



Children’s Sociability in Institutional Contexts: Theoretical Reflections on Cognitive Development Within Peer Interactions

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Abstract

Human beings are constituted through the presence and actions of others whom they encounter during the course of their lives. We are constituted by all the interactions we enact in different social contexts and through all the meanings we create together about the experiences we share. Therefore, in order to understand the ontogenesis of cognition, one must understand how meanings are constructed with the others we encounter. A substantial amount of research has addressed how infants and toddlers—when in interaction with adults—are able to understand others’ actions and engage in social dynamics by coordinating and regulating adults’ actions. This knowledge has advanced the field of developmental psychology significantly. However, not many efforts have been made to understand the origins of social cognition via peer interactions or explore how peer interactions constitute cognitive development. In this theoretical article, we use the microanalysis of three peer interaction episodes to discuss how the constitutive role of peer experiences can be analysed beyond isolated individual processes. The encounter, the situation and the social and relational process are used as a unit of analysis. This analytical approach considers the contributions and insights provided by the enactive theory, which offers a perspective to understand the processes of cognitive development in interactive experiences.

Keywords Peer interactions · Children’s sociability · Intersubjectivity · Embodiment

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Introduction

Investigations about the ontogenesis of human cognition have been conducted for almost a century from different theoretical and methodological perspectives (Bandura 1977; Bruner 1983; Hunt 1980; Piaget 1987; Stenberg 1979; Van Dijk 1980; Vygotsky 1978, 1995; Wallon 1945). Among the diverse theoretical approaches, socio-interactionism is recognised as a fundamental framework that has influenced significantly the research conducted in the fields of psychology, education and social sciences. The socio-interactionist viewpoint holds that social interactions and relations are the constitutive pillars of the complex functions of human cognition (Bruner 1983; Vygotsky 1978, 1995; Wallon 1945). Human beings are constituted through the presence and actions (mediation) of others they encounter over the course of their lives. In other words, we are constituted by all the interactions we enact in different social contexts and through all the meanings we create jointly about the experiences we share. Therefore, in order to understand the ontogenetic origins of cognition, one must understand how meanings are constructed with all the different others we encounter, within our social, biological, historical, cultural, political, material and other spheres of existence (Rodríguez 1999, 2006; Rossetti-Ferreiro et al. 2007; Tomasello 1999; Trevarthen 1979, 2015). This, undoubtedly, is a demanding task.

In this study, we examined how meaningful engagement constructed through/in experiences of peer interaction, since a very young age, is constitutive of human cognition. Accordingly, we dialogued with the notions of embodiment, enaction and situatedness (De Jaegher 2010, 2013; De Jaegher et al. 2017; Reddy 2008, 2010), and supported by a microanalysis of three different episodes of peer interaction, we discussed the elements (e.g. coordinated, collaborative and communicative acts) that reveal the intersubjectivity among small children. Our analysis went beyond individual processes (i.e. regulation of behaviour from A to B) and used the encounter, the situation and the social and relational processes as a unit of analysis to understand the processes of cognitive development.

Peer Interactions in Ontogenetic Development

Since the 1970s, there has been a growing interest in forms of sociability among children (Pedrosa and Carvalho 2009), and research has shifted away from the focus on adult-child dyadic relationships to explore the implications of peer relationships in developmental processes. As a result, a solid corpus of theoretical and empirical studies, from diverse frameworks, has evidenced peer relations as a *sine qua non* condition for infants' social cognitive development (Berndt and Ladd 1989). With technological advances allowing simultaneous analysis of individual, dyadic and group variables (Bradley and Smithson 2017), and by analysing children's interactions and relations, scholars have expanded the discussion about the different levels of complexity in children's social experience of participation in their peers' lives (Rubin et al. 2008).

Within the specific field of early childhood, new studies have shown that infants and toddlers interact with peers from a very early age (Amorim et al. 2012), highlighting differential patterns of communicative and expressive resources (Mendes and Seidl-de-Moura 2009) and specificities in the development of social engagement (Costa and Amorim 2015; Moura et al. 2020). Other studies, discussing intermodal sensorimotor processes with synchronisation and coordination of actions, have shown how babies' interactions promote advances in children's ability to imitate their social partners, and through imitation, their

behavioural and communicative repertoires expand (Bussab et al. 2007; Ferreira 2017). In the same way, objects, toys and even the peer's actions have been shown to be attractive to infants, allowing, for example, the establishment of baby-baby-object interactions, which are considered fundamental for the development of joint attention (Costa and Amorim 2015) and coordinated joint engagement (Moura et al. 2020). Therefore, it is widely known that interactions between children provide rich opportunities for developing interpersonal skills such as support, cooperation, empathy, imitation, learning and a wide range of children's competencies (Rubin et al. 2008). Thus, the developmental significance of peer experiences is unquestionable (Parker et al. 2006).

On the basis of a critical analysis of the literature on peer interactions and relationships, Rubin et al. (2008) identified two important gaps: first, the current studies should seek to understand how interactive elements affect peers in different ways (i.e. how these experiences of interaction differ from child to child), and second, although friendship, peer acceptance and peer network, among other topics, can be studied extensively, very little is known about the specific experiences of sociability, which justifying questions such as what do children learn from these relationships? and what do these experiences provide to children? While these questions and proposals are very important and should be considered for further investigation, in our view, these issues still lean towards an individualistic perspective of implications of peer encounters. It is observed that the focus on the sociability of small children has been addressed via a perspective that centralises cognition as a process happening inside each (individual) organism (Amorim et al. 2012). Thus, even though cognition is a social phenomenon, the processes are discussed from the perspective of what the individual is able to think, express and do. Individual differences in peer experiences, individual patterns of adaptation and maladaptation when interacting with another child and the attribution of meanings to each other's actions are analysed to determine the variation in success or failure of peer adjustment.

To mitigate the overemphasis on the individual perspective, we agree with previous studies that have pointed to the need for amplifying how an infant's sociability—ability to engage in meaningful interactions—can be analysed by recognising the relevance of peers since an early age (Amorim et al. 2012; Bradley and Smithson 2017; Bussab 1997; Carvalho and Rubiano 2004; Rubin et al. 2008; Parker et al. 2006; Viana and Pedrosa 2014). Further, we understand that when broadening the view on the forms of child's sociability, it is necessary to consider intersubjectivity as the space for the construction of meaning and, beyond individual mental processes, treat the experience of the interaction per se as a unit of analysis (De Jaegher 2010; Reddy 2010). Seeking to contribute in this direction, we aim at discussing the constitutive role of peer interaction, going beyond the individual processes of A and B (i.e. beyond the focus on the regulation of behaviour from A to B), and highlighting the encounter, the situation and the social and relational process as a unit of analysis to understand the constituent aspects of human cognition. Our approach frames phenomena that are considered essential for defining sociability (i.e. coordination, collaboration and communication) under a traditional developmental psychology perspective; however, it takes a different route to understand the emergence of such processes within peer interaction. We introduce an embodied footprint into the analysis, stressing the role of the body in children's sociability.

The Role of the Body and the Experience of Interaction as a Unit of Analysis

Socio-interactionist assumptions suggest that the constitutive processes of the subject are anchored in their actions and interactions with the physical, social and cultural world. Further,

development is understood as a product of interactions between individuals and their environment (Rodríguez 1999, 2006; Rossetti-Ferreiro et al. 2007; Tomasello 1999; Trevarthen 1979, 2015). According to Werebe and Nadel-Brulfert (1999, p. 19), it is ‘thanks to interindividual relations of sociability that your life opens up to development’. Thus, a discussion on child development under this approach implies reflecting on how interactions and experiences constitute this process. But then, what is required for a person to act and interact in this physical and sociocultural world? If cognition takes place in the social world, what does it mean to consider the experience as a unit of analysis? To conceptually clarify what we call ‘experience’, it is necessary to explore how this interaction and action take place in the context of the person in question. In this sense, we bring to the dialogue theoretical discussions and empirical studies in the field of embodied cognition to highlight two important aspects: the role of the body in cognition (Glenberg 2010; Uithol and Gallese 2015) and the understanding that interaction is not the summary of two individual perspectives but the co-creation of a new perspective shared by two or more people (De Jaegher et al. 2017).

That the body plays an important role in the ontogenesis of cognition is not a new knowledge. Piaget (1987) devoted much of his research to understanding the adaptive mechanisms involved in knowledge construction. According to Piaget (1987), from birth, children engage in action because their own biology drives them to act. Therefore, intelligence, from a Piagetian perspective, is a particular case of biological adaptation in which the child interacts with the physical world and, through adaptive mechanisms, builds knowledge about this world (Rodríguez 1999). Vygotsky (1978, 1995), breaking the dualist tradition of the physical world versus the social world, and understanding human beings as biologically cultural, had already noted that ‘man’s behaviour is formed by the peculiarities, biological and social conditions of his birth’ (p. 63). In this sense, it is constituted by the possibilities of perceiving and acting (moving) in the world, marked by a social historicity. Under this perspective, the body plays the relevant role of a stimulus receptor, which impacts the process of cognitive development (Vygotsky 1978, 1995). Within the realm of the body (biological element), the maturation of the central nervous system is responsible for the development of low level or primitive cognitive functions, such as perception, simple memory and involuntary attention, but the achievement of higher cognitive operations can only occur through social factors—psychological tools mediating thoughts, feelings and behaviour (Lindblom and Ziemke 2003). Cognition is understood as a process that starts first at the social level (between people-interpersonal) but has to later be internalised as an intra-psychological operation. Therefore, even despite being understood as a socially dependent phenomenon, cognition is internal, symbolic and framed in the individual’s mental operations.

With the development of research in neurosciences and increase in studies on how infants understand other people’s actions (see Uithol and Paulus 2014), there is a wide range of evidence pointing to the constitutive role of the body in social cognition (Uithol and Gallese 2015). As Glenberg (2010) states clearly, to fully understand how the brain works (i.e. how the cognitive functions operate), one has to acknowledge its embodiment—the brain lives in a body, uses a body and gets all its sensations through the body. Therefore, the way we experience the world depends on our movement in it, because the only way that the brain talks to the environment is through the body. Although the physical body is essentially individual—it belongs to a single cognitive system—the experiences it entails surpass its singularity, thus resulting in a self that is social. Our bodily nature shapes our perceptions and allows us to construct a conception of others as other selves, incarnated in sensorimotor and

capable physical bodies with capacities and experiences similar to ours (Gallese 2014; Uithol and Gallese 2015).

Moreover, embodiment captures the idea of and emphasises how cognition develops in order to control a body rather than engage in abstract thought and how specific types of cognitive operations, such as action selection, are fundamentally embodied (Uithol and Gallese 2015). Embodied perspectives also assert that instead of passively receiving sensorial inputs and processing them, the brain actively uses the body to sample those inputs under all the conditions that having a body implies (i.e. its physiological characteristics, its situatedness, its history, etc.) (Di Paolo 2005). This means that having a specific body not only determines the access one may have to a certain environment (e.g. a baby that cannot walk but can sit on the floor is able to reach only the toys that are close by) but also defines the actions that one is (or not) capable to perform and the sensations one is able to perceive (e.g. a toothless baby who is unable to chew cannot experience the crunchiness of crackers). It is through these possibilities and limitations that individuals interact with the world. Therefore, when bringing embodied approaches to the analysis of peer interactions in natural contexts, particularly those of small children (0–4 years), we highlight the possibility of prioritising the elements that are related to the body—skills needed for action attunement (e.g. motor and fine-grained perception) and for the development of such attunement skills with reference to the first and progressive signs of action understanding.

In line with this thought, Riviero (2003) calls for an approach to understand intentional communicative acts among small children—an approach that overcomes the divide between the mind of the sender or receiver, which make it a purely mental and individual issue, and focuses instead on the social, relational and observable process. For Riviero (2003), communicative intentionality is a hallmark of observable and contextualised human interaction. This is not restricted to cognitive processes that are independent of concrete actions and interactions but consider an embodied and personified process, situated in an interpersonal exchange that generates meaning. In this sense, it becomes necessary to elaborate a different way to approach and analyse interactions in natural contexts that focus on intersubjectivity by considering the experience of interaction, i.e. an experiential grid of dynamic, bodily, self-enacted differentiations (De Jaegher et al. 2017). According to Reddy (2008, 2010, 2012), one of the ways to rethink interactions between young children is by focusing on the perceptual processes of the experience and analysing them from a first- and second-person perspective (self and other perspective). This requires the researcher to bring in their own perceptions of the data. This approach focuses on what it takes for intersubjectivity—as a meaningful engagement with the environment—to emerge and considers the body in action a display of this process (Reddy 2008). Based on similar principles, the work of De Jaegher et al. (2017) offers theoretical and methodological support to an approach of looking at interactions between peers that evidences the construction of this intersubjectivity. By considering three references of perception (i.e. self, other perception and the modalities of sensing, feeling and thinking), De Jaegher et al. (2017) propose a systematic analytical process to determine what happens in the in-between of the interaction. Although we did not apply their method (PRISMA) fully, the framework has inspired our analytical pathway, leading us to believe that focusing on the perceptual process of the experience reveals important aspects of how peer interactions are important for the development of children's sociability. Considering the dialogue constructed so far, in the following section, we present the analysis of three episodes of peer interaction, illustrating the possibilities of using the experience of interaction as a unit of analysis to investigate development.

Peer Interaction in Analysis

The episodes we present in this paper were selected from three different databases of video observations of child-child interactions in natural environments (see Table 1). The databases were constructed in previous and parallel studies conducted independently by each of the three authors, in three different institutional contexts: institutional foster care service (in children's shelter mode), kindergarten and day-care centre. The studies (Ferreira 2017; Mieto and Cavaton 2015; Moura 2012) shared the theoretical basis of a socio-interactionist framework and the interest in micro-genetic analyses of interactive episodes. They sought to understand processes of cognitive, communicative and socio-affective development of children in contexts of collective care.

It is important to highlight that in Brazil, these three institutional contexts have distinct history, characteristic and organisation modes. Foster care services are provided by specific institutions, which are configured as an exceptional temporary setting for protective measures for children and adolescent in vulnerable condition (e.g. victims of abuse, violence or any forms of neglect) waiting for reintegrating into their family of origin or a substitute family (adoption). Institutional foster care can be offered in two modalities: (1) foster shelter, institution with capacity for up to 20 children/young people, or (2) foster home, residential unit with capacity for up to 10 children/young people, where at least one caregiver resides. In the present study, data comes from a foster shelter for children aged 0 to 3 years (or up to 6 years, in the case of groups of siblings). Although foster care is historically rooted in the philanthropic and welfare activities of religious entities, these institutions are nowadays part of the National Social Assistance System (SUAS) and seek to strengthen its identity as a social-educational community (Moura 2017).

Regarding the reality in day-care centres and kindergarten, in Brazil, these institutions are part of early childhood education and care system, and like other Latin American countries, they originated with welfare practices that emphasised different care routines to keep children safe while their families were working. With the advancement of studies on children's development, the emphasis on educational processes raised, and access to the system became a children's right. Day-care centres and kindergarten can be either private or public institutions. Day-care centres are responsible for offering care and developmental programs for 0-to-3-years-old infants. The organisation of care services for this age group is under the responsibility of municipalities, which then regulates the functioning of such institutions. As for kindergarten, the main goal is to provide instructive programs for specific age groups of children, usually targeting 3-to-5-years-old children. Most kindergarten programs have one

Table 1 General information about the database

Episode	Place, year	Age groups	Rights for usage of the data
Peer interaction in institutional care (117 s)	São Paulo, 2010	0–3 year-old	University of Sao Paulo, Department of Psychology (Moura 2012)
Peer interaction in a day care (93 s)	Brasília, 2016	1–3 year-old	University of Brasília, Department of Psychology (Mieto and Cavaton 2015)
Peer interaction in kindergarten (115 s)	Minas Gerais, 2018	3–5 year-old	Tampere University, Faculty of Education and Culture (Ferreira 2018)

certified teacher and one teacher assistant for each class group, and they can receive a number of 15 to 25 children in the same classroom. The focus on educational practices has become central to the functioning of kindergartens, demanding the reorganisation of the institutions and a transition period for employees to update their education and training. This service is under the responsibility of the municipalities, which then regulate the institutional organisation and assess the quality of the service being offered. Therefore, the infrastructure, the organisation and the service itself can vary significantly depending on the area and the municipality where the institution is located.

In this way, we acknowledge that, as important contexts of development and socialisation in early childhood, collective care environments represent, in their own way, challenges and provide opportunities for open peer interactions among small children. The combination of the three institutional settings highlights distinct ways in which interaction can occur.

After sharing these databases, we chose three interactive episodes, one from each context, using the following selection criteria: a scene that contemplated an interactive process between peers that entailed reciprocity, mutuality in the direction of behaviours and coordination (joint and mutually directed actions). The analysis was carried out via ELAN, a free software for video analysis (Brugman et al. 2004), which allowed us to isolate different types of movements (e.g. locomotion and object exploration), speech and gaze direction, as well as to identify their sequential relation with other's movements within the episode. The software improved the analysis of actions, movements and verbal and non-verbal expressions within the interactions and allowed us to apprehend how they occurred throughout the recording, illustrating the dynamics and (trans)formations of the interactions over a period of time.

The microanalysis of each episode began by identifying the movements of the participants within a threshold of 5 s. Using this material, and inspired by the embodiment proposed by De Jaegher et al. (2017), we focused on the perceptual process of the experience and constructed a grid of experiential dynamics from our perceptions of the children's sensing, feeling and thinking (see Fig. 1). We focused specifically on the children's movements to identify what each child could sense given their situatedness in the environment—what the child could sense and feel and how this manifested in movements/actions. We identified the origins of the engagement that led to joint and mutually directed action. In the sequence, we also analysed the moments where one child's movement (e.g. sitting in front of and looking at the peer) became part of the peer's field of senses (e.g. the child enters the peer's visual field and establishes a sensorial contact-gaze) or intersected with the peer's movements, creating a situation where intentions towards the other were evoked, i.e. a situation that demands one to respond and engage in a way that no other circumstance would. Those particular moments were considered as significant engagements (Reddy 2015)—the dynamic evidencing the intersubjectivity being constructed in interaction.

The analysis of the perceptual process of experience was carried out under an inductive model. That is, video data was analysed without the selection of predetermined observable behaviours. The researchers applied their own references of perception to different aspects of the interaction (e.g. moving, exploring objects, touching, etc.) (De Jaegher et al. 2017). Thus, each interaction revealed, in the course of its life, a specific significant engagement. The researchers paid attention to what emerged in the in-between and constructed an understanding of what, in that particular interaction, supported intersubjectivity. Each researcher had their own perception, stemming from not only their way of sensing, feeling and thinking but also from their knowledge of specific dynamics and processes of sociability as well as the institutional setting where the interaction was recorded. The individual analyses were plotted

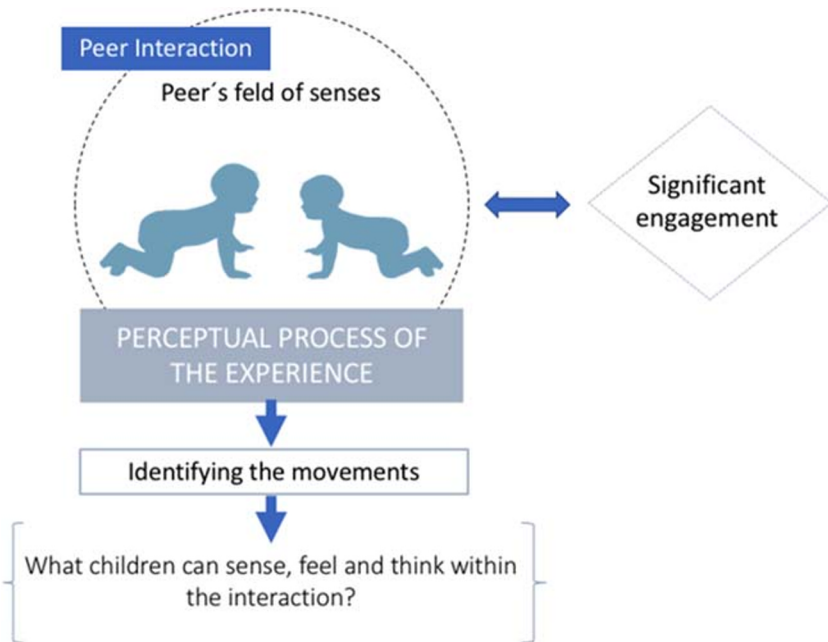


Fig. 1 Diagram of microanalysis. Source: produced by the authors

on a matrix of perceptions, which were then questioned, compared and refined to construct the final outcome of the interactions investigated.

In the following section, we present a detailed description of each episode of interaction, followed by the results of the analysis and discussions that are related to each context.

The Episodes

Episode 1 Peer interaction in institutional care—Construction of coordinated acts

The reported episode took place in the balcony of an institutional care facility (approximately 45 m² of open space furniture only with a couple of plastic chairs), which was responsible for the social care of children from 0 to 6 years old. The duration of the episode was 1 min and 44 s, and the participants were two babies: Lucas (9 months and 26 days), who was in a walker, and Rosa (8 months and 7 days), who was sitting on the floor. Together with the babies were other children (similarly aged) and three adults (one staff and volunteers). The adults played a secondary role in the interaction.

Lucas (sitting on a walker) looks at Rosa (sitting on the floor on the other side of the room) and moves towards her. Rosa, realising Lucas' approach, turns her body towards him (resting her hands on the floor and turning her body) and reaches for Lucas's walker, pulling the object towards her and bringing him even closer. Rosa looks at Lucas' walker carefully, and at the same time Lucas (from a standing perspective) gazes at Rosa (about 6 seconds). Lucas babbles ('ehhh ... ehhh ...'), raises his arms, claps his hands and turns and moves away from Rosa. After approximately 3 seconds, he stops the walker, turns

his body and looks back at Rosa, smiling. Rosa had followed Lucas's movements away from, and when he looks at her, she returns his gaze. Both infants start to move towards each other – Lucas with the walker and Rosa crawling. Lucas mumbles and smiles while sliding his walker towards Rosa. Rosa crawls until she can touch the walker (approximately 3 seconds). Seconds later, Lucas starts to move around with the walker again, coordinating movements and smiles – walking backward and forward, keeping a close eye on the girl's face. In turn, Rosa begins to follow Lucas' movements, turning her body, in coordinated movements, towards Lucas's walker and crawling towards him. Continuing the backward and forward movement, sliding around Rosa, Lucas jumps, smiles and keeps a close eye on her. And Rosa attempts to reach him, crawling and stretching her arms until she sits down again, halting her gaze under Lucas's face. At this moment, Lucas approaches her, looks at her and stays close, so Rosa manages to hold and pull the walker. Clutching the walker, Rosa moves her arms, as if drawing the walker close and moving it, controlling its proximity and distance. Lucas continues to watch Rosa. Suddenly, Lucas stammers away and slides across the room with the walker. Rosa follows him again, with movements and glances. Rosa keeps her attention focused on Lucas's movements as he glides around. Lucas keeps looking at Rosa, while moving, raising his arms and babbling. Suddenly, Lucas runs towards Rosa and bumps into her. At that moment, Rosa looks at her feet and then at Lucas. In the background, the volunteer says to Rosa, 'Aiii! my little foot... how bad!' She then tells Lucas, 'Don't run!' Rosa listens and then turns her body, resting her hand on the floor and looking at the volunteer. Noticing Rosa's gaze, the volunteer continues, 'Hey, didn't you want to leave your walker? You're crying to go to the ground...'. Rosa turns her attention from the volunteer and gazes back at Lucas, who is still sliding the walker across the balcony while smiling at Rosa. Rosa crawls back towards Lucas, who runs off, smiling and babbling, continuing the previous dynamic.

In this episode, from Lucas' erect point of view, he could perceive the amplitude of the space, how it was arranged, the different objects placed on the floor and other people occupying different positions. At the same time, Lucas was also able to feel the constraints of the walker and how his feet barely touched the ground. He was thus forced to use his body to push himself from an inert state to start walking around the space. Lucas was then able to identify Rosa as an element of interest, establish the possible trajectories for locomotion and place in action the movement towards her. The interest for Rosa (or the intention to interact with Rosa) is evident in the pairing of the gaze direction, its fixation over time, the direction of the movement towards the peer and the cessation of the movement when Lucas reached Rosa's feet.

In parallel, sitting on the floor in the middle of the room was Rosa. From her seated position (Rosa could not stand on her own yet), her perceptual field comprised the toys immediately in front of her and the amplitude of the space. Her position also allowed her to feel the body tension necessary for her to continue sitting or to move (crawl), apart from the material features of each object (toys) in front of her. Her actions were then related to the exploration of this immediate material world. When Lucas started to approach her, the sounds made by the approaching walker and Lucas' laughter immediately entered Rosa's perceptual field. She changed her position by placing her hands on the floor and turning her body towards her peer, seconds before he reached where she was (anticipating his presence). With the encounter, Rosa could then perceive specific features of the object (shape, colour and height of the walker), and

by touching and pulling it, she could perceive the density, weight and texture of its metallic structure. Like Lucas, Rosa also showed interest in the interaction by maintaining eye contact, changing the orientation of her own actions towards exploring the walker and, finally, by following Lucas. In the episode, Rosa's exploration of the world was constrained by the position of her body, which limited her perceptual field and the areas she could reach through movement.

From that point on in the episode, new elements were incorporated. Making use of the walker that facilitated displacement through space, Lucas began a cycle of movements (distancing and re-approaching). The motion was interspersed by a series of gazing at the partner, smiles and vocalisations. With the exchange of eye contact, Rosa once again modified her actions, this time initiating her own movement towards Lucas (crawling at different speeds). The physical contact established between Rosa and Lucas' walker materialised the encounter, but it was the following dynamic and particularly the eye contact between the children that materialised the engagement. Gaze has been one of the most observed facets in interactions among babies, enabling them to follow and respond to actions or movements and to communicate to others their interests and preferences—what could be interpreted as their intentions (Amorim et al. 2012; Moura et al. 2020). However, what we aim to highlight with this episode is that Lucas' approximation (accompanied by gaze, smile, vocalisation and movement) triggered or evoked a response from the peer (Rosa), and as described by Reddy (2015), we find that 'it is in the infant's responses to others' infant-directed intentional actions that others' intentions first become meaningful' (p. 24). Thus, the engagement necessary for intersubjectivity can be strongly perceived by the analysis of the intentions produced by the interaction, which resulted in coordinated actions.

The children's intentions of being and doing together were constructed throughout the interactions. Both the children showed positive affection—an emotionality that sustained the continuity of the interaction (Gazzaniga et al. 2018) and enabled the construction of coordinated actions and expressive repertoires that composed the continuity of the dynamic (Pedrosa and Carvalho 2009). While Lucas showed enthusiasm during the approach (smiling and raising his hands under his head as he took a few leaps), Rosa sustained her attention and movement regulation during the encounter. According to Viana and Pedrosa (2014), coordination of mutually directed actions between infants (evidenced by actions towards a shared goal, such as touching each other) promote the development of cognitive skills important for recognising each other and oneself as an intentional agent, in addition to prompting the acquisition of new resources and testing of their limits. Interactions with the other (in this case, with the peer) are the arena for developmental processes, where multiple elements interrelate. Therefore, looking beyond the individual behaviours of each of the interactive partners, and what each child could perceive in particular, we highlight what was built between the children through engagement: reciprocity, synchrony, rhythm, complicity and simultaneity. All these elements—of social order—could only be constituted in the interpersonal space; they could only be identified from the encounter, from the perception of responsiveness and mutual direction.

This episode of peer interaction allows us to discuss how the experience constituted within the interaction between Lucas and Rosa—as a set of movements (distances and approximations), affects, touches and sensations, among various sensorimotor information—enabled the construction of meaning, knowledge and the (trans)formation of thought. As highlighted by Smolka (2004) and Amorim and Rossetti-Ferreira (2008), enmeshed in relationships, the bodies that sense, feel, experience and know each other become signs. Movements become communicative gestures, and sensations and feelings are opened to new sense-making. This

sense-making is inescapably made in togetherness; it implies mutual agreement, stabilisation as well as differentiation and breakdowns. Therefore, for Smolka (2004) and Amorim and Rossetti-Ferreira (2008), the possibilities of sense-making (process of signification) are anchored in interpersonal relationships or social practices. In this sense, the interaction between Lucas and Rosa captures an experience of interpersonal engagement—a search for each other where attentional, emotional and motivational processes that are fundamental to child development can be witnessed (Bussab et al. 2007).

Episode 2 Episode of peer interaction in a day-care centre—Construction of collaborative acts

The episode was recorded in the yard of a kindergarten (approximately 15 m²) and involved five children (1–2-year-olds) and two educators. On the upper left of the frame, Dudu was sitting on a bicycle, Fred was sitting on the floor and Olivia (educator) was sitting between them. On the right, Vitoria and Erica were sitting on two seesaws, Jen was standing next to the fence and Marcia (educator) was standing among the children. This episode draws attention to the interaction established between Erica, Jen and the educator Marcia.

With Marcia's (educator) help, Jen gets off the tricycle and is standing by the fence. Then, Marcia and Erica (who is on a rocking horse) look at each other. Marcia moves towards Erica and says, 'Oh my! Do you want to ride the tricycle?' On noticing that the educator is approaching and speaking to her, Erica raises her arms so that Marcia can pick her up. Marcia lifts Erica and, placing her on the tricycle, says, 'Do you want to ride the tricycle?' Marcia began to push the tricycle. Jen keeps watching. Erica looks down at her feet, observing the movements of her legs on the pedals, as Marcia pushes her saying, 'Go Erica... Go Erica...'. Jen watches Erica and Marcia's movements carefully. When Erica moves away from the educator and stops, Jen goes towards Marcia and begins to push the tricycle on which Erica was seated. Marcia says, 'Go Jen...'. When Jen succeeds in moving Erica's tricycle, both educators applaud, exclaiming 'Ehhhh'. Erica looks towards the pedals and observes the movement. The tricycle is headed towards a wall, and Marcia intervenes to change its direction. She then says to Jen, 'Back here, see... (pointing towards the back of the tricycle)'. Marcia continues, 'Come here Jen, come to the back, look.' As the educator is talking and pointing, Jen watches Marcia's gestures, and Erica keeps her feet on the pedals and her hands on the handlebars. Erica looks at Jen quickly. With the educator's encouragement, Jen pushes the tricycle, while Erica releases her hold over both handles and lets her body lean on the object. Seeing Erica's posture, both the educators (Marcia and Olivia) speak in unison: 'Careful, Erica! Careful!' Marcia takes Erica's hands and places them on the handlebar, helping the child regain a firm posture. The other educator (Olivia) says, 'That is it, Erica!' While Erica holds the handlebars, Jen pushes the tricycle towards the protection grid on the opposite side of the yard. At this point, Marcia intervenes (grabbing the tricycle and changing its position) and prevents the tricycle from hitting the grid. Jen walks towards the front of the tricycle and exchanges gazes with Erica, who then vocalises ('ahh') some irritation. Marcia, who is observing, immediately says, 'Let her ... she's helping you!' Jen starts to push the tricycle again, but now in the opposite direction: from the front to the back. Jen tries to sit on the tricycle, but Marcia leads her to the back of the object and repeats the instructions to push from that particular end. Erica is attentive to the handlebars and the pedals. Jen resumes the movement and continues pushing Erica.

In this episode, Erica focused on the movements of the tricycle for the majority of the time. From Erica's point of view (sitting on the tricycle), she was visually exploring the different parts of the object and how they behaved when the tricycle was moving (going forward) or stationary, particularly the action of the pedals, handlebars and wheels. Erica could feel and explore her own posture on the tricycle: standing erect, holding the handlebar firmly or gently, releasing her hands and bending back. She could perceive through her posture how the tricycle moved. In addition to this sensorimotor experience provided by the interaction with the object, Erica could also perceive her immediate social field, which was composed of Jen's and Marcia's body-to-body actions as well as Marcia's responsiveness, gestures and verbal commands, encouraging her to hold on to the handlebars and to sit firmly.

Close by, Jen was also attentive to the tricycle's movements, but unlike Erica (who was sitting on the object), Jen perceived the movement from the point of view of an outsider—one who stands on the premises and pushes/pulls the object. This position implies another sensorial experience, constituted by the simultaneous walk-push movement and the specific senses of weight, strength, traction, endurance and friction with the floor. Jen could also perceive the physical space formed by obstacles (such as the walls and railings), which imposed restrictions on circulation. Other people's actions and reactions were also within her social field, such as Erica's and Marcia's responses. Instead of focusing on all the possible stimuli and sensations in this interaction, here we acknowledge that sensing organs are organised into systems (Souza 2016), and as such, when Jen pushed the tricycle, she could feel her own actions and movements, the object, the context, the presence and actions of others (especially Marcia and Erica), simultaneously.

In this interweaving of various perceptual pathways, there was a range of experiences involving 'alteration in the states of tension, seek[ing] for balance maintenance, reorientation of the direction of the body with tonic compensatory muscle reactions, and resizing of body and its spatial relations with the environment' (Souza 2016, p. 12). This whole set of sensorial and perceptual experiences constituted the joint activity of involving the social other. Their actions towards the object represented an opportunity to recognise physical and social materiality. In line with the viewpoint of Coelho Jr. (2003) and Furlan (2004) explain that before existing on the mental sphere, the other exists in the concreteness of what is perceived; the experience with the other enables a level of interpersonal perception, which is dependent on their own embodiment in that environment (Amorim & Rossetti-Ferreira, 2008). Before becoming an idea or a thought about someone, the encounter with the other happens through perception—'the other's body is a perceived object, and intersubjectivity is then understood as 'co-perception'' (Coelho Jr. 2003, p.198). Thus, the emphasis on the intercorporeality (Merleau-Ponty 1960) refers to the simultaneity of being the subject and object of a sensorial act (e.g. touching and being touched during a handshake).

Within this complex perceptual field, the action that engaged both children in the interaction—pushing the tricycle—allowed the construction of collaborative acts. As the interaction unfolded, we could observe Jen approaching the tricycle in different ways (e.g. holding the handle from the side, steering the wheels from the front or pushing the cycle from the back), exploring the possibilities of its movements and the roles she could play in the interaction. The changes in her actions were not only regulated by the tricycle's movements but also by Erica's coordinated and mismatched actions and Marcia's interference in the process.

In this episode, the construction of collaborative acts within the interaction is heavily supported, or even guided, by the adult's interference, which highlights the daily cultural

dimension present in children's institutional spaces. Through demonstrating the use of the object, providing instructions about what to do (e.g. 'Back here, look... back here, look'), naming objects and its parts, interpreting the actions of the children (e.g. 'Do you want to ride a motorcycle?') and producing gestures that circumscribe the interaction, Marcia's mediation introduces new sensorial stimuli for both the children. This mediation presents the conventionally established use of that object, conveys its socially shared function by triggering different semiotic mediators and facilitates the presentation of the cultural world (Cardenas et al. 2014; Cavalcante et al. 2018; Palacios and Rodríguez 2015; Rodríguez 1999; Rodríguez 2006). As a play dynamic, the tricycle has a certain conventional (culturally shared) use, which is related to its transport function, and a symbolic use, which is linked to its similarity to a motorcycle (a symbolic motorcycle). This episode reinforces Rodríguez's (1999, 2006) statement that objects are not only the context but also a part of the communication with the other.

In addition to the focus on interaction with the object, it is noteworthy that Marcia supported peer interaction by demarcating the contours of the physical space (encouraging and directing the transport route, preventing the tricycle from colliding with the wall and the grid) and helping them build the boundaries of the coming and going with the tricycle. Verbally (using linguistic signs), Marcia indicated to Erica how she should sit, indicating which posture is considered correct and safe ('Careful, Erica! Careful!', 'That is it'), and guided Jen how and from where she should enact ('back here, see... back here, see'). Thus, the educator had a circumscribing role in the children's perceptual experience, and she supported the continuation of coordinated action (e.g. when Jen interrupted the pushing action, the educator, with gestures and speeches, insisted that she resume the activity). She interpreted and named the coordinated actions as a collaborative act (e.g. when she said 'let her... she's is helping you'), which is culturally valued aspect in peer interactions.

Episode 3 Peer interaction in a kindergarten—Construction of communicative acts

In this episode, Alex (a 3-year-old boy with a speech disorder) and Leo (3 years) engaged in a communicative interaction, in which Alex explained what happened to him a few minutes before. A classmate had thrown one of his sneakers on top of the slide and left him with just one shoe. Given his stage of development, Alex could not formulate understandable words or sentences. He used vocalisations (syllables of a word or just mumbling) and gesturing to express his feelings, ideas and desires. Leo was typically developed and was capable of expressing himself through speech. They had been peers in the day-care centre for approximately 9 months, sharing the same classrooms and playtime. They often played together and were considered preferred partners by the teachers.

Alex is sitting under the slide and, from a distance watches a group of children playing. Leo approaches Alex, sits under the slide and asks, 'Alex, what happened to your sneakers?' Alex turns his body towards Leo, looks at him for a moment, mumbles something (incomprehensible), points to his own foot, makes a gesture with his hands (extends his left hand up and makes a large circular movement) and says 'he pu'. Leo then asks, 'How are you going to get it?' Alex again makes the same gesture but now with his right hand and then with both his hands at the same time. Alex stands up and, while pointing towards the other slide across the yard (approximately 3 meters away) where a few are children playing, he says, 'The'. Then, he raises both his hands and, while gesturing, mumbles these syllables 'No... he pu... thro... the'. Leo looks towards

the other slide and then back at Alex (Alex is making another gesture). Immediately after Alex finishes gesturing, Leo says, 'He must have discovered them all'. Alex continues, now making a specific gesture with his right hand, placing his thumb and index finger close to each other and pointing to the top of the slide. At the same time as the gesturing, Alex mumbles syllables and sounds: 'lide', 'ta', 'the'. Leo asks, 'But where's the other sneaker?' Alex says, 'the' and at the same time points to the top of the slide. 'Fly?' asks Leo. Alex turns towards the bottom of the slide, points to the sides and to the top of the slide. He looks at Leo, mutters different syllables, walks towards Leo and touches Leo's chin gently, looking right into Leo's eyes. In the sequence, Leo looks at Mateus (another peer that has been observing them), turns his head and says, 'Lukas took Alex's sneakers and threw it on the top of the slide, we have to find his sneakers.'

In this episode, Alex and Leo established a communicative process that revolved around what had happened to Alex's sneakers. The interactive dynamic resembled those identified in adult-child proto-conversations (Delafield-Butt and Trevarthen 2013; Tomasello 2003; Trevarthen and Aitken 2001), but here, it enabled the construction of meanings between peers of the same age. From where Alex was positioned, he could see the size of the slide's structure (a plastic slide suitable for playgrounds), hear the sounds made by other children playing around and notice the presence of another child approaching him. As Leo approached him and sat in front of him, Alex's field of perception widened, and he could perceive Leo's gaze (which remained directed towards Alex's body or followed Alex's movements), body posture (directed at Alex) and voice intonation (which expressed interrogation). These elements of the scene supported Alex's response to Leo's questioning (a direct verbal interaction that demands an answer) and created the perceptual clues that invited Alex to communicate what happened. This set of behaviours in the sequence supported communication, even though there was no equivalence in the way of expressing thoughts (speech versus gestures and vocalisations).

In parallel, from where Leo stood, he was able to observe the totality of the courtyard, hear and see the other children who were constantly moving and how the toys were used. As he got closer to Alex, gestures, vocalisations (as verbal expression forms) and the absence of Alex's sneakers (referential object in the communication) became part of Leo's perceptual field. The interaction—as a process of regulation of behaviours—began when Leo noticed Alex's barefoot, but it was the active questioning composed by verbal utterances, gestures and an attentive gaze that demanded Alex's response, revealing a moment of meaningful engagement. In the sequence, by directing the body towards Alex and waiting for a verbal expression, Leo created the rhythm of the dialogue, providing a synchronisation of communicative expressions. The subsequent engagement allowed the narrative to materialise. Trevarthen (1993, 2005) explains that language is invented in the routine experience—it is a tool fabricated from collective human fantasy and learned by sharing. Sharing, in this case, is the result of interpretation of meanings (usually studied in the adult-child relationship) throughout the interaction. In this episode, one could say that Leo, who was already able to express himself through speech (structured and conventional use of language), interpreted (attributed meaning to) the gestures and vocalisations of his partner Alex, producing a shared understanding of the story. However, when analysing the experience of interaction, and not just the behaviours of both children in isolation, we can see the movements of progressive approximation, similar to the ones explained in the previous episode. The children are refining their senses, narrowing their perceptual field and not merely interpreting signs but producing and acting towards something that does not belong to the representative field of one or the other—

it emerges at the moment of interaction because it is significant to them in that interaction. This process is described by De Jaegher and Di Paolo (2007) as participatory sense-making. Here, the interaction goes beyond the production of A in relation to the production of B; it focuses on what is essentially important for the members of that dyad in the interaction itself.

Moreover, the construction of the communicative acts in this episode materialises the dynamic of approximation-distancing through a common communicative repertoire between the two children. In this repertoire, gestures, which were used throughout the interactive process, play an important role in engaging the peer and communicating the story. From a representational perspective, gestures add a spatial and imaginative component to verbal communication, and as they are not confined by the linear rules of the spoken language, they have the potential to create an open space of multiple ideas, which may be difficult to communicate through words (Novack and Goldin-Meadow 2015). In this episode, Alex's gestures contain the constituent elements of the narrative (they place where the story takes place, the direction of actions and the emotional content), and they are complemented by the verbalisation of syllables that are possibly related to the verbal signs (words) of the objects or actions narrated. Gestures construct proto-conversations and play an important role in maintaining joint attention with peers. Long before they acquire senses in the linguistic format, the interactive experience allows children to develop senses of a perceptive nature. As Furlan (2004) points out, through the development of motor activity, the perceived world expands progressively, especially in the case of young children. The foot on the ground, the weight of the other's body, the directed gesture, the cooperation and the agreement, domination or conflict are sensible experiences that constitute the circumstance of meaning as well as the faculty of thinking about something.

The learning provided by this interaction is directly related to the construction of peer cultural routines, which allowed both children to experience togetherness and the continuous amplification of signs that a communicative process demands. It is at this stage that it is understood that language can not only be an instrument, or mode of action, but the very process of the social constitution of man (Smolka 1995). It is also important to highlight that the children in the episode were preferred partners; that is, during the time that they spend in the day-care centre, these two children spontaneously choose to play together. Parker et al. (2006) revealed that friendship has been a recurring theme in studies on peer relationships. Considered a particular form of socialisation that favours exchanges between children, friendship enables the understanding of the different needs and social styles of various peers and favours the negotiation of objectives and goals (Rubin 1997; Rubin et al. 2008). According to the authors, the analysis of peer experiences is complex but necessary since it can reveal paths towards enhancing emotional support in social contexts.

Final Considerations

In this manuscript, we have sought to examine and discuss the experiences of peer interaction and how meaningful engagement constructed through/in it is constitutive of human cognition since a very young age. We started by providing a summary of how previous studies have addressed peer interactions, highlighting how peer interactions and relations enable rich opportunities for socio-cognitive development (Amorim et al. 2012; Parker et al. 2006; Rubin et al. 2008) and how within these interactions children construct peer culture (Ferreira et al. 2016; Lucena and Pedrosa 2014; Pedrosa and Carvalho 2009). Further, we emphasised

the need for analysing peer interactions from the complex viewpoint of experience—considering not only what is produced by each of the participants in relation to the other in the dyad (straightforward regulation of behaviour) but mainly what the encounter per se has allowed the participants to create together. For such an approach, we referenced socio-interactionist perspectives and theoretical and empirical studies about embodied cognition, focusing specifically on the evidence on the role of the body and particularly its action in cognition and how intersubjectivity guides this exchange (De Jaegher 2013; Reddy 2008). The views of embodiment offered new perspectives on the analysis of peer interactions in natural environments, supporting, in particular, the focus on perceptions, feelings and actions to reveal significant engagements.

In the paper, we presented three episodes of peer interactions in natural institutional contexts in Brazil, followed by their analyses and discussions. The different episodes allowed the identification of three different elements of how sense-making in peer interactions can reveal important cognitive operations, such as constructing coordinated, collaborative and communicative acts, even if it occur in distinct moments of the development. These three elements in this work are suggestive of the origins of one of the most complex forms of cognition related to social competence—our sophisticated capacity to engage with others (De Jaegher 2019).

Nevertheless, from a generic perspective, in all three episodes, we are able to identify, first, how other's 'goal-directed actions towards ourselves have a different phenomenal quality from that of actions towards other elements in the world' (Reddy 2015, p. 24). In other words, other's actions towards ourselves are relevant also to infants. Second, the process of signification in interactions among small children occurs through sensing, feeling and acting in the interaction. Since peers have an equivalent history and perceive the world with similar eyes (as a conspecific), the accumulated culture is not transmitted (mediated) by a more experienced partner; however, signification is built considering all the affordances of the environment that embed children in a specific cultural context. Third, the episodes allow us to reflect on the undeniable role of the body and intersubjectivity as a process that sustain this interaction and constitute cognitive development. Enlarging the views of cognitivist approaches, the microanalysis of this empirical data reveal how in the coordinative, collaborative and communicative acts cognition is shaped by the bodily experience. Thus, the process of meaning-making takes place at a level of interpersonal perception, in tune with their own embodied experiences in each environment (Amorim and Rossetti-Ferreira 2008; Moura et al. 2020).

While the body's physiology integrates movement and emotion so that the motor aspects of emotions (e.g. body's enactment, facial expressions and visceral activity of the organism) as well as the body's tonic activity and postural impressions enable a range of sensations and perceptions for the infant (Wallon 1945), the expressive dimension of movement enables communication—dialogue—even if it is a 'silent dialogue' (Scorsolini-Comin and Amorim 2010). Thus, despite infants' dependence and frailty, their expressiveness is highly effective in triggering other's attention. Infants' facial, vocal and bodily manifestations are visible to the other (adult or child) and are potent resources for interaction. Expressiveness is developed throughout life, and it becomes more sophisticated as children develop, been positively correlated to social competence in school context (Lindsey 2019). In this study, the episode with 3-to-5-years-old children shows how the expressiveness was incorporated to gesturing and speech, supporting the construction of a narrative that led the actions within the interaction.

Further, infants learn by observing and experiencing the actions of other children (Lucena and Pedrosa 2014). Learning is not as a synonym for acquisition (a final product achieved) but a dynamic process of perception-action (Costa and Amorim 2018) that involves imitations, confrontations and recognitions. For example, observation enables the infant to realise that the peer's action on an object results in a specific effect (a noise, movement, an opening of a door, a change in colour, etc.). Later on, observation will be a key element for small children to engage in complex social interaction, which demands sophisticated action coordination and collaborative dynamics to engage in social play routines. In line, the affective aspects of this interaction such as the smile are powerful communicative resources that ensure the maintenance of attention and mutual engagement. If in infant-infant interaction in day-care centres, smiles promote more responses and reactions among pairs of babies than crying, for preschool age children, smile becomes already part of the communication; it regulated the engagement and signals the valence in meaning-making. Moreover, babies/children not only smile at peers but with peers (Dentz 2016). Thus, it is verified that through various expressive and communicative resources (including emotions, vocalisations, gestures and movements), infants as well as small children address each other and (co)respond mutually (Amorim et al. 2012; Costa and Amorim 2015; Moura et al. 2020).

Therefore, it is precisely in the possibilities of the experience with the other—as evidenced in the dynamic of approaching and distancing in episode 1, in communicating in episode 3 and in the different attempts to push the cart in episode 2—that children refine this process of understanding/being part of the other's action. This process of experimentation in the perceptual field enables them to understand the other. This shared meaning among peers permeates the body, beyond trivial forms (dependence on different organs and physical systems), and influences how experience, and consequently cognitive processes, will take place. We agree with Uithol and Gallese (2015) that when such a situation arises, it is necessary to recognise that cognitive processes performed throughout the interaction experience (e.g. emotion recognition, joint attention, joint action, etc.) are body dependent.

Conclusions

In order to answer comprehensively the question raised in this special issue—how do culture and semiosis shape cognition—we believe that several subjects still need to be addressed, particularly the integration of different theoretical perspectives and fields of science, the development of methodologies that support the investigation in natural environments and the exploration of the constitutive role of peers as a significant other since an early age. In this paper, we have outlined how peer interactions feature some of the elements identified empirically in previous research on adult-child interaction, such as the construction of coordinated actions, collaboration and communicative acts. We believe that the way to advance our understanding of the ontogenesis of human cognition is to investigate human capacity for intersubjectivity—the mechanisms involving it, as well as how it develops, or how it complexifies along life. Developing methodologies for exploring intersubjectivity can contribute significantly to this goal.

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Compliance with Ethical Standards

Conflict of Interest The authors declare that they have no conflict of interest.

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