Contributions from Gallese's Neurophysiology and Bruner's Psychology to the Understanding of Social Learning

Contribuições da Neurofisiologia de Gallese e da Psicologia de Bruner para a Compreensão da Aprendizagem Social

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Abstract
The current article makes an articulation between recent findings from neurophysiology such as the mirror neurons and neural plasticity, and others which were originated in psychology in order to achieve a better understanding of human social learning. Several of those recent findings provide support for concepts of psychology such as the relevance of inter-subjectivity, language and culture to psychological development, regarding not only individuals but also the human specie. More specifically, they evidence the role of direct and implicit understanding of others' actions, emotions and feelings in order to understand the development of social relationships. In this sense, relations are drawn between biological and cultural aspects. Gallese and Bruner are the authors taken as references for this reflection.
Keywords: Mirror Neurons; Social Learning; Social Cognition, Gallese; Bruner.

Resumo
O artigo propõe algumas articulações que se podem estabelecer entre novos achados da neurofisiologia – no caso, a atuação dos neurônios-espelho e a plasticidade neural – e outros oriundos da psicologia, visando uma melhor compreensão da aprendizagem social. Vários desses achados recentes fornecem apoio para conceitos da psicologia como a importância essencial da intersubjetividade, da linguagem e da cultura para o desenvolvimento psicológico, não só do indivíduo, mas também da espécie humana. Mais especificamente, evidenciam um aspecto até o momento menos considerado no que se refere à cognição social – o papel do entendimento direto e implícito das ações, emoções e sensações para a compreensão do outro, para o estabelecimento e desenvolvimento das relações sociais. Nesse sentido, são traçadas relações entre elementos dos âmbitos biológico e cultural. Gallese e Bruner são os autores tomados como referência para a presente reflexão.
Palavras-chave: Neurônios-Espelho; Aprendizagem Social; Gallese; Bruner.

The objective of this article is to establish articulations between new findings in neurophysiology and psychology – such as mirror neurons and inter-subjectivity, respectively – in order to provide a better understanding of learning in social cognition. It further seeks to evaluate some implications derived from establishing a connection between both areas, e.g. the issue of continuity between species. It is important to point out that our concern with this analysis is to search for points of approximation and support between findings from both disciplines, without reducing concepts from one to the other.

Therefore, we will first examine results relative to the mirror neuron systems recently discovered by neurophysiology (mainly basing ourselves in Gallese's contributions). Next we will examine how the issue of other people's behaviors, in the case of phenomena like inter-subjectivity and theory of mind, are treated in the field of psychology (according to Bruner's considerations).

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Social Cognition according to Neurophysiology

The discovery of a new class of neurons named mirror neurons (Umiltà et al., 2011), may present new subsidiaries for understanding human social cognition. This is mostly due to the fact that such neurons have formed a mechanism of representation and comparison, a basic organizational characteristic in our brain. This mechanism engenders intersubjective experiences by being activated when determined actions are executed, or emotions and sensations are felt, for example, when actions, emotions or sensations are observed in other people (Gallese, 2003). According to Gallese (2003), these mirror neuron circuits would be the organic foundation for our ability to share our actions, emotions and sensations with others in a pre-reflective and implicit level. Thus, they are at the foun-

dation of our ability to form a social identity and of accomplishing an "intersubjective communication, social imitation, and ascription of intentionality" (p. 177).

This neurophysiological perspective emphasizes the motor system's contribution for social comprehension. In other words, unconscious functional precursors are highlighted as constituting the self and bonding with another human being (Metzinger & Gallese, 2003). Such mirror neurons would show a human's organic tendency for detecting intentionality of action in others by inducing a process of internal simulation of actions, emotions and sensations from other people. This ability to detect the intentionality of actions in others by internally simulating them contributes to the understanding of this perceived action. This reveals a human being's tendency to be social in order to be able to relate to other members of its species.

As is exposed, there is an emphasis on the automatic, unconscious, pre-reflective, and therefore, pre-linguistic character in the construction of social knowledge. When defending such a perspective, Gallese (2006) opposes the traditional view from cognitive sciences. The author believes that in these sciences, social cognition becomes almost the same as mind reading abilities, due to their concepts of "Folk Psychology" and Theory of Mind. According to these concepts, human beings are capable of understanding the behavior of others by attributing mental states – intentions, beliefs and desires. On the other hand, Gallese (2006) believes that social cognition is not only a "social metacognition," that is, to explicitly think about the contents of another person's mind through embodied representations. There should also be an experiential dimension of interpersonal relations that allows any individual to have a direct understanding of the meaning of actions, emotions or sensations from other individuals. Such a dimension would be incorporated when mediating experiential knowledge that each one has of himself and of others. From this, the author proposes, "our capacity to share experiences with others rests on the constitution of a shared meaningful interpersonal space." (Gallese, 2006, p. 2)

Therefore, for the author, human ability to capture the meaning of actions, sensations or emotions from other individuals in a direct way may be characterized, in a functional level, as an embodied simulation, and at the brain's level, through shared neural connections; the mirror neurons systems.

Social Cognition and its Learning according to Psychology

In light of these considerations, it is relevant to return to Bruner's theoretical proposal. Considered to be one of the founders of Cognitive Psychology, Bruner's proposal is a theoretical perspective that makes up, along with other disciplines, what are called the cognitive sciences cited by Gallese. We see that relations may be established between both perspectives regarding the social constitution of the mind.

More recently, Bruner (1990/2002) evaluated the cognitive perspective of Cultural Psychology[1], defining the Psychology of Common Sense or Folk Psychology as crucial characteristics for this last approach – a system through which people organize their experiences in the social world, their knowledge about it and the exchanges that they maintain with it. But for the author, if on one hand, narrative is fundamental in organizing experience (which deals with the material of action and human intentionality) on the other hand, there is also a pre-linguistic aptitude for apprehension of meaning in the world; something innate, automatically released. This would be the genesis of the ability to narrate.

Thus, for the author, human beings are already born with a primitive form of Folk Psychology, a very malleable representation released through acts and expressions of others and by a basic determined social context in which human beings interact, an assemble of predispositions to interpret the social world in a particular form, and to act over our interpretations (Bruner, 1990/2002). A mention to these predispositions, described as being some theory from a proto-linguistic mind, would justify the reflection about the proximity of ideas supported by both researchers.

In Bruner's (1990/2002) conception, culture with language as its main instrument, wield the role of a scaffold for the development of the human mind. Given the extent in which culture and language molds the human mind, they also offer tools to construct the conceptions that human beings have of themselves and of their worlds. Thus, just as impossible to understand humans without referencing their biological roots, it is also not possible to understand them without referencing their culture – keeping in mind that culture is not only created, but also has the power to create the mind and to allow for a constitution of a symbolic world sufficiently flexible for meeting human needs.

Cultural Psychology places the emergence of culture at the phenomenon of inter-subjectivity as the way in which people come to comprehend what others are thinking of and how they adjust themselves by taking that into consideration (Bruner, 1996/2001). In other words, without inter-subjectivity it is not possible to have culture. Inter-subjectivity consists of the ability that human beings have developed of inferring and representing thoughts, intentions, beliefs and mental states from members of its species in a culture. This is something that, according to the author, marks a change from a primate functioning to a symbolic human functioning. Human beings, equipped with the power of language and immersed in a culture with a common body of traditions, develop mutual networks of expectations, a pattern imbricated with reciprocity in

[1] Cultural Psychology, almost by definition, is not worried about behaviors, whereas about actions, its counterpart intentionally founded and, more particularly, about *situated action*, actions situated in a cultural scenario and in an intentional scenario mutually interacting where people participate (Bruner, 1990/2002).

relation to intentional states of an individual's partners that constitutes the social-cognitive negotiation at a human, and cultural level (Bruner, 1996/2001). Culture is built upon such mutual networks of expectations, and it is from those networks that it becomes possible for human beings to adapt to their culture and extract meaning from it.

It is important to explain why Bruner establishes a distinction between primate and human functioning – derived from the conception of inter-subjectivity stated above – as a mutual network of expectations, and also, its origin. For Bruner, it is possible to observe the first signs of inter-subjectivity at the beginning of human life, when there is a combined attention between baby and its caretaker. An example of this is when a baby follows an adult's eyesight at the moment that he stops looking at the baby and looks at something else in the environment. He claims to have no knowledge of the occurrence of this phenomenon in early stages of primates, although primates, once more mature, follow the eyesight of other animals in order to find food. He further remembers that primates attempt to deceive members of their species, which confers to some sort of theory of mind. He also adds that when acculturated primates understand that their human caretakers intend to refer to something by using symbols… – a notion of intentionality – that a spoken word or arbitrary visual symbols 'represents' something for yourself and your interlocutor. It is in this sense of mediating process between human and the world that Bruner understands the role of culture, which justifies establishing a discontinuity between human and the rest of the phylogenesis. Thus, language allows for the construction and elaboration of mutual networks of expectations that are the matrix over which culture is constructed.

As stated, Bruner (1990/2002) argues that the entrance into language should be based on a selective ensemble of pre-linguistic aptitudes in order to attribute meaning. For him, there are determined classes of meaning, with which human beings are innately in tune with, and actively seek. These meanings exist in a primitive form before language as a proto-linguistic representations of the world, whose realization depends on the cultural tool from language.

Thus, there should be a predisposition to syntonize with other people in order to attribute meaning to their action. Furthermore, according to the author, a large part of this search for syntonization is due to human's dependency for survival at the beginning of life. Communication with an adult is given in the sense of being attended to: children acquire these communicative skills due to an interest in making things happen in the world: solicitation, indication, affiliation, protest (Bruner, 1986/1998).

Bruner's affirmation about the relation between human's dependency and social predispositions receives empirical support from results revised by Ribas and Seidl de Moura (2007) in the field of Evolutionary Psychology. These results indicate that the human baby is born very well equipped for first contacts with the caretaker. The baby selectively responds to social stimulus, showing greater preference for human faces than to other stimulus. The same happens in relation to auditory stimulus, for they show preference towards human voices, mainly the mother's voice. These are behaviors that trigger responses for care and which also guarantee survival during this period.

Meltzoff and Decety (2003) present other evidences obtained through research on imitation – performed with newborns – that is illustrative of social predispositions to syntonize with other people and to attribute meaning to their actions. The research conducted by them with newborn babies obtained results in imitation of adults that suggest a common codification between actions perceived in other people, like sticking out the tongue, and having the action being imitated by the baby. Such results indicate that a shared representational network is innately connected to human beings, favoring learning about the other from the beginning of life and to a later development of empathy and theory of mind. Research cited by Meltzoff and Decety (2003) further shows that babies correct their imitative action, which suggests the existence of an active comparison between what is observed and what is executed, and most importantly, the absence of confusion regarding self and other which is essential for constructing inter-subjectivity.

Evidences of imitation obtained after 24 hours of exposure to a model, presented by the authors cited above, demonstrate that the baby is capable of storing a representation of what was observed and reproduce it in its absence. This requires more than a simple visual-motor resonance. Furthermore, according to the same authors, at 14 months, the babies show that they are able to recognize when they are being imitated by an adult – they stare at the adult for longer, smile more, and test their behavior with sudden, unexpected movements to see if they are really being imitated. Meltzoff and Decety (2003) further add that at 18 months, babies demonstrate an ability to infer intended objectives from other people, like a failed attempt to grab a slippery object; through similar actions they are able to reach the inferred goal from the observed behavior.

Meltzoff and Decety (2003) weaved an assumption that their results would show that human imitation goes beyond the action of mirror neurons. It is important to explain why they assumed a position divergent from Gallese (2006) regarding human imitation and its role in the development of inter-subjectivity. Meltzoff and Decety (2003) assert not having attributed imitation to mirror neuron action because at that time there was no proof of neonatal imitation in monkeys (evidenced in 2006 by Ferrari et al.) who also have these neuron structures. Thus, they saw a gap between mirror neurons and theory of mind, which led them to propose that motor imitation – processed in other brain structures like the inferior parietal lobe – would be the connection between neonatal imitation and adult theory of mind in the human being. They further state that evidences of activation of the parietal lobe struc-

tures involved in adult imitation guided by an objective indicate that this processing is more complex than a simple resonance, as is the case in mirror neuron activation. In other words, they proposed that superior processes (top down) like intentionality would guide the processing of imitation. They argued that observation with intent for imitation produces an activation pattern similar to that of action generation, rather than mere observation. Thus, they questioned the innate character of the activation of mirror neurons, which was verified during observation of actions by adult monkeys. They rose the hypothesis that it is not innate, but rather, a product of learning through generalization, provoked by self-observation during the performance of an action. Other evidences support this thesis, like the ability to infer the other's intention, which was verified through imitation in 18 months babies, even when the action's objective was not reached (Meltzoff & Decety, 2003).

Although Bruner emphasizes the role or predispositions when attributing meaning for the entrance into culture – through inter-subjectivity, as well as language acquisition – he also attributes a crucial role to experience. He already emphasized the importance of learning through observation during the 1970s, seeing it as necessary for the transmission of culture (Bruner, 1972). This type of learning depended on two pre-requisites: differentiation of the self – in a way that it is possible to model one's action through some aspect observed in the action of the other. The second pre-requisite would be the construction of an adequate pattern of action in terms of the sequence of components that constitute the observed act. These aspects are strictly linked to acquisition of a new action, and later on, to its adaptation in other contexts by observing the model.

In summary, learning through observation provides the model for action as well as the contexts in which it is applied. This is different from the perspective defended by Meltzoff and Decety (2003) who only demands differentiation of the self-other, being an organization of action to be imitated in a given context.

Implications of Different Concepts of Imitation on Learning in Social Cognition

It is relevant to note that the position defended by Meltzoff and Decety (2003) is not a consensus among researchers. Subjacent to their proposal, one finds a debate surrounding the continuity between species – mainly in what it says about the human being – as is pointed out by De Waal and Ferrari (2010), who are favorable to the continuity hypothesis. When it comes to imitation, they argue that a definition emphasizing intentionality substituted the classic definition of imitation. In other words, such definition emphasizes processing guided by superior processes (top down) in function of having included understanding the goal of the action to be imitated as a defining factor. This position, however, is inherently in favor of discontinuity and always emphasizes the existence of homology (shared ancestry) in the cognitive domain as well as in the physical domain. They also remember that the distinction between homology and analogy (functional parallels that evolved independently) is not as clear in the cognitive domain as it is assumed, precisely due to an imprecision in the definition of cognitive capacities and their mensuration. They further argue that evolution acts more over predispositions and behavioral motivations when modeling cognitive capacities, while keeping the basic learning mechanisms. Thus, they support that until there is more evidence, the most parsimonious suppositions in a Darwinist sense, would be that the closest species – whether they are squids and octopuses, or humans and simians – manifest similar solutions to similar problems that probably involve similar cognitive mechanisms.

Gallese (2007) also adds arguments that are favorable to the thesis of cognitive continuity between species. His goal is to demonstrate that embodied simulation from mirror neurons may explain not only the most primitive social cognition mechanisms, but also the most sophisticated, being a precursor of social communication mediated by facial gestures. For such he proposed the hypotheses of neural exploitation, that consists in the adaptation of integrated motor-sensory mechanisms in new thought functions and in language, all the while maintaining their original functions. Gallese (2007) argues that the execution of any complex coordinated action involves, at least, two sections of the brain. For example, the motor function for execution and the pre-motor function for control and coordination of simple acts in coordinated actions, which is executed through the activation of specific areas of the motor cortex. He further adds that, the same pre-motor circuit that governs the control of executing an action should also govern embodied simulation of actions observed in others. Therefore, there is a structuring computational circuit functioning in two ways: one that structures the execution of an action/and or perception/idealization of an action as explained above. The second, the system is disassociated from its function of perception/idealization of an action and offers its structuring computations through non motor-sensory parts of the brain. According to this hypothesis, the same system that controls our body's movement and allows for our understanding of the other's actions, may, at least in principle, also structure language and the abstract thought. When it comes to differences between humans and other primates, Gallese (2007) suggests that a possible explanation for our qualitative leap in social cognition would be a greater computational power, as well as a superior level of resources reached by the human pre-motor cortex of which the mirror neurons are a part of.

In summary, it is verified that neonatal imitation observed in monkeys (Ferrari et al., 2006) is more restrict in terms of variety of imitated actions, as well as in duration, which is smaller than the human. It is further verified

that the cognitive continuity proposal is only based on hypothesis, like sharing of similar mechanisms for the solution of similar problems (De Waal & Ferrari, 2010), or the adaptation of integration mechanisms with other processes (Gallese, 2007). But, even if so, the parsimony of these last hypotheses seems to corroborate the role of mirror neurons in the development of human social cognition.

Detection of Intentionality, Attribution of Meaning and Culture

Ferrari et al. (2006) deal with the relation between mirror neurons and intentionality. According to the authors, data obtained through imitation research on newborn monkeys are compatible with the hypothesis that observing facial gestures – like opening the mouth and clicking lips – activates similar programs in pre-motor areas in the monkey, making them resonate, and explicitly replicate the observed gestures. They further believe that neonatal imitation in human babies may be interpreted through the same hypothetical perspective. Evidences of the existence of mirror neurons in the frontal and parietal lobes in humans shown through neuroimaging are homologous to those found in monkeys.

Based on theoretical proposals regarding the function of imitation, the authors hypothesized that the ability to detect intentionality is as central as being able to do so in order to promote social interaction between the baby and caretaker. In the case of monkeys, they remember that clicking the lips has an important social function in affiliation and collecting communications. The responses of monkeys that are directed towards a social environment are crucial for learning and the emission of responses appropriate to social gestures of other individuals during its first weeks of life. Thus, the authors hypothesized that the newborn monkey imitates affiliating gestures because they are the most appropriate responses when syntonizing their conduct with those of individuals that address affiliating behavior to them. In human beings, they see a similar communicative function in neonatal imitation, mainly in that which takes place through face-to-face interaction.

Gallese (2007) also supports the thesis of understanding an action's objective, in other words, intentionality through mirror neuron activity. According to data obtained through neuroimaging, observing contextualized actions in favor of understanding their objective provoked greater activation in the neural areas where these actions are represented than observing a decontextualized action.

Defending the existence of proto-linguistic mechanisms for attributing meaning does not make Gallese disregard the role that language has on human ontogenesis and its characteristic as a more sophisticated mediator. However, the author makes it clear that, even in language and cognition in a general way, there is the presence of a pre-reflective and base mediator functioning, supported by mirror neurons: embodied simulation (Gallese, 2006, 2007). Thus, what remains is an explication of how culture and language evolved from the detection of intentionality in the other, or, in other words, how culture and language have evolved by having inter-subjectivity as its basis.

Detection of Intentionality, Language and Learning according to Neurophysiology

For Gallese (2007) there is a strict relation between language, action and embodied simulation. The author argues that a proof of this would be the pronouncement based on his neuroimaging research of the Broca region, traditionally considered as exclusive to language. The Broca region contains representation of facial gestures and manual actions that may be considered a part of the mirror neuron system. This suggests that the system involved in speech production might be derived from the neural pre-motor circuit involved in the control of gestural actions.

Thus, Gallese considers that: "A target for future research will be to determine how embodied simulation, which is experience-based, and probably the most ancient mechanism from an evolutionary point of view, may scaffold more sophisticated, language-mediated forms of mind reading" (2006, p. 6).

Some posterior results from research (Iacoboni, 2009) suggest how this support may happen: in the first place, the fact that only one third of the mirror neurons are discharged when a same action is observed or executed. The remaining two-thirds, the called congruent neurons in an ample sense, are discharged for actions that are not the same, but that reach the same objective or that are logically related. The property of this last class of neurons suggests that these cells provide a flexible codification of actions of the self and of others. This flexibility is an important property for well-succeeded social interaction because even if imitation is a phenomenon that happens in an ample gamut of human conducts, we do not imitate each other all the time, but rather, develop coordinated, cooperative, and complementary actions.

Mirror neurons of ample congruency seem to be the ideal support for this type of cooperative behavior between people. Other evidences favoring this hypothesis is the discharge of these neurons even with a partial vision of an observed action; or even when only hearing an action, without seeing it at all. Mirror neurons gifted with these auditory properties are in an anatomical region of the brain of the preferential subject for more invasive research, the primate, homologous to language in the human brain. From this comes the hypothesis that such neurons may have facilitated the emergence of language in the human being (Rizzolatti & Arbib, 1998). Besides that, there are evidences that indicate that their properties are modeled by experience in such a way that, through observing performance, intention is codified and serves as an input for discharge. Other interesting data from the present work

is that not only motor behaviors are mirrored, but also facial expressions, especially those in the mouth region (Iacoboni, 2009).

Thus, for us, there is a question that underlies the discussion undertaken until the moment and that could be formulated in the following way: analogous to the relation between mind and culture, in which culture is not only created by, but also creates the mind, would it be admissible to consider the biological substrate not only as a producer of inter-subjectivity and cognition, but also as its product? Gallese highlights the importance of experience, at the level of a phenomenon, or even, of an intentional attunement besides an embodied simulation and the organic base of mirror neurons. But when problems that may come up in the functioning of inter-subjectivity, most specifically when dealing with autism, his hypothesis is that "these deficits . . . are to be ascribed to a deficit or a malfunctioning of the 'intentional attunement' because of a malfunctioning of embodied simulation mechanisms, in turn produced by a dysfunction of the mirror neuron systems" (2006, p. 7).

It is worth remembering that Gallese's hypothesis mentioned above is based on a few evidences, most specifically regarding the relation between autism and structural or functional anomalies in the insula, limbic system and amygdala. In the literature they are pronounced as the inability of autistic people to attribute intention to the other, understand different points of view, and to have a theory of mind (Butman & Allegri, 2001). It is assumed that these areas are functionally connected to mirror neuron areas, created by an ample network that serves as a basis for a form of empathy based on simulation. Activity detected in this network serves as a marker of sociability and empathy. Empirical evidences presented by Iacoboni (2009) show that the more severe the autism, the less amount of activity in these areas during observation and imitation of facial expressions by autistic children in comparison to children that have a typical development. Differences may be found even in the case of individuals whose development follows a typical trajectory: there are evidences that the greater the number of mirror neurons activity during observation and imitation of facial expressions by pre-adolescents, the greater the interpersonal competence and empathy (Iacoboni, 2009).

Contributions presented from the neurophysiological perspective confer greater importance to the role of observing an action or the manifestation of the other's emotions for the individual's learning: "Action is . . . a suitable candidate principle enabling social bonds to be initially established" (Gallese, 2003, p. 174). Or even: "Once a rudimentary subjective perspective has been established with help of the motor system, inter-subjectivity can follow" (Metzinger & Gallese, 2003, p. 567), concluding that "behavior-reading is transformed into mind-reading" (Metzinger & Gallese, 2003, p. 568). This perspective considers that we internally simulate actions, emotions and sensations from others in a direct and pre-reflective way, without detecting intentionality, which reinforces the importance of inter-subjectivity as a social learning hypothesis. Thus, our sociability is also deeply molded by these abilities to detect intentionality and empathize.

The Co-Evolution of Mind, Culture and Language

According to Donald (1993), by considering evidences in Neurosciences, Paleontology, Linguistics and Anthropology, culture and mind must have co-evolved. In the perspective defended by the author, three great cognitive transformations must have facilitated new modes of representing reality, and, consequently, new forms of culture that favor the transformation of the mind.

At the most primitive level, we would have an episodic mind, similar to those of more evolved primates that would have been gifted with an intuitive Physics and with other notions like a sense of numbers. Thus, it would be an implicit mind, that is, impermeable to the scrutiny of conscience and also "local" in the sense of being in the here and now.

In a more advanced level we would have a mimetic mind, whose access to a new type of more flexible communication – supported by a system of corporal representation – justifies the establishment of a relation with the data relative to the mirror neurons mentioned above. According to Donald (1993), this is due to the fact that mimesis may be considered as a precursor to the ability to simulate foreign mental states. This is a sophisticated ability that would also be responsible for a progressive clarification or a conscious access to the contents of the human mind. Mimesis may be considered as a more complex ability because it requires a progressive control of the action, in the sense that it is necessary to represent that what is observed, and transform it into conduct.

The following step would be a symbolic mind (Donald, 1993), resulting from the invention of the lexicon. This is due to the fact that the conquest of language not only allows for a representation of the world, but also favors advancement in knowledge by allowing representation in the absence of the object. With this, it is possible to perceive other perspectives of the world and talk about them. Therefore, in this sense, it is reasonable to assume that language may favor development by allowing the conscious access to implicit or unconscious contents, clarifying them, and making them more accessible to the scrutiny of thought.

A more careful examination of how the passage from mimesis to lexicon might have happened is worth doing. According to the hypothesis mentioned above (Rizzolatti & Arbib, 1998), it emerged from the activity of the mirror neuron system. In order to describe how this trajectory possibly happened, Corballis (2009) departs from a conception of human language as a gestural system –

both in oral and signalized form – which has also undergone a process of evolution.

According to the author, communication abilities of primates, and sign language from the deaf, support the conception that human language gradually evolved, from manual gesticulation into a grammatically organized gestural or oral system. Primates like chimpanzees, gorillas and bonobos communicate more frequently through gestures than through vocalization, which confers greater flexibility to communication. This happens because these gestures are socially learned and are sensitive to the recipient's attentive state. Vocal communication between animals – through vocal calls – precisely serves as warnings for environmental conditions. They are also stereotyped, confining the information transmitted to the context of the occurrence. In this sense, it is less beneficial in an adaptive point of view (Corballis, 2009) than gestural language, which in virtue of its greater flexibility for elaboration, may transmit more information about variable environmental aspects. However, in order to be effective, it demands learning and shared attention on the part of the transmitter and the recipient. Due to this demand for a shared attention, it is assumed that this more effective form of communication has supported itself on primate mirror neuron systems, which have acted as a support for the production and reception of intentional corporal acts. Homonid's bipedalism must have also favored (Corballis, 2009) the emergence of this new form of communication for it liberated the hands, allowing for a more elaborated and varied gesticulation. Throughout time, language has changed from a gestural system to an articulatory vocal treatment system, requiring a smaller release of energy and freeing the hands for manipulative activities.

However, these changes do not explain the complexity and flexibility of the human language when compared to other forms of animal communication. Corballis (2009) understood the complexity and flexibility of language as having emerged as a response to adaptive pressures, occasioned by our ancestor's shift from a more sheltered forest environment into the savannah. This change must have demanded more cooperation between them, involving an exchange of experience and action planning. In the same line of discussion, Corballis (2009) states that memory systems limited to regular recognition must have evolved during this occasion for storing and recovering episodes, which not only allowed for "time travel," but also allowed for a greater forecast and planning of individual and collective actions, as well as a more permanent sense of the self.

It is possible that other animals may also "time travel," but without the flexible character of human beings that combine people, objects, actions, situations and emotions. The same author argues that, despite an adaptive advantage that these combinations represent, they may – due to the quantity of elements involved – amount into an overload in memory. A greater quantity of concepts would be needed in order to refer to non-directly accessible episodic elements. The syntax must have emerged through a series of rules in order to combine episodic elements that facilitated communication in response to this pressure (Corballis, 2009). Clarifying his position, Corballis (2009) defends that language and the ability to mentally travel through time must have co-evolved, for communication about events may create episodic memories in the receptor contributing to the development of this sort of thought, and collaborating for its adaptation in similar future conditions. It is assumed that it was during this grammatical stage that the gradual passage from manual to oral language took place. Another important aspect that has been placed on language is a great variation between grammars, which are developed in accordance to their cultures. One example of this is the keeping track of time. Corballis (2009) remember that some cultures have a great quantity of terms to refer to events, according to their chronology, while other like the Pirahã in Brazil, use only two. These consist of two morphemes in two types of time, which indicate whether an event takes place in the present or not. It is highly probable that this limitation is a reflection of a smaller concern of the group with the passing of time than otherwise – lack of terms to express temporality that in a last analysis, would mark mental functioning (Corballis, 2009).

It is worth remembering the positive impact of written and subsequently printed language over the development of knowledge – even if it does not have a relation of determination over the mind. The liberation of memory propelled by written support allowed thought to be occupied with analysis, comparison of ideas, critiques and so forth. These are mental operations that were being hampered by the need to memorize accumulated knowledge (Pozo, 2005). These operations are at the base of advancement in knowledge, which is only possible to reach through questioning and putting it to test. On its part, the advancement of knowledge propels the development of culture, creating new technologies like the printed text that helped to disseminate knowledge far from where it was produced. In the same measure that the advancement of knowledge propels culture, this advancement has had a lever impact over the mind, which is being able to start its learning at increasingly advanced stages, thanks to the technology that favors it.

In summary, there are strong indications coming from Neurophysiology that mind and culture have its origin at a physical base, in the case, of mirror neuron systems – for as everything points towards it – it is through their action that comes inter-subjectivity, an essential component of culture and language. But, at the same time, the effect of culture, language, and representational structures as a whole are evident over the way in which the human cognitive apparatus functions.

Final Considerations

To conclude, we must assure that we do not intend to ignore important differences between the examined fields of knowledge, their theoretical origins, their objectives and specific research questions. On the contrary, what was sought after through this analysis was a preservation of coherent connections in each one of the fields, seeking only the possible articulation and approximations in order to deepen knowledge about cognition and social learning.

In one side, we have Neurophysiology of Interactions, having mirror neurons as their object, and a reflection about the implicit role that action has over their functioning. In other words, it is seen as a principle in which social connections may be established and developed. We have also seen that such bonds have their origin in imitation, whose function would be to promote social interaction between offspring and caretaker. This will favor learning through observation that will lead to the acquisition and syntonization of other people's responses. On another side, we have Cultural Psychology having inter-subjectivity as its object, which is funded on an innate disposition to meet the other. This is mostly defined as an explicit, representational capacity necessary for sociability, affectivity and culture itself – as we have seen with Bruner's affirmations.

For Gallese (2007) – author referenced in the discussions presented in the field of Neurophysiology – the embodied simulation process induced by mirror neurons would not only be present in the most simple and primitive social cognition mechanisms, like those involved with empathy, but also at the base of more sophisticated processes, like attribution of mental states to others, and in language itself. However, he also highlights the singular importance of narratives, like Bruner, for a complete competence of the use of popular psychology, a system through which people organize their experiences in the social world, their knowledge about it and the exchanges that they maintain with it (Bruner, 1990/2002).

For such placements, we have aligned contributions from considerations made by Corballis (2009) and Donald (1993) regarding the co-evolution of the mind, culture and language – from a more corporal, primitive and implicit level to a more advanced and symbolic one – from evidences found in Neurosciences, Paleontology, Linguistics and Anthropology. These considerations fortify the thesis defended by Neurophysiology about the existence of a corporal support for initial psychological functioning, like the mirror neuron system here examined.

Thus, even if there is much left to be researched and discussed, all these contributions seem to allow for an approximation that shows itself promising in terms of better understanding of the considered phenomena.

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