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Teacher–infant interactions in early childhood education and care: a review from an embodied, intersubjective, and multimodal perspective

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This narrative review examines multimodal interactions between teachers and infants and toddlers aged 0–3 years in Early Childhood Education and Care (ECEC) settings. It focuses on dyadic teacher–infant interactions from embodied and intersubjective perspectives, with particular attention to nonverbal and prelinguistic forms of exchange. Early communication is inherently multimodal, integrating visual, tactile, rhythmic, vocal, and affective dimensions. This perspective has gained relevance in recent decades, partly through the development of embodied approaches in developmental psychology and, more specifically, through the framework of communicative musicality. However, although educational quality during the first years of life depends substantially on teachers' relational competence and responsiveness, research in educational settings remains limited compared with the extensive literature on adult–infant interaction in family contexts. The findings indicate that the field is still incipient, with a clear predominance of qualitative, especially ethnographic, studies and limited use of quantitative, longitudinal, and microanalytic designs. Key gaps include the scarcity of research on children under one year of age and the methodological complexity of analyzing both dyadic and group dynamics in ECEC. The review argues that strengthening empirical research and incorporating tools such as video feedback may improve teacher education and educational practice. Future studies should examine how educators sustain intersubjective connection through multimodal resources such as gaze, proximity, bodily orientation, rhythm, and affect attunement, while also exploring care routines as privileged contexts for early interaction.

KEYWORDS

adult responsiveness, communicative musicality, early childhood education and care (ECEC), intersubjective interaction, multimodal interaction, nonverbal communication, teacher–infant interaction

1 Introduction

We present a critical narrative review aimed at integrating and analyzing relevant literature, prioritizing interpretive depth and contextualization of the topic (Ferrari, 2015; Grant and Booth, 2009; Snyder, 2019). We focus on studies of intersubjective, multimodal, non-semiotic dyadic teacher–infant interactions in Early Childhood

Education and Care (ECEC). The aim is to critically synthesize the field, identify gaps in the research and highlight the psychological constructs and methodological approaches that have made it possible to study these types of interactions.

Human development in the early years can be understood as a process of relational construction that emerges from the interactions of the infant with others and with the environment in which he/she participates. From socio-constructivist and ecological perspectives, it is recognized that cognitive, communicative and socioemotional competencies emerge and are organized through shared experiences, in which affective bonds and the quality of interactions play a structuring role. In this sense, early childhood education and care environments not only provide learning opportunities, but also configure key relational scenarios for development.

There is currently a sustained expansion in the participation of children from 0 to 6 years of age in ECEC settings. Recent data confirm this trend, with schooling rates exceeding 94% from the age of 3 and increasing participation before the start of compulsory education in the European context (Eurostat, 2022). For children under 3 years of age, a progressive increase in their participation in ECEC contexts is observed in OECD countries (Organisation for Economic Co-operation and Development, 2023). Globally, this expansion is linked to the growing recognition of early childhood education as a key policy priority to foster child development and promote social equity (UNICEF, 2019). This context reinforces the need to examine more precisely how interactions are shaped in these educational settings.

The literature agrees that educational quality in early childhood is deeply conditioned by the teacher's behavior, relational and didactic competencies, and ability to establish strong affective bonds with infants (Biringen et al., 2012; Vandell et al., 2010; Wittmer and Petersen, 2010). Although adult-infant intersubjective communication has been extensively studied in family and laboratory contexts (see, among the classic works, Gibson and Walk, 1960; Murray and Trevarthen, 1985; Tronick et al., 1978), the volume of research developed in infant schools remains comparatively smaller.

In this paper, we focus on studies on nonverbal and nonrepresentational dyadic interactions between children from 0 to 3 years old and their teachers. This approach responds to the interest in investigating early forms of exchange typical of primary intersubjectivity (Trevarthen, 1979), that is, dyadic, bodily and non-semiotic communicative processes in which the bases of intersubjective capacities are configured. These capacities appear in the first months of life and later will be complementary to language and will be maintained later in adult life as capacities for intense psychological contact or mutuality (Dissanayake, 2000; 2009). These interactions are multimodal exchanges of bodily expression that include body movements, facial gestures, sounds, glances, skin contact, and even variations in breathing and muscle tone. Several lines of research have proposed considering these interactions as a manifestation of human communicative musicality (Malloch, 1999; Malloch and Trevarthen, 2009). Consequently, this review paper excludes research focused on the first semiotic behaviors: declarative (pointing) and ostensive (showing and giving) gestures. These types of behaviors are key to communicative and linguistic development; however, the focus here is on non-semiotic forms of intersubjective exchange.

In recent decades, two movements in the social sciences have driven the emergence of studies on nonverbal interactions and underpin the theoretical assumptions of this paper: the bodily turn and the affective turn. The bodily turn has renewed the social and human sciences (Johnson, 2017; Kinsella, 2014; Sheets-Johnstone, 2009; Varela et al., 1991; Zhura and Rudova, 2017) and has had a great impact on Psychology and Education bringing the focus towards the body as the center of experience, knowledge and social practice (Gallagher, 2005; Glenberg and Gallese, 2012; Thompson and Varela, 2001), influencing current research in Developmental and Educational Psychology (Delafield-Butt and Trevarthen, 2015; Di Paolo, 2020; Reddy, 2008) and ECEC studies in particular (Da Costa et al., 2024).

Regarding the affective turn, it responds to the approach observable in contemporary Pedagogy, where the centrality of affect in the educational relationship is being pointed out (Dahlberg et al., 1999; Zembylas, 2007). In the field of ECEC, this becomes particularly relevant, since in ECEC the emotional bond, bodily presence and responsiveness of the educator constitute necessary conditions for the development of communication, self-regulation and a sense of basic security in the child (Biringen et al., 2014; Page, 2018; Shapiro and Appleyard, 2007).

The study of nonverbal dyadic interactions in ECEC contexts is relevant, as it will allow us to examine to what extent these interactions are configured in a similar or differential manner with respect to those observed in the family context. Given the decisive role that such exchanges play in early development, it is interesting to analyze how often schoolchildren have access to this type of experience and what other modalities of intersubjective contact structure their daily life in the infant school.

The ECEC context is characterized by a predominantly polyadic relational organization, in which one or two teachers simultaneously attend to a group of infants or toddlers. This creates a framework that is qualitatively different from the family environment. The teacher must distribute his or her attention and availability among multiple children, alternating continuously between dyadic interactions with one child, polyadic exchanges with the group and accompanying peer interactions, which involves a complex dynamic of intersubjective coordination. Teachers also face the challenge of a remarkable heterogeneity in developmental levels in the 0–3 years age group, which requires them to adjust their communicative and intersubjective strategies to different children's capacities simultaneously. Added to this is the specifically educational nature of ECEC, where interactions not only respond to care and communication functions, but are guided by explicit pedagogical intentions, mediated by routines, activities and objects typical of the school context. Therefore, it is particularly relevant to study how dyadic interactions are configured and sustained in this polyadic environment and what are the strategies that allow teachers to articulate, in real time, multiple relational and educational demands.

The fundamental forms of adult-infant dyadic interaction in ECEC contexts are unlikely to differ substantially from those observed in the family setting, given that the basic processes of attunement, reciprocity, and intersubjective construction will be common to both contexts. However, it is necessary to analyze how these interactions are modulated by the specific ECEC

environment and to obtain information about their frequency, duration of sustainment and characteristics of the exchanges.

2 Methodology

This research employs a qualitative narrative synthesis review approach rather than a systematic review under the PRISMA protocol, with the aim of integrating heterogeneous evidence within a very specific field of knowledge (Page et al., 2021). This approach prioritizes argumentative logic and interpretive synthesis (Baethge et al., 2019). It also ensures rigor through transparency in the criteria for searching, selecting and analyzing documentation, thus guaranteeing the traceability of the process.

Initially, the research question was established: *what is the current state of scientific evidence regarding teacher-infant interactions in ECEC contexts (0–3 years) analyzed from an intersubjective, multimodal and non-semiotic perspective?* Based on this question, an exhaustive search was carried out in several international databases and references in the psychoeducational field: Scopus, Web of Science, ERIC, Google Scholar, Dialnet and ProQuest. The main search terms were *early childhood education OR ECEC (early childhood education and care) AND teacher*-infant* interaction* AND nonverbal interaction* OR multimodal interaction OR multimodal communication OR communicative musicality*.

Inclusion and exclusion criteria, following the research question, are provided in Table 1. After performing the search and applying the filters, the publications selected for this narrative review are shown in Table 2.

3 Early socioemotional development and emotional and relational competencies of the adult caregiver: main theoretical approaches

Attachment theory demonstrated that the quality of the bond is profoundly influenced by the emotional competencies of the adult caregiver. Maternal responsiveness is a construct that has been operationalized in different ways (Beebe et al., 2010; Garner et al., 2019; Madigan et al., 2024). In general terms, it is defined as the adult’s ability to perceive and appropriately interpret the child’s emotional expressions and respond with promptness, consistency, and warmth (Ainsworth et al., 1974; Beebe et al., 2007, 2010; De Schipper et al., 2006). This capacity is essential in the 0–3 years stage because infants cannot regulate their emotions on their own and need the co-regulation offered by the adult (Fogel 1992; Thelen and Smith, 1994; Vogel and Müller, 2021; Tronick et al., 2007). Maternal responsiveness has been found to be positively related to the infant’s later socio-emotional and cognitive development (Bornstein et al., 2008; Kochanska et al., 2008; Lindsey et al., 2009).

Adult responsiveness is a key variable in the development of secure attachment within the family (Bornstein et al., 2008; Posada et al., 2018), although it is not the only one. Other variables that also play a very relevant role are child temperament and contextual factors such as the level of parental

TABLE 1 Inclusion and exclusion criteria for narrative review.

Element	Inclusion criteria	Exclusion criteria
Population/sample	ECEC studies without age limit	ECEC studies with children 0–3 years of age
Approach	Analysis of teacher-infant interactions from a multimodal perspective, including nonverbal components (gestures, gaze, prosody, contact, emotional regulation, etc.).	Traditional approaches focused exclusively on verbal communication or studies that do not incorporate multimodal analysis.
Study design	Original and completed articles, controlled research, single case studies with scientific rigor, systematic reviews, conference and conference proceedings, books and book chapters.	Unfinished articles, letters to the editor, non-scientific outreach articles, blogs, or social media videos.
Access to the document	Open	Not open
language	English and Spanish	Other languages
Time period	2006 y 2026	Publications prior to 2006, except those considered relevant.
Field of research	Psychology, education, anthropology, and behavioral sciences.	Other scientific disciplines

Source: own elaboration.

stress (O’Dea et al., 2023) and community support (de Waal et al., 2023; Li, 2023; Moss et al., 2011; Niccols, 2008).

Intersubjectivity theory (Trevvarthen, 1979) has documented that adults and infants have intuitive capacities to establish emotional attunement and share affective states and has proposed the concept of “Communicative Musicality” as the human capacity to synchronize emotionally and bodily with others, constructing rhythmic and expressive forms of communication that precede and accompany the use of verbal language (Español et al., 2022; Martínez et al., 2018; McLean, 2016; Moreno-Núñez and Alessandroni, 2021; Malloch and Trevvarthen, 2009). Both attachment theory and this theory have provided important insights for understanding the relational dynamics between caregivers and infants.

The analysis of adult-infant interactions with a multimodal approach has been in the minority until recently (Español, 2011; Jover and Gratier, 2023). Pioneering studies appeared in the 1970s (e.g., Stern 1971, 1974; Stern et al., 1977; Sander, 1977; Tronick and Cohn, 1989; Trevvarthen, 1979; Trevvarthen and Hubley, 1978). In recent decades, this approach has gained new momentum with the body turn and the rise of embodiment (Carretero and Español, 2016; Levin and Gratier, 2024; McGowan and Delafield-Butt, 2023).

A key antecedent was the study by Gogate et al. (2000), who defined multimodal motherese as infant-directed stimulation that integrates visual, tactile, and auditory cues. Subsequent

TABLE 2 Publications selected for this review.

Author(s)	Year	Title	Source	Main results	Relevance to the review
Recchia, S. L. & Shin, M. S.	2012	"Baby teachers": How caregivers and infants at different developmental levels negotiate relationships in a child care center.	Early Childhood Research Quarterly	They identify in-synch (adjusted) and out-of-synch (misadjusted) episodes. Teachers make constant microadaptations in interactions.	Emphasizes the importance of teacher sensitivity to cultural diversity and individual infant cues.
White, E. J., Peter, M. & Redder, B.	2015	Infant and teacher dialogue in education and care: A pedagogical imperative.	Early Childhood Research Quarterly	Infants' responses are most often to combined behaviors (V + NV). Dyadic dialogue is highly multimodal.	It is the only quantitative/mixed study. Evidence that verbal-only behaviors are less effective in engaging in the infant.
Quiñones, G., & Cooper, M.	2023	Infant-toddler teachers' compassionate pedagogies for emotionally intense experiences.	Early Years	The educator deploys sensitive, regulatory, and attuned responses to the child's emotionality.	Validates the teacher's capacity for emotional regulation at critical transitional moments.
Plum, M.	2024	Multi-sensitive attunement: exploring the relationship between the toddler and the nursery teacher in the institutional arrangement of early childhood education and care.	Pedagogy, Culture & Society	Defines body attunement as multisensory attunements. Introduces the role of objects and spaces (multi-sensitive attunement).	Expands the concept of dyadic interaction to a systemic view that includes the material environment.
Manning-Morton, J.	2026	Holding the baby: holding the educator. Embodied interactions between educators and 0–3-year-olds in early years settings.	Doctoral Dissertation, Bath Spa University*.	There is a continuum of touch. Video reflective processes (VERP) enhance teacher sensitivity and confidence.	It highlights affective touch and reflective practice as key tools for child well-being.

Source: own elaboration.
*It is the only source that is not a book, a chapter of a book or a scientific article.

studies showed that its intersensory redundancy supports attention and early learning by providing convergent perceptual cues (Bahrick and Lickliter, 2000; Bahrick et al., 2004). Currently, this perspective has been extended to the study of language development (Karadöller et al., 2025), consolidating the multimodal approach as an expanding field within research on adult-infant interactions.

4 Multimodal nonverbal interactions in the family context. Main approaches to their study

The design and implementation of methods oriented to a multimodal approach to interactions is a particularly complex task from the methodological point of view. A high degree of precision is required in the identification, delimitation and recording of signals, since these are sometimes extremely subtle, brief and unstable, making it difficult to observe them systematically, for which the analysis of video recordings is often used. This poses the challenge of how to perform the selection, segmentation and sequencing of the episodes under analysis (Jover and Gratier, 2023).

We discuss here some of the ways employed to approach this study.

4.1 The temporal organization of early interactions

The quantitative study of early interactions used a key construct to assess interaction dynamics: contingency. Robust

evidence for dyadic responsivity was obtained by analyzing the temporal contingency between the child's expressive behaviors and those of the adult, based on detailed coding of audio and video recordings. The reciprocal nature of the adult-infant interaction and the active and influential role played by the infant were tested. The classic Still Face experiment (Tronick et al., 1978) dramatically demonstrated the importance of adult contingency. This is defined as the caregiver's ability to respond immediately (within 1–3 s) and appropriately to the infant's cues, adjusting his or her reactions to the infant's condition and needs in real time.

Cohn and Tronick (1988) demonstrated that mother-infant coordination is bidirectional and based on a nonperiodic temporal organization. The results of Jaffe et al. (2001) corroborate this hypothesis and explain the rhythmic logic of these interactions. In these interactions, both participants influence each other and the temporal organization is probabilistic. This means that the rhythm adopted by adult and infant is not stable or mechanical; rather, it follows a recurrent pattern that is not fully regular and shows variation. These patterns follow a mathematical structure, but are not fixed; they contain an element of variability and controlled randomness. Probabilistic organization means that each participant adjusts his or her behavior according to the other, but not in a mechanical or repetitive way. For example, the mother does not always wait the same amount of time to respond to an infant's vocalization, but adapts her response according to the context and emotional state.

There have been studies focused on the contingency of different behaviors: vocal contingency (e.g., Goldstein and Schwade, 2008; Hane et al., 2003; Kaye and Fogel, 1980); visual and attentional contingency (e.g., Van Egeren et al., 2001),

emotional contingency (McQuaid et al., 2009) or motor and tactile contingency (López Pérez et al., 2017). Some of these studies are aimed at assessing the relationship between early contingency and different aspects of later child development (attentional, linguistic, communicative or emotional development). Only a few of all these nonverbal contingency studies perform a multimodal analysis, combining the simultaneous analysis of several behavioral modalities (Carretero and Español, 2016; Jover and Gratier, 2023). Beebe and colleagues have worked extensively for decades conducting multimodal microanalyses of parent-infant exchanges and assessing whether relationships were found between the characteristics and quality of these interactions and later indicators of infants' affective development. For example, they found correlations between levels of maternal multimodal contingency in early interactions at 4 months and the type of attachment developed by infants at around 12 months (see Koulomzin et al., 2002; Beebe et al., 2008, 2010, 2011).

Recently Jover and Gratier (2023) propose a methodological redefinition of the study of early interactions considering that adult-infant coordination cannot be adequately understood by means of discrete behavioral units or aggregate analyses, but as a continuous, multimodal and situated process. They argue that, despite half a century of research on adult-infant interaction, the scientific problem remains wide open because most of the empirical tradition has described discrete behaviors, often aggregated at the group level, and has captured with difficulty the temporal continuity, dyadic specificity and cross-modal coordination that constitute the real texture of early encounters. Her proposal is to reorient the field toward a naturalistic, longitudinal, multimodal, and continuous approach to study how voice, movement, gaze, touch, temporality, and contingency are co-organized in development.

Based on three longitudinal pilot studies, they examine motor, vocal and vocal-motor coordination in mother-infant dyads between 1 and 6 months, showing that temporality, latencies, mirroring, alternation and dyadic specificity are constitutive dimensions of the exchange. Their main contribution is to propose a microanalytic agenda capable of capturing the corporeal and narrative flow of interaction prior to conventional language, noting that much of the most fertile recent literature already moves precisely in that direction (see Abu-Zhaya et al., 2017; Beebe et al., 2016; Murray et al., 2016; Rohlfing and Nomikou, 2014).

4.2 The communicative musicality research

Malloch and Trevarthen proposed the concept of communicative musicality (hereafter CM), defining it as the human ability to intersubjectively attune to others through the coordination of motor and sound gestures. The constitutive dimensions of such an interaction are pulse, quality and narrative. Pulse is understood as the temporal recurrence of interactive behaviors. Synchronizing temporal patterns allows for experiences of communion. Quality refers to the diversity of sound and movement qualities that can be used in the interaction. In communicative musicality events, melodic and timbral contours of vocalizations and their

equivalents in the form and speed of body gestures are matched. Finally, the narrative consists in the tracing of a path or a development of behavioral units that are concatenated and build a unit of meaning. These are non-verbal units of meaning, defined by a certain compositional structure of movements, sounds and other behaviors (Malloch, 1999; Malloch and Trevarthen, 2009).

Under this umbrella of CM, the lines of work oriented to the study of movement in adult-infant interaction that were born in the 1970s have re-emerged, proposing new concepts and theoretical frameworks that are described below.

Dissanayake (2000, 2009) proposes the idea that adults intuitively deploy an expressive shaping in front of infants in which they use specific procedures of music and dance such as exaggeration, ornamentation, repetition with variation, accentuation, anticipation, surprise and the structuring of climax and resolution. This aesthetic procedure increases the salience of the interaction for the infant (as also argued by Gogate, 2000) and constitutes a basic mechanism for establishing mutuality and intimate psychological contact. This author coins the concept of multimodal performance to designate these interactive episodes.

Español (2008), Español et al. (2022) and Gratier and Apter-Danon (2009) pointed out that performances are structured through the repetition-variation form. Varied repetition is a fundamental compositional procedure of intuitive parenting, by which the adult organizes sequences of sounds and movements. It involves the reiteration of a motif or interactive scheme by introducing slight modifications in parameters such as time, intensity or form. This varied repetition makes it possible to create a predictable but dynamic environment for the infant, essential for affective regulation and joint attention. By acting in this way, the adult facilitates the infant's anticipation of events, which is the basis for interactive synchrony, and the infant's active participation in the interpersonal world from the first months of life.

The performances as they occur in the family environment have been analyzed through microanalysis, defining them as sonorous-kinesthetic phrases where the adult uses repetition and variation to expand the intersubjective encounter. Español and Shifres (2008) analyzed an interactive sequence between an adult and a 7-month-old infant and concluded that adult stimulation is organized in sound and movement phrases, similar to what occurs in temporal arts. Subsequently, through a microanalysis of the adult's sounds and movements with tools from Laban's movement analysis and musical performance studies, they showed that adults use sound resources -timing, dynamics and vocal quality- and bodily resources to mark boundaries, accents and tension-relaxation relationships, thus configuring a nonverbal hermeneutic that facilitates the encounter and regulates the atmosphere of intimacy (Español and Shifres, 2015).

Carretero et al. (2022) conducted a longitudinal single-case study with a dyad between 2 and 9 months analyzing the frequency and characteristics of three CM interactions: *performances*, *protoconversations* (Bateson, 1979) and *action songs* (Eckerdhal and Merker, 2009; Trevarthen, 1979). To do so, they developed an operational definition of each of these interactions. They found that the frequency of protoconversations remained stable throughout the period 2–9 months, the frequency of

performances increased above the others between 4 and 9 months, while the frequency of action-songs resembled that of the other interactions only after 6 months. Taken together, these findings suggest a shift from exchanges focused on vocal and facial expressivity in the early months toward increasingly complex, rhythmic, and choreographed forms of body play. This study has the limitation of a single-case longitudinal design. Even so, its microanalytic and heuristic value allows the identification of relevant interactive processes and justifies the continuation of this line of research through designs that expand the sample and contrast these dynamics in other early trajectories.

4.3 Affect attunement: a specific intersubjective phenomenon

Affect attunement is a concept coined by Stern (1985) that describes a brief intersubjective phenomenon in which the adult responds empathically to the infant's internal affective state by returning an expressive behavior similar to the one performed by the infant. It is an observable adult-infant experiential attunement phenomenon in the first year of life (Stern et al., 1985; Bordini, 2018; Bornstein, 2022; Español et al., 2022; Bartling et al., 2010).

For example, if an infant vocalizes with a tone of high arousal and the adult responds by moving his or her arms or making a facial gesture with the same rhythm, intensity, or modulation with which the infant acted. This is a mode of communication that allows the dyad to be in tune. According to Stern (1985), these adult behaviors do not seek to calm or emotionally regulate the infant, but simply to show recognition and emotional closeness. They allow the infant to feel perceived, which contributes to the development of a sense of self.

There is evidence that affect attunement appears around 2 months of age, increases during the first year and predominates over direct imitation in the second semester of life. Jonsson et al. (2001) suggest that this is because it allows the adult to accompany the infant's exploratory experiences as he or she moves through the environment. In addition, affective intonation has been described as a transmodal, brief behavior associated with marked changes in the infant's subjective state, although it is not usually observed in situations of extreme distress. It has also been related to development: Legerstee et al. (2007) found that a higher maternal frequency of affective intonations favors triadic joint attention at the end of the first year. However, more studies are needed on this phenomenon both in the family context and in ECEC.

This concept has been influential in various applied fields such as in the professional training of nursery teachers (Broström et al., 2011; Plum, 2024; Trevarthen and Delafield-Butt, 2017) and in studies on therapist-patient interactions in clinical psychology (Gill, 2010; Seligman, 2020; Stange Bernhardt, 2021).

5 Studies on multimodal interactions in ECEC

In the ECEC framework, the emotional and relational competencies of the educator have been shown to have, as in

the family setting, a strong impact on the child's development and learning possibilities (Howes and Ritchie, 2002; Xu et al., 2024). In this sense, the impact of early interactions on socioemotional development acquires central relevance, since the quality of these exchanges, marked by sensitivity, contingency and attunement, is closely associated with the construction of secure attachments and the development of relational competencies. In a scenario in which an increasing number of children spend a significant part of their development in ECEC contexts, it is particularly relevant to analyze how these processes are configured in the classroom.

In this context, published studies on multimodal nonverbal interactions in ECEC are scarce and, for the most part, qualitative and ethnographic in nature; the only quantitative study identified (White et al., 2015) presents a mixed design and of an exploratory nature. This limited availability of research is consistent with the specific focus adopted in the present work, centered on the analysis of teacher-infant interactions in ECEC from an intersubjective, multimodal and non-semiotic perspective. As explained in the methodology section, this orientation has implied an intentional delimitation of the corpus reviewed by means of rigorous inclusion criteria, which have made it possible to identify and analyze a reduced set of studies, five in total, that respond to this particular approach. Thus, this restriction should not be interpreted as a limitation of the field in general terms, but as a consequence of the specificity of the theoretical framework adopted, which prioritizes the study of the bodily, relational and prelinguistic dimensions of early interaction, leaving out those investigations focused on semiotic, linguistic aspects or on interactional configurations of a different nature.

White et al. (2015) observed interactions between infants and their educators at an ECEC Center in New Zealand. This study combines qualitative and quantitative methods. They filmed two infants' interactions with their teachers at 4 and 10 months and conducted interviews with the teachers. They recorded with several synchronized cameras: two of them were frontal cameras on the infants' and the teachers' heads; another camera was positioned to take a general shot of the situation. This allowed recording the episodes from simultaneous perspectives. The study quantitatively analyzed how the dyads initiated and sustained their exchanges by counting how many times the teachers initiated the interactions and how many times the babies did so. It also recorded whether the mode of initiating and responding to dialogue was vocal, verbal, nonverbal or combined.

Infants' responses to the teachers' interactive invitations were much more frequent when the teachers used combined behaviors (vocal+nonverbal). Both infants' responses and their initiations were also mostly combined. The teachers' verbal-only initiations were shown to have the least potential for engaging infants in a reciprocal exchange. This is evidence that the teacher-infant dialogue was highly multimodal and therefore the nature of the exchange goes far beyond words and vocalizations. The most common nonverbal response mode used by the infants was to combine vocalizations with body movement, with the privileged mode of infant participation also being multimodal. This approach is particularly valuable for examining the multimodality of behavior and the reciprocal dynamics of

initiations and responses, although it retains the limitation of a very small sample size.

These results reaffirm the hypothesis that infants become bodily oriented toward adults in order to establish intersubjective interactions not only in the company of their usual caregiving figures, but also with other responsive conspecifics, such as ECEC professionals (Delafield-Butt and Trevarthen, 2015; Malloch and Trevarthen, 2009).

Recchia and Shin (2012) conducted a qualitative study in a New York City nursery with three infant-teacher dyads observed at 12 and 18 months. From 13 h of videotaping of spontaneous activities per child, they coded indicators of reciprocity and shared meaning construction in order to describe the evolution of these interactions over six months. They distinguished *in-synch episodes*, characterized by contingent and emotionally adjusted adult responses to the infant's signals, and *out-of-synch episodes*, marked by mismatches between the child's intentions, emotions or actions and the teacher's response. Results showed that educators made continuous microadaptations to sustain attunement to each infant's changing needs. The highest frequency of asynchrony was observed with a child newly incorporated from a different cultural and linguistic context, suggesting that synchrony depends on both teacher sensitivity to read infant cues and the child's ability to adjust to adult expectations.

Quiñones and Cooper (2023) present a narrative ethnography of an episode of interaction between an 18-month-old girl and her teacher during the beginning of nursery school. They analyzed the facial expressions, body language, tone of voice, and emotional responses of the educator and the child. They concluded that the educator displayed sensitive, regulatory, and attuned forms of response to the child's emotionality.

Plum (2024), in an ethnographic study conducted in a UK infant school with children aged 18–36 months, combined six weeks of daily recordings with teacher interviews. Her results show that teachers build emotional intimacy and mutual regulation with children through body, rhythm and gestural synchronization. She defines body attunement as a set of multisensory adjustments by the adult to resonate with the child's emotional state. Furthermore, she argues that this connection is not only established dyadically, but also through the material elements of the environment. Building on the concept of *affect attunement* (Stern, 1985), she proposes the notion of *multi-sensitive attunement* to emphasize the role of objects, spaces, and classroom rhythms.

Manning-Morton (2026) qualitatively investigated the physical interactions between educators and children aged 5–30 months in four ECEC centers in the United Kingdom, from the theoretical framework of embodiment and intersubjectivity. The study adopted a co-operative inquiry with collaborative and participatory methods, and involved eight educators in a Video Enhanced Reflective Practice (VERP) process complemented by work discussion, video observations, group sessions and reflective writing; the analytic corpus included everyday scenes of care and interaction, such as rocking to sleep, diaper changes, comforting, physical play or songs, to examine how embodied interactions are configured in ECEC.

Findings show that educators and young children are in constant communication through bodily signals, variations in

proximity and touch, as subtle forms of embodied intersubjectivity. The thesis identifies a continuum of touch according to adult intention and impact on children's experience, highlighting the value of affective and attuned touch, proximity and so-called loving moments as relational configurations that contribute positively to children's well-being; it also underlines that these interactions are modulated by a matrix of factors including material environment, noise, time, group composition and the educator's ability to attune and contain children and to self-regulate. Finally, it shows that teachers' attuned bodily practices can be strengthened through reflective processes based on video analysis, which increase educators' sensitivity to children's signals and reinforce their professional confidence. Along these lines, works such as those of Filliettaz et al. (2022) conceptualize video-based interaction analysis as a formative device that allows for a fine-grained and situated examination of interactional dynamics. Through collective researcher-mediated analysis sessions, practitioners can reinterpret their own practices, developing a greater awareness of the multimodal, sequential and situated nature of interaction, as well as of the interactional competencies that are built in it.

The studies reviewed, although they present diverse designs, a mixed and exploratory study in White et al. (2015), qualitative and ethnographic studies in Recchia and Shin (2012), Quiñones and Cooper (2023) and Plum (2024), and a participatory research in Manning-Morton (2026), all shift the analysis from a verbalist conception of interaction towards an embodied, affective, multimodal and situated understanding of early communication; however, the constructs used to study this phenomenon are too broad and partially overlapping, with little operationalization and the samples analyzed are very small.

White et al. (2015) found that combined vocal and nonverbal teaching behaviors generate greater infant engagement than exclusively verbal initiations, evidencing that teacher-infant dialogue is organized through integrated multimodal configurations. Recchia and Shin (2012) provide a relational and temporal dimension by distinguishing *in-synch* moments, based on contingent and emotionally adjusted adult responses, and *out-of-synch* moments, marked by mismatches between infant signals and teacher response. Their study shows that synchrony is not a stable property, but a dynamic achievement that depends on continuous microadaptations and can be affected by the relational, cultural and linguistic history of each child. Quiñones and Cooper (2023), from a microethnographic scale, show how the educator regulates children's emotionality through facial gestures, voice, posture and proximity, emphasizing that teacher sensitivity is expressed in subtle forms of bodily presence and emotional availability.

Plum (2024) and Manning-Morton (2026) extend this approach by placing the body, touch, everyday rhythms, and classroom materiality at the center of educational intersubjectivity. Plum conceptualizes bodily attunement as a set of multisensory adjustments through which educators resonate with the child's emotional state, and proposes the notion of *multi-sensitive attunement* to show that affective regulation occurs not only in the adult-child dyad, but also through objects, spaces, institutional rhythms, and material atmospheres. Manning-Morton, from the framework of *embodiment*, shows

that touch, proximity, bodily support, comfort, physical play, songs or sleep accompaniment constitute central communication scenarios. Her identification of a *continuum of touch* makes it possible to differentiate forms of contact according to their intentionality and impact on the infant experience, while the *matrix of factors* shows that these interactions are modulated by institutional conditions such as noise, temporal organization, group composition, material environment and professional self-regulation. In addition, their study provides evidence that teacher bodily sensitivity can be strengthened through video-based reflective processes, which help to recognize subtle child cues and build professional confidence.

From a cross-sectional perspective, these studies agree that early educational interaction is organized through affective, bodily and multimodal adjustment processes, although they employ different concepts for phenomena that seem partially overlapping. Recchia and Shin's (2012) *in-synch* moments and Plum's (2024) bodily attunement refer to similar forms of sensitive adjustment between educator and child, based on the reading of infant signals and modulation of adult response; however, being broadly defined, it is not possible to determine whether they designate exactly the same phenomenon or different dimensions of interactive adjustment. Something similar happens with the concept of *multi-sensitive attunement*, theoretically suggestive for incorporating the sensory and material dimension, but too general for a precise empirical operationalization. As a prospective line, it would be necessary to elaborate more delimited definitions that refine these concepts.

For example, Plum's *multi-sensitive attunement* concept could perhaps be refined by taking into account the operational definition of *attunement* developed from Stern and other authors referenced in section 3.3, which offer a more precise basis for studying how the adult captures, transforms and returns the child's affective state through another expressive modality. This approach would allow us to systematically analyze *attunement* in ECEC contexts, applying observational methodologies and more precise quantitative analyses.

In the field of communicative musicality, we have found only two isolated studies on infants' CM behaviors with themselves, with other infants and/or with teachers in ECEC (see the commentary by Baxani, 2008 and Alcock, 2024 in point 5). But none of them focus on dyadic teacher-infant interactions, indicating that this study remains a research gap.

However, for the study of dyadic interactions, concepts operationalized in the study of early home interactions such as *multimodal performance*, *song-action* and *protoconversation* could be used to investigate their frequency, characteristics and mode of occurrence in ECEC. The descriptive power of constructs such as *multimodal performance* is precisely that the operational definition created from the microanalytic and longitudinal study of the phenomenon allows studies to analyze it quantitatively and thus study it longitudinally, in line with the interesting methodological critique of Jover and Gratier (2023), who call for a naturalistic, longitudinal, multimodal and continuous approach. Studies of this type would constitute an interesting contribution to understanding the characteristics of these interactions, and they continue to be vacant both within the family and in the ECEC.

6 Discussion and conclusions

Teacher-infant interactions in early childhood care and education (ECEC) settings have received considerably less research attention than adult-infant dyadic interactions in the family setting. The findings of this review indicate a marked predominance of qualitative approaches -especially of an ethnographic nature- since only one quantitative study was identified. The scarcity of localized works should be understood in relation to the specific analytical focus of this review, oriented to the study of teacher-infant interactions in ECEC from an intersubjective, multimodal, and non-semiotic perspective. In this sense, such delimitation is not necessarily an indicator of the inadequacy of the field but rather responds to the specificity of the theoretical framework adopted. This framework prioritizes the analysis of the bodily, relational and prelinguistic dimensions of early interaction, and therefore excludes research focused mainly on semiotic, linguistic components or on forms of interaction configured from other analytical assumptions.

We agree with Albon and Huf (2021) that ethnographic approaches have contributed decisively during the last decades to clarify which aspects are relevant in ECEC. Their richness lies in their holistic and ecological perspective, which enables a deep understanding of interactions and allows working with complex and contextually situated data, which is particularly relevant at an early stage of consolidation of the field. However, the results of this review point to the need to complement these contributions with quantitative methodologies that systematically and accurately describe the multimodal dynamics of teacher-infant interactions. It is also necessary to investigate longitudinally and with larger samples how dyadic interactions occur, as well as other specific intersubjective resources used by teachers in the context of ECEC.

There are standardized instruments for assessing the quality of teacher-infant interactions -such as the Infant Classroom Assessment Scoring System® (CLASS®) for infants. Multimodal and longitudinal descriptive studies could increase the interpretability and behavioral substantiation of such instruments by facilitating the linkage between their quality dimensions and observable markers of predominantly nonverbal communication.

The intrinsic complexity of the analysis of multimodal teacher-infant interactions probably contributes to the scarcity of studies in this field. Among the methodologies available for their description, microanalysis and some mixed approaches, such as that of White et al. (2015), stand out. A relevant result of this review is that, in the context of ECEC, we did not identify studies that employ microanalysis to examine dyadic interactions, despite the fact that this methodology has been widely used in research on these interactions in the family context. Its use would be particularly relevant, as it allows us to capture aspects of the interaction that are imperceptible in real time. Microanalysis sequentially examines recorded fragments of interaction, describing second-by-second vocalizations, gestures, gazes, and movements of both participants, which allows "opening a window into the details of the microprocesses of adult-inter-subjective adult-infant communication" (Beebe and Steele, 2013, p. 586). This methodology has been used both in exploratory studies of single scenes and in broad longitudinal

investigations linking early interactions to later developmental milestones.

Microanalyses would provide data that must then be complemented and evaluated longitudinally and in broad populations. Whether there is a causal relationship between responsiveness in teacher-infant interactions and children's later social-affective, social-communicative, and cognitive abilities could then be assessed through correlational studies.

Mixed methodologies can offer many advantages for this type of study, as they combine rich data collection in the ecological context with the possibility of quantitatively analyzing the results. The methodology employed by White et al. (2015) is a promising option for future research. Through multi-camera video recordings it is able to capture in great detail the complexity of interactions and, in addition, it incorporates a quantitative treatment that favors a systematic and global analysis of the observed data. The method of Carretero et al. (2022), used in the family setting, can also be useful in ECEC contexts. It combines a qualitative phase of creation of new categories generated through the constant comparative method (Strauss and Corbin, 1994) and a quantitative phase, where these categories are analyzed during a given evolutionary period.

Due to the methodological challenge posed by these studies with a multimodal approach, specific psychological constructs are not abundant in this field. We have reviewed that, in research on interactions in the family context, the constructs *multimodal contingency* and *affective intonation* have been developed and used. One could both use these constructs in the ECEC field and develop new constructs and categories of analysis. It could be considered whether concepts coming from the field of CM, such as *performances*, *protoconversations* and *action songs* could be fertile. It would be interesting to describe which are the resources for intersubjectivity most used by teachers on a daily basis and how they use them, since they will orchestrate and structure them in different ways with respect to what happens in families.

Another finding of this review is that most of the studies found are focused on the 1–3 years period, therefore, it is evident that there is a huge gap in the investigation of these interactions in children under 1 year of age.

Based on the results of this review, we propose three main lines of future development to advance the understanding of teacher-infant interactions in ECEC contexts. First, it is necessary to deepen the study of the multimodal intersubjective resources that educators deploy in polyadic environments to sustain the connection with children. Secondly, it is especially relevant to investigate specifically the moments of care, traditionally less explored, in order to highlight their role as privileged contexts for dyadic interaction and intersubjective attunement, as well as to support the need to protect and value them in educational practice. Finally, the importance of developing teacher training strategies focused on interactional competencies, through approaches that incorporate the analysis of the practice itself, for example, through the use of video recordings and guided reflective processes, as a way to make visible, understand and strengthen the relational skills of professionals.

It is necessary to identify and understand the set of intersubjective resources that teachers deploy in ECEC contexts to establish intersubjective contact in polyadic settings. In 0–3 classrooms, the educator does not relate exclusively to one child, but must be simultaneously available to several, which implies complex forms of distributed presence. This translates into the use of subtle resources such as different gaze modalities—peripheral gaze, focused gaze, joint attention, etc.—body orientation, modulation of proximity or management of the pace of interaction, which allow the adult to be with one and at the same time with all. From this perspective, it is particularly relevant to analyze how these multimodal resources configure forms of intersubjective attunement that are not limited to the dyad, but expand into a broader relational field. Delving deeper into these mechanisms will provide a better understanding of how affective connection and child participation are sustained in complex educational ecologies. As prospective work, given the importance of polyadic interactions in the ECEC context, it will be relevant to study them.

Affective intonation, in the family setting, has been shown to be more frequent in the second than in the first semester of life. The authors suggest that this is due to the fact that it allows the adult to accompany the baby's exploratory experiences while moving through the environment (Jonsson et al., 2001). Because of this and because it is a very brief behavior, it is a particularly useful resource for establishing intersubjective contact with infants when there is no physical proximity. Being at a distance and observing the child, the teacher could respond to the child's behaviors through intonation, voice or movement and thus subjectively “reach” the child at a distance, which is especially relevant in ECEC contexts characterized by polyadic configurations. It is therefore relevant to study whether perhaps in the ECEC setting, affective intonation functions as a relational bridge that facilitates the distributed presence of the educator.

Secondly, further study of teacher-infant interactions in ECEC contexts and their impact on development would provide theoretical support for concerns widely shared in educational practice: the hierarchization and professional enrichment of dyadic moments of care, to the same extent as moments of shared play. For example, the works of Cadima et al. (2022) and Degotardi (2010) explore this concern, because they study the performance of ECEC teachers and find lower levels of educational quality in moments of care than in moments of play. As we have reviewed in point 4, Manning-Morton (2026) stresses the relevance of dyadic moments of care to build teacher-infant intersubjective attunement.

Third, in relation to teacher professional development, an advance in the descriptive study of these interactions and their implications for child development could contribute substantively to the enrichment of educational practices in ECEC, as other authors have also pointed out (see Moreno-Núñez et al., 2022), an area that continues to show important associated shortcomings due, in part, to significant gaps in teacher training (Crawford et al., 2022; Mortensen and Barnett, 2015). Just as it is methodologically complex to investigate these interactions, it is also a challenge for practitioners to develop and refine their interactional competencies in the classroom.

Teacher training strategies based on reviewing recordings of actual interactions can be a particularly fertile avenue for strengthening professional competence. Some studies have shown that techniques such as video feedback can improve teachers' interactive skills in different educational contexts (Fukkink and Tavecchio, 2010; Sherin and van Es, 2009). Filliettaz et al. (2022) describe video-based interaction analysis as a structured training device that is articulated through collective researcher-mediated data analysis sessions. In these sessions, practitioners jointly analyze recordings of their practice, allowing attention to be directed toward multimodal and sequential details of interaction and making visible interactional competencies that, in many cases, remain implicit in everyday tasks. This process not only favors awareness of one's own performance, but also contributes to the shared construction of professional knowledge and the development of teaching competence.

In summary, this review shows that teacher-infant body interactions in ECEC contexts constitute a field that is still underdeveloped, but fundamental for understanding how early intersubjectivity is sustained in complex educational ecologies. The specificity of the ECEC environment lies in its polyadic organization, which integrates dyadic moments, the alternation between care routines and play situations, and the structural conditions of the classroom. All this requires moving towards multimodal, microanalytical and longitudinal methodologies that allow for a more precise description of the intersubjective resources deployed by educators. Going deeper into this field would not only broaden the understanding of early development in educational contexts, but also provide empirical foundations for improving teacher training, protecting moments of care, and strengthening the relational quality of ECEC.

Author contributions

SC: Conceptualization, Funding acquisition, Investigation, Methodology, Supervision, Writing – original draft, Writing – review & editing. MdC: Conceptualization, Writing – original draft, Writing – review & editing. DMJ: Methodology, Visualization, Writing – review & editing. AMC: Writing – review & editing.

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