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RESEARCH

An Embodied View on Collaboration in Early Childhood Education: Combining Microanalysis and Introspective Analysis of Experiences to Understand Meaning-Making Between Children With and Without Intellectual Disabilities

Juliene Madureira Ferreira[1]

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Abstract
This paper has a twofold aim. The first is to report a qualitative study exploring the construction of collaborative interactions between typically developing children and children with intellectual disabilities in early childhood education, shifting from a cognitivist toward an embodied account of social cognition. The study combined microanalysis of embodied engagements and a phenomenological method of systematic introspective analysis of experience (PRISMA) to investigate the emergence and maintenance of collaborative interactions. The second aim is to showcase the complementarity of the methods and their potential use as a tool for understanding intersubjectivity in children's social interactions. Participants were twenty-four children aged 3–4: six with intellectual disabilities and eighteen typically developing children. Data consisted of eighteen video recordings of collaborative interactions in a semi-natural context in daycare centres. The results show how typically developing children start the interaction and lead it toward task completion through a scaffolding process of non-verbal regulations facilitated by abbreviations of communication and a combination of sequential actions. This process created bodily invitations for the peer's engagement, notably stronger amongst preferable peers, corroborating previous research on the relevance of such relationships in this age group. The introspective analysis provided insights into how the desire to work together surpasses the need to complete the task—collaboration can emerge outside the pre-determined task and relies on joint actions rather than understanding tasks' goals. Peer relations built during the interactions guided children's behaviours and changed their engagement in the task. This result brings a new perspective to pedagogical planning in early childhood education, indicating the need for teachers to understand children's intersubjective processes as well as elaborate on task instructions and organisation of space and materials. Results also suggest that previous individual embodied experiences can influence such collaborative efforts, which, although may be expected intuitively, is an underexplored perspective in education sciences. This insight underscores the importance of considering students' backgrounds and relationships when designing pedagogical approaches. Understanding how prior experiences and peer dynamics affect collaboration can inform more effective teaching strategies in inclusive early childhood education and guide professional training in the field. The findings are critically discussed concerning the implications for professional education and training in inclusive early childhood education.

Extended author information available on the last page of the article

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Introduction

From early stages of life, children have shown a remarkable ability to engage with and respond to others' behaviours, evidencing a specific inherent, intrinsic, and psychological capacity that integrates perceptual information to serve motive states (Trevarthen & Aitken, 2001). Particularly in collaborative situations, children can express engagement and synchronised behaviours that facilitate collaboration in routine activities, such as feeding and changing diapers, even before developing verbal language (Costantini et al., 2018; Fantasia et al., 2016), and continue to improve their ability to collaborate in different social situations during childhood, for example, in constructing social play in daycare centres (Amorim et al., 2012; Fatigante et al., 2021) or in foster care institutions (Moura et al., 2020). In collaborative play with same-age peers, children display rich differential patterns of communicative and expressive resources, which build on peer culture and a long engagement process that supports cognitive development (Costa & Amorim, 2015; Ferreira et al., 2020). Children with disabilities also engage in social play. Non-verbal children with disabilities can actively initiate interactions with peers, supported by augmentative and alternative communication, building on different patterns of communication (Clarke & Kirton, 2003). Furthermore, investigating episodes of non-serious interactions (e.g., conversations involving jokes) between children with cerebral palsy and typically developing children, Clark and Wilkinson (2009) found that non-verbal children with cerebral palsy are clearly active in organising displays of alignment and affiliation with their peers through the intentional placement of smiles, laughter, nodding, and vocalisation concerning their peers turns.

However, collaborative learning interactions between children with significantly different developmental paths, such as children with intellectual disabilities or developmental disorders and typically developing children, are less studied, especially in the early years when adults' presence mediating children is predominant. Although interacting with typically developing peers positively impacts the language development of children with intellectual disabilities (Hofmann & Müller, 2021) and decreases prejudice and social isolation in school (McManus et al., 2021), research on collaborative learning has neglected this partnership. Consequently, further investigation is needed into how these peers coordinate collaborative efforts in learning situations and what is essential when collaborating on a task.

Collaborative Learning and Its Challenges for Children with Intellectual Disabilities

To better understand collaborative learning and its challenges among children with intellectual disabilities, it is important to clarify some key concepts and theoretical accounts that have traditionally circumscribed collaboration as a broader phenomenon. From philosophical and developmental perspectives (for more details, see Fantasia et al., 2014), collaboration involves coordinated action between partners resulting from building and maintaining a common goal for a specific activity. Thus, it differs from other types of social interactions, such as conversations, as children and their interactional partners establish a specific kind of engagement (i.e., how partners interact with each other and the task itself) that is dependent on the human ability to understand others' intentions and behaviours

(Tomasello et al., 2005). This ability is also known as social cognition or intersubjectivity (Fantasia et al., 2014).

When applied to learning contexts, collaborative learning is defined as a 'coordinated, synchronous activity that results from a continued attempt to construct and maintain a shared conception of a problem', aiming to promote learning among group participants (Roschelle & Teasley, 1995). It often enhances the joint construction of knowledge, where multiple group participants regulate each other's behaviours through communication and coordination at a high level—also known as socially shared regulation of learning (Isohätälä et al., 2017). This specific type of engagement creates an interdependence that connects students to the task at hand and the enactions of others simultaneously (Johnson & Johnson, 2008), demanding a sophisticated mechanism of intersubjective processes (i.e., knowing and understanding others). Without these joint and coordinated actions and active regulations of others' behaviours, working in groups (or pairs) per se does not guarantee that collaboration will happen (Ferreira & Zabolotna, 2022).

It is well established that children with typical development can collaborate in different social situation early in life. For example, Brownell et al. (2006) reported peer collaborative problem-solving among typically developing children aged 19–27 months. Warneken and Tomasello (2007) observed children at 14 months cooperating with parents in instrumental helping, showing that children can identify adults needing help and engage in different tasks to help them. However, collaboration among children with intellectual disabilities is understudied, especially in early childhood education contexts.

Challenges in Research

Two main issues are challenging the analysis of collaboration involving children with intellectual disabilities or developmental disorders: theoretical and methodological—first, the predominance of the inferential representational theoretical framework of cognition (Bratman, 1992). Traditional theories of joint actions explain the ability to coordinate actions to achieve a common goal through an inferential representational model of cognition (Bratman, 1992; Tomasello, 1995). It presupposes *shared intentionality* (Gilbert, 1989) that is only possible through an ability to infer intentions and predict the actions of others, creating a representational system of action understanding (Cannon & Woodward, 2012; Carpendale & Lewis, 2004). Inferring and predicting other people's states of mind demands high-level mental processes—the use of sophisticated psychological concepts (Butterfill, 2012). Such sophisticate psychological concepts are assumed to be limited among children with intellectual disability, hindering their ability to understand, predict, and enact other people's state of mind.

Second, a methodological issue is the focus on verbal utterances as the primary units of analysis of collaborative interactions. The construction and use of language are central for the development of joint or coordinated actions (Astington & Pelletier, 2005; Whitehead, 2010), as conversations play a significant role in children's learning about others' beliefs and their comprehension of others' actions (Astington, 2000). The predominance of the inferential representational theoretical framework of cognition (Bratman, 1992) and the focus on verbal utterances as the primary units of analysis of collaborative interactions challenge the analysis of collaboration involving children with intellectual disabilities or developmental disorders. Therefore, poor performance in peer collaborative interaction involving children with intellectual disabilities is expected (Colombi et al., 2009; Fantasia et al., 2014) since it is still unclear how their social competencies for engaging or creating collaborative learning emerge.

This knowledge gap prevents teachers and other early childhood education professionals from taking advantage of peers' dynamics in classroom collaborative interaction and providing adequate support, such as tailoring instructions, making intentional pairings, or mediating the interactions in crucial moments. This knowledge gap and the overall idea of deficit around collaborative interaction with children with intellectual disability influence how teachers organise peer or group work in the classroom, often hindering the promotion of collaborative learning situations (Kutnick et al., 2002). Teachers tend to act as mediators of tasks and the use of materials rather than mediators of intersubjective and cognitive processes (Tolmie et al., 2010). Additionally, methods for investigating children's intersubjectivity in classroom interactions are scarce, leaving teachers without any tools to analyse these partnerships systematically.

The present study closes some research gaps by exploring peer collaborative learning interactions between typically developing children and children with intellectual disabilities, aiming to contribute to the ongoing discussion on collaborative learning in inclusive early childhood education contexts. Corroborating with the assumption that multimodal, interactional organisation remains relatively unexplored in such interaction (Pentimalli & Spreafico, 2020) and that there is a need to enlarge the conceptual framework and develop alternative ways to investigate children's collaboration ability (Baggs, 2018); the study applies an alternative framework for conceptualising and analysing collaboration—the enactive account of social cognition. This approach opens a new way of looking at how individuals communicate and co-construct meaning (i.e., participatory sense-making) during collaboration and how mutually meaningful engagement can become a unit of analysis (Fantasia et al., 2014). Instead of focusing on individuals' verbal participation, enactive theory inspires methods to look at the bodily actions produced within the interaction and adopt a second person's perspective for the analysis to grasp the intersubjectivity constructed during collaborative learning situations (Fantasia et al., 2014; Reddy, 2010). This theoretical framework can support unravelling intersubjectivity (i.e., social cognition) in collaboration situations among children with intellectual disabilities and their typically developing peers.

An Enactive Approach to Analysing Collaboration

The enactive cognition approach proposes a non-representational account of social cognition (i.e., intersubjectivity). This means that intersubjectivity is not based solely on simulating or representing the intention of others and acting accordingly and does not involve only the use of sophisticated psychological concepts. Instead, cognition is a continuous and situated process shaped by the experiences of the body and guided by self-organisation dynamics (i.e., the principle of maintenance of identity where enactments are guided by what is most relevant for the individuals within the interaction)—a process defined as sense-making (De Jaegher & Di Paolo, 2008). The meanings we create of the world depend on our body's ability to move and interact with the world instead of being already present in an individual's mind (De Jaegher & Di Paolo, 2007; De Jaegher et al., 2010). Thus, cognition is crucially dependent on the body and its affordances for active engagement with the social environment, including another individual (De Jaegher & Di Paolo, 2007).

Two important pillars of this approach are essential for this study. First, the body is not passively receiving and processing information but actively enacting the world and generating meanings through specific experiences. Second, social cognition is not the result of combining two individuals' mental states and affects; instead, it is the joint

creation of meaning. Thus, intentions 'do not first arise or are first made individually, but they emerge as the interaction goes on' (Fantasia et al., 2014, p. 5); intentions are not hidden in the mind but are constructed within the interactive action.

The implications of an enactive approach to studying collaborative interactions are twofold. First, it opens alternatives for looking at interactions not necessarily grounded in using specific types of dialogue, favouring situations involving young children with disabilities. The necessity to consider phenomenological approaches to gesture studies, which involve naming as gestures, a variety of expressions, actions, and behaviours, has previously been pointed out under the argument that gesture is the happening, or enactment, of thought (Cuffari, 2012). The body is always the medium of expression, and the use of words is an instance of body movement and expression. For example, the careful assessment of gesturing has revealed evidence of the engagement of autistic children with their partners in school or family contexts (Fantasia et al., 2014; Park, 2008). Second, it shifts the focus from the outcomes of the interaction (e.g., learning outcomes or task resolution) toward the experience of building collaboration as a participatory sense-making process (i.e., capacity to flexibly engage with a social partner to coordinate sense-making (De Jaegher, 2013). Embodiment and situatedness delimit the direction of the coordinated actions; in the case of children's interactions, they allow children to actively engage in sense-making of the experience of collaborating. Thus, when the interaction is analysed from this perspective, children's actions are not observed individually (what Child A does and what Child B does); it is what is produced in the in-between—the interaction itself—that becomes the focal point which provides new approaches for investigating intersubjectivity. Thus, this approach supports understanding the intricate, multilayered complexity of the intersubjectivity of children with significantly different developmental paths (De Jaegher, 2013; Fantasia et al., 2014). The enactive framework is a potent approach for investigating collaborative interaction as it brings insights into the dynamic between peers that establish collaboration through non-verbal communication, thus contributing to the field of inclusive early childhood education.

Shifting the paradigm in the investigation of collaboration also requires changing research questions and perspectives. Thus, in this study, instead of searching for specific patterns in verbal dialogues and measuring how adequately children with disabilities respond to a situation, the interest lay in what was relevant in the interaction that made children engage or disengage and how the construction of collaboration occurred in a task requiring joint effort. The study was guided by the following research questions: (RQ1) How do young, typically developing children with their peers with intellectual disabilities, use their bodies as a resource for coordinating collaborative learning efforts? Are there specific bodily engagements that facilitate or constrain the interaction towards collaborating? (RQ2) In which way(s) can *participatory sense-making* lead to collaboration?

Methods

The present qualitative study applied a combination of microanalysis of embodied engagements (Heath, 2004) and a phenomenological method of systematic introspective analysis of experience (PRISMA) (De Jaegher et al., 2017) to investigate the emergence and maintenance of collaborative interactions in six case studies.

Table 1 Identification and general information on participants

Children with intellectual disabilities and their specific diagnosis	Peers with typical development	Cases	Collaborative learning task/time
Case study 1: Child 1 Four years old, boy, Down syndrome	Child A[a], girl	Ep.1 Pair_1A	Building blocks (14:50)
	Child B, girl	Ep.2 Pair_1B	Gym task (13:12
	Child C, girl	Ep.3 Pair_1C	Painting (07:12)
Case study 2: Child 2 Four years old, boy, Down syndrome	Child D, boy	Ep.4 Pair_2D	Gym activity (12:20)
	Child E, girl	Ep.5 Pair_2E	Painting (03:50)
	Child F[a], boy	Ep.6 Pair_2F	Puzzle (13:55)
Case study 3: Child 3 Three years old, boy, cerebral palsy	Child G, girl	Ep.7 Pair_3G	Gym task (14:10)
	Child H[a], boy	Ep.8 Pair_3H	Painting (15:22)
	Child I, girl	Ep.9 Pair_3I	Play with Lego (13:44)
Case study 4: Child 4 Four years old, boy, neurological malformation	Child J, boy	Ep.10 Pair_4J	Painting (13:37)
	Child K[a], girl	Ep.11 Pair_4K	Painting (13:51)
	Child L, girl	Ep.12 Pair_4L	Building blocks (14:57)
Case study 5: Child 5 Three years old, girl, Down syndrome	Child M[a], boy	Ep.13 Pair_5M	Play with Lego (04:21)
	Child N, girl	Ep.14 Pair_5N	Puzzle (13:55)
	Child O, girl	Ep.15 Pair_5O	Modelling clay (14:11)
Case study 6: Child 6 Three years old, girl, Down syndrome	Child P, boy	Ep.16 Pair_6P	Play with Lego (09:05)
	Child Q, boy	Ep.17 Pair_6Q	Painting (14:53)
	Child R[a], girl	Ep.18 Pair_6R	Play with Lego (12:40)

[a]Preferable peers: children expressing mutual interest in interacting with each other, sharing similar interests. Preferable peers were designated by the class teacher based on observations throughout the year

Participants

Six children (2 girls; 4 boys) aged 3– years old diagnosed with intellectual disabilities participated in this study; they are the pivot participants of each case study. Eighteen peers joined them with typical development in the same age cohort (seven boys, eleven girls, see Table 1). Participants were organised in randomly paired dyads ($n = 18$, lottery conducted by the teacher before the task), except for the pairing with the preferable peers, which were purposefully invited to participate in the study. Considering the exploratory nature of this study, the heterogeneity of cases strengthened the dataset, providing different conditions in which intellectual disabilities could be expressed.

Participants were selected from daycare centres with an existing research cooperation agreement with the researcher's university, assuring the study's viability. Three criteria guided participants' selection: a diagnosis of intellectual disabilities with no severe comorbid physical disabilities, parental authorisation, and the child's engagement. Medical records provided by the ECEC institutions with family permission presented the diagnosis of intellectual disabilities. The level of the disability was not measured, and the aetiology of the intellectual disabilities varied (e.g., cerebral palsy, genetic alterations like Down syndrome and neurological malformation caused by the mother's use of isotretinoin during pregnancy).

Data Gathering

Data came from two public ECEC contexts: a preschool in Brazil (Uberlândia, Minas Gerais) and a daycare centre in Finland (Tampere, Pirkamaan).[1] The study recognises that the social, cultural, and structural differences between these ECEC contexts directly influence how pedagogical practices are developed and can determine the affordances children enjoy establishing interaction with peers (Ferreira, 2017). Cross-cultural and specific pedagogical implications arising from structural and social differences will be explored in future reports. Still, all cases are analysed as a single dataset for the purpose examined in this study.

The researcher undertook a period of immersive fieldwork (3 weeks) before the data collection to build on the knowledge about the institutions' routines, providing an overview of the situation in which the interactions happen, as recommended in previous studies (Heath et al., 2010). This process provided specific knowledge on classroom routines and children's preferences and allowed insights into how the video recordings would be better collected.

Activities were not the same for all 18 pairs. Decisions were made collaboratively with the teacher on what type of activity would be filmed and what goals should be reached, considering each case study. From an ethical point of view, the study avoided framing the interactions as a repetitive comparable test and respected each child's developmental path. Thus, the activities had to be familiar to the children, prompt joint and coordinated actions with a specific goal in place and incorporated into the classrooms' routines coherently with what children were learning and experiencing at that time. Three critical features of collaborative learning kept all the tasks aligned: (1) the need for mutual participation, (2) clear instructions for working together, and (3) a clear goal to be achieved. The tasks followed children's daily activities, respecting the authenticity of the natural environment (see the description of collaborative tasks in Appendix A).

The video recordings were scheduled according to the flow of the classrooms' routines, all at the end of the academic year (November in Brazil and May in Finland) to ensure that children have already experienced diverse joint learning situations and may have already constructed ways to communicate with one another. Any previous knowledge of working together may facilitate collaborative learning interaction and better expose its dynamics (Ferreira, 2017). Video recordings (Pentimalli & Spreafico, 2020) were the primary tool used for data gathering, and materials from teachers' planning records (various documents containing descriptions of teachers' planned activities and pedagogical goals) and field notes made by the author served as supplementary data. Ultimately, the data consisted of 178 min (18 episodes with an average time of 9 min) of video recordings of collaborative interactions between children with intellectual disabilities and peers with typical development.

Ethical Considerations

Considering that the data was collected in two countries, this study complied with regulations and ethical requirements for research with human beings according to Finnish and Brazilian laws. Data collection in Brazil received approval from the ethical board of the Faculty of

[1] The differences between these institutions are as follows: (1) In the public preschool, ECEC starts with groups of 3-year-old children, while the younger group in the day care includes 8-month-old infants; (2) the curriculum in the public preschool focuses on education, supporting systematized intentional teaching in the majority of its activities, whereas the daycare centre presents less systematized activities, privileging free play instead; and (3) the maximum time spent in the public school is 4 h every workday, whereas children stay in the daycare from 4 to 8 h every workday.

Philosophy, Sciences and Letters, University of São Paulo, number 24599213.2.0000.5407. Data collection in Finland received approval from the Municipality of Tampere on 11.09.2015. The process for obtaining a research permit from the municipalities in Finland does not generate a protocol number. Documentation is available upon request.

This study also followed recommendations from EECERA (2016) and Ukkonen-Mikkola and Ferreira (2019) related specifically to research with children. Consent agreements from parents were gathered through direct correspondence via school-family channels. Considering the sensitivity of research with small children and with children with disabilities, consent with children was negotiated through several meetings with the children before the study. The researcher started visiting the children's classroom two weeks before the beginning of the study, gradually introducing herself to the children and explaining the work in the classroom. During small group discussions, the researcher showed the children how the camera worked and explained that all children were invited to participate. Still, only some would have their activities video recorded. The researcher also showed a video recording of herself doing tasks in a classroom to explain to the children what kind of research they were being invited to partake in and observed children's reactions and engagement. Children were asked directly about participating in the study, and they answered verbally or by gesturing. However, the researcher was particularly attentive to any signs of distress or discomfort from the children when the camera was on. The video recording would stop if such signs were present, even if children previously consented. Parents did not consent to the reuse of data for further projects or the publication of images in any format. Metadata of all video recordings are available upon request.

Analysis

The episodes of collaborative learning were analysed from two different perspectives. The first was a microanalysis (Heath, 2004) focusing on how the interactions, particularly the coordination of task-oriented actions, were built. The second was the adapted version of the PRISMA protocol for systematic introspective analysis of one's embodied experience. This phenomenology-oriented method was created to grasp intersubjectivity and participatory sense-making (De Jaegher et al., 2017) using the analysts' 'assessment' and systematic annotation of their experiences interacting or observing social interactions. The combination of the two perspectives enabled: (1) the identification of the bodily engagements of each pair's interaction (i.e., the direction of attention, gestures, actions and verbal expressions), (2) the identification of action coordination (Sebanz et al., 2006) and regulations of learning, which answered to how children use their bodies in collaborative interactions in natural contexts (RQ1); and (3) a qualitative look into what made *collaborating* meaningful within the interaction, which enhanced the understanding of *participatory sense-making* (RQ2).

Microanalysis of Social Interactions: Coding Bodily Engagements to Understand the Construction of the Interactions

This analysis was conducted entirely through the ELAN annotation software package (Brugman & Russel, 2004), which allowed the researcher to make annotations at the precise time that the behaviour or verbalisation happened, extract the timestamps of each bodily engagement, and visualise the dynamics based on the quantification of the annotations (see Fig. 1). The transcripts generated from the software differ from those constructed manually but offer the same analytical affordances.

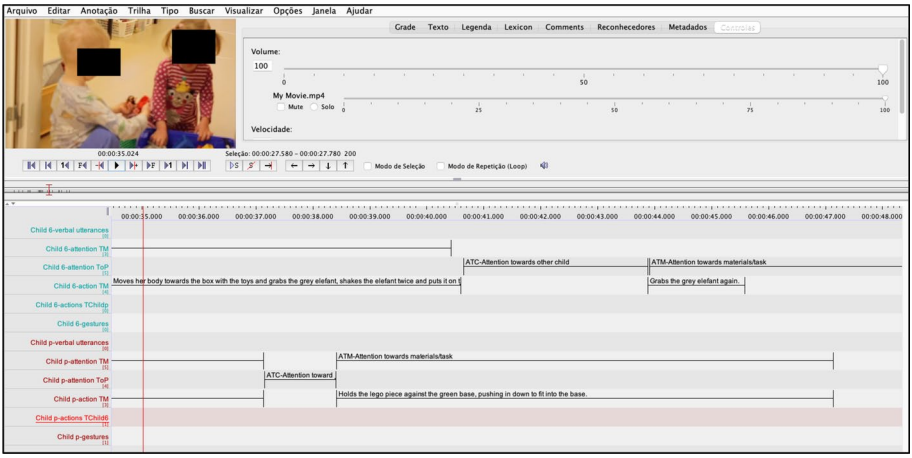

Fig. 1 Visualization of how microanalysis looks in ELAN software, pair 6. Note. TM stands for towards materials; *ToP* towards other people

The first step involved coding bodily engagements. Literature on communication processes in young children's social interaction and gesture studies (Camaioni et al., 2004; Crais et al., 2009; Goldin-Meadow, 2000, 2009) supported the coding of bodily engagements (see Table 2). Actions differ from gestures in terms of function—'gestures are abstracted representations and are not actions tied to particular events and objects; they can play a powerful role in thinking and learning beyond the particular' (Novack & Goldin-Meadow, 2017, p.652). Gestures are spontaneous hand movements accompanying speech, and actions are movements produced to achieve external goals.

Each bodily engagement expressed by each child was marked as an independent annotation on the individual tiers in the ELAN, and the description of the behaviours was written directly in the annotation segment. This procedure allowed identifying the exact timeframes of the behaviours during communication and the qualitative analysis of what was happening in each part of the interaction. The content of the bodily engagements, particularly the visual alignment between the children's gazes (Goodwin, 1980), provided the entrances for analysing the emergence of joint attention and coordinated actions and then the analysis of behavioural regulations of learning in children's interactions (e.g., how one child's behaviours are connected to the other child's actions). It was within the coordinated actions that potential regulations of learning could be found.

The second step was to generate an annotation density plot that showed the behaviours throughout the timeline of the interactions and, through this visualisation tool, identify the moments where joint attention and coordinated actions are taking place (Fig. 2). Joint attention happens when there is a coordination of attention between two speaking social partners towards an object or situation of mutual interest (Tomasello, 1995). Thus, the gaze alignment (Goodwin, 1980) between the children provided the entrances for analysing the emergence of joint attention (Fig. 2, marked by a pink circle). The coordinated actions, such as passing an object needed to complete a task, were identified by following the sequences of actions and gestures performed by both children. When these moments were identified, it was possible to go back to the video and analyse the contents of these events qualitatively, understanding how children use their bodies as resources for coordinating collaborative learning efforts (answer to research question 1).

Table 2 Coding scheme for the bodily engagements

Categories of bodily engagements	Sub-categories	Description of the concept/code and *examples*
Verbal expressions	Verbal utterances	Sentences carrying conventional lexical meaning *For example, 'you are doing it all wrong'*
Gestures	Vocalizations	Protolanguage with a context-dependent meaning *For example, 'ghaa', 'uhrr'*
	Iconic	Representational or lexical gestures. It includes those hand/arm movements that bear a perceptual relation with concrete entities and events *For example, following a line with your fingers when verbalizing the idea of the 'process of following'*
	Beat	Speech primacy movement. The performed gesture follows the rhythm of the person's speech *For example, up and down flip of a hand*
	Deictic	Concrete or abstract pointing *For example, point to the materials to direct attention*
Orientation of attention—eye gaze	Towards other people	The eye gaze is directed towards the other child or an adult present in the classroom. It may or not establish eye contact *For example, a student looks at the peer while listening to what they are saying*
	Towards the task/materials	The eye gaze is directed towards the materials displayed for the task, or other objects in the classroom *E.g., child is looking at the toys, or the materials provided by the teacher for the task*
Actions	Towards/involving others (peer)	Set of movements including or not physical contact that directly involves the peer *For example, taking something from the peer's hands, or giving it to him/her, tap on a shoulder, pulling or pushing the peer*
	Towards/involving materials	Set of movements performing a specific interaction with the available materials, such as holding or manipulating it *For example, moving the paper sheets around, picking up a brush and colouring the paper*

A blind coder checked the codes, and inter-observer agreement was established by applying Cohen's kappa coefficient. Reliability was acceptable in all cases (gestures, $k = 0.78$; actions, $k = 0.91$; orientation of attention, $k = 0.78$)

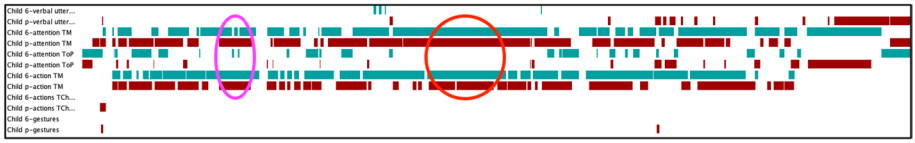

Fig. 2 *Joint attention and coordinated actions in the visualisation of the density plot.* Note: visualization plot of episode 16

Only some of the events visible in the density plot configurated joint attention or coordinated actions. For example, both children might simultaneously display eye direction towards materials (a code used to analyse the videos) yet look at different objects (marked by a red circle in Fig. 2). The coding process focuses on isolated behaviours; thus, the qualitative analysis was essential to determine the content of the dynamic and if the requirements of joint attention and coordinated actions were present in the sequence of events.

The third and last step of the microanalysis consisted of choosing the episodes that could provide insights into understanding the sense-making process in the interaction (participatory sense-making) that could suggest what was important for children in the interaction that guides them in maintaining engagement in collaborating (answer RQ2). For this process, the study prioritised choosing episodes that were most significant in the collection of data (i.e., outliers) in presenting two specific criteria. The first was the frequency of coordinated actions. Coordinated actions are the materialisation or the embodiment of engagement, and it is through the coordinated action that participatory sense-making can be constructed. Therefore, looking at what is happening in the interaction that allows a high frequency of coordinated actions or hinders it is important to understand sense-making in collaborative learning situations. Additionally, previous studies in collaborative learning have shown that higher engagement and collaborative learning are positively correlated (Grau & Whitebread, 2012; Malmberg et al., 2015), thus corroborating the rationale that understanding coordinated actions is essential to understanding collaboration. The second criterion was task completion. Focusing on task completion is described as part of the definition of collaborative learning situations, and it is the component that would reveal the shared intentionality that makes collaborating possible (Roschelle & Teasley, 1995). Although this study challenges the idea that shared intentionality depends on representational processes of other's minds, it still assumes that shared intentionality is created within the interaction. Thus, it is important to observe in collaborative learning situations.

Grounded in this rationale, the coordinated actions were quantified, task completion was assessed, and three distinctive episodes were selected for further analysis of intersubjectivity through the systematic introspective observation of experience (PRISMA)—two episodes with a higher frequency of coordinated actions with and without resolution of the task (episodes 1 and 6, respectively) and one with lower frequency of coordinated actions and resolution of the task (episode 16) (the descriptions of episodes 1, 6, and 16 are found in Appendix C). It was particularly important to understand why in one situation, even with highly coordinated actions, task was not completed, and in another, the task was completed with minimal effort. The researcher and teachers discussed assessing children's achievements by considering each child's developmental and educational processes and establishing specific goals for each pair (Hofmann, 2012). Thus, completing the task could look different even if it was the same type of activity.

PRISMA: Grasping Intersubjectivity Through Systematic Introspective Observation of Experience

To grasp intersubjectivity and thus understand participatory sense-making, this study adopted the PRISMA method developed by De Jaegher et al. (2017), adapting it to this research context. PRISMA builds on a variant of phenomenology, which is centred on the researcher's experience of approaching a specific phenomenon (e.g. video recordings of peer interaction) and proposes the analysis of social perception by focusing on introspective observation of the modalities of sensing (stimuli perception), feeling, and thinking. Thus, it entails analysing the researcher's embodied experiences—sensations, feelings, and thoughts coming up while viewing and processing the video as an object of analysis, shifting perspectives on the analysis of social interaction. By focusing on the researchers' embodied experiences (i.e. second-person approach) instead of his projections or inferences about children's intentions and their display of verbal understanding (e.g. a third-person view of the phenomenon), PRISMA supports researchers in finetuning self-awareness in all three modalities, allowing researchers to use themselves as sophisticated instruments for generating insights into human interactive experiences. It will enable us to approximate the individual's experiences by way of introspective analysis, bringing a unique perspective to understanding how collaborative learning is constructed among peers with significantly different developmental paths in early childhood education.

In PRISMA, the analysis is carried out by multiple observers looking at the recordings and making individual annotations about what they analyse from their experience as observers of the interaction in place. In this study, the analysis was done by the author and two other researchers from the research group familiar with the method (female, ages 25 and 30, with backgrounds in psychology and education, respectively). The analysis comprises several examinations of the video recording of peer interactions from different perspectives: (1) self-perception, researchers annotate their sensations, feelings, and thoughts while observing children interacting; (2) the other's perception, researchers annotate their sensations, feelings, and thoughts while positioning themselves as each of the children interacting; and (3) the interaction's perception, researchers annotate their sensations, feelings, and thoughts while positioning themselves in the *in-between* of participants. The analysis is also guided by specific analytical prompts, not enacted by the children in the data but by the researchers in their observation. This study used the following three analytical prompts: (1) looking at the *result of the interaction,* (2) looking at what was *important for the children during the interaction,* and (3) looking at *collaboration* supporting what was important for the children.

The analytical procedure started with participants reflecting on their observations freely, notating their sensations, feelings, and thoughts. Subsequently, participants watched the video another 12 times. In each view of the video material, participants adopted one of the three perspectives (self, others, and interaction), notating the three modalities of embodied experience (sensing, feeling, and thinking) guided by one of the three analytical prompts. Lastly, all annotations from all participants (a total of 108 annotations) were compiled to generate an understanding of what is happening in social interaction. The PRISMA method allows the unfolding of the interaction and the emergence of a unique material between two children interacting.

Results

Microanalysis: Understanding How Children Use Their Bodies as Resources for Collaboration

The microanalysis showed the bodily engagements used to start and construct the interaction (an example of how each bodily engagement was interpreted is available in Appendix C) and the frequency of bodily engagements in complete and incomplete tasks, providing the anatomy of the collaborative interactions from its onset to the end.

Collaboration was initiated and was led predominantly by typically developing children (16 out of 18 episodes), who either verbally regulated the planning and monitoring of the task (5 out of 16 episodes) or performed actions directly related to the given task, e.g. picking up a brush, putting together the puzzle pieces, or assessing and manipulating the materials available. Children with typical development interacted with their peers with intellectual disabilities with the task's goal in mind and by providing a direction for actions, evidencing that task instruction is relevant for establishing this learning experience. However, during the interactions, verbalisation was not as central for young children as it was for school-age groups (Schuitema et al., 2019). In four of five episodes where children started the collaboration by verbally regulating the peer, the verbalisation was synchronised by gestures used to point to materials (deictic gestures) or to support what the child expressed verbally (iconic gestures), regulating the peer's behaviours.

Verbalisation did not ensure that children reached a consensus on what to do in the task, nor was it used to scaffold coordinated actions that resulted in collaboration. The verbal utterances expressed by the children with typical development were mainly used to reprehend the peer's behaviours, e.g. 'you can't do that' (Child E, episode 5) or 'you are doing it all wrong, can't you see it?' (Child C, episode 3). Such verbalisations in episodes 3 and 5 were followed by specific bodily engagements used to set boundaries with their partners or, in many situations, provoke breakdowns in the interactions. For example, in episode 3 (see Appendix B), Child 1 turns his back to Child C after verbal reprehension, blocking Child C's view of what he is doing. He also avoids physical contact, isolating himself from the peer, showing that children also use their bodies to break down the interactions.

Furthermore, children used verbalisation to self-regulate during the task talking out loud 'I need to try (referring to trying to fit the puzzle piece)' (Child N, episode 14). The use of verbalisation to construct collaborative efforts was only present in 2 episodes yet did not guarantee task completion (see Fig. 3), challenging the idea that shared meanings are created in dialogue only (Roazzi & Bryant, 2011). Although typically developing children can support peers' formal-operational thinking through their more advanced verbal skills (Roazzi & Bryant, 2011), verbalisation hindered more than scaffolded collaborative efforts in this study, corroborating previous studies that have shown how dominant attitudes from typically developing children disengage the child with disabilities (Stepanovic & Baucal, 2011).

Task completion is the main aim of collaborative learning activities (Roschelle & Teasley, 1995); it sets the task's goals and grounds the instructions that guide the interaction (Zimmerman, 2000). However, the goal of completing the task did not necessarily guide the interactional dynamics and regulatory behaviours that constitute collaboration (Ferreira & Zabolotna, 2022). In this study, gesturing and acting with the materials and others intensified joint attention and supported subsequent coordinated actions that built collaboration.

Regarding the frequency of coordinated actions, results showed more coordination among pairs with preferable peers regardless of the episode's duration (see Table 3), potentially

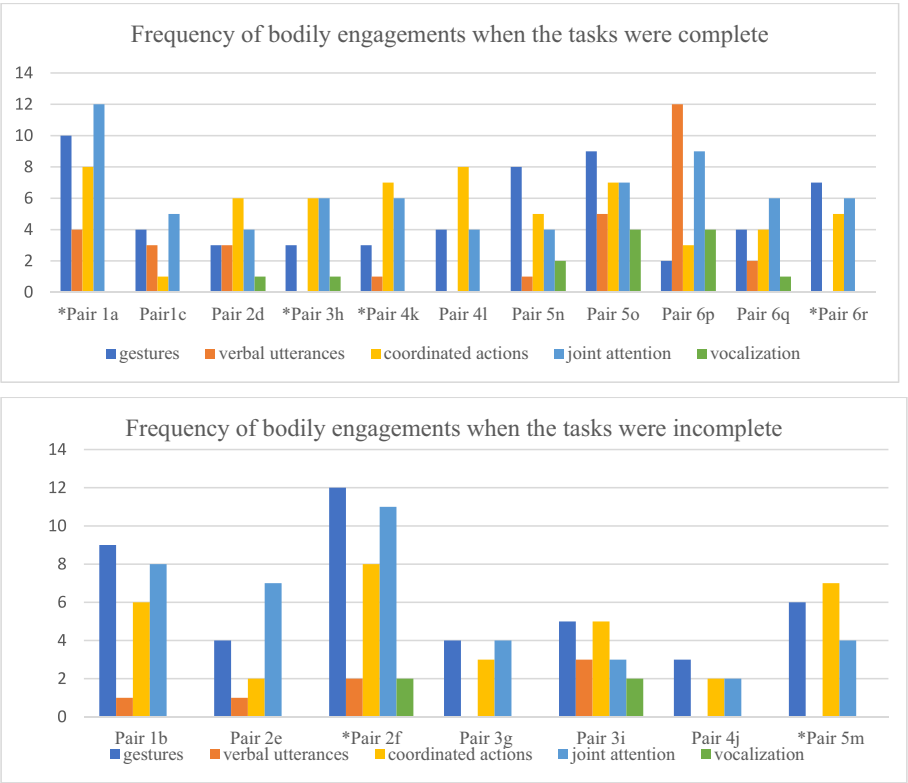

Fig. 3 Frequency of bodily engagements in complete and incomplete tasks. Note: The *y*-axis shows the total frequency of events. The timeframe of each event can overlap with the real timeline of the interactions. The series of *coordinated actions* and *joint attention* in the *x*-axis derive from the qualitative analysis of the bodily engagements *actions* and *orientation of attention*, respectively. *Preferable peers

indicating that they are the best partners for collaborative learning situations. Between preferable peers, iconic gestures carrying meanings shared only by the children (also called ritualised gestures, Crais et al., 2009), and sequential joint attention and action towards the materials that include joint use of objects facilitated collaboration. These bodily engagements created abbreviations in the communication and invitations for engagement.

Table 3 Total occurrence of coordinated actions

Reference child for pairing	Most occurrences of coordinated actions	Other occurrences of coordinated actions
Child 1	Pair 1A = 8[a]	Pair 1B = 6/Pair 1C = 1
Child 2	Pair 2F = 8[a]	Pair 2D = 6/Pair 2E = 2
Child 3	Pair 3H = 6[a]	Pair 3I = 5/Pair 3G = 3
Child 4	Pair 4 K = 7[a]	Pair 4L = 6/Pair 4 J = 2
Child 5	Pair 5 M = 7[a] / 5O = 7	Pair 5N = 5
Child 6	Pair 6R = 5[a]	Pair 6P = 3/Pair 6Q = 1

[a]Preferable peers

To illustrate, in episode 6, pair 2F (full description in Appendix C), Child 2 expressed an iconic gesture (moving the hands up and down) just after observing that Child F was looking at him touching the object. Within the interaction context, the gesture communicated a meaning that regulated Child F to abandon his actions and engage with the new toy. The meaning of the gesture is shared explicitly between the children, belonging to a specific category of iconic gestures known as ritualised. The expression of these ritualised gestures has been previously associated with abbreviations of meaning-making (Amorim et al., 2012) when the duration of the exchange of information or construction of meanings between children is reduced as negotiations are immediately established (Pedrosa & Carvalho, 2006). The longer children interact, the more sensitive and precise their communication becomes.

In the same episode, Child F positions his body diagonally to the toy and Child 2, creating space for approximation. The simultaneous exchange of eye contact creates joint attention. The time Child F waits for Child 2 to approach affords the subsequent action coordination to try using the toy, a sequence of bodily engagements that creates *invitations* for collaboration. A similar process has been identified in adult–child interactions, showing how infants are drawn into actions by *inviters* of action and response (Reddy et al., 2013). Through these constant openings, children understand and realise one another's directives, which is essential for their development and further generalisation of the mechanisms of interaction dynamics (Reddy et al., 2013). However, this situation has not yet been reported in child-child relationships. Here, in similar ways, as previously reported in adult–child interactions, children are setting up contexts of repeated and routinised invitations to act and join in cultural rituals, supporting different ways of engagement across episodes 1A, 2F, and 6r. This kind of mutual observation created during joint attention afforded children to follow others' bodily acts, which produced a resonance between one's own and other's bodies, prompting advances in action coordination (Rizzolatti & Craighero, 2004).

Introspective Analysis of Experience: Looking at Participatory Sense-Making and When Collaborating Is Significant for Children

The introspective analysis of experience with the PRISMA protocol is displayed through the configuration grid merging all researchers' introspective observations (see Figs. 4, 5 and 6). The configuration grip and the discussions produced during PRISMA sessions allowed relevant insights into how collaboration emerged or broke down in episodes 1, 6, and 16. Three important points are highlighted.

The *first point is that the desire to work together surpasses the need to achieve the goal of the task*. The aim of the task was abandoned in favour of maintaining the interaction. In episode 6, which had a high occurrence of joint attention and coordinated actions but incomplete tasks, children adjusted the original goal to fit their willingness to work together. The child with typical development (Child F) initiated the task and the interaction following the teacher's instruction. However, Child 2 called attention to a different toy through pointing behaviours, regulating Child F's gaze, conveying emotional expressions during the actions, and setting the grounds for a different activity (see the description from minute 1 to minute 2 in Appendix C). From that moment on, the sequence of coordinated actions no longer related to the original task but prioritised the action of playing together.

Looking at the perceptions of the in-between that are described on the PRISMA observational grid of analysis, it is noted in the level of sensing the openness of space created by the peer a mutual approximation (the two children move towards each other) and time for

Prompt 1	**Configuration of Self-perception** ***looking at the result of interaction*** Looking at the interaction, I perceived what happened between the children and sensed/felt/thought myself:	**Configuration of other's perception** ***looking at the result of interaction*** Looking at the interaction, I put myself in what happened between the children. Regarding sensing/feeling/thinking it seemed to me that between them...
Sensing	Closeness; warmth; happy; laughter.	There is acceptance; there was a change of direction; there was complicity and friendship.
Feeling	Surprised, happy, optimistic; enchanted by the actions of the children.	They were happy; they were engaged; strong engagement; there was understanding;
Thinking	The task was not so important; children really want to be together; children are very capable social partners.	They understood each other; they learned with each other; they collaborated although not in the original task.
Prompt 2	**Configuration of Self-perception** ***looking at what was important for children.*** Looking at the interaction, I perceived what happened between the children and sensed/felt/thought...	**Configuration of other's perception** ***looking at what was important for children.*** Looking at the interaction, I put myself in what happened between the children. Regarding sensing/feeling/thinking it seemed to me that between them...
Sensing	Engaged in the situation; wanting to continue observing them play; being pulled into the scene; happy.	Approximation; closeness; connection; reciprocity; understanding.
Feeling	Harmony; touched by the children's movements; fascinated by their communication; worried that they didn't do the task.	There was engagement and complicity; familiarity; enjoyment of being together.
Thinking	It was important to stay together; it was important to let the other person to try; there is a lot of knowing each other.	The most important thing is to play together; they can create their own tasks to play together; it is important to let the other play.
Prompt 3	**Configuration of Self-perception** ***looking at collaboration supporting what was important for children.*** Looking at the interaction, I perceived what happened between the children and sensed/felt/thought myself:	**Configuration of other's perception** ***looking at collaboration supporting what was important for children.*** Looking at the interaction, I put myself in what happened between the children. Regarding sensing/feeling/thinking it seemed to me that between them...
Sensing	Getting more and more excited; willing to interact with the children; connected to what was happening.	Continuity and flow; turns to act and engage; fine tuning, engagement.
Feeling	Happy for the children; excited to see that collaboration happened anyways; concerned that the task was abandoned; emerged in the interaction.	There is excitement for playing together; playfulness and friendship in action; patience to let the other try; admiration and understanding.
Thinking	Collaboration supports exploring new things; collaborations support developing new abilities; children are brought together; children enjoy their time together.	Collaboration supported children's constant engagement; being together was the most important thing and collaboration maintained that; children know each other well and it's easy for them to be together.

Fig. 4 Configuration grid – episode 6 (Pair 2F – puzzle)

Prompt 1	**Configuration of Self-perception** ***looking at the result of interaction*** Looking at the interaction, I perceived what happened between the children and sensed/felt/thought myself:	**Configuration of other's perceptions** ***looking at the result of interaction*** Looking at the interaction, I put myself in what happened between the children. Regarding sensing/feeling/thinking it seemed to me that between them...
Sensing	Becoming more impatience; wanting them to work together; laughing; playfulness.	Admiration; sense of doing together; connectivity; familiarity, friendship.
Feeling	Fear that they wouldn't find themselves; bothered by the rushing; enjoyment.	There is engagement and support; there are different interests; there is tolerance; there is friendship; there is dependence.
Thinking	Children see this activity through different perspectives; children have different rhythms; building is as fun as	Children had fun during the task; Children were interested in assembling the tower together, but they experience the process
	breaking it; they might be experimenting on the boundaries of their relationship.	differently; Not knowing how to work with the Lego influenced the dynamic.
Prompt 2	**Configuration of Self-perception** ***looking at what was important for children.*** Looking at the interaction, I perceived what happened between the children and sensed/felt/thought myself:	**Configuration of other's perceptions** ***looking at what was important for children.*** Looking at the interaction, I put myself in what happened between the children. Regarding sensing/feeling/thinking it seemed to me that between them...
Sensing	Proximity; connectivity; becoming doubtful sometimes;	Temporary disconnection; misunderstanding; mismatching at sometimes;
Feeling	Some frustration; tension; fear that they don't converge; relieved with their laughter; satisfied they found a way.	Tolerance; willing to be together.
Thinking	Children were just starting to learn how to assemble the pieces together; rhythms were different; collaboration was important for both children; collaboration can happen.	Takes time to learn what the other wants to do; collaboration demands patience and tolerance; they are happy to be together; the task was more important to child A.
Prompt 3	**Configuration of Self-perception** ***looking at collaboration supporting what was important for children.*** Looking at the interaction, I perceived what happened between the children and sensed/felt/thought myself:	**Configuration of other's perceptions** ***looking at collaboration supporting what was important for children.*** Looking at the interaction, I put myself in what happened between the children. Regarding sensing/feeling/thinking it seemed to me that between them...
Sensing	Closeness; excitement; enjoyment.	Gradual approximation; flow of actions in a good rhythm; enjoyment between them.
Feeling	Optimistic; hopeful; relaxed to enjoy their dynamic.	Closeness; playfulness; connected; engaged.
Thinking	Moments of collaboration supported the recovering of breakdowns; children must really want to work together; breakdowns tested their relational bonds	They just needed time to figure it out; collaboration support them to play together; collaboration strengthen their friendship.

Fig. 5 Configuration grid of episode 1 (Pair 1A – building blocks)

Prompt 1	**Configuration of Self-perception** ***looking at the result of the interaction*** Looking at the interaction, I perceived what happened between the children and sensed/felt/thought myself:	**Configuration of other's perception** ***looking at the result of interaction*** Looking at the interaction, I put myself in what happened between the children. Regarding sensing/feeling/thinking it seemed to me that between them...
Sensing	Distance; gradual disengagement; a desire to intervene; the rhythm of the play being determined by one peer; uncomfortable sensations when the child is crying.	Unfamiliarity, stuck in the situation, tense, lack of communication; no eye contact; a quiet presence of the peer; the rushing to assemble the pieces; no connection to the peer.
Feeling	Disappointed; impotent; upset; limited; concerned with the child crying.	Sadness, frustrations, disappointment, indifference, loneliness, tired of the playing.
Thinking	They wanted to play together but they didn't know how; intervention is necessary to support children's communication; wondering if they have ever played together before; they did achieve the goal of the task although they did not have a good time together	There were little encounters; actions were not recognized in time; children are gradually distancing from each other into their own worlds;
Prompt 2	**Configuration of Self-perception** ***looking at what was important for children.*** Looking at the interaction, I perceived what happened between the children and sensed/felt/thought...	**Configuration of other's perception** ***looking at what was important for children.*** Looking at the interaction, I put myself in what happened between the children. Regarding sensing/feeling/thinking it seemed to me that between them...
Sensing	Experiencing the toys; there is a search for the other; shift of interest during the interaction; finishing the task.	There is distance; a connection that needs to be better supported; unfamiliarity.
Feeling	Disconnect, frustrated, sad.	Uncertainty; insecure about my actions; self-absorb; gradual disconnection.
Thinking	Children have different individual goals; children don't see how they can work together;	Although they want to play together, they don't know how; They don't seem to find each other during the interaction; they express differently their willingness to play together; they need to get to know each other better.
Prompt 3	**Configuration of Self-perception** ***looking at collaboration supporting what was important for children.*** Looking at the interaction, I perceived what happened between the children and sensed/felt/thought myself:	**Configuration of other's perception** ***looking at collaboration supporting what was important for children.*** Looking at the interaction, I put myself in what happened between the children. Regarding sensing/feeling/thinking it seemed to me that between them...
Sensing	Lack of collaboration, lack of engagement	Two different rhythms; barrier; distance; attempt.
Feeling	Disconnected; disappointed; uneased.	Feeling of not been understood; boredom.
Thinking	I thought myself that this interaction was not reciprocal; children are playing together but individually at the same time; children don't know how to respond to each other; children need more assistance to collaborate.	Collaboration was too difficult; there are no mutual help; there are separate plays even though they are using the same toys.

Fig. 6 Configuration grid – episode 16 (Pair 6P – play with Lego)

experimentation (they take the time to observe and let the other explore the object), which led to feelings of complicity and synchronicity from both self-perception and perception of the other. How the children were able to completely change the course of the activity and create a new set of goals with the new toy reflects how interactions can take on a life of their own and how collaboration can arise during the interaction without there being a predefined intention for a particular action (Fantasia et al., 2014). The intention of changing activity and working together (*sense-making of* collaboration) emerged from and within the interaction, with the desire or need for togetherness. It is possible that what mattered to the children was not the maintenance of their identity as constructors of the task but rather the identity of being partners; thus, the interaction prevailed over individual autonomy.

De Jaegher and Di Paolo (2007) argue that when an individual is regulating its coupling with the environment (here, another child), it does so because there is something in this interaction that 'allows the continuity of the individual's identity(es) that initiates the regulation' (p. 488). In episode 6, the environment (space, time, task, and instructions) delimits the direction of the coordinated actions. It assigns individuals to specific roles in maintaining the interaction. This role becomes part of each person's identity within that moment where the activity is in place, and it is continuously modified, created, and recreated by the interaction itself. Not all forms of collaborative interaction demand explicit agreement on a shared goal; in many cases, collaboration can occur to maintain or facilitate an ongoing interaction. Differently from the traditional analysis of collaborative learning, where collaboration is only identified when children explicitly share a goal, and it is expected that the task's goal is the focal point of the children's interaction, the analysis of participatory sense-making allowed the observation of how children negotiated the abandonment of the original task and engaged in a different activity to accommodate their interests in playing together. Children keep their identity as collaborators by jointly constructing the abandonment of the objective of the task. To be engaged with others is more relevant than following original instructions.

The second point is that previous embodied experiences influence the interaction. In episode 1 (Fig. 5), the coordinated actions happened throughout the interaction, and the task (building a tower with building blocks) was considered completed, portraying some specificities of collaborative learning interactions. Nevertheless, looking at sense-making, it is noticed that previous embodied experiences—children's motor coordination to use the materials—influenced how they focused on different phases and aspects of the task to meet their individual needs, prioritising either the process or the achievement of the results.

For Child 1, the task demanded movements and actions that seemed challenging for him to perform independently, like assembling the building blocks. Child 1's motor coordination was limited, and participating in this task might have provided the means for a new experience. The interaction provided space for experimentation, observation, participation, and achievement that was absent in this child's repertoire. Thus, repeating the action (assembling the blocks) felt more relevant than achieving the task goal. In contrast, there was a sense of familiarity observing the Child C's action—sensory-motor competencies were sufficiently developed to assemble the pieces and complete the task easily. Thus, for Child C, achieving the goal might have been more significant. The goal of the task was clear, but the intentionality related to how these goals would be achieved was not a priori shared by the children. The intentionality emerged during the interactions, regulated by individual needs until task completion.

Collaboration is a precarious system, and this episode exemplifies how sensory-motor competency can influence children's engagement and resourcefulness for the task and modulate children's actions along the way. The children's bodies and bodily experiences

carried meanings that were the starting point for shared sense-making processes. The body guides the actions and the meaning they carry. In the case of this study, it consequently increased the precariousness of the interaction between them, deepening the gap created by the different developmental paths and influencing how children participate in one another's sense-making. Therefore, children's previous experiences can deepen the asymmetry created by the different developmental paths and influence how children participate in one another's sense-making (De Jaegher & Di Paolo, 2008).

The third and final point to be highlighted is the importance of coordinating actions to establish collaborative efforts. Performing specific actions for executing the task (e.g., mounting Lego pieces) to its completion usually frames collaborative interactions. However, it is not sufficient to construct an experience of collaboration if children do not mutually situate themselves and others. In episode 16, where the task was completed (Fig. 6), the interaction presented only three moments of coordinated actions, which did not sustain the necessary engagement to perceive collaboration. From both a self and others' perspective, the PRISMA protocol revealed a perception that children gradually distanced themselves from each other. Senses of disengagement and lack of connection led to a permanent and heartful breakdown which are verbalised by the discouraging contents of Child P's utterances and the manifestation of negative emotions when he cried. The lack of coordinated actions may explain the overall sense and feeling of disconnectedness that grounds the thoughts that children cannot play together or that they do not know how to do it. Coordinated actions also may play a role in adjusting and maintaining an idea of a shared goal. As a process of participatory sense-making, collaboration is constituted by the ways of moving and perceiving affections and emotions that determine the significance individuals give to the world within the situated experience of interaction (De Jaegher, 2013). Thus, the sensations and feelings observed during the reflection of the result of the interaction point toward a lack of communication (e.g., children losing track of each other) and no connection between them (e.g., increased alone playing). An overall feeling of frustration and sadness despite task completion.

The PRISMA protocol also shed light on how even though the task was executed, building collaboration was difficult—a sense of distinct rhythm and distance, especially when considering how collaboration supported what was important for the children. Child 6's coordinated actions towards completing the task were not recognised by the peer when they eventually occurred, and the delay in the responses or even the use of alternative ways of communication made the construction of collaboration unfeasible in the experience of working together. The children transited from very immersed individual processes to searching for the other during the interaction, with few moments of reciprocity.

Lacking coordination does not mean that the children are not engaged or fail to understand the task's goals. On the contrary, when integrating results from PRISMA protocol and the microanalysis, it is noticeable that children's actions were aligned with the task but not necessarily with each other in a coordinated way. Understanding intersubjectivity through the perspective of participatory sense-making implies looking at the interplay between interactive and individual autonomy (De Jaegher & Di Paolo, 2008). In this case, when considering both steps of analysis, the response delays (eye contact or action towards the materials in specific ways) provoked feelings of disengagement or discontinuity in the researchers, which indicated a threat to not only the interactive but also the individual's identity that demands reassurance for the continuation of coordinated actions in the resolution of a task. It is possible to surmise that if the child perceives that the partner is not paying attention or that he or she does not value what is being done, the identity of the partnership is threatened. The interaction, as a precarious system, breaks down. Breakdowns are

not necessarily negative for the interaction; on the contrary, interactions are comprised of engagements and breakdowns, and it is through the perception of an imminent breakdown that adjustments can be made (Di Paolo et al., 2018), as it was noticeable in episode 6. Episode 16 explicitly shows how the breakdown is constructed within the interaction and how the partner with intellectual disabilities is not solely responsible.

Discussion

This study investigated collaborative interactions between typically developing children and their peers with intellectual disabilities in inclusive early childhood education. Shifting from a cognitivist toward an enactive account of social cognition (De Jaegher et al., 2010), the study combined microanalysis (Heath, 2004) and introspective analysis of experiences with PRISMA protocol (De Jaegher et al., 2017) to explore how children use their bodies to coordinate collaborative learning efforts, looking at what bodily engagements facilitate or constrain the interaction and in which ways participatory sense-making lead to collaboration.

The results of the microanalysis indicate that typically developing children play an important role in the construction of collaborative learning interaction with peers with intellectual disabilities, corroborating with previous studies exploring such scaffolding roles (Ferreira, 2017; Howard et al., 2012; Stepanovic & Baucal, 2011). However, differently than verbally guiding children with disabilities on how to perform the task as it could be anticipated (Colombi et al., 2009), peer scaffolding was created in a much more subtle level of being together. *Children used their bodies to create abbreviations of communication* (Pedrosa & Carvalho, 2006) *and a combination of sequential actions that created bodily invitations for the peer's engagement*. This leadership emerged largely through non-verbal behaviours, particularly in preferable peers.

Non-verbal communication is critical in child-child social encounters (Ferreira, 2017; Howard et al., 2012; Lima & Cruz-Santos, 2012; Stepanovic & Baucal, 2011). For example, children can use imperative and declarative gesturing in action comprehension (Camaioni et al., 2004) and express knowledge (Evans et al., 2001) from an early age. Moreover, gesturing, body positioning, and vocalisations can mark turn-taking in conversations with people with social and communicative challenges (Sterponi, 2017), showing how these unique linguistics characteristics are brought forth in service of interactional aims (Bottema-Beutel, 2017; Bottema-Beutel et al., 2015; Sterponi et al., 2015). The present study adds to this ongoing discussion by further understanding the role and relevance of coordinated actions in non-verbal communication. Combining micro and introspective analytical approaches, results suggest that *simple regulation of body positioning and waiting for the partner can result in an observational process that prompts subsequent physical engagement between peers*. Collaboration emerged when both children displayed coordinated actions, and it was sustained, particularly when they shared the desire to work together. In this context, making sense of others and with others—*participatory sense-making—was possible through a series of mutual observations and imitations that supported building coordinated actions*, not as a scaffolding resource for the child with intellectual disabilities like in previous studies (Ferreira, 2017), but *as a provider of time and space for children to 'try out' and discover their mutual interests, following each other's directions without the directiveness of verbal instructions.* Within the world of non-verbal engagement, the non-speaking child can act and enact, participating fully in the construction of the interaction (Clark & Wilkinson, 2009).

From an enactive point of view, this result shows an alignment between the maintenance of individual identities and the efforts made by each child to stay engaged with the other (De Jaegher & Di Paolo, 2008). This alignment depended not on the children's developmental similarities but on their ability to construct meaning through each other's actions (e.g., Episode 6, in which children learn with and from each other how to execute a new task, mediate object exploration, and elaborate non-verbal communicative resources). However, the PRISMA protocol suggests that the developmental differences influenced and were relevant when 'learning the process' and 'achieving the task' became conflicting goals (e.g., episode 1). Children's previous experiences influenced how they entered the collaborative interaction and directed their interests in object use. Participatory sense-making was hindered because the reference to building a sense of others' actions was grounded in distinct embodied experiences with the objects and activity in place. Unlike episode 6, in episode 1, conflict is established and opens the reflection on the need for adult intervention.

This study also indicates that the relational bonds between children are essential in creating and sustaining participatory sense-making that leads to collaboration. On the one hand, it points out the *potential for collaboration in partnerships between preferable* peers. Previous studies have indicated that among preferable peers, children can build idiosyncratic verbal and behavioural patterns, which facilitate communication (Clarke & Kirton, 2003; Ferreira et al., 2020), support effective learning, and enhance inclusion in social routines (Ferreira, 2017). This study's results showed that beyond expressing higher coordinated actions and joint attention, preferable peers build on abbreviations of communication that create more sensitive and precise communication (verbal and non-verbal), facilitating complex interactions.

On the other hand, results also point out that the lack of coordinated actions and continuous response delays (e.g., episode 16) may prevent the collaboration experience from emerging. Delays in communication with children with disabilities are common. They can even benefit children with intellectual disabilities, providing them time to structure social responses in adult–child interactions (Johnson & Parker, 2013). However, the introspective analysis of the experience reveals that in interactions between children, the different interactional rhythms and mismatched actions can hinder collaboration construction. Simultaneously, the study also contributes to revealing the subtle co-constructions of meaning within peer relations in structured activities included in the learning processes foreseen for children in early childhood. From both analytical approaches, the relational bonds between children played an important role in creating and sustaining collaboration by allowing bodily negotiations throughout the interaction. This result evidences the potential in interactions with preferable peers, indicating that pedagogical practices should include, encourage, or support the creation of this type of relationship.

Based on the findings, this study argues in favour of adopting an enactive account of social cognition (De Jaegher et al., 2017), where instead of assuming that all social interactions happen first as a mental representation (e.g., ToM, Simulation Theory), humans can also build on meaning together within the interaction—what in enactive theory is called participatory sense-making. The idea of participatory sense-making allows for a person-based approach to learning difficulties by focusing on intersubjective aspects of the lived experiences of children and their social activities. Learning difficulties emerging in collaborative interactions are then understood as specific challenges and differences in sense-making practices.

Implications

In taking an enactive framework and reflecting on the study's results, new pedagogical solutions for inclusive educational settings should include using multimodal communication (i.e., actively maintaining non-verbal references while verbalising their ideas) and mediating intersubjective processes between social partners. For example, the use of sign language associated with verbal communication may benefit children with disabilities as well as small children with typical development. It creates a sense of awareness in the group and supports gradual language development (Thompson et al., 2006; Lamberth & Lambeth, 2013). Other forms of multimodal communication, such as assistive word board, could also be applied widely in the classroom, supporting group-level interactions instead of being isolated in the context of special education.

Furthermore, the study's results indicate that the intersubjective processes created within child-child interactions should be mediated. More than intentionally organising the space and the task itself, teachers and other early childhood educators should contemplate what is at stake for children in the concrete interactive situation (De Jaegher, 2013), better understanding children's diverse ways of relating. This entails, first, knowing children's previous experiences with a specific activity—a historical knowledge of one's enactments with similar materials and actions. This knowledge allows teachers to bring together to the collaborative process children who share not only interests but engagement experiences with a specific task. Second, it means analysing children's collaborative interactions by asking why something means something to someone in that social encounter (Di Paolo et al., 2018), so that when ruptures or delays emerge, teachers can support children to find ways to coordinate actions again. The challenge of performing such expertise in everyday life in daycare centres is recognised, and these implications should be reflected within a wider discussion, including the debate on the necessary teacher training and time for implementing an enactive pedagogical practice.

As a final consideration, this study highlights three implications for future studies. The first is the need to investigate further the collaborative experiences between typically developing children and their peers with disabilities, particularly exploring how children learn to know each other within the interaction. Non-verbal communication in ECEC is considered a critical element in child-child social encounters (Bussab et al., 2007; Howard et al., 2012), affording cultural and embodied constructions (Ferreira et al., 2020), and it is the starting point of language development for children with intellectual disabilities (Clark & Wilkinson, 2009; Ferreira, 2017). However, the role and effectiveness of non-verbal communication are less explored in situations of collaborative learning, in which verbal utterances of cognitive, motivational, and emotional regulations are the central elements of analysis (Ferreira & Zabolotna, 2022; Grau & Whitebread, 2012). The analysis of collaborative learning interactions is often dependent on verbal exchanges, even in cases where children have intellectual disabilities and multimodal communication is considered (Stepanovic & Baucal, 2011). In this study, non-verbal communication expressed by simple regulation of body positioning and attentive waiting for the partner resulted in an observational process that prompted subsequent physical engagement between peers. It allowed children to follow others' bodily acts and negotiate sense-making, leading to collaboration. However, more knowledge on the intersubjective dynamics between typically developing children and their peers with disabilities would allow teachers and other practitioners to better elaborate on pedagogical practices in educational contexts. Other methods, such as multimodal conversation analysis, could reveal specific communication patterns, and incorporating

interviews with children could bring insights into their experiences of collaborating that can enrich the investigation. Additionally, a longitudinal research design would allow analytical depth into the construction of the peer relationship, which would benefit understanding its implications on learning and development.

The second implication regards the systematic analysis of peer relationships and the inclusion of partnerships with preferable peers in the pedagogical plan for special support. The present study suggests that among preferable peers, scaffolding is not pedagogically intentional but motivated by the context/content of the interaction or the relational bonds between children. Thus, identifying such relations becomes important in planning group activities in the class. Instead of looking solely at how often children play together or what is produced when they work side-by-side, the enactive approach adopted in this study invites teachers to use their perceptions (senses, feelings, and thoughts) to understand children's participatory sense-making and, by doing so, look at how children find ways to be with each other, to build trust, reciprocity, and coordination. By systematically analysing social engagements, teachers can include peers in specific grouping and organise collaborative activities more efficiently.

The third and last implication is a methodological one—developing techniques and protocols for including systematic introspective analysis of experience as a tool for teachers' professional assessment of children's interactions. The present study's methodological contribution was using a complex array of interactive factors, which are usually addressed in isolation simultaneously. The two different methods of analysis complemented each other. The third-person perspective in the microanalysis and the PRISMA protocol for investigating researchers' experience of the interaction (De Jaegher et al., 2017) support the systematic exploration of the data through distinct perspectives (construction of communication and sense-making), allowing the refinement and expansion of a method to grasp intersubjectivity (Fantasia et al., 2014). By grasping the experience of collaborative interactions, teachers can finetune their ability to use themselves as tools for analysing social experiences. Teachers can also learn to look beyond task completion and material usage toward how children coordinate their actions when collaborating, mediating intersubjectivity, monitoring the interaction for eventual breakdowns, and intervening only when necessary. These actions will increase opportunities for meaningful peer interactions, fostering an inclusive learning environment where children's abilities in participatory sense-making are constructed progressively, impacting their social skills throughout their lives.

Limitations

Although the decision to arrange familiar activities respected ethical considerations of research with young children by avoiding disturbance, it also limited the possibility of comparing children's achievements directly, and possible difficulties related to the activity itself could not be addressed. Additionally, there was no standardised psychological or neurological testing to identify the extent or characteristics of children's diagnosis of intellectual disabilities; thus, generalisations or correlations between disability and behaviour are not possible at any level. Regarding methodological limitations, the experienced-based PRISMA protocol presents challenges, one being the difficulty of merging the different perspectives into the configuration grid without hierarchical judgment between the statements. It is unknown, for example, if starting the analysis from the self-perspective point of view creates biases for the analysis of the remaining perspectives (others and interactions).

Such methodological questions should be addressed in future studies using the PRISMA protocol. In the future, it would also be worth creating strategies to collect data using the same type of collaborative activities, constraining the data collection to a particular task, and inviting other researchers to compose a team for the analysis, which would provide a larger grid of perceptions and more material to reach data saturation. Furthermore, future studies should also consider exploring multi-party collaborations which offer a much complex configuration of group interaction. The process of participatory sense-making in groups may differ significantly than those found in dyads and reported in this study.

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Author Contribution Juliene Madureira Ferreira collected, processed, and analysed the data and reported the study's findings.

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Authors and Affiliations

Juliene Madureira Ferreira[1]

✉ Juliene Madureira Ferreira
Juliene.madureiraferreira@tuni.fi

[1] Faculty of Education and Culture, Tampere University, Åkerlundinkatu, 5. Virta Building office 509, Tampere 33100, Finland