



Characterization of dyadic interaction features between fathers and mothers playing with their autistic children

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ABSTRACT

Background: Socio-communicative difficulties are a core symptom of autism that deeply impact interaction with others. Despite that, research on bidirectional caregiver-child interaction variables has been notably scant and predominantly focused on autistic children's interactive differences and the consequences on parenting behaviors.

Aim: The study aimed to assess parent-child interaction in the context of autism through observational validated instruments that consider qualitative and structural features in a complementary way to obtain a comprehensive characterization of the exchange within the dyad.

Methods and procedures: This study involved 56 paired parent-child dyads of 28 autistic children (mean age = 38.60 months, *sd* = 9.50) playing with their mothers and their fathers for 10 min. The video-recorded sessions were coded through the Emotional Availability Scales (EAS) and the Interpersonal Synchrony (IS) coding system.

Outcomes and results: Fathers and mothers do not show significant differences in IS except for mother widenings, which are more frequent and successful, and in Emotional Availability. Further, dyads present moderate levels of Emotional Availability, indicating that parents may struggle with structuring, sensitivity, and interactive abilities with their autistic children, which in turn present low levels of responsiveness and involvement. Further, we explored an association between IS and EA characteristics.

Conclusion and implications: This study suggests the need for interventions to target interaction considering both caregivers, ultimately targeting both interaction structure and affect features. Research that includes fathers fosters strategies for individualization and treatment optimization.

1. Introduction

Autism is a neurodevelopmental disorder identifiable as early as 6 months of age (Tanner & Dounavi, 2021). Moreover, it is a lifelong condition, persisting across the entire lifespan. Considering the differences in the socio-communicative and repetitive interests and behaviors areas, as well as the comorbid conditions frequently associated (American Psychiatric Association, 2013), Autism presents the individual and the caregivers with challenges in several domains. Specifically, the tendency of autistic children to be less responsive to the caregivers' initiative and less involving toward others can determine differences in the relationship between the caregiver and the child. In fact, parents may not understand their child's needs and behaviors, leading to an absence of correspondence between the needs, requests, and responses

of the child and the responses and requests of the adult, ultimately altering the child's development (Mandy & Lai, 2016). Several studies have shown reduced parents' warmth and affection and controlling behaviors toward their autistic children (Shorey et al., 2020).

A healthy caregiver-child relationship influences the child's brain development (Ilyka et al., 2021), influencing the maturation of the child's cortic limbic circuitry, which plays a role in emotion regulation (Gee & Cohodes, 2021). Further, parent-child interaction influences a child's cognitive ability (Dunham et al., 1988; Jeon et al., 2013) and social development (Uzun et al., 2021).

This emphasizes the relevance of studying parents and their children in the autism context, guaranteeing the activation of functional and appropriate relationships between these dyads (Loncarevic et al., 2023; Siller & Sigman, 2002).

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1.1. Studies on parents in the context of autism

Many studies involving caregivers in the context of autism focused on parents' characteristics, such as enhanced levels of parental stress (Schieve et al., 2007), difficulties related to parents' mental health (Stewart et al., 2017), coping skills, and parents' experiences related to their parenting role in the context of autism (Ghanouni & Hood, 2021). Also, a consistent body of research addresses the effects of the difficulties experienced by parents associated with caretaking, namely finding and managing services, coping with the social stigma, and lack of support (Ault et al., 2021; Chan & Leung, 2021; Operto et al., 2021). Parent difficulties also stem from the need to face the child's behaviors associated with autism, specifically the ones related to the different social abilities that ultimately alter the interaction with others. In particular, social interaction constitutes a primary feature of this condition, characterized by differences in imitation (Williams et al., 2004), intentional communicative behaviors (Sandbank et al., 2017), joint attention, a crucial milestone that refers to the ability to share attentional focus between objects and interaction partners (Bruinsma et al., 2004; Meindl & Cannella-Malone, 2011), turn-taking (Carmo et al., 2023), reciprocity (Ochi et al., 2019), perceived behavioral synchrony when interacting with adults (McNaughton & Redcay, 2020; Zampella et al., 2020). In line with that, dyadic interaction with autistic children presents different characteristics compared to parents' interaction with their typical child from the first year of life (Wan et al., 2019).

However, the investigation of bidirectional caregiver-child interaction variables has been scant despite the theories supporting the mutual influences of the two parties involved in the exchange (Venuti et al., 2017; Sameroff, 2009). In line with this, studies on infants showed that dyadic variables, such as dyadic mutuality and infant positive affect and attentiveness to parents during the interaction at 12 months, can predict the diagnostic classification at 3 years (Wan et al., 2013). A systematic review has confirmed results suggesting that interaction differences are related to dyadic features and highlighted a link with children's language outcomes. Specifically, maternal sensitive structuring and verbal responsiveness were associated with different aspects of expressive languages (Wan et al., 2019).

Although informative, research on parenting often disregards the bidirectional dyadic aspects of the relationships, overlooking reciprocity, a competence in which autistic people present differences compared to neurotypical individuals (Palomo et al., 2006). Reciprocity also constitutes a core feature of autism and influences the ability to initiate interactions and respond to others, take turns, imitate and talk to others, share interests, and affect (APA, 2013; Backer van Ommeren et al., 2022).

Additionally, when studying parenting and interaction in the context of autism, researchers mostly focused on mothers. However, researchers should consider societal changes characterized by a growing involvement of fathers in caregiving, involving them in research as relevant subjects as mothers. This would foster the ability to personalize intervention strategies and heighten parents' quality of life.

Some research suggests the absence of differences in social interaction during play (Elder et al., 2002), in the engagement (Forsyth, 2018), and strategies used to support child regulation, as well as in the affect displayed by parents (Bentenuto et al., 2020). Hence, fathers seem sensitive to their children's emotional needs (Keller et al., 2014).

Other studies showed differences in parent responsiveness to the child, with the mother being more responsive (Karaaslan, 2016), more structuring (Gullu et al., 2024), and more oriented toward symbolic play while fathers engaged more often in exploratory play (Perzoli et al., 2023b). Further, mothers and fathers seem to present different language characteristics, with fathers presenting a lower number of requests and a high degree of use of verbal structuring strategies (El-Ghoroury & Romanczyk, 1999; Flippin & Watson, 2011; Bentenuto et al., 2021).

Hence, the current research presents the relatively innovative aspect of including fathers. As highlighted by Flippin and Crais (2011), fathers'

unique interaction style, characterized by being more active and generative (greater tendency of fathers to use objects attributing to them different properties going beyond the physical ones), and language directiveness differently contribute to the child's milestones acquisition, especially regarding language and emotional regulation, determining better developmental outcomes for children. These results support the equal importance of fathers' involvement in intervention. However, the review also highlights the scarce number of studies taking into consideration fathers in interaction with their autistic children during play and "parent-mediated" interventions.

In line with the above-mentioned findings, this study aims to characterize parent-child interaction from a quantitative and qualitative perspective to comprehensively view the dyadic exchanges in the context of autism. To do that, we focused on two constructs: interpersonal synchrony, which allows us to obtain information regarding the interaction structure, and emotional availability, which offers a qualitative understanding of its emotional aspects. Further, observational approaches are particularly relevant considering their minimal invasiveness (Chorney et al., 2015) and the possibility of studying dyadic variables without interfering with the interaction.

1.1.1. Interpersonal synchrony

Interpersonal Synchrony (IS) is a social and complex construct ascribable to intersubjectivity that refers to the multimodal coordination of socio-communicative behaviors of two partners in interaction (Delaherche et al., 2012; Leclère et al., 2014; Zampella et al., 2020).

Previous research on the topic explored neuro-biological aspects, neural (Tanabe et al., 2012) and physiological (Dunsmore et al., 2019) synchrony, as well as conversational, verbal, and non-verbal (Hobson et al., 2012; Zampella et al., 2020) or motor synchrony (Brezis et al., 2017). In its different aspects, IS is a social signifier related to prosocial behaviors, affiliation, and rapport. As measured in different contexts and through different tasks, autistic people often present lower neural, motor, and conversational synchrony compared to the neurotypical population (Bowsher-Murray et al., 2022; Carollo et al., 2021) and suggested the role of IS as a potential biomarker relevant both in the diagnosis process and intervention monitoring (McNaughton & Redcay, 2020). However, research on IS often focused on micro-behaviors such as gaze, chair rocking, and body movements (Bowsher-Murray et al., 2022; McNaughton & Redcay, 2020).

A recent work aimed to predict treatment response based on therapist-child interaction features, focused on IS of social interaction behaviors considering child communicative signals in terms of intentionality and activity initiations, adults' activity initiations, and the partner response to the attempts. Further, states of mutual engagement were considered and characterized based on child engagement and complexity. Specifically, this study showed that IS might be a significant predictor of overall response to intervention. The above-mentioned research presents the novelty of using an observational approach to quantifying socio-communicative behavior synchronization bidirectionally, studying the interaction dynamic and structure in an ecological context without contaminating the natural interaction. Considering this approach, it would be relevant to expand upon prior research, moving the focus from clinicians to parents as they are the child's primary interaction partners. Hence, literature on parenting in the context of autism reveals that early functional caregiver-child interactions foster better child cognitive, social, and affective development (Anderson et al., 2013; Tamis-LeMonda et al., 2004). Along with the literature supporting the need to involve caregivers in interventions (Burrell & Borrego Jr, 2012; Musetti et al., 2021), deepening the knowledge of the parent-child synchronous aspect might have relevant clinical implications in early diagnosis and intervention optimization and personalization.

1.1.2. Emotional availability

The construct of Emotional Availability (EA) considers the

bidirectional effect of interaction, also identified as “connective tissue in relationships” (Biringen et al., 2014; Biringen et al., 2022). EA focuses on the emotional aspects and mutual accessibility of adult-child dyadic interactions, considering their bidirectional role during the exchanges (Biringen, 2008; Biringen & Robinson, 1991) and the active child’s role. Specifically, it considered the ability of the parent to sensitively guide the child, follow their interests, and the bidirectional ability to appropriately respond and involve each other in an exchange characterized by positive affect.

The Emotional Availability construct is operationalized and measured using the Emotional Availability Scales (EAS, Biringen, 2008), a highly validated tool for research and clinical purposes. Further, the EAS consider four categories where to score the caregiver’s behavior (Sensitivity, Structuring, Non-intrusiveness, and Non-hostility) and two for the child’s (Responsiveness and Involvement).

Despite, previous studies on EA have been mainly conducted on typically developing children (Biringen & Easterbrooks, 2012), a growing body of research is focusing on interactions of autistic children with their mothers, showing that children might present lower scores in responsiveness and involvement compared to neurotypical peers; further mothers of autistic children seem to present higher structuring abilities during the exchange (Gul et al., 2016). Researchers showed that Emotional Availability in mother-child dyads was influenced by the level of structure during play (e.g., free play versus structured play), the child’s cognitive functioning, and their characteristics related to autism. Specifically, lower EAS’ scores were associated with lower cognitive functioning and greater symptoms (Dolev et al., 2009). Maternal mental health variables also seem to influence dyadic attunement evaluated through the EAs, as higher levels of maternal stress and anxiety predict poorer attunement (Kulasinghe et al., 2022).

Recent studies widened the focus, including father-child dyads, and found no differences between mother- and father-child interaction. Moreover, dyads showed similar results also when considering the correlation between the different EA’s dimensions both in the Israeli and Italian context (Bentunuto et al., 2020; Dolev et al., 2009). This is in line with studies conducted on children with Down syndrome, which showed that parents were similarly emotionally available to their children, and children were equally responsive and involving toward mothers and fathers (De Falco et al., 2009).

Conversely, a recent study showed that mothers might present better sensitivity and structuring than fathers while interacting with their autistic child in the Turkish context (Gullu et al., 2024). To our knowledge, only the above-mentioned studies considered father-child EA in the context of autism. Considering the lack of replication studies, expanding the knowledge on fatherhood and on caregivers’ EA is crucial. Hence, a study on father-child emotional availability showed a positive association between play sophistication and EA dimensions in children with a developmental disability (de Falco et al., 2008), potentially presenting EA as an area of intervention with fathers in order to foster the child’s milestones acquisition.

1.2. The current study

For all the above-mentioned reasons, with this study, we aim to assess parent-child interaction in the context of autism through observational validated instruments that consider qualitative and structural features. In particular, IS and Emotional Availability will be explored, potentially gaining new relevant information on temporal dynamics during interactions, which entail information about adults’ sensitivity and structuring behaviors and child initiative and responsiveness to the caregiver. Specifically, the EAS evaluate these constructs from a global point of view, while the IS coding system allows to grasp the temporal characteristic of the exchanges, quantifying socio-communicative behaviors, frequencies, latencies, their sequence, and success rate from a bidirectional point of view.

- (1) Given the lack of literature considering parents’ differences in interaction with their children in the context of autism, we aim to explore the interaction considering parents’ differences by combining IS and EA measures.

Our aim is to investigate IS differences between mothers and fathers, which have not been investigated before in parent-child dyadic interaction. Therefore, our research will be partly explorative in nature. We also aim to replicate the research conducted on the Emotional Availability parameters by studying caregivers’ differences while interacting with their children, as research on fathers is still scarce, as specified in the 1.1 and 1.1.2 sections. We hypothesize no differences in the father-child and mother-child EA dimensions based on the EAs studies mentioned above and conducted in the Italian context. Furthermore, the EAS and the IS coding systems overlap, as highlighted by the Bertamini et al. (2021). For instance, while the EAS qualitatively evaluate parents’ structuring abilities and child’s initiations, the IS coding scheme measures the frequency of parent’s activity and activity expansions. Considering EAS’ parent sensitivity and child responsiveness, these are evaluated in terms of frequencies and latencies of parent and child responses to the interaction partner’s initiations. Therefore, we expect that what emerges from using the IS coding system will be in line with the EAS results, hypothetically not showing differences in the temporal dynamics between mothers and fathers.

- (2) The constructs of IS and EA allow interaction evaluation considering its bidirectionality and, despite their different nature, one being quantitative and the other being qualitative respectively, both provide an evaluation of the dyadic exchange measuring different aspects of parent sensitivity, children’s initiations, and responsiveness to the adult: the EAS with a focus on emotional aspects and attunement, and the IS coding system with a focus on socio-communicative behavior structure and temporal dynamics. Based on that, we expect the interaction features assessed through the IS coding system to be predicted by EA characteristics; this would align with previous research that showed an association of the two dimensions in the context of therapist-child interaction (Bertamini et al., 2021, 2023).

2. Methods

2.1. Participants

This study involved 56 paired parent-child dyads of 28 autistic children (mean chronological age = 38.60 months, $sd = 9.50$), 15 males and 13 females, with their mothers and their fathers. Specifically, the same child interacted with one of the caregivers first and the second one later, and the interaction order was randomized.

All parent and child dyads were recruited at ODFlab, a clinical and research center of the Department of Psychology and Cognitive Science—(University of Trento). The study was advertised within ODFlab through posters, and families of children undergoing a clinical assessment spontaneously expressed interest in participating.

Information about families’ socio-economic status were requested and provided by 20 out of the 28 families involved. Then, an index was calculated based on the four-factor index of social status, which considers education and years of schooling, occupation, sex, and marital status (Hollingshead, 1975). The score ranges from 8 to 66. The families participating in this study present a status that falls within the middle range.

The mean developmental quotient of the sample is 71.50 ($sd = 18.60$), and the mean mental age is 29 months ($sd = 7.36$).

Regarding the Autism characteristic evaluated with the ADOS-2, the sample presented a mean Social Affect score of 10.90 ($sd = 3.20$) and 3.54 ($sd = 1.30$) in the Restricted and Repetitive behaviors score, with a mean comparison score of 5.89 ($sd = 1.40$). The comparison score can be

interpreted based on the following levels: 1–2 minimal risk/no evidence, 3–4 low risk, 5 to 7 moderate risk, and 8 to 10 high risk. See Table 1 for participants' demographics.

The sample was recruited at the Laboratory of Observation Diagnosis and Education (ODFLab) of the Department of Psychology and Cognitive Science of the University of Trento, where children received a diagnostic assessment. The inclusion criteria were:

- A diagnosis of Autism based on the Diagnostic and Statistical Manual of Mental Disorders – 5 version criteria through clinical judgment by a licensed psychologist through free play observation and the administration of clinical instruments meant to assess developmental profiles and autism-related behaviors.
- Chronological age was between 18 and 60 months.
- Children have not received prior interventions.

Participants have been excluded based on the following criteria:

- A confirmed comorbid diagnosis.
- The absence of interaction videos with both caregivers.
- Significant motor difficulties or disorders that limit play interaction and environment exploration.

2.2. Procedure

All procedures of this study were in accordance with the ethical code of the Italian Association of Psychology (AIP), with the last version of the Declaration of Helsinki (Associazione Medica Mondiale, 2014) and were approved by the Ethical Committee of the University of Trento (Italy).

Data were collected at ODFLab, University of Trento, a research and clinical center specialized in neurodevelopmental disorders, especially autism, where caregivers generally turn to for a functional diagnosis of their children and/or undertake an intervention program.

During the first clinical assessment, 10 min of parent-child dyadic interaction was video-recorded with bird-eye cameras. Interaction length was determined by previous studies conducted on parent-child interaction, which showed that a coding time comprised between 5 and 10 min is adequate to analyze adult-child interaction (Ann Eastbrooks & Biringen, 2000; De Falco et al., 2009; Hudry et al., 2013).

Dyads were asked to play as they typically would using a standard set of toys. Video-recordings were first analyzed using the ISobservational coding system through the Behavioral Observation Research Interactive Software (BORIS) (Friard & Gamba, 2016), an open-source time-constrained event-logging software. Specifically, behaviors are coded as point events when the firstly happen, except for the characterization of shared playtime.

Second, the Emotional Availability Scales (EAS) (Biringen, 2008) were applied to the same video-recorded interactions.

Video-recordings were coded by four independent observers, two of

whom used the observational coding system, and two applied the EAS. All coders were adequately trained, blind to child diagnosis and research aims, and all reached satisfactory interrater reliability.

Further, during the diagnostic and functional evaluation of the child, the child's developmental level was studied using the Griffiths Mental Development Scales (GMDS-ER, Luiz et al., 2006). Then, based on the level of language development and chronological age, the Autism Diagnostic Observation Schedule – 2 (ADOS-2, Lord et al., 2012) was administered to investigate specific autism-related behaviors. For the purposes of this study, ADOS Toddler, module 1 and 2 were used.

2.3. Measures

2.3.1. The ISCoding system

An observational coding system (Bertamini et al., 2021) has been applied to video-recorded interactions to evaluate ISfeatures quantitatively. It comprises 15 codes (see Table 2), describing adults' and children's behaviors and identifying two main scenarios: *Interaction Units* and *Shared Action*. All the codes are point events, as they are noted when the behavior is manifested, except for the Shared Action code, which is code at the beginning and at the end of each interplay, this allows for the calculation of the duration. There is no minimum time for the dyad to be engaged in order for the code to be used.

Interaction Units refer to the combination of codes characterized by the intentionality of the child followed by the adult or the activity initiation accepted by the child and might lead to a Shared Action. Specifically, it is possible to quantitatively analyze the child intentionality signal (CI) caught by the adult (AI), the child activity initiation (CP) accepted by the adult (AA), if the adult does not respond to the child nothing is coded, and the adult activity initiation (AP) accepted by the child (CA), refused by the child (CR), or followed by child indifference, in this case, nothing is coded. Regarding CI and CP, both are coded when the child manifests a goal-directed signal meant to initiate an activity,

Table 2

Codes of the observational coding system used to evaluate interpersonal synchrony.

Code	Description	ICC (Alternative Hypothesis $r_0 > 0.8$)
AP	Adult activity initiation	0.958; F(9,5.100) = 5.400; $p = 0.038$ (0.764–0.990)
AW	Adult widens	0.953; F(9,9.090) = 4.620; $p = 0.016$ (0.824–0.988)
CA	Child accepts	0.952; F(9,5.580) = 4.600; $p = 0.039$ (0.765–0.989)
CR	Child refuses	0.627; F(9,9.49) = 0.477; $p = 0.858$ (0.096–0.889)
CI	Child's intentionality	0.940; F(9,7.990) = 3.640; $p = 0.042$ (0.766–0.985)
AI	Adult recognizes intentionality	0.957; F(9,5.820) = 5.250; $p = 0.030$ (0.786–0.990)
CP	Child activity initiation	1
AA	Adult accepts	1
SA	Shared activity	1
CX	Child inadequately ends the sharing	0.992; F(9,10) = 28.800; $p < 0.001$ (0.971–0.998)
AE	Adult ends activity	1
CE	Child adequately ends the activity	0.975; F(9,10) = 8.700; $p = 0.001$ (0.908–0.994)
CD	Child's signals of dysregulation / activation state	0.571; F(9,9.870) = 0.401; $p = 0.907$ (0.014–0.869)
AR	Adult recognizes child's dysregulation signals	0.667; F(9,9.960) = 0.556; $p = 0.805$ (0.138–0.904)
ENG 1 (low engagement)	Child engagement displayed during the interplay	0.943; F(9,5.91) = 3.9; $p = 0.057$
ENG 2 (medium engagement)		0.741; F(9,6.56) = 0.738; $p = 0.672$
ENG 3 (high engagement)		1

Table 1

Participants: descriptive statistics for chronological age, developmental quotients and ADOS-2 scores.

	n	Min (Max)	M	SD
Chronological age in months	28	22.00 (58.00)	38.60	9.45
Socio Economic Status	20	17.00 (66.00)	37.60	14.90
GMDS - Mental age in months	28	20.00 (47.00)	29.00	7.36
GMDS - Developmental quotient	28	20.00 (103.00)	71.50	18.60
ADOS-2 - Social Affect Score	28	6.00 (17.00)	10.90	3.20
ADOS-2 - Restricted and Repetitive Behaviors Score	28	1.00 (7.00)	3.54	1.43
ADOS-2 - Total Score	28	9.00 (22.00)	14.40	3.58
ADOS-2 - Comparison Score	28	3.00 (9.00)	5.89	1.40

the first one is coded when this is atypical or unimodal, when the child does not directly address the behavior toward the adult. While, CP is coded a clear initiation of joint attention that combines different communicative channels (e.g. verbal and eye-gaze or pointing).

A *Shared Action* regards the state of dyadic mutual engagement, it can be either dyadic or triadic if an object is involved, and it is characterized by length, the level of engagement displayed by the child (ENG), its complexity, how it is ended, and by whom.

Regarding Shared Action characteristics, Engagement (ENG) is coded at the end of a Shared action, and it is coded using a three-point scale evaluating the level of shared pleasure and participation from lowest (1) to highest levels (3). Specifically, it is determined by considering children's active participation through verbal and non-verbal signals, physical proximity to the parent, and attentional focus shared between the parent and the object they are playing with. Level 1 is coded when children are engaged, but they display low participation signals without evidence of positive affect. Level 3 identifies a child that actively takes part in the interaction, displays positive affect and reciprocity, consistently responds to the adult's widening of the activity, and frequently initiated and communicates with the adult.

The complexity of Shared actions is determined by the number of sequences of adult widening (AW), which individuates the adult's tentative to add new requests, support the child's development of socio-communicative and cognitive skills, or activity variations introduced by the caregiver when the child shows rigid behavioral pattern or engagement is lowered.

Finally, the exchange is characterized by who ended it: the adult (AE) or the child. In the latter case, child adequateness (CE) or child inadequateness (CX) in ending the exchange is considered with respect to child developmental levels and communicative abilities.

Coders have shown satisfactory inter-rater reliability with respect to the codes noted, measured with the Intraclass Correlation Coefficient (ICC), reaching the maximum agreement, and Cohen's k , which ranged between 0.725 and 0.847 (mean = 0.767; SD = 0.037) (Bertamini et al., 2021, 2023).

For data analysis, different behavioral descriptors are calculated using a Python script that allows the extraction of the data regarding Units of Interaction (CI-AI; CP-AA; AP-CA/CR) frequencies and success rates. Success rates are identified by the frequency of starting codes followed by the correct code (e.g., child intentionality, CI, followed by the adult that recognizes it, AI) over the frequency of the starting code considered. Further latencies between the two codes of the pair and between the second code of the pair and the start of the shared action are calculated.

Considering shared actions (SAs), frequencies and durations are measured.

When used to study child-therapist interactions, the code showed a good convergent validity with the EAS children subscales.

2.3.2. The Emotional Availability Scales (EAS)

Emotional Availability Scales 4th Edition (EAS) (Biringen, 2008) is a multidimensional observational scale applied to analyze dyadic interactions with children aged between 0 and 14 years. This instrument operationalizes and measures the concept of Emotional Availability (EA) which refers to the affective quality, mutual accessibility, and responsiveness of parent and child during the interaction (Biringen et al., 2014; Biringen, 2000). The EAS consider both caregiver affective behaviors and child emotional regulations and responsive behaviors. Six global dimensions are considered, four related to the caregiver's EA (Sensitivity, Structuring, Non-hostility, Non-intrusiveness) and two to the child's EA (Responsiveness and Involvement). Each dimension can be scored on a 7-point Likert scale, which ranges from 1, the lowest level of EA, to 7, the optimal level of EA. Furthermore, for each dimension, seven subscales are measured on a 7-point scale (for the first 2 subscales) and on a 3-point scale (for the other 5 subscales).

Regarding adult dimensions, *Sensitivity* refers to the adult's ability to

verbally and non-verbally respond to the child's behaviors and emotions. It is evaluated considering affect, clarity of perceptions and appropriate responsiveness, awareness of timing, amount of interaction, flexibility and variety in modes of play and interaction, the skills exhibited in dealing with conflict situations, and acceptance showed toward the child in terms of speaking and acting in respectful ways. *Structuring* refers to adult scaffolding and offering guidance during activities while following the child's lead, and it evaluates how the adult provides guidance, the success of interaction attempts, the amount of structure, limits, and boundaries setting during play, how the adult deals with pressure, if the structuring is more verbal or non-verbal, and if the adult is able to maintain its role. *Non-intrusiveness* evaluates adult interference behaviors, that is the lack of over-direction or over-stimulation, which regards if the adult is able to follow the child's lead, if he waits for optimal breaks to enter the interaction, if the caregiver uses commands or directive behaviors, the use of the communication, the use of didactic teaching and interferences, physical or verbal, and last if the child indicates that the adult is intrusive. Finally, *Non-hostility* regards the absence of observable and direct (e.g., aggression) or indirect hostile behaviors (e.g., silence) toward the child, evaluating the lack of negativity in face or voice, lack of mocking, threats of separation, silence or frightening behaviors. This dimension also considers if the adult is able to maintain composure during stressful times and if the play is appropriate to the material or if the themes introduced are hostile.

Considering the child scales, *Responsiveness* refers to the child's behavioral and emotional responses, affective quality, and regulation toward the caregiver. In particular, this dimension evaluates emotion regulation of affect and behaviors, child's verbal or non-verbal responsiveness, age-appropriate autonomy seeking and environment exploration, positive physical positioning, lack of role reversal and avoidance, and child focus orientation.

To conclude, *Involvement* regards the child's ability to involve the caregiver in the interplay and the balance between autonomously playing and engaging the adult. The dimension evaluates simple initiative in bringing the adult into the interaction, elaborate initiative (that considers playful and emotional aspects and regards the involvement of the adult creating positive storylines), use of the adult for emotional or instrumental reasons, lack of over-involvement, use of eye-contact, body positioning and speaking/babbling to involve the adult.

Two independent observers attended the official training course as indicated in the EAS training (Biringen, 2008), their reliability was then calculated using ICC with absolute agreement (Koo & Li, 2016) considering the 21.45 % of the videos coded in the present sample (12 videos) reaching a satisfactory level for all the global scales calculated. Specifically, the Sensitivity scale presented an ICC of 0.97, the Structuring scale presented an ICC of 0.98, while Non Hostility scale and Non Intrusiveness scales showed a 0.86 and 0.89 ICC, respectively. Considering the child's scales, Responsiveness presented an ICC of 0.98, while Involvement was 0.92.

2.4. Data analysis

Data regarding the Coding system were extracted using *Python*. Particularly, frequencies, latencies, and proportions were computed for both Units of Interactions and Shared Action. For the latter, also the duration has been calculated. Further, datasets regarding clinical tests, the coding system, and the EAS have been merged.

Data were analyzed using R software (R Core Team, 2020). Data was checked for normality using the Shapiro Test. Descriptive statistics means and standard deviations, or median and interquartile range, have been calculated for the parameters measured. Mother and father ISand Emotional Availability differences using a paired *t*-test or its non-parametric equivalent, the Wilcoxon signed rank tests, when data did not attend normal distribution assumption. Then, Cohen's *D* effect size was calculated for parametric data, while Wilcoxon's effect size was computed for non-parametric data. Linear models have been used to

explore the relationship between the ISparameters and EA of parent and child's global dimensions, considering mothers and fathers separately.

Regarding the ISwe referred to the rate of either parent and child behaviors, which provides information regarding the overall synchrony of the exchange, which is the main measure providing information on interaction success, and the engagement displayed by the child during play in quantitative terms, which is relevant as it is strictly connected to affective aspect of the exchange. With respect to the parent EA we considered the main scales of sensitivity, structuring and non intrusiveness dimensions, as these might directly impact synchronous behaviors. Both child EA dimensions, responsiveness and involvement, have been considered.

3. Results

3.1. Mother and fathers ISdifferences

Considering the parameters calculated, differences in interaction parameters during play with mothers and fathers were calculated and no differences emerged, except for the number of caregiver widenings during the shared activities ($W = 504$, $p = 0.03$, $r = 0.29$) and their success rate ($W = 150$, $p = 0.03$, $r = 0.44$), which were higher during the interaction with mothers.

See Table 3 for descriptive and inferential statistics for each parameter for mothers and fathers.

Rate of synchronous codes identifies the overall synchrony of the exchange, specifically it is calculated computing the rate of response codes that follow the initiating code, reflecting if the child responds synchronously to the parent and the parent is attuned with the child needs and signals.

3.2. Emotional availability

No significant differences emerged in the Emotional Availability parameters during play with mothers and fathers. See Table 4 for descriptive and inferential statistics.

3.3. Linear models to study the relationship between ISand emotional availability

The model developed to predict the rate of synchronous codes based on parent EAs dimensions resulted to be significant ($F(3,52) = 4.26$ $p = 0.009$) with an adjusted R^2 of 0.15. The parameter was predicted by parent sensitivity ($\beta = 0.09$; $p = 0.02$).

The same IS parameter was also predicted by the model based on child EA dimensions ($F(2,53) = 9.20$, $p < 0.001$) with an adjusted R^2 of 0.23, and in particular child responsiveness resulted to be significant ($\beta = 0.09$; $p = 0.01$).

The model developed to predict the engagement displayed by the child during the interplay based on parent EAs dimensions resulted to be significant ($F(3,51) = 5.55$ $p = 0.002$) with an adjusted R^2 of 0.20. The parameter was predicted by parent sensitivity ($\beta = 0.38$; $p = 0.002$) and parent non intrusiveness ($\beta = -0.23$; $p = 0.032$). Engagement evaluated with the IS coding system was also predicted by the model based on child EA dimensions ($F(2,52) = 18.73$, $p < 0.001$) with an adjusted R^2 of 0.40, and in particular child responsiveness resulted to be significant ($\beta = 0.25$; $p = 0.01$).

4. Discussion

The aim of the study was to assess parent-child interaction in the context of autism through observational validated instruments that adopt a bidirectional perspective, focusing on socio-communicative behaviors and affect. In particular, considering IS and EA constructs allowed us to obtain a characterization of dyadic features, with the innovative aspect of considering parents' attunement to their children's

Table 3

Descriptive and inferential statistics for each Interpersonal Synchrony (IS) parameter.

ISparameters	n	M	SD	Median	IQR	Statistics
Rate of synchronous codes – Mother	28	0.70	0.17	0.70	0.22	$t(27) = 1$
Rate of synchronous codes – Father	28	0.67	0.14	0.66	0.20	
% interactions initiated by the adult – Mother	28	0.46	0.20	0.50	0.30	$W = 208$
% interactions initiated by the adult – Father	28	0.45	0.27	0.41	0.45	
% interactions initiated by the child using a single communicative channel – Mother	28	0.49	0.22	0.48	0.36	$W = 394$
% interactions initiated by the child using a single communicative channel – Father	28	0.31	0.49	0.48	0.58	
% interactions initiated by the child combining multiple communicative channels – Mother	28	0.05	0.13	0	0	$W = 378$
% interactions initiated by the child combining multiple communicative channels – Father	28	0.07	0.18	0	0	
Success rate of caregiver activity initiation – Mother	28	0.67	0.26	0.67	0.41	$W = 213$
Success rate of caregiver activity initiation – Father	28	0.57	0.23	0.54	0.35	
Success rate of child intentionality signals – Mother	28	0.85	0.18	0.89	0.23	$W = 62$
Success rate of child intentionality signals – Father	28	0.84	0.25	1.00	0.22	
Number of shared activities – Mother	28	2.93	1.27	3.00	2.00	$W = 85$
Number of shared activities – Father	28	3.04	1.29	3.00	2.00	
Mean duration of shared activity – Mother	28	86.50s	42.10s	73.00s	54.90s	$W = 160$
Mean duration of shared activity – Father	28	93.70s	51.80s	89.90s	55.50s	
Total duration of shared activity – Mother	28	283s	176s	230s	200s	$W = 138$
Total duration of shared activity – Father	28	296s	196s	224s	257s	
Mean engagement during the shared activity – Mother	28	1.47	0.47	1.40	0.53	$W = 125$
Mean engagement during the shared activity – Father	28	1.40	0.50	1.25	0.67	
Complexity – Mother	28	3.42	1.60	3.40	2.45	$W = 138$
Complexity – Father	28	2.86	2.02	3.00	2.50	
Number of caregiver widenings during the shared activity – Mother	28	1.38	0.80	1.25	1.29	$W = 504^*$, $r = 0.29$

(continued on next page)

Table 3 (continued)

ISparameters	n	M	SD	Median	IQR	Statistics
Number of caregiver widenings during the shared activity – Father	28	0.96	0.94	0.83	1.00	
Success rate of caregiver widenings during the shared activity – Mother	28	0.71	0.29	0.78	0.38	W = 150*, r = 0.44
Success rate of caregiver widenings during the shared activity – Father	28	0.55	0.32	0.50	0.42	

* $p < .05$.

Table 4

Descriptive and inferential statistics for Emotional Availability Scales (EAS) parameters considering mothers and fathers.

EAS parameters	N	M	SD	Median	IQR	Statistics
Sensitivity (EAS) – Mother	28	5.11	0.79	5.25	1.50	W = 114
Sensitivity (EAS) – Father	28	5.02	0.91	5.00	0.63	
Structuring (EAS) – Mother	28	4.70	0.67	5.00	0.63	W = 110
Structuring (EAS) – Father	28	4.62	0.90	4.75	1.00	
Non-intrusiveness (EAS) – Mother	28	5.05	0.74	5.00	0.00	W = 53
Non-intrusiveness (EAS) – Father	28	5.02	0.62	5.00	0.13	
Non-hostility (EAS) – Mother	28	5.93	0.62	6.00	0.50	W = 32.50
Non-hostility (EAS) – Father	28	6.02	0.67	6.00	1.00	
Responsiveness (EAS) – Mother	28	4.00	0.84	4.00	1.00	W = 62.50
Responsiveness (EAS) – Father	28	3.98	0.99	3.75	2.00	
Involvement (EAS) – Mother	28	3.55	0.83	3.50	1.00	W = 78
Involvement (EAS) – Father	28	3.50	1.07	3.00	0.63	

needs and initiation. This offers a comprehensive perspective on the interaction features, analyzing IScoding system allows the quantification of parent and child behaviors, which are studied with the EAS from a global and emotional point of view (Biringen, 2008; Biringen et al., 2014).

Specifically, parents’ structuring abilities originally studied with the EAS are examined with the IS coding system, examining the amount of parents’ initiations and elaborations during the exchanges. The sensitivity of parents is evaluated by considering the frequency and latencies of their responses to the child’s needs and interaction attempts. Child initiations are examined both via EA and IS instruments, allowing a deeper and more accurate analysis of the integration of different communication channels as well as the child’s frequency of responses to the parent by the IS coding system.

Given the inherently bidirectional nature of human interaction, the relevance of the approach adopted by both instruments is underscored, as they systematically account for both parental and child behaviors.

Further, the use of observational approaches, combining an analytical and a global one, enables both the acquisition of insights into the temporal dynamics of the interaction. This specifically allows the quantification of interactive behaviors and a nuanced understanding of behavioral sequences, interaction structure, and the affect displayed by the dyad.

Our primary objective was to explore the profiles of children in interaction with their parents and the differences between mothers and fathers related to the dyadic parameters during social exchanges.

Interestingly, a significant difference between the two caregivers emerged regarding the number and the success of caregiver expansions during the shared activities. In fact, when children and parents played together, mothers seemed to be more effective in offering adequate elaboration of the playful activity. Mothers provided a higher number of widenings during play activities as an attempt to raise the cognitive stimulation during play, offering the child learning opportunities to broaden play repertoire and level. These results seem to be in line with previous studies on parental language when interacting with their autistic children, showing that mothers have the tendency to gain the child’s attention more often than fathers, who in turn result to present the child with fewer demands and requests while talking to their child (El-Ghoroury & Romanczyk, 1999; Flippin & Watson, 2011; Bentenuto et al., 2021; Perzolli et al., 2023a). Further, research showed that mothers tend to engage more often in symbolic activities during play than fathers, this would potentially allow them to present the child with more frequent and sophisticated learning opportunities in the cognitive domain (Perzolli et al., 2023b). Considering ISand Emotional Availability, no other differences have been shown considering mothers’ and fathers’, revealing parents’ similar abilities in the interaction with their children in almost all domains. These results replicate and expand a previous study conducted by Bentenuto et al. (2020) which showed similar mothers’ and fathers’ Emotional Availability. Hence, parents demonstrate equal proactivity in structuring the interaction, responding, and adapting to the child’s interactive bids.

Considering children’s interactive behaviors, both in terms of communicative intentionality, caregiver involvement, and responsiveness with mothers and fathers, autistic children present similar levels of IS and interaction structure with their caregivers as well as similar emotional aspects (Bentenuto et al., 2020). In particular, the child exhibits a similar level of responsiveness to both mother and father’s activity initiations.

These findings are particularly relevant in regard to the planning of treatments that involve parents. Indeed, fathers seem to be less involved in intervention than mothers (Rankin et al., 2019; Sharabi & Marom-Golan, 2018), while the current study supports the need to study fathers’ role in intervention, as previous research mainly focused on mothers (Rankin et al., 2019). Specifically, considering the literature on fathers, research showed that they present the child with different learning opportunities focused on cognitive elements (Flippin & Watson, 2011, 2015; Bertamini et al., 2021; Bentenuto et al., 2021), underlining the pivotal role of fathers in the cognitive, social, and affect regulation development (Cabrera et al., 2007; Flippin & Watson, 2011, 2015). Our research expands on these results, highlighting that, despite potentially different styles, fathers and mothers present similar abilities in engaging the child and maintain their engagement. Moreover, caregivers, despite presenting similar EA reached moderate levels, representing an area where intervention should be conducted with both parents. Specifically, parents’ sensitivity seems to present inconsistencies in detecting and adequately responding to child needs or interactive bids, sometimes being less flexible, while parent structuring abilities, both regarding the play itself and the environment, seem sometimes less than ideal as the child leaves the interaction. Difficulties seem to be present in the use of verbal versus non-verbal communication, often, the two are not combined, and the verbal one is preferred. Regarding the adult non-intrusiveness during play, parents seem to present the tendency to direct the child or interrupt child’s play without following the child’s lead.

Differently, the non-hostility index is proximal to optimal, indeed, parents do not present negativity and do not lose patience while facing more frustrating situations.

Regarding child EAS’ dimensions, participants seem to be less responsive to parents than optimal, with low behavioral indices of positive affect. Further, despite not consistently being avoidant toward the parent, the child seems to focus more on toys, sometimes excluding the adult. The child’s physical proximity and attention to the adult are

not consistently adequate.

The area that shows the greatest difficulties is child involvement. The child seems to be more oriented toward the toys than the adult and presents difficulties in developing an activity while actively involving the parent. The child also appears to engage in instrumental use of the adult, wherein they employ the parent as a means to accomplish a goal rather than engaging in typical interaction. For instance, rather than directly requesting a toy, the child guides the parent to the toy. Difficulties regarding child abilities in involving others and initiating the interaction emerge also from the IS coding system, where considering the overall interactions, these seem to be more often initiated by the parent. A greater amount of difficulties is represented by child initiations, specifically when these involve the use of multiple communication channels.

These results support the importance of involving both mothers and fathers in the intervention process to help them reach more appropriate interactive elements to respond adequately to their child's needs. Moreover, fathers' involvement should be supported to better impact both parents' parenting experience and psychological well-being.

Our second aim was to study the relationship between IS coding system parameters, specifically the overall success rate of parent and child behaviors, and engagement during the interplay, and the EA characteristics.

Parent sensitivity and child responsiveness emerged as significant dimensions which are able to predict both overall synchrony and child engagement during the interplay. These results highlight that parents who are more sensitive and adapt the level and the frequency of their requests, seem to give more structure to the interaction, scaffolding child participation and maintaining child engagement for longer periods. On the other hand, a more responsive child is more likely to accept parent initiations and might have enhanced abilities to attend longer exchanges. Child responsiveness plays a pivotal role in the learning process, allowing the child to engage with a greater number of learning opportunities presented by the parent.

Additionally, our research confirms the relationship between IS and EA suggested by a previous study (Bertamini et al., 2021) conducted on interaction between therapists and children, expanding on current literature by showing similar associations independently from the partner the child is interacting with. This supports the use of the two constructs to globally characterize the interaction as the EA dimensions can also be quantitatively evaluated considering the exchange's complexity in terms of its structure and dynamics as well as the qualitative aspects related to affect (Bertamini et al., 2021).

While the earlier study focused on child Emotional Availability dimensions, the current study underscores the relevance of adult sensitivity in fostering effective interaction structure, emphasizing the importance of examining dyadic interaction from a bidirectional perspective.

Despite the important insights into the interactive features of fathers and mothers in interaction with their children, the present study is subject to several limitations mostly associated with its relatively small sample size, given by a constraint imposed by the availability of paired parent-child interactions involving both fathers and mothers and that might prevent generalization of results. Higher sample sizes may be used in further studies to control for different dimensions of parents. For example, the study does not consider the variable of divorce in families with an autistic child and other possible intervening factors that call for further investigation. Future studies should consider this variable as it might influence parent-child interaction patterns (Hetherington et al., 1979; Yu et al., 2010). Other variables such as autism characteristics in parents as well as mental health variables should be taken into consideration. Hence, a parent's mental health influences the quality of their relationship with their child (Kulasinghe et al., 2022).

Child sex differences should be considered, widening the females' sample. Indeed, autistic females might present socio-interaction differences that could also influence child-caregiver interaction.

Moreover, despite offering a more detailed picture of parent-child interactive profiles, the utilization of observational instruments necessitates thorough training to achieve satisfactory inter-rater reliability and its application is time-consuming.

Another limitation of the current study is also represented by the focus only on observational measures. Future research might need to expand the current findings by considering different measures that evaluate parents' perception of the child during the interaction and social abilities.

In conclusion, our results reflect the Italian context and might not be generalizable to different cultural groups that might present different interaction characteristics with their children (Oppenheim, 2012).

5. Conclusions

Studying interaction features is particularly relevant as socio-communication differences are one of the areas that characterize autism. Despite being examined from distinct perspectives, interaction has been primarily investigated, considering children and parents separately and not fully acknowledging its bidirectional nature. Combining IS and Emotional Availability observational instruments facilitates the evaluation of the structure of parent-child social exchanges through the quantification of socio-communicative behaviors, providing a more nuanced understanding of interactive temporal dynamics and qualitative emotional aspects, offering a comprehensive assessment of parent structuring, sensitivity, and child responsiveness and involvement.

Exploring mothers and fathers IS and EA with their autistic children, we did not find significant differences in affect nor structure of the interaction, except for more frequent and successful mothers' widenings during the shared actions, which might be ascribable to different play sophistication requested and subsequent requests. Our study highlights also that parents and autistic children do not reach the optimal Emotional Availability, this highlights the need for interventions to target interaction considering both caregivers, ultimately targeting both interaction structure and affect.

CRedit authorship contribution statement

Eleonora Paolizzi: Writing – review & editing, Writing – original draft, Software, Methodology, Formal analysis, Data curation. **Silvia Perzoli:** Writing – review & editing, Writing – original draft, Methodology, Data curation. **Arianna Bentenuto:** Writing – review & editing, Supervision, Data curation, Conceptualization. **Giulio Bertamini:** Software, Methodology. **Paola Venuti:** Writing – review & editing, Supervision, Conceptualization.

Declaration of competing interest

None.

Data availability

Data will be made available on request.

Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.actpsy.2024.104411>.

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