and widely accepted (Parr et al., 2007; Van Hooff, 1972; Vick et al., 2007). However, the meaning or function of the similar facial expressions observed in primates has been the subject of a more complex debate. This is mainly due to the elusive nature of meaning in non-human primates, and the impossibility to access a first-person perspective for the establishment of a definitive meaning or function for their facial expressions. In fact, until recently, there was a strong resistance to accept the classification of facial expressions of non-human primates in "human-like" emotional categories (Wynne, 2004). Nowadays, most ethologists agree that facial expressions of non-human primates can be assigned to emotions or emotional contexts (Andrew, 1963; Parr & Waller, 2006; Parr, Waller, & Fugate, 2005; Preuschoft, 2000). In fact, there exists a standardized and reliable classification of non-human primates facial behavior based on their morphological features and the emotional context in which they

occur (Andrew, 1963; Chevalier-Skolnikoff, 1973; Goodall, 1986; Parr, Preuschoft, & de Waal, 2002; Van Hooff, 1967)

Of particular interest to the present work are chimpanzee (*Pan troglodytes*) facial expressions reported in their natural repertoire. The *silent bared teeth* expression (henceforth: SBT) has been described within a variety of social contexts as ranging from aggression to affiliation, being morphologically characterized by the withdrawing of the corner of the lips and the display of teeth (Chevalier-Skolnikoff, 1973; Goodall, 1986; Parr et al., 2002). The SBT in chimpanzees has clear morphological (Figure 2, b1) and emotional context similarities with human smiling expression, which has led scientists to consider them as evolutive homologues (Parr et al., 2007; Waller & Dunbar, 2005). Also, a functional homologue of the human laughter has been described in chimpanzees as the *relaxed open mouth* (henceforth: ROM) or *play face* (Figure 2, b2)*;* both (Laughter and ROM) share physical and contextual features, being normally accompanied with laugh-type sounds (Chevalier-Skolnikoff, 1973; Goodall, 1986; Parr et al., 2007; Waller & Dunbar, 2005). Also a neutral expression in chimpanzee has been described as *calm face* (Figure 2, b3), which these primates display when no emotional or social context in particular is present, similar to the how the human neutral facial expression is defined (Vick et al., 2007). Furthermore, the chimpanzee *pout face* (Figure 2, b5) has been associated with crying in infants and also in adults after fighting and it is characterized by tense protruding lips, with no similarity points to the human sadness face (Preuschoft, 2000). Finally, when chimpanzees are enraged they display a *scream face* (Figure 2, b4) physically very similar to a human scream face but bearing no resemblance to the

prototypical angry face (Parr et al., 2007; Preuschoft, 2000). Another chimpanzee facial expression, usually described, corresponds to the pant-hooting face, not commonly associated to a particular emotion or social context but to excitation whether of negative or positive valence (Goodall, 1986; Parr, Preuschoft, & de Waal, 2002; Van Hooff, 1967). In sum, only some of the facial expressions (SBT and ROM) found in chimpanzee had been studied profoundly enough to claim them homologues of certain human expressions, sharing both morphology and context. While some chimpanzee expressions may resemble their human counterparts morphologically (Neutral), others (Pout and Scream) only are similar in terms of the emotional context to which they are related.

Are humans able to recognize the emotions related to different primate facial expressions? This question was for the first time assessed by Foley in 1935. In his study, Foley (1935) used six images of a five-year-old male chimpanzee supplied by the Russian primatologist Ladygina-Kohts. Each picture was classified by the primatologist in one of the following categories: quietude, sadness, laughter, weeping, anger and excitement. These pictures were then shown to 127 students of Columbia University (75.6% women) who were given 16 emotional categories from which to choose the one that best described de emotion expressed by the chimpanzee in each image. What Foley found, only by contrasting percentages, and using only non-parametric correlation, were broad individual differences in the judgment of each picture, and no correspondence between the choice made by the students and those made by Koths. He concluded that humans are not able to recognize the emotion behind facial expressions of chimpanzees (Foley, 1935). Nonetheless, two major problems have been identified in Foley's study.

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First, the pictures used in the study were classified just by one primatologist and long before scientists reached a clear consensus about the classification of facial expressions of primates that exists today (Chevalier-Skolnikoff, 1973; Goodall, 1986; Vick, Waller, Parr, Smith-Pasqualini, & Bard, 2006). Moreover, a post-study classification of these images carried out by Ekman (1973) with the help of the primatologist Cheavalier-Skolnikoff rendered a different classification for two of the pictures used in Foley study. On a different issue, Foley compared the percentage of correct answers and the variability of the answers using as statistical test only a non-parametric correlation between the consistency of the answers and their accuracy. Having this in mind, Ekman (1973) re-analyzed the data from the Foley study changing the classification of the two pictures, previously incorrectly classified, and ran the proper statistical test at the time (Chi-square test) to answer whether the proportion of correct answers for each picture was above that expected by chance. Interestingly, Ekman's re-evaluation of Foley's data shows, contrary to the original results, that human observers can accurately judge al least some of the chimpanzee facial expressions. Acording to Ekman's results, participants in Foley's study were able to recognize quietude, joy and excitement expressions above chance. More recently, Fernández-Carriba and Parr (Fernández-Carriba & Parr, 2012) replicated Foley's study in American university students, (87.1% women) finding again positive results by using the same statistical approach of Ekman (the $\chi^2$ test). Their results show participants are capable of recognizing the emotion behind ROM, SBT, Scream faces, and to a lesser extent Pout, Neutral and Pant-Hooting above chance levels. Even though Ekman (Ekman, 1973) and Fernández-Carriba & Parr (Fernandez-carriba & Parr, 2012) chose to use a widely used and accepted statistical test as the Chi-square test ($\chi^2$ test) at

least two major problems have been raised about the application of this test for categorical judgment data. In particular, the Chi-square test does not take into account the possibility of category bias when calculating accuracy hit rates, failing to ascribe true chance values for each category (Wagner, 1993). The second issue is that, the Chi-square test is based on a binomial distribution where frequencies are supposed to be independent from each other, assumption that does not hold for within-subject studies (and most categorical judgment studies) and underestimates the probability that the results might have arisen by chance alone (Wagner, 1993). As a result of these problems newer and more reliable statistical procedures have been implemented for the study of categorical choice studies (Wagner, 1993). These approaches take into consideration both the observer bias for certain choice categories and the real chance proportions for within-subjects studies, developing a suitable statistical treatment for this kind of data.

In the present work we address Foley's question about human's ability to recognize emotions associated to chimpanzee facial expressions. This time we rectified the reported methodological problems by using a larger, gender-balanced sample of participants, a higher number of chimpanzee pictures —previously classified by experienced researchers— and by applying adequate statistical tests to assess the hypothesis at hand. Previous evaluations by Ekman (1973) and Fernández-Carriba & Parr (2012) overcome some of these problems, namely by using a correct classification of the pictures and by implementing a more appropriate statistical testing approach. However, newer statistical methods have been proposed for within subject category judgment studies (Wagner, 1993) that could change previous results. In the present study we tried to determine if

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humans with no experience in chimpanzee behavior can recognize emotions in chimpanzee facial expressions. Based on a classification accepted by experts, using morphological and contextual variables (Goodall, 1986; Parr et al., 2002; Van Hooff, 1967), facial expressions related to anger, joy, affiliation and sadness, plus a neutral expression where used. In addition, ratings of intensity, credibility and aversion were evaluated to clarify some of the choices participants make. If humans are indeed capable to choose the correct emotional category above chance for pictures of different chimpanzee facial expressions, it would mean that, with no need of experience, humans are able to recognize the emotions expressed facially by a closely related evolutive species. This capacity would count as a behavioral support of the hypothesis of evolutive continuity and the common origin of facial expressions originally proposed by Darwin. Finally, if positive results were found using newer and more appropriate statistical approaches, the results would lend support to existing empirical evidence on this issue.

**Methods**

**Participants**

A first sample of 263 students (110 women, 153 men), aged 18-27 years (M=20.36) of the Pontificia Universidad Católica de Chile participated assessing chimpanzee pictures. A second sample of 280 students (149 women, 131 men), aged 18-29 years (M= 20.68) of the same academic establishment judged pictures of human facial expressions. Both samples were recruited from twenty different courses taught between January and March

2014, ranging from calculus and chemistry to psychology and computer science. Participants aged less than 18 years old and older than 30 years old were discarded for homogeneity purposes (n=12). Exclusion criteria were that participants had no previous experience studying chimpanzee behavior or as a keeper of this species of primate (at a zoo for example), and that they were not aware of the experimental hypothesis. All participants took part of the study voluntarily. They were given the chance to abandon the study at any stage of the process. Also the university ethics committee supervised recruitment, data recollection, database management, inclusion criteria as well as participant disclosure processes. Finally, all participants read and signed an informed consent before taking part of the study and they did not received reward for their participation.

**Apparatus and stimuli**

The experiment used digitalized pictures of facial expression of chimpanzees. Samuel Fernández-Carriba, Ph.D, obtained the images at the Yerkes National Primate Research Center and at the Madrid Zoo-Aquarium and provided them for this study. The database consists in 186 images of six different categories of chimpanzee facial expressions. The images were obtained either from videotapes or photographs of spontaneous interactions captured for other purposes in these two facilities and some of them belonged to the Living Links Center stimuli collection (Yerkes National Primate Research Center, Emory University). Based on image quality in terms of resolution, illumination and direction of the face, 70 images already classified in five categories (16 SBT, 16 ROM, 22 neutral

faces, 8 pout and 8 scream faces) were selected (Figure 2, b1 to b5). The classification was done by researchers at Yerkes National Primate Research Center based on morphological features and contexts in which each expression occurred (Fernandez-carriba & Parr, 2012; Goodall, 1986; Parr et al., 2002; Van Hooff, 1967). Selected images depicted males and females from different ages ranging from infant to adult chimpanzees.

To compare the recognition accuracy of emotions behind chimpanzee facial expressions with human emotion recognition, pictures of equivalent human facial expressions were included. As most human facial expressions databases do not include a broad diversity of ethnic groups, human facial expressions pictures of people from the same culture were taken to discard possible racial effects (Kelly et al., 2009). Fourteen professional actors (7 women, 7 men) were filmed from a front view while they were sitting against a white background with proper illumination. They were instructed to facially express the basic emotions (Ekman, 1992) in the most natural and realistic way, ranging from a neutral face to the most intense expression of the emotion in a gradual way and back to neutral. Examples of facial expressions from other databases were supplied to give them the basic idea. Once these videos were obtained, a careful revision was carried out to obtain one or two frames per emotion per actor in which they expressed the corresponding emotion in a intense prototypic way that was also realistic and did not appear overacted. The final selection contained 105 pictures of five different facial expressions (Sadness, Anger, Smile, Laughter and Neutral) (Figure 2, a1 to a5) produced by 14 actors (7 women, 7 men). For the sadness, laughter and neutral categories of the 21 pictures, 10 were women and 11 men, while for sadness and smiles, 11 were women and 10 were men. The videos

of 8 (5 women, 3 men) of the 14 actors recruited were provided by researcher Vladimir López who created these videos for a previous experiment (López 2009). He obtained written consent for the use of the videos and paid each actor. The remaining 6 actors (2 women, 4 men) were recruited by the researchers in order to obtain a more gender-balanced sample. They participated in the video production following the same instructions supplied by Vladimir Lopez, and also signed written consents.

Finally, the set of images of both chimpanzee and human facial expression was converted to black and white, and homogenized in size and other visual features by digital processing. At the end of this process all images were 1.59 cm wide and 1.91 cm height, with a resolution of 400 pixels/inch, selected due to the resolution limits of pictures of the chimpanzee database. Chimpanzee and human facial expression categories were selected to depict emotional and morphological homologues in each species. Smile and Laughter in humans have been proven to be evolutive homologues of SBT and ROM, respectively, in chimpanzees (Mehu & Dunbar, 2008; Parr, Waller, Vick, & Bard, 2007; Vick et al., 2007; Vick, Waller, Parr, Smith-pasqualini, & Bard, 2006; Waller & Dunbar, 2005). While the Neutral facial expression in human represents a morphological equivalent of the Neutral face in chimpanzee, the Pout and Scream chimpanzee faces are associated to similar emotional context as Sadness and Anger facial expressions in humans (Parr et al., 2007; Vick et al., 2007, 2006).. The aim of establishing this equivalence in the categories was to make it possible to compare the recognition accuracy between both species later on.

**Procedure**

Participants were asked to judge the images of chimpanzee and human facial expressions while sitting in their classrooms after a class. Once in the classroom a brief explanation was given to students, emphasizizing both the voluntary nature of the participation and the fact that their cooperation had no relationship with the class or their academic evaluations. Then, printed answer forms were handed out to the particiapants containing the informed consent and instructions, in which they were asked "to choose the emotion you think the face in the image expresses". The instructions emphasized that the answers should be individual and that the images would be presented for a short time, so responses should be made fast and without overthinking.

Participants first observed a screen that asked to pay attention and to be prepared for the next image, and then a 550 ms alert sound was included in order to ensure visual attention to the screen while the image was presented. Then the corresponding picture was presented for 3 seconds, followed by 20 seconds to fill the response box corresponding to each image. After this, a new attention message was shown on the screen and so forth. The whole session lasted about 15 min. For human and chimpanzee pictures, participants could choose between seven possible emotion categories (Sadness, Fear, Happiness, Disgust, Surprise, Anger, Neutral) plus an "I do not know" alternative. The seven emotion categories were selected based on the basic emotions (Ekman, 1992) and adding surprise, neutral and "I don't know" as possible answers.

Three 7-points Likert scales were presented in a response box to judge (i) intensity, (ii) credibility, and (iii) aversion of each picture. An example of this response box used to collect the answers of participants is shown in Figure 2. Each answer form consisted of 35 response boxes plus instructions and written consent at the beginning. The stimuli presentation began when all participants reported having signed the informed consent and having read and fully understood instructions. A total of 70 chimpanzee images were divided in two groups of 35 images containing the same number of images of each category (SBT, ROM, Pout, Scream and Neutral) to control the total task duration. Moreover, to control presentation effects three quasi-random sequence of stimuli were used for each group of images. For the same purpose the 105 human facial expressions images were divided into three different groups of 35 pictures with the same number of pictures for each category (Anger, Sadness, Neutral, Smile, Laughter), and two quasi-random sequences of stimuli for each group were used to control presentation effects.

Images were displayed through a projector installed on the ceiling of each classroom where the study was executed, and projected on a retractable screen positioned on front of the classroom. To project the selected images, a regular notebook was used and the open-source experiment builder Open Sesame (Mathôt, Schreij, & Theeuwes, 2012) was used to create the picture presentation.

**Data analysis**

Analyses were performed in several steps. First, we calculated the hit rate for each picture, its mean (M) and standard deviation (SD) for each species. The most and leeast frequently reported emotion response was computed for all human and chimpanzee pictures ratings. Next the hit rate (%) for every facial expression in humans (Anger, Sadness, Neutral, Smile, Laughter) and in chimpanzees (Scream, Pout, Neutral, SBT, ROM) was computed. Instead of using the proportion of correct answers for statistical analyses or the commonly used contingency tables the *unbiased hit rate* was calculated (henceforth: $H_u$) proposed by Wagner (Wagner, 1993). Although proportions are the most frequently used methods to assess accuracy, they do not take into account the observer bias presented in categorical choice studies. That is, participants do not choose equally between each presented response category. The *unbiased hit rate* is obtained multiplying together two conditional probabilities, each of which is the cell entry in a frequency matrix divided by the appropriate marginal total. *Unbiased hit rates* where calculated per participant for each facial expression separately.

On the other hand Wagner (1993) points out another common problem with the analyses of category judgment studies, namely the use of statistical test based on binomial distribution to compare *observed proportion* and *expected proportion* determined by chance. Although this kind of statistical test requires the input frequencies to be independent from one another, this assumption is not satisfied in within-subject designs. As a result, these designs overestimate the sample size, and underestimate the probability

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that the distribution of the results is merely produced by chance. In other words, the statistical models often used to test category judgment studies are not suited for within-subjects designs because they tend to minimize the role that chance plays in the distribution of the results. Therefore, to check if participants selected the correct emotion at a rate higher than chance, a *chance proportion* score was calculated per participant for each picture category separately. Following Wagner (1993) the chance proportion was calculated by multiplying the independent probabilities of the co-occurrence by chance of a stimulus and of a corresponding category for each participant. Because $H_u$ is still a proportion, it needs to be arcsine transformed before performing any statistical test. Once the arcsine transformed $H_u$ was calculated various within-subject analysis of variance (ANOVA), post-hoc pairwise multiple comparisons with Bonferroni corrections and paired t-test were performed when needed to analyze the data in order to assess the investigation question. Also a chi-squared test analysis was used to compare the result obtained by traditional and newer statistical approaches to categorical judgment data.

**Results**

**Description and *Biased hit rate***

The mean percentage of correct answers for all human pictures was 73.54% (SD=21.74), ranging from 53.90% to 91.56% over different emotions. Of all human pictures, the most frequently reported answer by participants was "Happiness" (22.51%) and the least

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reported was "Disgust" (1.43%). On the other hand the mean percentage of correct answers for all chimpanzee pictures was 35.52% (SD=21.21), ranging from 13.78% to 56.80% for different emotions. The most frequent reported answer was "Happiness" (27.47%) and the leeast reported was "Disgust" (3.17%) of all the presented chimpanzee pictures. The mean *biased hit rates* for each emotion, and each species are presented as percentages in Table 1. Even though the percentage of accuracy is lower for chimpanzee pictures, it is interesting to observe for both species the Smile and its Chimpanzee equivalent (SBT) is the most correctly categorized, while Sadness and Pout are the least accurately classified. Also remarkable is that the major difference between species lies in the classification of Laughter and ROM pictures. Participants recognized the emotion associated for humans facial expressions more than for the homologous chimpanzee expressions.

**Cross-species recognition and $H_u$**

$H_u$ average for human pictures was 0.71 (SD=0.24) ranging per emotion from 0.54 to 0.92 (see Table 1). For chimpanzee expressions the mean was 0.34 (SD=0.26) and a range per emotion from 0.14 to 0.57 (see Table 1). The mean $H_u$ for each emotion are presented in Table 1. As we can see in Table 1 none of the tendencies before mentioned analyzing the *biased hit rate* radically changed, but small adjustments were made by the calculation of $H_u$, which may certainly affect the statistical tests.

To assess the potential differences in the recognition accuracy between the different facial expressions presented, a 7-level within-subject analysis of variance (ANOVA) was performed for each species. Different facial expressions were entered as an independent variable, Facial Expression (Anger/Scream, Neutral, Smile/SBT, Laughter/ROM, Sadness/Pout), while the dependent variable was the arcsine transformed $H_u$ of the correct answers per participant. For human expressions results revealed a main effect of Facial Expression $F(4,1120) = 252.7$, $p < .001$. Post-hoc pairwise comparisons with Bonferroni correction show that the arcsine transformed $H_u$ for Smiles (M=1.39, SD=0.25) was significantly higher than all other emotions, $ps < .001$, whereas Sadness (M=0.83, SD=0.25) revealed the lowest *unbiased hit rate* of all emotions, $ps < .001$. *Unbiased hit rates* associated with Laughter (M=1.30, SD=0.28) were smaller than those for Smile ($p < .001$) but higher than Neutral (M=0.98, SD=0.28) and Anger (M=1.02, SD=0.26), $ps < .001$. Meanwhile no significant difference was found between Neutral and Anger, although they both had higher recognition accuracy than Sadness, $ps < .001$. On the other hand the results for chimpanzee expressions also presented a main effect of Facial Expression $F(4,1052)= 213.6$, $p < .001$. And Bonferroni corrected pairwise comparisons revealed that the homologue expression of human smile in chimpanzee, the SBT (M=0.86, SD=0.31), also showed the higher $H_u$ of all other emotions, $ps < .001$. In its turn, the chimpanzee expression of sadness, the Pout face (M=0.27, SD=0.29), had the lowest score of all emotions, $ps < .001$. In the case of chimpanzee expressions, Neutral (M=0.64, SD=0.24), Scream (M=0.58, SD=0.42) and ROM (M=0.52, SD=0.24) where statistically indistinct from one another, but these were smaller than SBT and higher than Pout face, $ps < .001$. In sum, we found that the higher recognition rate was found for the

same expression in each species, the Smile and its chimpanzee homologue, the SBT. Furhermore, facial expressions that had the lowest accuracy rates were Sadness and Pout in both species. The only significant difference found between species was related to the Laughter and ROM expressions: whereas in humans the recognition accuracy of Laughter was significantly higher than Neutral, Anger and Sadness expressions, participants did not recognize in chimpanzees the emotion related to ROM more than they did for Neutral and Scream expressions.

To assess if the $H_u$ observed were different from what we would expect by chance, paired t-test were performed between the before computed *chance proportion* and the non-transformed $H_u$ as recommended by Wagner (1993). A Bonferroni correction was used to evaluate significance. For both chimpanzee and humans expressions all $H_u$ associated with the correct answer were greater than *chance proportions*. In the case of human facial expressions, Anger $H_u$ (M=0.69, SD=0.19) was far above the expected by chance (M= 0.03, SD=0.01), $t(280)= 60.97$, $p <.001$. This was also true for all other emotions, Neutral (M=0.66, SD=0.22) against chance (M=0.03, SD=0.01), Laughter (M=0.87, SD=0.16) versus chance (M=0.03, SD=0.01), Smile (M=0.92, SD=0.13) against chance (M=0.04, SD=0.01), and finally Sadness (M=0.54, SD=0.21) versus chance (M=0.02, SD=0.01), *ps* <.001. As for chimpanzee facial expressions, the $H_u$ for Scream (M=0.36, SD=0.27) was significantly higher than the *chance proportion* computed (M=0.01, SD=0.01), $p <.001$. A tendency also observed for all other emotions, Neutral (M=0.37, SD=0.24) versus chance (M=0.04, SD=0.02), ROM (M=0.28, SD=0.24) against chance (M=0.02, SD=0.01), SBT (M=0.57, SD=0.31) versus the *chance proportion* (M=0.03, SD=0.02)

and at last Pout (M=0.14, SD=0.21) against the random rate (M= 0.003, SD=0.004), *ps* <.001. In sum, for all facial expressions (human and chimpanzee) the emotion expressed was selected far above chance level.

Additionally, to evaluate whether the correct answer was the most frequently related to each emotion, a within-subject ANOVA was carried separately for each expression with all nine possible answers (Disgust, Anger, Happiness, Fear, Neutral, I don't know, No answer, Surprise and Sadness) as an independent variable, and the arcsine transformed $H_u$ per participant as dependent variable. Post hoc pairwise Bonferroni corrected comparisons where conducted to assess the significant differences between answers. Results revealed that for all human expressions the correct response was the significantly most frequently selected by participants. For the Anger facial expression a main effect of Answer was found ($F(8,2240)=723.6$, *p* <.001) and later comparisons show that Anger had the highest $H_u$ of all responses, *ps* <.001. Also, for the Neutral expression a main effect of Answer was revealed ($F(8, 2240)=604.7$, *p* <.001), whereas posterior contrasts confirmed "Neutral" was indeed the most recurrent answer, *ps* <.001. The same results were found for Laughter ($F(8,2240)=2120$, *p* <.001), where "Happiness" had the higher *unbiased hit rate* of all possible responses, *ps* <.001. The same answer was the most frequently choose for the Smile expression ($F(8,2240)= 3209$, *p* <.001), *ps* <.001. Finally the Sadness expression likewise showed a main effect of Answer ($F(8,2240)=403$, *p* <.001), where "Sadness" was the most recurrent of all answers, *ps* <.001.

In the case of chimpanzee facial expressions, results were mixed. While for Neutral, ROM and SBT the correct response was indeed the most recurrent of all answers, for Scream and Pout other than the correct one were more frequent or at least equally frequent than the correct answer. For instance, in the case of Scream a main effect of Answer was found ($F(8,2104)=114.6$, $p <.001$) and later contrasts revealed a significant difference of "Anger" (M=0.36, SD=0.27) with all other responses ($ps <.001$) except with "Happiness" (M=0.27, SD=29). On the other hand, ROM ($F(8,2104)=93.18$, $p <.001$), SBT ($F(8,2104)=323.3$, $p <.001$) and Neutral ($F(8,2104)= 210.2$, $p <.001$), showed a main effect of Answer, while post-hoc comparisons revealed the corresponding correct answer ("Happiness", "Happiness" and "Neutral") was chosen more frequently than all other answers, $ps <.001$. In the case of the Pout expression results showed a main effect of Answer ($F(8,2104)=95.07$, $p <.001$) but posterior contrasts showed that "Surprise" (M=0.28, SD=0.21) was the most frequent response followed by the correct answer "Sadness" (M=0.14, SD=0.21), $ps <.001$.

In view of these results, we compared $H_u$ of the Anger/"Happiness" and Sadness/"Surprise" pairs with the corresponding *chance proportions* for chimpanzee expressions. Paired t-test for these expression/answer pairs were done for this objective. The Anger/"Happiness" contrast was found significant ($t(263)=15.48$, $p <.001$) with the observed $H_u$ of "Happiness" (M=0.27, SD=0.29) being higher than chance (M=0.01, SD =0.01). The contrast Sadness/"Surprise" also revealed statistical significance ($t(263)=22.37$, $p <.001$) with the observed corrected proportion (M=0.28, SD=0.21) higher than the random proportion (M=0.01, SD=0.01). Finally, even though the

accuracy for each expression, either for chimpanzee or human expression, was far above the chance, results were fundamentally different for both species. While human expression pictures were consistently associated to the correct emotion expressed, in chimpanzee pictures only ROM, SBT and Neutral expressions were correctly associated by participants. Meanwhile the Scream expression was consistently related to its correct response, "Anger", but participants also persistently associated this expression with "Happiness". As for Pout, participants tended to associate this expression with the emotion "Surprise" more often than with "Sadness", so the correct answer had the second place in terms of frequency.

To highlight the possible differences between different statistical treatments, we conducted a traditional chi-squared test analysis. The input data corresponded to the contingency table of Facial Expressions versus possible Answers. The relation between these two variables was statistically significant ($\chi^2(32$, N=264$) = 4105.84$, $p < .001$). To determine which differences between observed and expected values contribute more to this relationship, and to know which of the facial expressions were correctly recognized, the standardized residuals were examined (Agresti, 2007). High standardized residuals were found in the following pairs of Facial expression/answer, Scream/anger (25.7), Neutral/neutral (34.8), SBT/happiness (35.7) and Pout/surprise (22.5). ROM/happiness (1.3) and Pout/sadness (3.7) presented very low standardized residuals, what means a poor difference between observed and expected values. As a result of this analysis, people are able to recognize chimpanzee's emotion associated to Scream, Neutral, SBT, but not ROM and Pout. As we can observe, very different results and conclusion rise

from the different statistical treatment used to analyze categorical judgment data. As stated above, this is the first study to use a large gender-balanced sample and to apply statistical test different to the chi-squared approach normally used.

**Intensity, credibility and aversion**

Regarding the other qualities assessed by the participants —intensity, credibility and aversion— interesting results were also found. A within-subject ANOVA with Facial Expression (Scream, Neutral, ROM, SBT, Pout) as independent variable and intensity rating as a dependent variable showed a main effect of Facial Expression ($F(4,860)$=106.1, $p$ <.001). Post-hoc Bonferroni corrected contrasts showed that while Scream (M=5.80, SD= 1.02) was rated as the most intense expression ($ps$ <.001), the Neutral expression (M=4.37, SD=0.97) was classified as the least intense ($ps$ <.001). As for SBT (M=5.18, SD=0.85), ROM (M=5.06, SD=0.80) and Pout (M=4.91, SD=0.99), no significant difference was found between them, although they all showed lower intensity rates than Scream and higher than Neutral, $ps$ <.001. In the case of human expressions, also a main effect of Facial Expression was revealed ($F(4,1112)$= 376.2, $p$ <.001) and posterior contrasts showed Laughter (M=5.77, SD=0.73) had the highest rate of intensity of all human expressions, $ps$ <.001, followed by Smile (M=4.76, SD=0.82), then Anger (M= 4.50, SD=0.86) and finally Sadness (M=4.20, SD=0.93), all significantly different from one another, $ps$ <.001. As expected, Neutral (M=3.66, SD=1.07) showed the lowest intensity rate, $ps$ <.001.

The paired *t*-test was used to compare intensity rating for each human expression to its chimpanzee correlative. For the expression of Anger, participants found the chimpanzee expression Scream to be more intense than the human equivalent expression ($t(418)=14.98$, $p <.001$). Following the same tendency, Neutral ($t(481)=7.77$, $p <.001$), SBT ($t(454=5.48$, $p <.001$) and Pout ($t(447)=8.13$, $p <.001$) were found to have higher ratings of intensity for chimpanzee expressions. In contrast, Laughter showed a higher intensity rating than ROM ($t(438)=10.23$, $p <.001$). As a result, while Neutral expressions are rated the lowest in intensity for both species, participants found the most intense Scream expressions in chimpanzees and Laughter expressions in humans. Only for human pictures we found the expected difference in intensity between Laughter and Smile, that is students rated Laughter as more intense than Smile. While most of the expressions where rated more intense in their chimpanzee version, human Laughter was the only one rated higher than its chimpanzee homologue, the ROM.

As for Credibility ratings, a main effect of Facial Expression was also found for both chimpanzees ($F(4,864)=23.02$, $p <.00$) and humans ($F(4,1136)=26.28$, $p <.001$). Posterior Bonferroni corrected contrasts revealed that for chimpanzee expressions Neutral (M=5.27, SD=0.82), Scream (M=5.07, SD=1.24) and Pout (M=5.06, SD=0.98) showed higher ratings of credibility than ROM (M=4.99, SD=0.89) and SBT (M=4.61, SD=1.03) expressions ($ps <.001$), but no significant difference between the first three expressions was found. However, a statistically significant difference was found between ROM and SBT where participants found more credible the chimpanzee homologue of Laughter than the homologue of Smile.

In the case of human expressions, post-hoc comparisons revealed that Smile (M=4.92, SD=0.94), Neutral (M=4.86, SD=0.88) and Laughter (M=4.67, SD=1.10) have higher credibility ratings than Sadness (M=4.43, SD=0.87) and Anger (M=4.41, SD=0.95), $ps$ <.001. No significant difference was found between these two groups. As for the difference between the ratings obtained by corresponding expressions in humans and chimpanzees results are as follow. Whereas for Anger/Scream ($t$(392)=6.53, $p$ <.001), Neutral ($t$(478)=5.40, $p$ <.001), Laughter/ROM ($t$(498)=3.54, $p$ <.001) and Sadness/Pout ($t$(434)=7.42, $p$ <.001), the corresponding chimpanzee expression was evaluated as more credible than its human correlative. Only the credibility rating of Smiles was found higher than for its chimpanzee homologue, the SBT ($t$(441)=3.49, $p$ <.001). In other words, whereas for chimpanzee expressions participants rated ROM and SBT as the least credible ones, for human expressions, Sadness and Anger were the least believable. Participants found all expressions to be more credible in their chimpanzee version except for the (human) Smile, which was rated more credible than the chimpanzee SBT.

Finally, for Aversion ratings given by participants the within-subject ANOVA results also show a main effect of Facial Expression for both chimpanzees ($F$(4,864)= 42.95, $p$ <.001) and humans ($F$(4,1136)=457.2, $p$ <.001). For chimpanzee expressions, Neutral (M=4.29, SD=0.90), Pout (M=4.20, SD=0.92), SBT (M=4.19, SD=0.95) and ROM (M=4.09, SD=0.81) were found to have higher ratings of aversion than Scream (M=3.47, SD=1.15), $ps$ <.001.  In humans, the expression with higher aversion rating was Smile (M=5.11, SD=0.83), $ps$ <.001, followed by Laughter (M=4.93, SD=1.02), and then

Neutral (M=3.88, SD=0.55), *ps* <.001. Although Sadness (M=3.44, SD=0.66) and Anger (M=3.33, SD=0.70) showed the lowest aversion ratings of all expressions (*ps* <.001), no significant difference was found between them. On the difference in aversion ratings between the equivalent expressions in humans and chimpanzees, only Anger/Scream showed no significant result. For Neutral ($t(333)=5.90$, *p* <.001) and Sadness/Pout ($t(374)=10.41$, *p* <.001) expressions with a higher aversion rate was found for the corresponding chimpanzee expression. While for Laughter/ROM ($t(498)=10.28$, *p* <.001) and Smile/SBT ($t(429)=11.43$, *p* <.001) the corresponding human expression showed a higher aversion rate than their chimpanzee homologues.

Finally, the results show that, for chimpanzee expressions, Scream generated the higher aversion between participants, while in human expressions Smile was the most disliked picture category. In chimpanzee expressions, Neutral and Pout faces where rated by the participants as more aversive than their human equivalents. In turn, Laughter and Smile expressions where perceived as more aversive in humans than in their chimpanzee versions.

**Discussion**

**Cross-species recognition of emotional facial expressions**

Results show mixed conclusions about human capacity to recognize the emotions associated to some chimpanzee facial expression. First, not all chimpanzee facial

expressions were associated to the correct emotion they were meant to represent; only Neutral, SBT and ROM met the criteria to count as being recognized. On the other hand, *Scream* and *Pout* faces were consistently confused with emotions different than the correct one. In contrast with the previous findings (Ekman, 1973; Fernández-Carriba & Parr, 2012; Foley, 1935) our results show humans are capable of recognizing only a few of the chimpanzee facial expressions. Major differences can be found in the results when different statistical approaches are used. In particular, our analysis shows that the observation that a given answer is presented above chance levels does not warrant that the emotion associated to a facial expression was recognized. As a consequence the use of proper statistical approaches for this kind of studies is essential to the adequate interpretation of results.

The most recognizable expression in chimpanzees was the SBT, which is the homologue expression of the human smile and also the most recognized expression in human pictures. Of the three expressions (Neutral, SBT and ROM) recognized by humans, the least correctly identified was ROM for chimpanzees, while for human it was Sadness. Previous research in human facial expression of emotion have found that happiness expressions are the most easily recognizable and sadness is the most difficult one showing lower accuracy levels (Ekman & Friesen, 1982; Goeleven, De Raedt, Leyman, & Verschuere, 2008). So our results follow the tendency of earlier studies, with joy expressions being more recognizable (Smile and Laughter) and Sadness as the least recognizable. However chimpanzee expressions results show that ROM is not as identifiable as SBT, while in human pictures both homologue expressions (Smile and

Laughter) were equally recognizable. Notably, previous studies have reported people are reluctant to accept or believe that chimpanzees or other primates can laugh (Scheumann, Hasting, Kotz, & Zimmermann, 2014), offering a possible explanation for the difference we observed.

In addition to these differences, chimpanzee expressions Scream and Pout were not correctly recognized, even though participants chose the correct answers more than expected by chance (Anger and Sadness) these correct emotions were not always he first preference. For instance the Scream face was judged by participants as related to anger, the correct answer, but also equally often related to happiness, choosing both of these answers above the expected by chance. A possible explanation is that the Scream face was confused with expressing happiness because of the physical resemblance between ROM/laughter and anger expressions (Figure 2, b2 y b3). These two expressions share two important facial movements related to the raise of the lips corner (*Zigomaticus Major*) and the separation of the lips (*Depressor Labii, Relaxation of Mentalis, Orbicularis Oris*). The main difference of Scream face resides in raising the upper lip (*Levator Labii Superioris, Caput infraorbitalis*) and lowering the inferior lip (*Depressor labii inferioris*), which results in a more prominent teeth display than in the other expressions (Parr et al., 2007; Vick et al., 2006). As for the sadness expression in chimpanzees, the Pout face, it was more commonly related to surprise and just secondarily to sadness. Results also showed that the facial expression of sadness in chimpanzee was the more confusing one, as it was its human correlative. Also, it is very plausible that human judges confused the Pout face with the prototypical cartoon like

surprise face. While the more realistic surprise face in humans does not comprehend the funneled lips or round mouth, we can observe it in cartoon surprise faces, where along with the eyebrow raising a tube like mouth is also displayed. The funneled lips, showed in the chimpanzee Pout face, result from the activation of the *orbicularis oris* muscle, and it is for sure a main source of the noted confusion (Parr et al., 2007).

Is the human recognition of chimpanzee expression based on physical similarities with the corresponding human emotional expressions? Since SBT, ROM and neutral faces in chimpanzee are the only ones the participants consistently recognized and since they are also the most physically similar to their human equivalent, the answer is probably yes. On the other hand, Pout and Scream faces were not recognized by participants and both are physically very different to the human sadness and angry expressions. Moreover, the Pout and Scream chimpanzee expressions were confused with emotions related to expressions that had some feature similitude at a muscular or physical level. It seems that the human ability to recognize facial expression of emotions in other primates might simply reside in the capacity to make physical anthropomorphic comparisons more than an authentic perception of the emotion behind each expression. Previous research shows valence ratings can also affect similarity rating of physical characteristic of chimpanzee facial expressions (Waller, Bard, Vick, & Smith Pasqualini, 2007), showing how other factors can influence physical similarity judgments. This anthropomorphic resemblance hypothesis is also consistent with Darwin proposed evolutive continuity and common origin of facial expressions. The morphological resemblance between different facial

expression in different species accounts finally for their shared evolutive origin and continuum.

**Credibility, Intensity and Aversion**

This cross-recognition study also included different additional ratings to the emotional expressed judgment, which provide interesting insights. Regarding credibility, the chimpanzee expressions of joy (SBT and ROM) were classified as the least believable, while for human pictures Smile and Laughter were rated as the most credible ones. This result is compatible with the above-mentioned general belief that our distant evolutionary relatives are unable to laugh, as it has been previously reported (Scheumann et al., 2014). Also when contrasting ratings obtained by human and chimpanzee facial expression pictures, results showed that chimpanzee expressions were judged as more credible than their human correlatives except for the Smile/SBT couple, where human smiles evidenced higher credibility than SBT. Even though only SBT was rated less credible than their human homologue, the results as a whole appear to support the idea that chimpanzee expressions of joy lack credibility. In sum, our results show a clear disadvantage of the chimpanzee facial expressions of happiness in terms of credibility, since people tend to see them as less honest and reliable.

Concerning the intensity ratings, as expected, neutral faces (both chimpanzee and human) revealed the lowest values for intensity. Even though some researchers have proposed a more careful definition for the neutral facial expression used in cognitive experiments

(Tottenham et al., 2009), neutral expressions are distinguished by their passive nature and in our results they were rated accordingly as the least intense expressions. In addition, the predicted difference in intensity between Smile and Laughter pictures was indeed found in human pictures, Laughter being rated as more intense than Smile. However, chimpanzee pictures did not show this expected distinction between the different expressions of joy. Moreover all chimpanzees facial expressions were rated as more intense than human expressions except the Laughter/ROM pair, in which the human expression was rated as more intense than its primate homologue. This supports the idea that ROM and SBT in chimpanzees represent a somewhat special case, being the only two proven evolutive homologous expressions of the chimpanzee natural repertoire (Mehu & Dunbar, 2008; Waller & Dunbar, 2005).

Finally, the aversion rates showed rather unexpected results, revealing that for both species facial expressions of joy are classified as the more dislikeable ones, while Anger and Scream expressions are rated as the least aversive within each species. These findings suggest that people see these expressions of joy as fake or posed, creating a rejection or aversion to the image. Furthermore, Laughter and Smile were the only two human expressions rated as more aversive than their non-human equivalents. These results can be explained by realizing that people usually have more knowledge and experience about the facial repertoire of their own species, making it easier to judge the honesty of human expressions. As a result they might be more inclined to judge more harshly the credibility of the human pictures, leading to higher aversion rates.

In conclusion, even though regarding some features human judges behave similarly for human and chimpanzee expressions some differences can be found. Mainly, the two expressions of joy showed to conform a special case, standing out as different from all other expressions. In the case of the chimpanzee expressions SBT and ROM, they both present the lowest credibility ratings. ROM was the only expression rated lowest in intensity than its human version, and the same happens in terms of credibility for SBT.

Taking into account all these findings, it seems that the distinctive results found for these evolutive homologues expressions of joy in chimpanzees are related to people beliefs about the feasibility of these expressions in primates. As a result, their ability to recognize the emotion behind them might be impaired by their disbelief that such emotions and expressions could exist in other primates. These beliefs probably reside in the common notion that humans are unique in their cognitive abilities, a phenomena also referred as anthropocentrism (de Waal, 2001). However, its brother concept anthropomorphism does not necessarily interfere with science, as proposed by some authors (Hebb, 1946); instead it acknowledges the continuity between humans and animals (de Waal, 2001). If anthropomorphism entails the risk of overestimating animal behavior and its cognitive complexity, denying anthropomorphism (anthropodenial) carries the risk of overlooking the shared characteristics between human and other animals (de Waal, 2001).

In the present study, current statistical methods developed for categorical choice data were used to investigate the human capacity of cross-recognizing facial expressions of

emotion of other primate species. It would be useful to obtain a replication of this study using the same methodology in a new sample of participants in order to confirm results and conclusions.

Our results also show that the evaluation of different features of the images used can indeed help to understand some processes behind cross-species emotion recognition of facial expressions. Eventual future investigations should look into the possible explanations underlying the limitations in the ability of humans to recognize the emotions associated to different facial expressions found in chimpanzees. An open question is whether the classification of the chimpanzee facial expressions is a consequence of inferences from morphological similarities between expressions and faces of each species, as suggested by our results. This question connects facial recognition with simulation theory, where empathy is achieved through the imitation of others and similarity plays a crucial role (Goldman & Sripada, 2005; Oberman & Ramachandran, 2007).

Furthermore, it would be important to explore how cross-species emotion recognition develops during human ontogeny. Previous studies have documented a perceptual narrowing regarding identity cross-species recognition, children being more capable than human adults (Pascalis, de Haan, & Nelson, 2002). Also advances towards using more ecologically valid stimuli, like field videos, have been suggested in different areas studying facial expressions (Bourgeois & Hess, 2008; Fernandez-Dols, 2013;

Rymarczyk, Zurawski, Jankowiak-Siuda, & Szatkowska, 2016; Wataru Sato, Fujimura, & Suzuki, 2008).

In sum, using the most up to date statistical treatments and testing for this type of categorical judgment data, our results suggest that humans are in fact capable to recognize the emotion manifested in at least some of the facial expressions found in chimpanzees. In particular, neutral and joy expressions were correctly identified. This might indicate that human beings are able to recognize in chimpanzees only those emotions involving physically similar human facial expressions. In addition, credibility judgments confirmed that the homologous expression of joy in chimpanzee might indeed be a special case. This interpretation is then only partly consistent with Darwin hypothesis on the common evolutive origin of facial expressions of emotion among humans and other primate species. These results also raise new questions on the role of physical similarity, imitation and simulation play in the recognition of the facial expressions of other species.
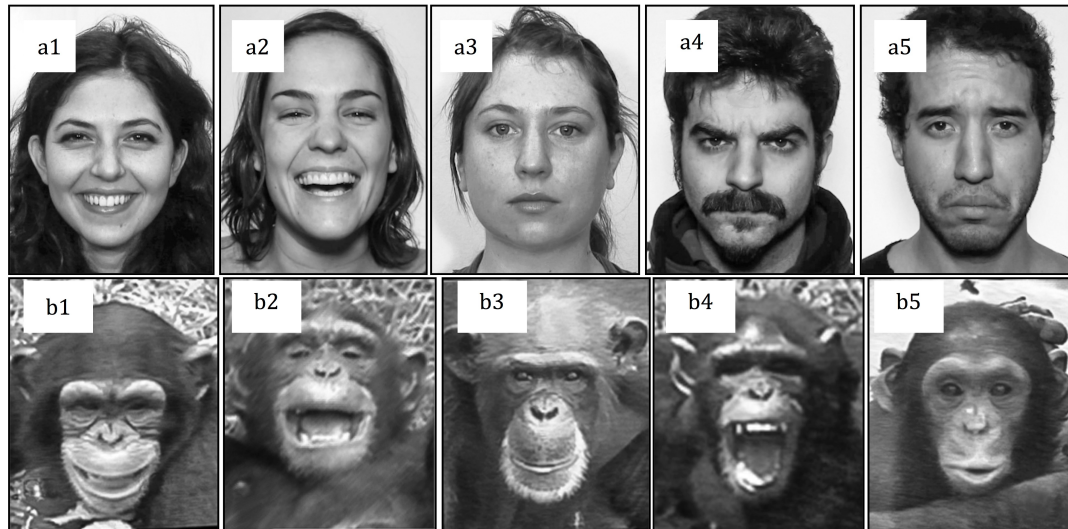
**Figure 1.** Examples of facial expressions pictures used in study. Pictures from a1 to a5 correspond to the following human facial expressions: Smile, Laughter, Neutral, Anger and Sadness. Pictures from b1 to b5 correspond to the following chimpanzee facial expressions: SBT, ROM, Neutral, Scream and Pout



**Figure 2.** Example of the box participant used to answer the questions about each picture in the written form

**Table 1.** Mean scores (M) and standard deviations (SD) for hit rate percentage, unbiased hit rate, intensity, credibility and aversion measures as function of facial expression for each species.

| | | Emotion | | | | |
|---|---|---|---|---|---|---|
| | | Anger/Scream | Neutral | Laugh/ROM | Smile/SBT | Sadness/Pout |
| | | M (SD) | M (SD) | M (SD) | M (SD) | M (SD) |
| *Biased hit rate (%)* | Humans | 69.14 (19.00) | 65.89 (21.61) | 87.34 (16.12) | 91.61 (13.39) | 53.79 (21.16) |
| | Chimpanzees | 35.85 (29.09) | 37.32 (20.05) | 28.08 (17.57) | 56.81 (24.58) | 13.78 (16.71) |
| *Unbiased hit rate* | Humans | 0.69 (0.19) | 0.66 (0.22) | 0.87 (0.16) | 0.92 (0.13) | 0.54 (0.21) |
| | Chimpanzees | 0.36 (0.27) | 0.37 (0.24) | 0.28 (0.24) | 0.57 (0.31) | 0.14 (0.21) |
| Intensity | Humans | 4.49 (1.48) | 3.76 (1.46) | 5.77 (1.21) | 4.75 (1.26) | 4.20 (1.54) |
| | Chimpanzees | 5.80 (1.40) | 4.40 (1.63) | 5.07 (1.52) | 5.18 (1.52) | 4.92 (1.53) |
| Credibility | Humans | 4.41 (1.71) | 4.87 (1.37) | 4.66 (1.78) | 4.92 (1.60) | 4.43 (1.74) |
| | Chimpanzees | 5.08 (1.79) | 5.28 (1.44) | 4.98 (1.61) | 4.6 (1.79) | 5.07 (1.61) |
| Aversion | Humans | 3.33 (1.17) | 3.88 (1.02) | 4.94 (1.53) | 5.12 (1.32) | 3.44 (1.12) |
| | Chimpanzees | 3.49 (1.69) | 4.29 (1.43) | 4.10 (1.58) | 4.19 (1.65) | 4.20 (1.53) |

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## 1.2. Manuscript 2: "Inter-species facial mimicry in humans"

Title: Inter-species facial mimicry in humans

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**Abstract**

Facial mimicry is a well described phenomena proposed to play an essential role in our social abilities. It is described as a robust and automatic process occurring outside our consciousness through which we covertly copy others facial expressions. Further more facial mimicry has been related to empathy and proposed to play a crucial role in our ability to understand what others are feeling or thinking. Due to its characteristics and relevance facial mimicry has been proposed to be of ancient evolutive origin. The present article aims to test if chimpanzee facial expressions evoke facial mimicry in human observers. Participants observed both chimpanzee and human facial expressions pictures while their facial muscle activity was recorded. Results showed no evidence of facial mimicry with chimpanzee facial expressions but neither with human's basic emotions expressions. Given the negative results where found for both experimental and control conditions a methodological fail should be assumed. Most likely the mixed presentation of human and chimpanzee pictures produced an incongruent context blocking facial mimicry altogether. Present research supports the main relevance of context and its possible effects on facial mimicry.

*Keywords: facial mimicry, evolutive, inter-species, context.*

**Introduction**

Face to face interactions and non-verbal communication play a crucial role in our social world. Within this type of communication facial expressions are one of the most studied phenomena. Since the *The expression of the emotions in man and animals* de Charles Darwin (Darwin, 1872) science has been interested in facial expressions, their muscular configuration, how we process them and the role their play in our social interactions (Camras, Malatesta, & Izard, 1991; Chevalier-Skolnikoff, 1973; Ekman, 1973, 1993, 1999; Ekman & Friesen, 1986; Krumhuber & Manstead, 2009; Parr et al., 2007; Posamentier & Abdi, 2003). A significant phenomena related to facial expression is facial mimicry. In general terms facial mimicry consists in the elicitation of congruent facial muscular activity when observing a given facial expression, a tendency that can be measure with electromyographic recordings (EMG). This kind of facial coordination has been described as very robust, the presentation of still images of basic prototypical facial expression (Dimberg & Thunberg, 1998) can evoke mimicry, even when the stimulus presentation is masked (Dimberg, Thunberg, & Elmehed, 2000). Facial mimicry is defined as the use, visible or not, of facial musculature by an observer to match the gestures in another person`s facial expression (Niedenthal et al., 2010). An important amount of knowledge about facial mimicry has been accomplished through classic experimental designs where stimulus are presented on a screen located in front of the participant while the electric activity of facial muscles are registered via facial EMG. Usually, the differential activation of one muscle between two contrasting conditions

involving two contrasting facial expressions (e.g., happy vs neutral or sad face) can be observed already at 200 ms after the stimuli presentation but only 100 to 200 ms later a significant difference is reached (Dimberg, 1997; Dimberg et al., 2000). Although researchers have tried to measure mimicry in several facial muscles, most evidence is related with the two major expressive muscles: the *zigomaticus major* (from now: *zig*) and the *corrugator supercilii* (from now: *cor*) (Hess & Fischer, 2013). On one hand *zig* is related with the upward movement of the corner of the mouths observed during smiling, whereas the *cor* draws the eyebrow downward and medially creating the main prototypical facial movement in angry facial expressions (Vick et al., 2007). As a result of its robustness, simplicity of study and relation with a broader interpersonal coordination phenomena a great deal of evidence and information has been obtained about facial mimicry. For instance we know that while the dynamic presentation of facial expressions can enhance the mimicry (Rymarczyk, Zurawski, Jankowiak-Siuda, & Szatkowska, 2016; Wataru Sato et al., 2008), the administration of testosterone or botulin toxin reduces its intensity (Oberman et al., 2007). Moreover, facial mimicry has been studied using static, dynamic and even avatar stimuli (Cannon et al., 2009; Wataru Sato et al., 2008; Weyers, Mühlberger, Hefele, & Pauli, 2006), using different expression intensities (Fujimura et al., 2010), varying the experimental task (Cannon et al., 2009) and even using more realistic facial expressions (Hess & Blairy, 2001). As a whole facial mimicry has been described as an automatic process, which occurs spontaneously without conscious attention or effort, and can also interferes with voluntary processes (Niedenthal et al., 2010). Furthermore facial mimicry has been related to a series of social variables such as perceived similarity, linking and empathy (Seibt et al., 2015). Also facial

mimicry, along with other interpersonal coordination phenomena, has been proposed as a fundamental part of the process of understanding others mental states. In particular, facial mimicry through facial feedback and emotional contagion is believed to play a crucial role in facial expression recognition, accessing other emotional states and empathy (Chartrand & Bargh, 1999; Hatfield et al., 2014, 2009; Preston & de Waal, 2002). As a result of this evidence is that interpersonal coordination, including facial mimicry, has been proposed as a crucial process in our evolutive history as fundamentally social beings. In this context, nonverbal coordination has been suggested to allow humans react collectively to dangers and form strong relationships with our offspring and group members in the course of evolutionary history (de Waal, 2008, 2009b; Preston & de Waal, 2002). Since facial mimicry is proposed as a robust, automatic and intimately related to our social core process it rises as a suitable candidate to examine the evolutionary origins of these coordination processes that could be at the center of our social abilities.

**Comparative view of facial expressions**

As a result of the comparative perspective introduced by Darwin (1872), research on human facial expressions has been accompanied by the study of non-human animals facial expressions from the beginning. Therefore a great amount of knowledge exists about the facial repertoire, muscles involved and behaviors associated with different facial expressions of non-human animals (Andrew, 1963, 1963), especially in the case of primates (Andrew, 1963; Chevalier-Skolnikoff, 1973) . In particular, the facial

expressions of one of our closest evolutionary relatives, the chimpanzee (*Pan troglodytes*), have been studied throughout (Burrows, Waller, Parr, & Bonar, 2006; Parr, Cohen, & de Waal, 2005; Parr, Waller, & Heintz, 2008; Parr et al., 2007; Vick et al., 2007). Moreover, two chimpanzees facial expressions have been postulated as the homologues of the smile and laughter in humans. The first one is called *silent bared teeth* (from now: SBT), which physically resembles much a human smile, involving in fact the same major muscle, the *zig*. While in humans smiles have been commonly related to happiness, that is as an expression of joy, other uses have been described, for example: irony, false or complaisance smiles (Niedenthal et al., 2010). In primates, the SBT display also has a diverse set of meanings and associated behaviors, whereas for some species of macaques is a signal of submission for others is sign of fear or defense (Mehu & Dunbar, 2008; Waller & Dunbar, 2005). However, for apes, the SBT display almost always is a signal of affiliation. Some authors have related the diversity of possible meanings of the SBT display with the variety of hierarchical styles present in the primate world and their respective complexity (Mehu & Dunbar, 2008; Parr & Waller, 2006). A diversity of hierarchical styles also observable in the complex human society, that is, a variance present in the whole order of primates that is evident in the complex social network of just one species, humans (Mehu & Dunbar, 2008). On the other hand, the chimpanzee expression homologue to laughter is less ambiguous about its function and is called *relaxed open mouth* or *play face* (from now: ROM) consistently related to play or playful behaviors (Andrew, 1963; Van Hooff, 1972). This facial expression is also very similar to their human counterpart, involving the same muscles, the *zig* and the *masseter* (from now: *mas*), and also commonly accompanied by a rhythmic vocalization very

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similar to audible human laughter (Andrew, 1963; Van Hooff, 1972; Willibald & Ekman, 2001). In relation with these two expressions, another muscle has been mainly related to smiles and laughter expression in humans, the *orbicularis oculi* (from now: *orb*). This muscle surrounds the eye and closes the eyelids, but it is also active when we squint or wrinkle the eyes raising our cheeks at the same time. As a result the *orb* muscle has been proposed as the mark to discriminate between felt and false smiles (Ekman & Friesen, 1982), but no definitive evidence has confirmed this (Krumhuber & Manstead, 2009). However, it stills remain a muscle of interest since while it is present in humans it has not described in chimpanzees (Mehu & Dunbar, 2008). Other chimpanzee facial expression that has been characterized is the *pout face*, this type of face is used during embraces, invitations and in response to aggression. A funnel type mouth achieved by the activation of the *orbicularis oris* muscle mainly characterizes this expression (Burrows et al., 2006; Parr & Waller, 2006; Parr et al., 2008). The *scream face* is another of the facial expressions in the chimpanzee repertoire and usually related to context of fear, nervousness and distress. Physically, this expression looks just like a scream would look in humans, its distinctive wide open mouth accompanied in the chimpanzee version by a retraction of the lips that leaves the teeth exposed (Burrows et al., 2006; Parr & Waller, 2006; Parr et al., 2008). Chimpanzees also present a *neutral face* expression typically present in non-emotional or resting times defined by no particular muscular activation and a general relaxation of the face (Burrows et al., 2006; Parr & Waller, 2006; Parr et al., 2008). An important number of chimpanzee facial expressions have been studied regarding their muscular configuration, physical traits and the behavior related to them. Considering all the knowledge gathered about animals, and particularly apes, facial

expressions keep pointing in the same direction Darwin hypothesized. As postulated by him, facial expressions of emotions in humans and other primates could have a common evolutionary origin as revealed by the shared features among them (Darwin, 1872). The important similarity between facial expression in greater apes and humans, species who took different evolutionary roads 6-7 millions years ago (Ayub et al., 2003), argue in favor of their evolutionary history and ancient nature. Facial expressions seem to have an evolutive continuity that connects them together.

Although both facial mimicry and non-human facial expressions have been studied for many years, no study has yet connected both areas examining interspecies facial mimicry. Few studies have explored whether facial mimicry exist between non-human animals (Mancini, Ferrari, & Palagi, 2013a, 2013b; Persson, Sauciuc, & Madsen, 2018; Ross, Menzler, & Zimmermann, 2008; Scopa & Palagi, 2016). Considering that facial mimicry has been postulated as an ancient automatic process that could have helped us to evolve as the social animals we are, it is intriguing the intersection between these two disciplines, rendering new lights about the evolutionary history of facial expressions and interpersonal coordination.

Humans display altruism and empathy not only to their own species (de Waal, 2009a). Human history is not completed if we do not include our relationship with other animals, from the hunter-prey relation in ancient times to the significant bond with have with our pets nowadays (Amiot & Bastian, 2014). Is this ability to relate to other animals unique to humans? How can we empathize with beings so different to us? How can we assess their needs and emotional states in such an effortless way? Some of these questions are addressed by the present study. By asking whether humans present facial mimicry when

exposed to chimpanzee facial expression we aim to evaluate the origin of our empathic capacities, the antiquity of facial mimicry and facial expressions as social glues, and the evolutionary foundations of our relationship with other animals. The present study approaches these issues exploring if chimpanzee facial expressions evoke facial mimicry in humans. In order to do this, a classic facial mimicry experimental design was carried out using still pictures of chimpanzee facial expressions while measuring the muscular activity of certain facial muscles in a human observer. Since facial mimicry between humans has already been proven in many circumstances we used humans facial expressions pictures as controls. Given the old evolutionary history of facial expressions, the automatic nature of facial mimicry and the ancient relationship we have with other species we expect to find that humans do in fact exhibit facial mimicry when observing chimpanzee facial expressions. Finally, to find positive results for our research question would open new interesting questions about the nature of our relationship with other species, interspecies empathy and their evolution.

**Materials and Methods**

**Design and Participants**

A within-subject design was implemented in which all participants were exposed to all experimental conditions. Participants observed images of both humans and chimpanzees facial expressions on a screen while their muscular activity by means of an EMG device was measured. In addition, considering the proposed relation between facial mimicry,

emotional contagion and empathy, and to assess differences among participants, we applied two empathy questionnaires as part of the experiment.

Participants were contacted through posters that were distributed in the Pontificia Universidad Católica de Chile on student walls over different departments in the San Joaquin campus. As a result, a sample of 52 participants (28 women, 24 men) aged 18-33 years (M= 21.52, SE = 2.92) coming from 27 different academic degrees took part of the present study. These participants were recruited and participated between the months of May and November 2014. Participants aged less than 18 and older than 30 were excluded for homogeneity purposes (1 case). Other two students were excluded for being too familiar to the research objectives and another participant was excluded because his data was lost in the data manipulation process. A final sample of 48 students (26 women, 22 men) aged 18-26 years (M=21.02, SE= 2.11) participated in the present experiment. All participants took part of this study voluntarily. The university ethics committee supervised recruitment, data recollection, database management, inclusion criteria and participant disclosure processes. Finally all participants read and signed an informed consent before taking part of the study and received a small economic reward (US$ 4.28) for their participation.

**Stimuli and Procedure**

The stimuli used in this study consisted of a set of images of both human and chimpanzee facial expressions. Digitalized pictures of facial expression of chimpanzees were

provided by Samuel Fernández-Carriba, who obtained them at the Yerkes National Primate Research Center and at the Madrid Zoo-Aquarium. This database consists in 186 images of six different categories of chimpanzee facial expressions. The images were obtained either from videotapes or photographs of spontaneous interactions captured for different purposes in these two facilities and some of them belonged to the Living Links Center stimuli collection (Yerkes National Primate Research Center, Emory University). Authors of the chimpanzee faces database used in the study categorized the facial expressions depicted in the images using published classification criteria based on morphology or appearance and in the functional context (Fernandez-carriba & Parr, 2012; Goodall, 1986; Parr et al., 2002; Van Hooff, 1967).

Taking into consideration that most human facial expressions database do not include a wide diversity of races, Chilean facial expressions pictures were obtained to expose participants to people of the same ethnical background, discarding possible racial effects (Kelly et al., 2009). Chilean actors were filmed from a front view while they were sitting against a white background with proper illumination set. Actors were instructed to express certain emotions facially in the most natural and realistic way. Examples of prototypical human facial expressions were supplied to give them the basic idea. Once the videos were obtained a careful revision was made to obtain one or two frames per emotion per actor in which they were well illuminated, facing the camera and expressed the corresponding emotion in a intense prototypic way that was also realistic and did not appear overact. The final selection contained 105 pictures of five different facial expressions (Sadness, Anger, Smile, Laughter and Neutral) produced by 14 actors (7 women, 7 men). For the sadness, laughter and neutral categories of the 21 pictures, 10

were of actresses and 11 of actors, while for sadness and smiles, 11 were women and 10 were men. The videos of 8 (5 women, 3 men) of the 14 actors recruited were provided by researcher Vladimir López who created these videos for a previous experiment (López, 2009). The remaining 6 actors (2 women, 4 men) were recruited by the head researcher. They participated in the video production following directions supplied by Vladimir Lopez. They also signed written consents for their participation.

To use the most appropriate images for the experiment, a validation study was carry out. Based on image quality in terms of resolution, illumination and direction of the face, 70 chimpanzee images already classified in five categories (16 SBT, 16 ROM, 22 neutral faces, 8 pout and 8 scream faces). The classification was done by researchers at Yerkes National Primate Research Center based on morphological features and contexts in which each expression occurred (Fernandez-carriba & Parr, 2012; Goodall, 1986; Parr et al., 2002; Van Hooff, 1967). Selected images depicted males and females from different ages ranging from infant to adult chimpanzees.  And 105 human images expressing five different emotions (Sadness, Anger, Smile, Laughter and Neutral) were selected to the validation process. Only five of the six categories available in the chimpanzee images database were used because the sixth category corresponded to pant-hooting, a chimpanzee vocal expression mainly characterized by the sound it produces, and considered as non-suitable for the present study, that used only still soundless images. The validation study was carried out in classrooms where students were asked to indicate which was the emotion expressed by the face observed in each image, the intensity of the expression, their credibility and the aversion they produce them. While for the emotion expressed question students had a to choose between seven possible emotion categories

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(Sadness, Fear, Happiness, Disgust, Surprise, Anger, Neutral) plus the alternative "I don't know". A 7-point likert scale assessed the intensity, credibility and aversion judgment. In the case of chimpanzee images, validation guidelines had to do mainly with the measures of intensity, credibility and aversion obtained and not with the emotion recognition since this last issue is still a topic of academic dilemma addressed experimentally in another article (Ekman, 1973; Foley, 1935; Pascalis & Bachevalier, 1998). The answers given in the emotion expression question for chimpanzee images, were used to explore the ability of humans to recognize emotions from chimpanzee facial expression in another study (Torres-Araneda & Cornejo, 2018). The final selected pictures of chimpanzee facial expression the mean intensity, credibility and aversion scores with their corresponding standard deviations (SD) are shown in Table 1. As observable in Table 1 the selection made through this validation study aimed to obtain a homogeneous group of images that had low aversion scores while having high credibility and medium intensity scores. It is important to explain that only 8 images were used for expressions Scream and Pout because no more suitable pictures, in terms of resolution, face orientation and illumination, were available in the database.

*Table 1.* Mean (SD) scores for intensity, credibility and aversion obtained for the group of images corresponding to each facial expression of chimpanzee

| Expression | Quantity | Intensity | Credibility | Aversion |
|---|---|---|---|---|
| Scream | 8 | 5.56 (0.58) | 5.19 (0.24) | 3.59 (0.47) |
| Pout | 8 | 5.03 (0.58) | 5.07 (0.45) | 4.11 (0.40) |
| Neutral | 10 | 5.05 (0.55) | 5.01 (0.44) | 4.04 (0.41) |
| SBT | 10 | 5.06 (0.56) | 5.04 (0.52) | 4.09 (0.42) |
| ROM | 10 | 5.05 (0.55) | 5.01 (0.49) | 4.11 (0.40) |

On the other hand the validation process regarding human facial expressions images was guided principally by the percentage of emotion recognition obtained for each picture. In the uncommon cases were nearly an equal percentage of recognition was found for two different images, intensity, credibility and aversion scores were used to find the more suitable image. Selection criteria consisted in selecting the most correctly recognized images with lowest aversion, higher credibility and medium intensity scores in order to obtain a homogeneous group of stimuli. The final selection of images along with the correspondent mean intensity, credibility and aversion scores with the emotion recognition percentages are shown in Table 2. No sadness expression images were finally used in the experiment because during the pilot study a need to reduce the time that total duration was found and human sadness images were selected as the least important to the research objective.

*Table 2*. Mean (SD) scores for percentage of correct answers, intensity, credibility and aversion obtained for the group of images corresponding to each human facial expression.

| Expression | Nº images | Correct answer percentage (%) | Intensity | Credibility | Aversion |
|---|---|---|---|---|---|
| Anger | 8 | 80.26 (11.87) | 4.64 (0.37) | 4.38 (0.80) | 3.22 (0.32) |
| Neutral | 10 | 78.62 (8.18) | 3.72 (0.25) | 4.92 (0.25) | 3.89 (0.14) |
| Smile | 10 | 97.32 (1.65) | 4.94 (0.49) | 4.84 (0.50) | 5.13 (0.38) |
| Laughter | 10 | 94.61 (3.04) | 5.79 (0.52) | 4.75 (0.41) | 4.97 (0.41) |

 Both human and chimpanzee facial expression images were converted to black and white, and homogenized in size and other visual features by digital processing. At the end of this process all images were 1.59 cm wide and 1.91 cm height with a resolution of 400 pixels/inch. Selected chimpanzee images depicted males and females from different ages ranging from infant to adult chimpanzees. Whereas for the selected human images depicted males and females from a narrow age range (20-28 years), also the group of images of each expression was balanced by gender.

Regarding the experimental procedure, after participants arrived to the laboratory they were explained in general terms about their participation in the study. In order to conceal the experimental hypothesis at hand students were told electrodes would be installed in

their face to register micro-changes occurring on sweat gland activity (Dimberg, 1982). After the brief explanation, participants read and signed the written informed consent, following the electrode installation they were instructed to enter the electrically shield room and seat in front a computer screen. The distance between the participant's head and the screen was kept constant at 1 meter to avoid grater variability, a computer keyboard was use by the students to control instructions and register answers. The screen used to display the stimuli presentation corresponded to a 32" Sony monitor. Once the head researcher had checked that all measuring and display systems were working correctly instructions were given to participants and the presentation of stimuli began only once the researcher leaved the room. Inside the room light was controlled with a dimmer and temperature with an air conditioner remote control, while the participant watch the stimuli presentation in dim light to avoid sleepiness the room temperature was kept confortable according to the participant. The stimuli display was showed through Presentation software from NeuroBehavioral systems available in the Psychophysiology Lab at the psychology school in the Pontificia Universidad Católica de Chile. The presentation started with written instructions displayed on the screen that could be self-administrated by the participants, the whole experimental session consisted of three different sections. The first part consisted in the presentation of human and chimpanzee facial expression images on a black background, a black screen follow by a white fixation cross precede each photo. While the black screen was presented for a time that varied randomly from 1300 a 1500 ms to avoid participants to get too familiar with the presentation timing. The fixation cross and images were presented for 1000 ms in order to avoid overthinking and make the presentation more dynamic or less tedious. The

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presentation times and sequence are shown in Figure 1. The total section duration was approximately 10 min depending of the self-administration of instructions.
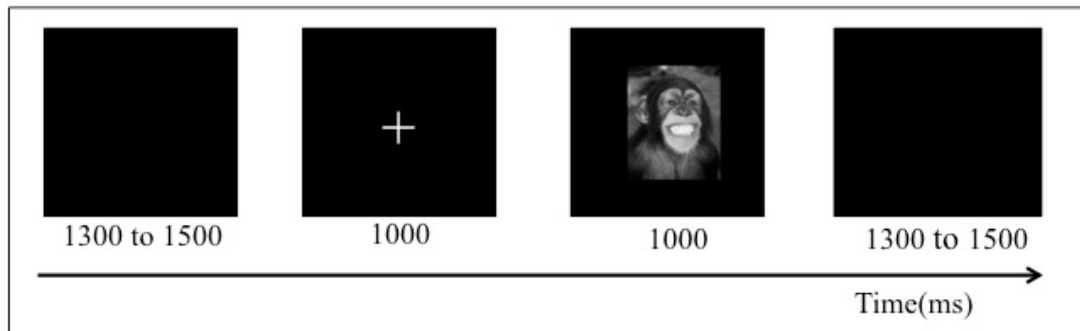


**Figure 1.** Time course of stimuli presentation from the first section of the experiment.

Besides, four different quasi-random sequences of stimulus were used to control presentation effects of the 84 (38 human, 46 chimpanzee) facial expression images presented. These quasi-random sequences were arbitrary assigned to each participant keeping balanced amount of every sequence.

In the second section of the experiment the 46 chimpanzee facial expression images were shown for a second time in order to ask the participants to judge which emotion they expressed. Participants briefly viewed (1000 ms) the image on the screen that was then follow by a screen with the question "Which emotion expressed the face you just saw?" plus the same eight possible answers used in the validation study associated to a number in the keyboard. Question and possible answers were available until an answer was register so total duration of the section depended of the response time of each participant. The aim of this second time was to reinforce the validation study data and to help answer

the question about humans being able to recognize the emotion in chimpanzee facial expressions (Ekman, 1973; Fernandez-carriba & Parr, 2012; Foley, 1935; Torres-Araneda & Cornejo, 2018). The last part of the experimental session consisted in just observing a sequence of funny pictures (9 images) and was intended to obtain EMG records of natural smiles or laughter. These pictures were displayed for 1000 ms and follow by a screen instructing to relax themselves and their faces before the next picture, the next image was shown when the participant resolved to do it. These registers would later serve to check correct position and function of the electrodes placed in the participants face. As a result the total duration of the experimental session was approximately 30 min, including the three sections, were the participant remain in the test room recording their facial muscular activity.

Finally, after participants had done the three experimental sections they were help out of the electrically shield room and electrodes were removed. Once the electrodes were detached participants were asked to fill two different empathy related questionnaires. After the participant had filled both questionnaires they were paid the promised reward and the debriefing process took place, once all participants question were resolved they were accompany outside the laboratory.

**Data acquisition**

Facial EMG was recorded with five pairs of Ag/AgCl electrodes, 4 mm diameter, to register the electrical activity of *zig*, *cor*, *mas* and *orb* at the left side of the face, as recommended by Fridlund and Cacioppo (Fridlund & Cacioppo, 1986). Two ground electrodes were placed in the middle forehead near the hairline, all impedances were kept below 10 kΩ by using electrode gel (Signa gel by Parker). The raw EMG signal was amplified a 2000 Hz sampling rate was obtained by a BioSemi ActiveTwo System. The signal was digitized with ActiView data acquisition software (BioSemi) and then transferred to the analysis computer via hard drive.

In order to evaluate empathy as a primarily emotional process a spanish translated version of the Toronto Empathy Questionnaire (TEQ) was used (Spreng, Mckinnon, Mar, & Levine, 2009). This brief, reliable and valid instrument allows assessing empathy using just 16 questions or statements and their respective answers (Never, Rarely, Sometimes, Often, Always). Therefore higher TEQ scores reveal a more empathetic person. On the other hand the Autism-Spectrum Quotient (AQ) was used to evaluate were an individual is situated in a continuum from autism to normality (S Baron-Cohen, Wheelwright, Skinner, Martin, & Clubley, 2001). Understanding autism as a continuum in the sense that autistic characteristics are not just present or absent, so they can be present in different extents in every human being. Also as it has been establish already autism-spectrum traits are intimately related with empathy traits, in particular individuals with more autistic traits tends to have less empathic abilities (Charman et al., 1997; Dapretto et al., 2006). The AQ questionnaire consists of 50 statements that can be answer with four

options (definitely agree, slightly agree, slightly disagree, and definitely disagree), were the higher the resulting score more close the autistic end of the spectrum continuum (S Baron-Cohen et al., 2001).

**Data Analysis**

The psychometric data obtained from the two above mention questionnaires was digitalized and scored as instructed by their respective authors (S Baron-Cohen et al., 2001; Spreng et al., 2009). Thus obtaining a final score of each participant for both TEQ and AQ, the observed average value were 47.8 (SD 6.6) for the TEQ and 20.2 (SD 5.8) for AQ, both with in the normal range for the given population (S Baron-Cohen et al., 2001; Spreng et al., 2009). The final scores, used as covariates in the EMG analysis, were then transformed to z-scores in order to standardize the achieved values. Outliers were considered a given value was more than 2 standard deviations away from the sample mean, no such cases were found for both TEQ and AQ.

EMG data was processed and analyzed with EEGLAB (Delorme & Makeig, 2004) and ERPLAB (erpinfo.org/erplab/) Matlab toolboxes (The MathWorks Inc.). The EMG signal was first segmented into 1500 ms epochs, containing the 500 ms pre-stimuli baseline and 1000 ms after the presentation. This used time-window should be sufficient to detect peaks of facial muscle activity in response to facial expression based on previous research (Ardizzi et al., 2014; Cannon et al., 2009; Dimberg, 1982; Dimberg et al., 2000). Once segmented, bipolar subtraction was performed to finally apply a 20-300 Hz band-

pass filter to the signal. The selection of the filter finally used a frequency spectrogram was analyzed to see in which frequencies the difference between baseline and stimulus presentation were more evident. Then for each muscle and participant a manual artifact rejection was performed, using a 1-20 Hz band-pass filter, in order to detect eye-blinks and other facial movements that could affect the higher frequencies. For this purpose big and high slope alterations in the EMG signal were marked as artifacts. Trials were condition-blind rejected based on the amount of electrical and movement related noise. Even though participants were instructed to remain relaxed and to try not to touch or move they face many participants disregarded these instructions during the trials, we confirmed this by the video recording, and then partially noisy registers were obtained. The result was a 6.25% of subjects rejected for *zig* artifacts higher that the 20% of their trials, for *orb* a 16.6%, a 6.25% of *mas* and finally a 33.33% of subjects were rejected due to *cor* artifacts. Of the initial 48 participants only 29 (14 men, 18 women) 18-26 years (M=21,19, SD= 1,91) had less that 20% of their trials rejected for all electrodes. Finally variance was used to approach the difference between baseline and stimulus presentation (trial) due to the nature of EMG signal. In other words, an activation of a given muscle will generate a greater variance in the electrical signal capture by the electrode, so that more variance implies muscle activation. The variance of EMG activity for two major segments, 0 to 500 ms (baseline variance) and from 500 to 1000 ms (trial variance) was calculated and used for later statistical analyses. Then a normalized variance value was calculated by dividing the trial variance with the baseline variance. As a result, values greater than one show more variance in the trial than the baseline (muscle activation due

to stimulus presentation) and values lower than one show more variance in the baseline than in the trial, values equal to one show no variation in variance from baseline to trial.

For the case of the funny pictures showed at the end of the experimental session, baseline and post-stimuli activity were contrasted through a repeated measures ANOVA with time (Baseline, Trial) as a with-in factor for the *zig* and *orb* muscles in order to check that electrodes were well positioned and effectively measuring these muscles activity.

To verify the main experimental hypothesis at hand repeated measures ANOVAs were preformed. Emotion (Neutral, Smile, Laughter and Anger), Species (Human, Chimpanzee) and Muscle (*zig*, *orb*, *cor*, *mass*) were entered as within factors and Gender, Age and z-scores of both empathy questionnaires were included as co-variables to control their effect. Statistical analyses were done with the R-project statistical software (R Core Team, 2014).

**Results**

Although the analysis showed some statistically significant results, no evidence of facial mimicry was found. Repeated measures ANOVA showed a main effect of both Emotion ($F_{3,868}$=4.908, p= 0,002) and Species ($F_{1,868}$=5.864, p=0.01) factors. No other main effects or interactions reached significance. Post-hoc comparisons performed on the Emotion factor, regardless of the Species or Muscle, showed that normalized variance was larger with Laughter (1.11, 0.02 SE, 95% CI 1.04 to 1.19) than with Anger (0.99, 0.01 SE, 95%

CI 0.96 to 1.03) facial expressions (p=0.005). Also normalized variance was higher when participants saw Neutral (1.01, SE 0.01, 95% CI 0.97 to 1.04) compared to Anger (0.99, SE 0.01, 95% CI 0.96 to 1.03) expressions (p=0.02). Post-hoc comparisons for the Species factor show higher normalized variance value for Chimpanzee (1.08, SE 0.01, 95% CI 1.05 to 1.11) than for Human (1.02, SE 0.01, 95% CI 0.98 to 1.05) facial expressions (p=0.017).

Results for the third part of the study, the observation of funny pictures as a control, both *zig* and *orb* showed activation in the trial compared to the baseline. Repeated measures ANOVA showed a main effect of Time ($F_{1,45}$=849.99, p= 0.000) and following pairwise comparisons revealed more muscular activity during the Trial (0.281 mV, SE 0.010, 95% CI 0.261 to 300) than the Baseline (-1.124 mV, SE 0.039, 95% CI -1.502 to -1.308) (p=0.000). Figures 2 to 5 show the normalized variance values for each emotion and species for the different facial muscles.
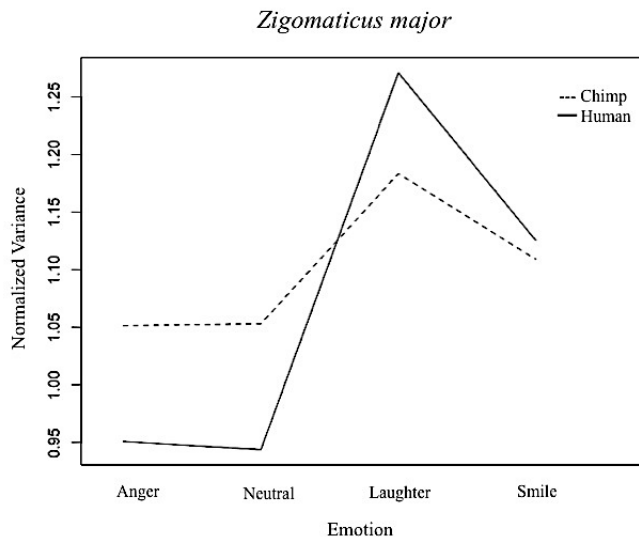


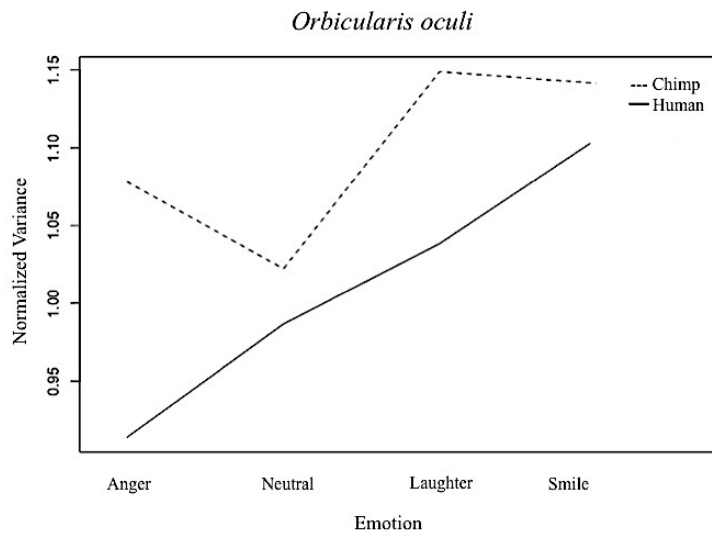**Figure 2.** *Zig* normalized variance for each Emotion and Species

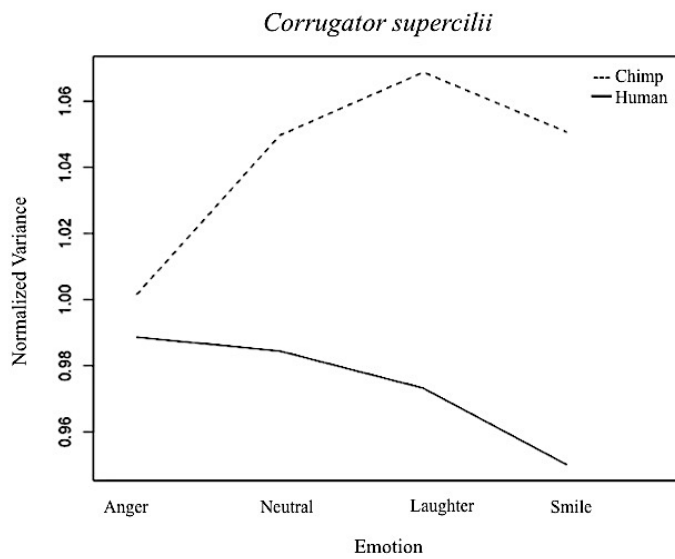**Figure 3.** *Orb* normalized variance for each Emotion and Species



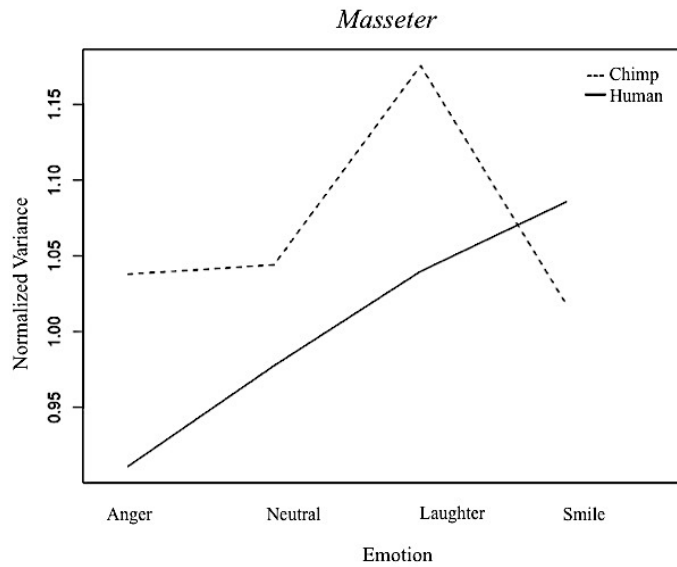**Figure 4.** *Cor* normalized variance for each Emotion and Species

**Figure 5.** *Mass* normalized variance for each Emotion and Species

Overall significant results showed a greater activation of all facial muscles during Laughter compared to Anger facial expressions, regardless of the Species presented in the picture. Also a greater activation of all muscles was present during Neutral than during Anger facial expressions pictures, again with no effect on the Species depictured. Besides Chimpanzee pictures evoked a greater activation than Human facial expressions across all Muscles and Emotions.

In terms of the tendencies reflected in the plots in Figures 2 to 5, even though no statistical significance was reached, some interesting observations can be made. In Figure 2 participants show a similar pattern of *zig* activation when watching Chimpanzee and Human facial expressions displaying more activity in the trial, compared to the baseline, for Smile and Laughter than for Neutral and Anger faces. If the difference in values of the y-axis are observed is understandable why no statistical significance was achieved. In figure 3 although different patterns are visible between the reaction to Chimpanzee and

Human facial expression the main results are the same. There is a greater activation of the *orb* during the trial, compared to baseline, for happy expressions such as Smiles and Laughter and a comparatively lower activation for Anger and Neutral faces. In Figure 4 both the patterns and main results differ when comparing Chimpanzee and Human facial expressions. While for Humans the tendency is as expected by facial mimicry, that is, higher activation of *cor* for Anger expressions than the rest of Emotions. In Chimpanzee *cor* activity was greater in Laughter and lowest for Anger facial expressions. In figure 5 we can observe the *mass* activation pattern, this is similar to *zig* activity, greater for happy expressions, with the difference that for Chimpanzee expressions only Laughter, and not Smiles, enhanced this muscle activity.

It is relevant to mention that many other statistical approaches were implemented to assure the final methods used were consistent. Among them multilevel analyses, using mean and sum values instead of variance, linear regressions, using empathy and activity clusters, separating by gender and species, eliminating the first trial, separating between first half of the trials and the second half, and dividing temporal data in ten and three epochs. In line with the presented results no clear pattern of facial mimicry was statistically significant.

**Discussion**

The present study investigated, for the first time, if humans display facial mimicry when observing chimpanzee facial expressions. To achieve this, adults viewed images of facial

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expressions of different emotions of both humans and chimpanzee while their facial muscles activity was recorded through EMG.

In general terms, as shown in the results section, the present study evidenced no statistically significant results on facial mimicry, neither for the experimental nor control conditions. No substantial difference was found, for any of the facial muscles, between the contrasted facial expressions in terms of electrical activity. In other words, no evidence was obtained of an activation of muscles characteristic of any facial expression in respect to neutral or other contrasting facial expression. Several reasons can be raised to explain these results.

Although none of the expected effects were observed, some statistically significant results were indeed found. The Laughter facial expression showed a high overall muscle activation in comparison to Anger facial expressions. That is, an activation of all muscles recorded, or whole face tension/activation, occurred during the presentation of both human Laughter and chimpanzee ROM expression. Also more muscle activation was observed during the presentation of Neutral than Anger facial expressions, for all Muscles and both Species. Taking into account the traditional definitions of these facial expressions (Laughter/ROM, Anger, Neutral) it is difficult to explain these results (Vick et al., 2007). Even tough these two significant results do not represent an evidence of mimicry, it is interesting to note that no difference between the evoked facial responses for human and chimpanzee expressions was found. Another significant result was that in general Chimpanzee pictures produced major muscle activation than Human facial expression pictures, across Muscles and Emotions. Although this result was not expected, is reasonable to think that pictures of facial expressions from a different species could

have generated more tension in the face of the observer. In the third experimental section, where participants observed funny pictures, more muscle activation in the Trial than in the Baseline for *zig* and *orb* was observed, what suggests the correct position and function of the electrodes used.

The second outstanding feature of these negative results is the absence of statistically relevant difference between muscles activations in the control condition. Results do not evidence facial mimicry in humans while looking at human facial expressions. This result contrast to the fact that facial mimicry between humans has been proven on several occasions, circumstances and in different participant groups (Chartrand & Lakin, 2013; Duffy & Chartrand, 2015; Seibt et al., 2015). Results from the funny pictures observation discard the malfunctioning or poor positioning of facial electrodes by showing significantly greater activity in *zig* an *orb* muscles during trial compared to the baseline. Still two main hypotheses could explain the negative facial mimicry results: either Chilean students do not display facial mimicry or some methodological mistakes were made during the design of the experiment. However, there is no reason to believe that Chilean population is different in this respect to other communities where facial mimicry evidence has been collected. In fact, previous facial mimicry studies had been carried on different populations as American, Japanese, Finnish, Dutch and Western European obtaining similar results, suggesting facial mimicry is a very robust and universal phenomenon (Hatfield et al., 2014; Stel & Van Knippenberg, 2014; Surakka & Hietanen, 1998; Tamura & Kameda, 2006).

The second interpretation of the negative results for the control condition is product of a methodological artifact. For methodological reasons, pictures of both human and

chimpanzee facial expressions were presented mixed, randomly, in the same trial. The aim was to minimize possible differences between the presentations of these distinct stimuli. For example, if different trials were used to present each set of stimulus, human and chimpanzee, the order of presentation would need to be controlled to avoid possible priming issues. Since no previous studies provided evidence about the effect of mixing different species facial expression in the facial mimicry area (Chartrand & Lakin, 2013; Duffy & Chartrand, 2015; Seibt et al., 2015), there was no ground to suspect that mixing human and chimpanzee facial expression could had a relevant effect in facial mimicry. However our results showed a different scenario. The absence of significant results regarding the control condition might suggest a strong effect of the presentation of facial expression from different species mixed together. Moreover it appears that the presentation of chimpanzee facial expression, in-between human facial expressions, inhibited altogether the participants' facial mimicry even regarding their own species.

The first possible explanation is that pictures of chimpanzee facial expression might have broken participants expectations disrupting the normal facial observation processes. When a face is observed multiple processes start to unfold rapidly, attentional, perceptual and emotional processes are trigger automatically (Allison, Puce, Spencer, & McCarthy, 1999; Leopold & Rhodes, 2010; McCarthy, Puce, Belger, & Allison, 1999; Puce, Allison, & McCarthy, 1999). We propose that normal facial processing curse was interrupted by the presentation of unexpected chimpanzee facial expressions. As a result, no facial mimicry could be observed. In relation to this broken expectation interpretation we predict that future research, using simultaneous EMG and EEG recordings, could find N400 potentials during the appearance of chimpanzee pictures in-between the

presentation of human facial expressions. Even though participants were informed of the presence of chimpanzee pictures, more subtle and involuntary reactions could have played a role. In brief, it seems that the effects of unexpected non-human primates pictures inhibited or blocked facial mimicry in humans, obstructing even between human facial mimicry of basic facial expression.

Related to this, recent research has emphasized the role of context in facial mimicry, in particular the social context in which mimicry takes place. Typical facial mimicry studies do not include context in their experimental trials, in an effort to control their possible effects. Nevertheless, these methodological frameworks are very distant from real life social interactions where context is always present. For this reason, recent research has highlighted the relevance to progress to a more ecological approach to facial mimicry, which takes into account the context, and all the interfering variables present in real life. In this line of research, several studies have described different contextual factors that affect or even suppress facial mimicry (Barrett, Mesquita, & Gendron, 2011; Bourgeois & Hess, 2008; Hess & Fischer, 2013). For instance, researchers have described that nonconscious priming of competition versus cooperation contexts suppressed facial mimicry (Seibt et al., 2013; Weyers et al., 2009). Furthermore, other contextual variables such as sad mood (Likowski et al., 2011), psychosocial stress (Nitschke, Sunahara, Pruessner, & Bartz, 2016), group-membership (Bourgeois & Hess, 2008), goal/task (Murata, Saito, Schug, Ogawa, & Kameda, 2016) and perceived similarity (Olszanowski, 2014) can weaken or inhibit facial mimicry. In support of this line of evidence brain event-related potentials related to face perception (N170) have been reported as sensitive to contextual variables (Righart & de Gelder, 2008). More interestingly the presentation

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of an incongruent context can suppress facial mimicry altogether (Philip, Martin, & Clavel, 2017). This evidence highlights the relevance of context and how sensitive facial mimicry can be to diverse factors, supporting our view that the presentation of chimpanzee pictures represented the introduction of incongruence in the context. The incongruence in the social context disrupted facial mimicry for both human and chimpanzee pictures suppressing facial mimicry completely.

Finally, although the aim of this study was to see if chimpanzee facial expressions evoked facial mimicry in humans, it was not possible to answer this question. Our data did not show statistically relevant differences to reject the null hypothesis what does not allow us either to affirm or to discard our experimental hypothesis. In other words, we cannot sustain definitely if humans present or not facial mimicry when observing facial expressions of other related primate species. Future studies should take into account the present results to develop a experimental design that at least divide in different blocks within a trial the pictures of human and chimpanzee facial expression. Future studies should additionally to consider the social context presented or inferred by participants, avoiding factors already proven that can have an effect on mimicry. Only in this way the proposed "incongruence" and context effects, found in this study, could be ruled out and proper interpretations to be extracted. As in other research areas, a tendency to move closer to more ecologically valid experimental setting is also apparent in facial mimicry research.

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## 1.3. Manuscript 3: "Convergences between evolutive biology and phenomenology on empathy"

Title: Convergences between evolutive biology and phenomenology on empathy

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**Abstract**

For many years scientists have tried to understand how we access the minds of others. Referred as the "problem of other minds", this debate has involved many different areas of knowledge. Nowadays two major proposals seem to dominate the debate: the so-called *Theory-Theory* and the *Simulation Theory*. Although both approaches have rendered a large amount of evidence, they have raised significant concerns. The present article takes these problems into consideration by presenting evidence coming from evolutive biology and the phenomenological tradition. In doing so, this paper applies knowledge gathered in these areas to the study of empathy in psychology, as a key concept to overcome the conundra of the dominant positions on the problem of other minds. From an evolutive-biological perspective, we develop Frans de Waal's ideas on empathy's evolutive origins. This approach traces empathy back to non-human social mammals, suggesting a less cognitive, more emotional, but still primordial role for it. On the other hand, the phenomenological tradition offers a more radical account on the relevance and ubiquity of sociality in daily life, discarding inferential processes as a condition for knowing others and underlining the essential role that emotions and the body play in this process. Taken together, both traditions configure a radically different approach to the problem of other minds.

**Introduction**

Empathy has been a central topic of research for years in many areas of knowledge, including philosophy, developmental and social psychology, neuroscience and ethology (Preston & de Waal, 2002). In general terms, empathy refers to the ability to understand others, to access their emotional and mental states (Zahavi, 2010). Therefore, this capacity is fundamental for our social competence. Beyond the agreement on its relevance to understand our social world, important differences exist on the exact definition of empathy, on what it involves and how it is accomplished (Coplan, 2011; Cuff et al., 2014).

The term empathy is not new. Originally introduced by Johann F. Herder as a methodology for human sciences (Musa, Carré, & Cornejo, 2015), *empathy* [*Einfühlung*] was however introduced in modern psychology later by the German psychologist Theodor Lipps as a psychological process involved in aesthetic appreciation but also in understanding others (Lipps, 1899, 1924). In 1909, Edward Titchener translated the German term "Einfühlung" as *empathy* and carried it into English-spoken psychology (Preston & de Waal, 2002; Zahavi, 2011). Since then a myriad of authors have been interested in empathy and its relations with numerous social phenomena. Even though there is still no agreement on its definition (Cuff et al., 2014), it has been directly related to concepts such as the understanding of the other's mind and altruism.

Nowadays there are two major approaches regarding empathy, namely the *theory-theory*

of mind (TT) and the *simulation theory* of mind (ST) (Michlmayr, 2002; Zahavi, 2010). Even though some hybrid theories exist, most psychological and neuroscientific approaches can be classified as belonging to either of these two views. In broad terms, the TT explains our ability to comprehend other's mind assuming that people generate theories about the mental states of others that are confirmed or unconfirmed through behavioral evidence (Churchland, 1991; Michlmayr, 2002). On the other hand, the ST claims that empathy is a necessary condition to understand others' minds. Empathy would correspond to the internal replication of the other's mental states by means of imitation. This internal simulation would make us capable to access the other's mind (Goldman, 1992; Michlmayr, 2002). Even though, in contrast to ST, TT authors never speak of empathy and strictly address the comprehension of other minds, most empathy definitions include the ability to access other`s mind states (Cuff et al., 2014) relating empathy and TT somehow.

The *theory-theory* emerged in developmental psychology as a response to the question of when children understand alien mind states (Michlmayr, 2002). Evidence shows that children are able to understand what others think at around 4-6 years old, when they successfully pass the "false belief test" (Michlmayr, 2002; Wimmer & Perner, 1983). This test identifies the stage when children are able to understand that others' beliefs depend on their point of view and not on their own (i.e. another person may believe that a ball is in a box because they did not see when someone took it out the box) (Premack & Woodruff, 1978; Wimmer & Perner, 1983). According to TT, children pass the false belief test when they develop a theory about the others' mind and contrast it with the behavior they observe. In this way, every behavior gives information that either confirms

or not the current theory and modifies it, and this process keeps going in an endless feedback of theory construction and evidence finding. Thus, the TT has a clear focus on higher-level cognitive processes. It describes our ability to access other minds, and hence empathy, as basically intellectual in nature and present in humans only after certain cognitive development has been reached.

On the other hand, according to the ST we access the mental state of others through empathy and imitation (Goldman, 1992; Michlmayr, 2002; Zahavi, 2010). This theory is fundamentally based on the evidence on the pervasiveness of imitation and emotional contagion (Decety & Ickes, 2009). Evidence from different areas has showed that humans and other apes have the tendency to imitate (sometimes covertly) and to grasp other's emotions easily (Hatfield et al., 1994, 2009). The ST proposes that imitating others allows us to feel what the others are feeling and then project it back to them. Imitation, emotional contagion and mirror neuron research are considered as evidence of a simulation process (Decety & Ickes, 2009; Oberman & Ramachandran, 2007). A differential contribution of ST has been the inclusion of the body and imitation as a relevant factor in empathy and understanding others.

Although both have been useful in studying the first stages of social life, TT and ST have several foundational assumptions that are questionable (Zahavi, 2007). In the first place, both theories are mainly self-centered ones, i.e., they assume that most of the important processes occur inside one individual, while the other party remains unexplored. Nonetheless, empathy is a social phenomenon in which interaction between two parties and their co-presence is fundamental; it rarely concerns only one mind. Hidden behind

this self-centered approach lies the assumption that the minds of others are from the start inaccessible and opaque to us, so that we can only infer it through the behavior that others deploy (Zahavi, 2010). Secondly, both theories rely heavily on high-level cognitive, to some degree voluntary, top-down, intellectually demanding processes. But such cognitive definitions of empathy contrast with the pervasiveness of the phenomenon. Empathy is present everyday in our social lives. We permanently relate with people and we are in constant need to understand others to successfully lead our own lives. It is neither sound nor parsimonious to rely on a highly complex and demanding cognitive process for doing something as relevant and ubiquitous in daily life. Furthermore, this depiction of empathy leaves small children and non-human animals out of the definition. It dismisses a significant amount of evidence from evolutive biology and ethology that could provide insights into the evolutive history of empathy and sociality.

The last point is crucial considering that, while psychology has mostly abstained from looking into the evolutive history and implications of empathy, evolutive biology has not. Various exponents in this research field have indeed studied empathy, its possible origins and its essential role in understanding animal sociality (Call & Tomasello, 1999; de Waal, 2012; Herrmann et al., 2007; Penn & Povinelli, 2007; Preston & de Waal, 2002; Tomasello et al., 2003b; Warneken & Tomasello, 2009). The aim of this paper is to review the most relevant evidence on empathy gathered by evolutive biology and to extract its consequences for psychology. We propose that a better understanding of empathy can be achieved by integrating insights from the evolutive-biological

perspective. To present the main contributions of this tradition we will introduce the proposal of the Dutch evolutive biologist and ethologist Frans de Waal, one of the main contemporary representatives of the evolutive study of empathy.

**Frans de Waal: from evolution and biology**

In the course of his career, de Waal has been interested in a diversity of topics that include empathy. Morality, chimpanzee peace-making, bonobo society, animal intelligence and altruism are among the issues of his bibliography addressed in its bibliography (de Waal, 2000, 2004, 1996, 2010; de Waal & Preston, 2017) Regarding empathy, de Waal has developed a model that relates this phenomenon to the evolutive continuity hypothesis proposed by Darwin (Darwin, 1872; Preston & de Waal, 2002) (Darwin, 1872; Preston & de Waal, 2002). The model stresses the emotional roots of empathy while it acknowledges its cognitively more complex forms. De Waal (2008) defines empathy as

> the capacity to (a) be affected by and share the emotional state of another, (b) assess the reasons for the other's state, and (c) identify with the other, adopting his or her perspective […] This definition extends beyond what exists in many animals, but the term "empathy" applies even if only criterion (a) is met. (p. 281).

At the center of de Waal's proposal is the Russian Doll model (de Waal, 2008). In this model, empathy is a phenomenon composed by several overlapping layers, much like a Russian doll. Since such layers correspond to the evolutive history of empathy, at the center are the more primitive and ancient phenomena upon which higher and

evolutionarily newer forms add up. As a result, higher forms of empathy like perspective-taking or cognitive empathy are built upon a hard-wired basis like emotional contagion (de Waal, 2008). In de Waal's view there is a more primal mechanism in which perception and all empathy phenomena are based, the Perception-Action Mechanism (PAM) (Preston & de Waal, 2002). This mechanism lies at the core of the Russian Doll model by allowing motor mimicry and the activation of similar state representations in the observer. The PAM consists of "automatically and unconsciously activated neural representations of states in the subject similar to those perceived in the object" (de Waal, 2008). This overlapping in neural representations evolved because it is adaptive for basic response to the environment and group living and was latter exapted (acquired a new function) in mammals that needed to care for vulnerable offspring (Gould, 1991; Preston & de Waal, 2002). In other words, PAM is a neural mechanism selected, before any empathy phenomena existed, for broader beneficial effects in general perception and survival, and that later in evolution served as the basis for empathy. In connection with the simulation theory, de Waal also proposes that empathy is built upon imitation and that the Russian Doll model also applies for different forms of imitation going from motor mimicry, at the center, to the more complex emulation or imitation in the outer layers (de Waal, 2008).

Another key element of de Waal's approach is the fundamental distinction between ultimate and proximate causes (de Waal, 2008; de Waal & Preston, 2017; Preston & de Waal, 2002). This distinction was originally introduced by evolutive biologist Ernst Mayr (Mayr, 1961) to clarify the difference between the causes that govern behavior in the present environment (proximate causes) and those responsible for the selection and

evolution of a given behavior (ultimate causes). Although this distinction is widely known in evolutive biology, it is often the source of confusion in psychology, particularly in evolutionary psychology (de Waal, 2002; Gould, 1991). As a result, the reasons by which a certain behavior was selected in evolutive history are seen as playing a role in the current motivation behind a given behavior. In contrast, evolutive biology states that individual behaviors can present motivational autonomy, that is, the current motivation becomes disconnected from its ultimate causes (de Waal, 2008). Even though behaviors like sex and feeding were originally selected for their primal importance in survival, they are currently not motivated by survival needs, but rather pleasure is the current proximate cause or motivation behind them.

This fundamental distinction plays an important role in explaining empathy. In evolutive terms, empathy was probably selected in the context of mother-infant relationship because it increased the survival of infants thanks to the fine-tuning between offspring and caregiver that it promotes (de Waal, 2012; Preston & de Waal, 2002). De Waal proposes that the proximate cause of empathy is a built-in reward that motivates empathy related behavior without any need of ultimate causes (de Waal, 2008).

The distinction is also useful to understand altruism. Altruism is defined as "… helping or comforting behavior directed at an individual in need, pain or distress" (de Waal, 2008) and it is related to empathy since to help other demands to understand what the other needs are. Similarly to empathy, altruism probably evolved in the context of family members and those inclined to return favors (de Waal, 2008). For this reason, some

authors have proposed that altruistic behavior is motivated by its ultimate causes, that is, future rewards, and therefor, only directed to family members (Preston & de Waal, 2002). Others suggest that empathy and altruism are ultimately egoistic since are motivated only to put an end to the personal distress produced by the other's cry (de Waal, 2008; Preston & de Waal, 2002). De Waal distances himself from those positions by claiming that empathy and altruism are motivated by an intrinsic reward, independent of ultimate evolutive causes. In this view, there would be a truly other-directed attention, which involves a "warm glow" (de Waal, 2012, p. 876; de Waal & Preston, 2017, p. 502) that offers the actor an emotional stake in the recipient's well-being.

De Waal distinguishes different types of altruistic behavior according to their complexity: from consolation and sympathetic concern to targeted helping and perspective taking (de Waal, 2008). It is precisely the evidence related to complex altruistic behavior in non-human animals what conflates with the cognitive approaches to empathy. For example, evidence of empathic targeted helping, that is, help adapted to the specific need or situation of another, has been found in apes, capuchin monkeys, dolphins and elephants (de Waal, 2008; de Waal & Preston, 2017). This kind of behavior is motivated by emotional contagion and requires self-regulation and perspective taking. In a similar vein, children display altruistic and helping behavior even way before they pass the false belief task (Warneken & Tomasello, 2006). Thus, an allegedly highly-complex cognitive empathy related behavior is found both in cognitively immature children and non-human animal without sufficient cognitive development, throwing doubts upon the supposedly intellectual nature of empathy proposed by TT and ST. More basic forms of empathy like

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emotional contagion have been reported in mice and chickens, and consolation behaviors have been observed in canines, macaques, elephants and mice (de Waal & Preston, 2017). Taken together, evidence on altruism in non-human animals and children favors more basic and ancient behaviors and traces empathy to the origins of social animals.

De Waal makes important contributions to the current debate on empathy. First, he proposes an encompassing integration model that covers a variety of empathy-related phenomena that are usually treated separately. His definition of empathy includes from basic forms, such as emotional contagion, to more complex and cognitive ones, such as perspective taking, allowing to establish an evolutive and functional connection between them (de Waal, 2008; de Waal & Preston, 2017). Furthermore, de Waal's model brings the focus out of cognitive processes back to more basic and primordial processes, such as emotion. The currently predominant approaches, TT and ST, stress the cognitive and intellectual aspects of empathy, proposing it is uniquely human, and overlooking the evidence coming from evolutive biology and ethology. De Waal's proposal suggests viewing empathy as a broad and complex social phenomenon that includes primordial basic emotional contagion at its core, upon which more complex cognitive forms are built. Finally, de Waal introduces the evolutive perspective, with the needed accuracy and distinction of relevant terms, in describing a phenomenon that is clearly related to the origins of sociality and at the basis of our evolution as social species.

In brief, De Waal contributions show empathy in a new light, as an evolutive ancient phenomenon, highly relevant to understand social life. The features underlined by

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evolutive biology — such as its primal, emotional, non-voluntary, pervasive and ancient nature— lead us to revisit the forgotten psychological and philosophical perspective of phenomenology. This tradition knowingly accounts for the subjective world experienced as it is lived, pre-theoretically and pre-reflexively (Stern, 2010). Phenomenology develops insights concerning the nature of social cognition, including empathy, embodiment and the relevance of the social world, which are partially convergent with the above described evolutive-biological approach to empathy.

**The phenomenology of empathy**

Despite the general oblivion regarding the phenomenological tradition in psychology, renewed exponents have emerged in contemporary debates (Cornejo, 2008; Fuchs, 2013; Gallagher, 2005; Gallotti & Frith, 2013; Stern, 2010; Zahavi, 2010). Contributions by phenomenology on social cognition include many issues of interest for the study of empathy. In particular concepts like intersubjectivity, direct perception or experience of others, face-to-face interaction, expressivity and affectivity are tightly connected to empathy and its investigation. In what follows we will review some of these ideas to capture possible contributions of phenomenology to our subject of study. In the following section we will address the contributions phenomenology can make to the study of empathy by exploring the extent of sociality, the direct perception proposal and how body and emotions play a role in all this.

**What do we understand by "social"?**

From a phenomenological point of view we live in a world that is social from the very beginning. We live immersed in a world full of social clues that make sense for us solely by its social nature. For example, Gurwitsch (1979) stresses the pervasiveness of the "social" in the world by asserting that every object in our perception has a social background or context behind it "…thus in the horizons which are 'co-included,' something like a world of fellow human beings is found…Insofar as every situation refers beyond what is inherent in it, it also continuously refers, therefore, to 'other people' " (p.96). Schutz (1967) likewise describes how everything finally makes reference to others:

> … for even in the natural standpoint, a man experiences his neighbors when the latter are not at all present in the bodily sense. He has knowledge not only of his directly experienced consociates but also about his more distant contemporaries. (p.109)

In this view even a purely physical object like a book or a table, or non-physical entities like a word, never exist without making reference to other people; who made it, invented it or might use it. Therefore we live immersed in a world where others are constantly present in our minds, an utterly social world. In addition, Gurwitsch (1979) talks about how relationships can be self-sufficient, that is, "exclusively for its own sake" (p. 379) with no communicative goal in-between. He refers to this self-sufficient relation as the originary relation. This self-sufficient feature of human relations resembles the intrinsic reward proposed by de Waal in empathy, granting sociality with its own fulfillment. In

this way, social encounters are not only viewed as an objective communicative instance but as an ancient evolutive self-rewarding situation. Gurwitsch and de Waal coincide in yet another point: both, to different extents, refer to the "warmness" of human encounters. While de Waal points this out in the context of altruism and its built-in reward, and describes it as a "warm glow" (de Waal, 2012, p. 876; de Waal & Preston, 2017, p. 502), Gurwitsch refers to "the human warmth" (Gurwitsch, 1979, p. 120) of belonging together and being part of a community. Another evolutive researcher mentioned also this self-fulfillment feeling found by people in sociality:

> It is a feeling infinitely wider than love or personal sympathy —an instinct that has been slowly developed among animals and men in the course of an extremely long evolution, and which has taught animals and men alike the force they can borrow from the practice of mutual aid and support, and the joys they can find in social life. (Kropotkin, 1902, p. 6)

In the same line, de Waal (2012) states that "nature has ensured that we find fulfillment in eating, sex, nursing, and socializing, all of which are necessary for survival and reproduction" (p.874). It is clear that all these authors refer to the same phenomenal experience, namely the subtle and deep feeling of pleasure in being-with-others. Gurwitsch underlines that all humans are born and raised as belonging to a community of social beings, making interpersonal understanding or empathy a default mode for us (Gurwitsch, 1979).

Current research in phenomenology of the social world has also taken into account the relevance of sociality. Fuchs, for example, in his research on affectivity (Fuchs, 2013)

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calls humans "essentially relational beings". Gallotti and colleagues (Gallotti & Frith, 2013) describe what they call the *we-mode*, defined as a mode in which "interacting agents have their minds shared by cognizing in a irreducibly collective mode of cognition" (Gallotti & Frith, 2013, p. 163). In other words, these authors suggest human cognition is enriched by cognizing in a collective mode when we interact, proposing a sort of extended "social" mind. As a result, and in their own words, "…this theory suggests that the mind is not just a product of the social: it is social all the way through." (Gallotti & Frith, 2013, p. 164). In addition, other studies show the adverse effects of social isolation remarking how essential is the social world to us (Cacioppo, Hughes, Waite, Hawkley, & Thisted, 2006; Carter et al., 2009).

In contrast to the traditional approaches to social cognition, phenomenology proposes a non-intelectualistic understanding of the others. Although traditional social cognition perspectives declare to be interested in the social aspects of cognition, an individualistic focus has always prevailed (Gallotti & Frith, 2013; Schilbach et al., 2013). The social aspect of cognition has been usually studied in an intellectualistic way. For instance, mindreading is conceived as the outcome of an individual cognitive process abstracted from the interaction with others —and in fact it is presented as a precondition to this interaction (Gallotti & Frith, 2013; Schilbach et al., 2013). This perspective, focused solely on the observer, supports social cognition experiments, where the interest is focused on the mental processes that happen in an individual while s/he is observing other people (or social stimuli) and not really interacting with them. Even though contemporary research has warned about the dangers of reducing social life to individual mental representations (Gallotti & Frith, 2013; Stern, 2010; Zahavi, 2010), the social

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cognition field has until now opted for ignoring the "true self-transcendence" (Zahavi, 2014, p. 133) and the genuine orientation-to-others that we experience during empathic social encounters. Behind the individualistic approach to social cognition lies the assumption that other minds are not accessible to us; we only can access and observe their overt behaviors, since what is behind is invisible to us (Zahavi, 2011). It is on this crucial respect that phenomenology offers an alternative view, focusing instead on the direct perception of others.

**Direct perception**

One of the most controversial proposals of phenomenology is that we are able to directly and immediately perceive what others are thinking or feeling, what is commonly called *direct perception*. Although the first version of this claim —made by Max Scheler— was more radical, arguing that we are actually capable of directly perceive the other's mind, the phenomenological tradition developed through time a more cautious variant (Zahavi, 2011). Scheler originally proposed that what we now call empathy was a special kind of perception, a direct and non-inferential one. He suggested we are able to empathically experience other's minds and called his theory the "perceptual theory of other minds" (Scheler, 1954 in Zahavi, 2010, p. 292). Later on, Husserl and Stein (Zahavi, 2014) moderated Scheler's vision by arguing that empathy was at the same time like and unlike perception. It resembles perception because it is a direct, unmediated and non-inferential process, but it is unlike perception insofar as the other's experience is not given to me originally or completely.

Taking one step further, Schutz proposes that only some aspects of people's minds are

accessible through direct perception, accepting the existence of higher, more cognitive forms of empathy and also stressing the importance of context in any social encounter (Schutz, 1967). Schutz conceives context as a complementary source of information in sense-making, for instance any particular situation in which we encounter others always provides information. This meaningful perceptual field is present whenever we perceive an object and others (Zahavi, 2011). Schutz also underlines the heterogeneity of interpersonal understanding, integrating basic forms of intersubjectivity to more intellectual projective forms of understanding (Zahavi, 2010). In this respect, Schutz' position resembles de Waal's. Moreover, Schutz stressed the relevance of face-to-face encounters in our social lives, where the physical presence and immediacy of the encounter play crucial roles. In a natural face-to-face encounter, different degrees of attention, orientation and dispositions to the other can determine the nature of the relationship, being the *We-relationship* the purest other-orientation, in which a reciprocal and pre-declarative relationship is established (Schutz, 1967).

The direct perception of others means that the act of perceiving others corresponds to a non-reflexive, non-conscious, and basic form of interpersonal understanding (Cornejo, 2008; Schutz, 1967; Zahavi, 2010, 2011). It is relevant to note that this form of unmediated and non-inferential kind of knowledge is convergent with the more basic and evolutive ancient form of empathy, proposed in evolutive biology. For instance, both Scheler and Husserl addressed the direct perception of others as "primitive" (Zahavi, 2014, p. 133,136) and modern phenomenologists have highlighted its ancient evolutive origin (Stern, 2010; Zahavi, 2011). The phenomenological view is consistent with the evidence of empathy and altruism in non-human animals and small children, and by

extension, in agreement with the idea of evolutive continuity. The direct perception of others is compatible with the evolutive history of empathy as presented by de Waal and the evidence supporting his model. Furthermore, the phenomenological perspective of direct perception stresses another important aspect of interpersonal understanding and empathy: its non-reflexive character makes possible interpersonal understanding to meet the contingencies of our social lives (Cornejo, 2008; Fuchs, 2013; Schutz, 1967; Stern, 2010). Taking into account the relevance of sociality in our daily lives, and the need for parsimony or "economy" (Gurwitsch, 1979, p. 53), empathy cannot be a slow and cognitively costly process. Several phenomenologists ponder this fact. Schutz, for example, talked about a "ready at hand" process (Schutz, 1967, p. 80), while Gurwitsch affirmed that through "immediate perception" (Gurwitsch, 1979, p. 53) we access the mental life of others. The emphasis on face-to-face situations, directness and immediacy are still to be found in current phenomenological approaches (Cornejo, 2008, 2013; Zahavi, 2010), underlining the importance of this feature in the tradition. Finally, direct perception presents an account of interpersonal understanding that is genuinely other-oriented, allowing social cognition to leave behind its individualistic perspective (Zahavi, 2014).

In brief, phenomenology sustains that the original disposition of humans in encounters with others is a pre-reflexive other-oriented process, where we are totally present in the interaction itself and not detached from it and theorizing about it. On the contrary, when we think or reflect about the other or the present interaction, we leave this primordial orientation and become self-centered (Schutz, 1967). However, in traditional conceptions of empathy we are, paradoxically enough, mostly in this later state, absorbed in our own

thoughts and theories about the other or in our own (individual) simulation and its projection. Evolutive biologists such as de Waal, as well as current phenomenological authors point out an alternative approach to the individualistic perspective that reduces an interaction into its interacting parts, and focus on the "self-transcendence" experienced during social encounters.

It is important to note that direct perception is not proposed as the only way of interpersonal understanding, as clearly exposed by Schutz (1967) "…still, your whole stream of lived experience is not open to me…To be sure, your stream of lived experience is also a continuum, but I can catch sight of only disconnected segments of it." (Schutz, 1967, p. 106). Besides, direct perception does not mean we are able to perceive every aspect of the other's mind, as if they were transparent to us (Zahavi, 2011). Instead it is a constitutionally different experience from the first-person access we have to our own minds, since it is truly and originally other-oriented. In order to grasp the real quality of direct perception we need to address a further statement from the phenomenological tradition that highlights its robustness and relevance for the current study of empathy. This is the primary role of emotions and the lived body in interpersonal understanding.

**Body, expressivity and affectivity**

Another relevant concept of the phenomenological position on interpersonal understanding corresponds to bodily expressivity. In this context, expressivity refers to the phenomenal attribute of the movements of what is alive (Gurwitsch, 1979). Gurwitsch

sustains the existence of a natural expressive unity of mental living and expressive movements, so that mental and emotional processes have an exterior form by expressive phenomena (Gurwitsch, 1979). Scheler also referred to this "expressive unity" that we encounter in face-to-face interactions as the unity of an embodied mind (Scheler, 1954 in Zahavi, 2010, p. 292). Also in Husserl´s work: "Husserl speaks of how the mindedness of the other, his thinking, feeling, desiring, is intuitively present in the gestures, the intonation and in the facial expressions" (Zahavi, 2014, p. 135). What this expressive unity means is that our bodily expressions have intrinsic psychological meanings that we are able to directly perceive. In this context, the body is regarded a *field of expression*, whether voluntary communication is meant or not, where mental states of others are "visible" to us (Schutz, 1967, p. 117). Merleau Ponty (2005) likewise addressed the primal relevance of the lived body, and claimed that gestures and language in general have an *intrinsic meaning*:

> It is through my body that I understand other people, just as it is through my body that I perceive 'things'. The meaning of a gesture thus 'understood' is not behind it, it is intermingled with the structure of the world outlined by the gesture…The smile, the relaxed face, gaiety of gesture really have in them the rhythm of action, the mode of being in the world which are joy itself. (p.186)

In this framework the opacity of other minds is replaced by an alternative, where important aspects of the internal life of others are accessible via its bodily expressions. By stressing the role of bodily expressions of emotions and mental states, the phenomenological tradition directly communicates with the current interest in the

embodied mind (Thompson & Varela, 2001). Although traditional approaches to embodiment focus on the individual aspects, phenomenology invites us to assess its consequences in empathy, interaction and communication.

It is also important to mention another difference between the phenomenological and embodiment perspectives, in particular as to how they conceptualize the body. Phenomenology introduced a terminological distinction between *Leib* and *Körper*, that is, between the pre-reflectively lived body and the subsequent thematic experience of the body as an object (Cornejo, Olivares, & Rojas, 2013; Gallagher & Zahavi, 2010). Among the variety of embodied mind perspectives, including the influence of body and action in metaphors, perception, cognition and meaning (Glenberg, 2010), the "radical embodiment" approaches that include the interplay between brain, body and world (Clark, 1999; Thompson & Varela, 2001) get closer to the lived body that phenomenologist refer to without necessarily making reference to it pre-reflexive nature. The embodied and phenomenological traditions agree on the essential role of the body in our cognition but only some embodied perspectives include more clearly the lived experience as essential to it.

As an example of this embodied emphasis, Daniel N. Stern revisited the concept of *vitality* as a primitive and fundamental experience with an important role in basic interpersonal understanding (Stern, 2010). Vitality corresponds to the phenomenal reality contained in movement, including force, time, space and directionality. It refers to the Gestalt of how we move, both physically and mentally, and not to why we do it (Stern, 2010). Every movement has a dynamic quality to it; it is abrupt, slow, big or small. Even emotions and thoughts are not static; they smoothly flow, or invade us in a second. Stern

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even proposes a neural system responsible for vitality forms, the arousal system located in the brainstem. This complex, flexible and fast system, of primitive origin, also communicates with the cortex allowing for bottom-up or top-down control (Stern, 2010). The description and study of such basic forms of expressions, once neglected by science, allow us to understand the real dimension of embodiment and the full repercussions on empathy.

Similarly to de Waal's position, several phenomenologists stress the crucial role that emotion plays in social relationships, especially if empathy is conceptualized as basic and pre-reflexive. Both the traditional cognitive account of empathy and the established account of emotions as evaluative have maintained these phenomena apart from each other (Fuchs, 2013; Zahavi, 2010). But new approaches propose a broader, bodily and relational description of affectivity with a clear connection to empathy and phenomenological experience. For example, Fuchs (2013) describes a wide range of affective phenomena —including affective atmospheres, moods and emotions— emphasizing that they are experienced through the resonance of the body in different forms and intensities, and that such resonance in the "sensitive" body also affects back our emotional states. He proposes the presence of an *interaffectivity* arguing that during a natural interaction emotions become relational, since we experience them through interbodily resonance in a feedback loop of being affected by the other's expressions and affecting the other with ours. This relational process makes possible interpersonal understanding (Fuchs, 2013, p. 624). As a result, interaffectivity would be consistent with the existence of an expressive unity providing our body with a more fundamental role in empathy and emotion. Moreover interaffectivity is compatible with de Waal emphasis in

mirroring and imitation, situating the body as essential for empathetic understanding (de Waal, 2008). Fuchs highlights the link between action readiness and emotions. Here emotions are seen as an intentional arc of drive, using a concept from Merleau-Ponty, where behind every emotion lies the potential for movement, as a force motivating movement and action (Fuchs, 2013; Merleau-Ponty, 2002). Thus, a connection is established between vitality and affectivity, where what we usually refer as an emotion is the coming together of a vitality form and a specific emotion (Stern, 2010). This link between motivation and emotions also connects the ideas of Fuchs and de Waal. When de Waal refers to the intrinsic reward present in empathy, altruism and sociality, he considers an emotional rewarding feeling, a "warm glow" (de Waal, 2012, p. 876; de Waal & Preston, 2017, p. 502). This "warm glow" represents a proximate cause as a result of thousands of years of evolution as social animals, a positive feeling that moves or motivates us to empathize, socialize and help others. For Fuchs (2013) affectivity satisfies another primordial role in our lives, "Emotions 'befall us': they interrupt the ongoing course of life in order to inform us, warn us, tell us what is important and what we have to react upon" (p.8). Within this theory, emotions give meaning to our lives, for only through them we live in world where other persons and things matter to us. Every aspect of our cognition is made upon objects or persons that are important to us, upon our affective participation in the world (Fuchs, 2013).

Phenomenology advocates an alternative to the assumption of the opacity of other minds, proposing a meaningful expressive unity between internal states and its bodily expressions. As a result, phenomenology encourages science to study the wide range of expressive phenomena present in everyday life, like vitality and affectivity, taking into

consideration their relevance for interpersonal understanding. In such a framework emotions are experienced through bodily resonance with others and granting meaningfulness to our lives. In sum, the phenomenological tradition offers a different account on the centrality of our body and emotions in empathy, in line with the evidence and arguments of evolutive biology.

Several insightful contributions from phenomenology research may be relevant to the contemporary study of empathy. In first place, the concept of an immanently social world, where others permeate every aspect of it from our birth, and the concept of social interactions as self-sufficient and intrinsically rewarding. From this point of view the understanding of what "social" means needs to be expanded, in agreement with the relevance of sociality in our evolutive history as presented by evolutive biology. Secondly, phenomenology offers an alternative account to the traditional intellectualist approach to empathy, which takes for granted the opacity of other minds. By acknowledging the link between internal states and bodily expressivity, some aspects become directly perceivable, enabling a rapid, non-conscious and basic form of empathy. To be sure, this basic form of empathy does not deny the existence of higher cognitive and more complex ways of interpersonal understanding. But by recognizing the expressivity of bodily movement in the social world, the whole complexity and variability of the phenomena included in empathy are captured. This statement converges again with evolutive biology accounts, where more primitive and basic forms of empathy lie as a foundation to more complex forms. Finally, phenomenology makes visible the tacit role that the body and emotions play in empathy. By giving them both an essential function in our ability to understand others, embodiment takes a new meaning and

emotions replace cognition as the center of our lives.

**Conclusions**

Empathy has been studied for more than a century, receiving an increasing attention in the last years. Different theories have tried to analyze and study it, appreciating its fundamental importance in building social life. The two main current perspectives, the theory-theory of mind (TT) and the simulation theory (ST) are the most prominent ones. Although they configure different approaches to human sociality, they coincide in visualizing social life as requiring complex cognitive developments and processing to take place. The main difference between TT and ST is probably the different relevance given to the different forms of empathy. While the TT defines empathy as a fully logical ability in the mind of the individual who observes the behavior of the other, the ST states that simulation is what makes us capable of then projecting the states to others. Although these two theories have dominated the field for a long time, new approaches are trying to comprehend a wider variety of phenomena including more basic and non-reflexive forms of empathy.

In this article we broaden the current approaches to empathy as studied in psychology. We reviewed evidence coming from evolutive biology and phenomenology, trying to bring evidence from other research areas to better define empathy. From the beginning interpersonal understanding has been studied by different disciplines including philosophy, psychology and neuroscience. As a result from this review it seems critically necessary to integrate the knowledge acquired by each of these disciplines in a unified

model. Interdisciplinary communication is imperative in order to reach a broader comprehension of empathy and its related phenomena. Empathy is a complex and diverse ensemble that needs the integration of information coming from different areas of science.

In evolutive biology, Frans de Waal has argued that empathy is better understood as a continuous phenomenon that includes a wide range of behaviors acquired in increasing complexity through evolution. At the center, primitive, non-rational, emotional and body-centered processes sustain empathy. Empathy is proposed to be motivated by an intrinsic reward, and is present in early childhood and non-human animals, evidencing the essential relevance of sociality. In a similar direction, the phenomenological tradition offers a more radical statement about the importance of sociality in our lives, underlining its omnipresence and the positive feeling that tacitly accompanies it. While de Waal proposes a mechanism for empathy that resembles the simulation theory of mind in the role of bodily imitation and the use of personal representations for the comprehension of others, it differs from it in other relevant aspect, such as the ancient evolutive origin, automaticity and emotional drive. Meanwhile, phenomenology suggests that relevant aspects of the internal lives of others are directly perceived, in a word immanently social and where body, expressivity and emotions play a crucial role. Both traditions coincide in stressing that empathy needs to be a rapid, pre-reflexive and non-conscious process in order to satisfy the vast requirements of sociality and its ancient evolutive origin. In addition, phenomenologists developed the central role that bodily expresiveness and emotions play in our capacity to understand others. As a whole, these two traditions

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mostly agree in giving relevance to a more basic, emotional and embodied form of empathy, product of millions of years of evolution as social animals.

This analysis shows that the concept of empathy has progressively become closer to an emotional, pre-reflexive and basic core: starting from the purely cognitive approach of theory-theory, passing through a moderated and body-centered simulation theory, until reaching an evolutive continuous conception, where understanding others is a more direct, rapid and emotional process. The phenomenological tradition should play an important role in these new conceptions of empathy, where sociality is at the center of our lives.

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## 5. General Discussion

A general overview of experimental results obtained suggests no clear sign of inter-species empathy. Even though humans were able to recognize some of the emotions related to chimpanzee facial expressions, results showed they only recognized those expressions physically more similar to their human homologues. In addition, at electromyographical level, no evidence of facial mimicry was found when humans were presented with chimpanzee facial expressions. Below, some methodological issues are mentioned that might explain these negative results. In its turn, the theoretical review and analysis help to integrate evidence and knowledge from different disciplines studying empathy. Both phenomenology and evolutionary biology converge to a broader definition of empathy that includes more basic and less cognitive manifestations along with the usual conceptions.

In general terms, experimental results show no support to the idea of inter-species empathy, and though to the ancient evolutionary origin of this crucial social phenomena. Findings from the emotion recognition study show humans are only able to recognize chimpanzee facial expressions that resemble their human counterparts. This fact suggests the possibility that participants did not really recognize the emotions behind each chimpanzee expression but rather they made physical analogies based on their knowledge about human facial expressions. Results from the inter-species facial mimicry study show convergent results: findings show no signs of mimicry in humans when presented with chimpanzee or human expressions. However, these negative results can be explained by

the mixed presentation of chimpanzee and human facial expression. Such arrangement possibly elicited contextual incongruence that eventually reduced the mimicry for both species. Finally, the theoretical analysis shows the benefits of interdisciplinary integration on the comprehension of a complex phenomenon such as empathy. The paper argues that even distant disciplines as evolutionary biology and phenomenology coincides in allowing for a less cognitive account of empathy. As a whole, although the three studies provide no support to the existence of inter-species empathy, they do not necessarily disprove the possibility that empathy corresponds in fact to an evolutionary ancient phenomenon.

Results from the inter-species emotion recognition of facial expressions showed participants are only able to correctly recognize the emotion behind Neutral, SBT and ROM expressions. These three expressions are exactly the most physically similar to their corresponding human homologues Neutral, Smile and Laughter expressions. In contrast, the Scream chimpanzee expression was associated above chance levels with anger and happiness, showing no clear recognition. A possible explanation relates to the physical similarity between laughter/ROM expressions and the scream face in chimpanzees. Similarly the Pout chimpanzee expression was associated above chance with surprise and to a lesser degree with sadness. Again, these results can be explained by the physical similarity between the Pout expression in chimpanzees and the surprise face in humans. This study highlights furthermore the relevance of the use of proper statistical tools that take into account the special challenges of categorical judgment data, as well as the careful report and interpretation of results (Agresti, 2007; Wagner, 1993). In sum,

results showed that only those chimpanzee expressions that are physically similar to their human homologue were associated to the correct emotion, in contrast with previous findings (Ekman, 1973; Fernandez-carriba & Parr, 2012; Foley, 1935). Moreover, not recognized expressions tended to be confused with physically similar human expressions, failing to prove the hypothesized existence of inter-specie facial emotion recognition.

Concerning the inter-species facial mimicry study, results did not show evidence of inter-species mimicry. Additionally, they show a blocking effect of all kind of mimicry. As a result, no statistically significant result was found that indicate the presence of mimicry neither in the experimental condition —chimpanzee facial expressions— nor in the control condition —human expressions. The only significant results showed elevated muscle activation for chimpanzee expressions across all muscles and emotions presented. Also more significant muscle activation was observed during Laughter/ROM presentation compared to Anger/Scream expressions across muscles and species. The negative results for both conditions could be explained by an induced general effect that blocked facial mimicry altogether. Mainly two possible factors are proposed to have produced these results, both possibly produced by the mixed presentation of pictures of facial expressions of different species. One possibility is that the presentation of chimpanzee pictures among human pictures may have broken the participant expectations and some how blocked facial mimicry between humans. Another possible explanation is that context might have played a crucial role (Hess & Fischer, 2013; Philip et al., 2017; Seibt et al., 2013) and suppressed the normal occurring mimicry. Recent evidence shows that facial mimicry can be suppressed or blocked by the presentation of incongruent

context during experimental trials (Philip et al., 2017). In the present case participants could certainly consider the mixed presentation of chimpanzee and human pictures as an incongruent context that interfered with the mimicry. Finally results fail to show any evidence of inter-species facial mimicry and suggest context play an essential role when observing facial expressions.

Finally, the theoretical study argues in favor of interdisciplinary communication and integration. The review of both evolutionary and phenomenological traditions clearly shows psychology, and other disciplines studying empathy, could greatly benefit from evidence and knowledge coming from them. Evolutionary biology, De Waal in particular, proposes a broad definition of empathy that includes both simpler/emotional and complex/cognitive processes organized in a Russian Doll model (de Waal, 2008; Preston & de Waal, 2002). He also suggests that empathy is an evolutionary ancient phenomena linked to maternal care and the origins of social mammals (de Waal, 2012; de Waal & Preston, 2017). Moreover De Waal argues that empathy is motivated by a build-in reward, a "warm glow", an ancient, primarily emotional, non-voluntary, rapid and pervasive phenomena. On the other hand, the phenomenological tradition brings to light alternative accounts to traditional social cognition perspectives on empathy and interpersonal understanding. This tradition proposes a much more radical conception of what "social" means, so that an immanently social word is what gives sense to the living world granting sociality a relevant central role in human life (Gallotti & Frith, 2013; Gurwitsch, 1979; Schutz, 1967). Phenomenology also suggests a non-inferential alternative to interpersonal understanding through the direct perception approach.

Originally, direct perception proposes we are able to access other's mental states directly, rapidly, in a non-voluntary nor inferential form of interpersonal understanding that is truly other-oriented (Schutz, 1967; Zahavi, 2010, 2011, 2014). Finally, through the study of affectivity, vitality and expressivity phenomenology has put greater emphasis on the role that bodily expression and emotion play in empathic processes (Fuchs, 2013; Schutz, 1967; Stern, 2010; Zahavi, 2010, 2011). In sum, both phenomenology and evolutionary biology coincide in many important contributions to the study of empathy in psychology providing alternative views to current traditional conceptions.

Regarding the above stated questions, our findings showed limited support to them. The two experimental studies render no empirical support for the three question proposed above. First, in terms of facial mimicry, no evidence of inter-species mimicry was found rendering a negative answer to the Question 1 and disabling Question 2 and 3. In relation with Question 2 and the possible difference between facial mimicry evoked by human and chimpanzee pictures, chimpanzee pictures showed significant larger muscle activation than human pictures across all muscles and expressions. Denoting a possible overall tension in the facial muscles when participants observed chimpanzee pictures. Regarding Question 3 a significant difference in muscle activation was found when comparing Laughter/ROM and Anger expressions for both species and across all muscles registered. Representing the only evidence of a difference between Smiles and Laughter, and SBT y ROM expressions. Facial emotion recognition results exhibited a limited ability to recognize emotions behind chimpanzee facial expressions and though a partial support to the existence of inter-species facial recognition. In relation to Question 2,

regarding differences between human and chimpanzee, participants recognized far better the humans than the chimpanzee facial expressions as it could be expected. On the other hand joy expressions in chimpanzee (SBT and ROM) where judged as the least credible ones and their humans counter parts (Smile and Laughter) as the more aversive ones. Showing in some way that the expressions of joy represent a special case among all other facial expressions. Intensity rating showed in general chimpanzee expressions where judged as more intense, excluding ROM, and credible than human pictures, excluding Smile. As for Question 3, the facial recognition study showed several differences between Smile/SBT and Laughter/ROM expressions. While Smile and SBT where among the most recognizable ones, Laughter was significatively more recognizable than its chimpanzee homologue ROM. Only for human pictures was the expected difference in intensity between Laughter and Smile found, and Smile was rated as more aversive than Laughter in humans. Finally, results from both experimental studies no evidence of inter-species facial mimicry but partial support to inter-species facial recognition, and some interesting results regarding the differences between humans and chimpanzee expressions and the difference between the expressions of joy (Smile/SBT and Laughter/ROM).

As a consequence the present thesis and its respective results have a number of interesting consequences that should be addressed. First studies of emotion recognition should be cautious in the use of traditional statistical methods for the study of categorical judgment data. This type of data present several challenges in term of analysis and is relevant to keep its particular features. Humans showed a limited ability to recognize the emotions behind chimpanzee expressions, and their answers were clearly biased by the

physical resemblance with different human expressions. Therefore participants did not showed evidence of empathic understanding when presented with chimpanzee facial expressions. Future research should investigate the possibility that inter-species empathy is present in humans at early stages in life and then narrowed as ability by conspecifics experience, like for inter-species perceptual narrowing (Pascalis, de Haan, & Nelson, 2002; Pascalis, Demont, de Haan, & Campbell, 2001).

In second place, despite the negative results, facial mimicry study provides an interesting insight to the relevance of context in this kind of experiments. Findings in the second study showed no sign of facial mimicry in humans when presented with chimpanzee facial expressions, but neither when presented with conspecifics facial expressions. We propose that the most probable case is that the mixed presentation of human and chimpanzee pictures created an incongruent context that prevented all mimicry to occur. Previous findings support the idea that incongruent or unexpected context can suppress or block facial mimicry all together (Hess & Fischer, 2013; Philip et al., 2017; Seibt et al., 2013). These results enhance the importance of experimental contexts and of creating ecologically valid tasks and experimental settings. The obvious empirical test should be to either prove inter-species facial mimicry using a within subject design and presenting different species pictures in different trials or to present chimpanzee and human facial expressions to two different groups of subjects. Either way the present research highlights the relevance of experimental design and the usual tension between controlling variables and aiming for ecological validity.

The theoretical manuscript succeeds in showing the importance of interdisciplinary communication in the study of empathy. Different areas of study have arrived to similar conclusions highlighting different aspects of empathy normally neglected by traditional psychological approaches. Focusing on the multiple aspects and expressions of empathy, and integrating evidence and knowledge coming from different disciplines is essential to reach a full understanding of this complex phenomena. Evolving from the original cognitive conception of empathy, new and old information from evolutionary biology and phenomenology among others disciplines are turning the focus on a basic, emotional, body-centered and ancient from of empathy. More efforts should be implemented in the future to integrate and combine evidence arriving from different areas such as neuroscience, philosophy, social psychology and social cognition. The proposed integration will only bring benefits to the study of such a primordial and heterogeneous phenomena as empathy.

As a general conclusion, the present thesis failed to find evidence of the existence of inter-species empathy and so to provide support to the conception of empathy as a basic, automatic and evolutionary primordial phenomenon. However, studying the evolution of empathy through the study of inter-species relationship is only one of the available possibilities to provide evidence of the old evolutionary origin of empathy. Studies about conspecific empathy and mimicry in monkey, apes and other social species (Mancini et al., 2013b; Palagi, Nicotra, & Cordoni, 2015; Ross et al., 2008), and also inter-species empathy in young children are also viable alternatives for assessing the general problem. The present thesis exhibits other limitation that is worth mentioning and taking into

consideration for future research. This refers to the inter-species facial mimicry study, where methodological issues might have prevented either to prove or disprove the hypothesis at hand. In order to control possible presentation differences, it was here decided to show human and chimpanzee pictures mixed in the same trial. Unexpectedly, this mixed presentation might have produced the undesired effect of blocking facial mimicry, by introducing an incongruent context to participants. Since no previous inter-species facial mimicry study has been done before the present one, no antecedent existed to think this effect could occur. Future research should be careful with possible contextual effects and aim to more ecologically valid studies. The emotion recognition study highlights the importance of establishing a common and proper statistical method to deal with categorical judgment data studies. This is fundamental to compare and unify results and finally establishing if humans are able to recognize de emotions behind chimpanzee expressions.

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