

NATURALISTIC PROGRAMS FOR SOCIAL SKILLS AND COMMUNICATION IN BABIES AND TODDLERS WITH AUTISM SPECTRUM DISORDER – A REVIEW OF THE LITERATURE

Aliny Lamoglia [1], Célia Sousa [2]

[1] Instituto Politécnico Jean Piaget do Norte, Portugal

[2] ESECS/CRID®/CICS.NOVA.IPLEiria/Universidade de Leiria e Oeste, Portugal

alinylamoglia@gmail.com

ABSTRACT

This article identified the scientific studies on naturalistic intervention programs in social and communication skills for babies and toddlers with Autism Spectrum Disorder (ASD) in international journals. The present study shows that naturalistic intervention programs for children with Autism Spectrum Disorder (ASD) were effective in improving their performance in Social and Communication Skills. Naturalistic contexts are where interactions take place and can be modelled as ideal settings for intervention. These interventions minimize or neutralize the effects of ASD on the child's developmental path. In this sense, the importance of mediation/interaction is highlighted. Although clinical outcomes are important for understanding the development of children with ASD, they are not able to reproduce the systematicity necessary for delays in social behaviour and communication to be minimized.

Keywords: Autism Spectrum Disorder; Early Intervention; Naturalistic Programs; Communication and Social Skills.

RESUMO

Este artigo identificou os estudos científicos sobre programas de intervenção naturalista nas competências sociais e de comunicação em bebés e crianças pequenas com Perturbação do Espectro do Autismo (PEA), publicados em revistas internacionais. O presente estudo mostra que os programas de intervenção naturalista dirigidos a crianças com PEA revelaram-se eficazes na melhoria do desempenho ao nível das competências sociais e de comunicação. Os contextos naturalistas, nos quais ocorrem as interações, podem ser modelados como cenários ideais para a intervenção. Estas intervenções minimizam ou neutralizam os efeitos da PEA no percurso de desenvolvimento da criança. Neste sentido, destaca-se a importância da mediação/interação. Embora os resultados clínicos sejam relevantes para a compreensão do desenvolvimento das crianças com PEA, não conseguem reproduzir a sistematicidade necessária para que os atrasos no comportamento social e na comunicação sejam atenuados.

Palavras-chave: Perturbação do Espectro do Autismo; Intervenção Precoce; Programas Naturalísticos; Comunicação e Habilidades Sociais

1 INTRODUCTION

Two of the goals of the United Nations for sustainable development are “quality education” and “quality health”. These include: (1) Ensuring access to inclusive, quality, and equitable education and promoting lifelong learning opportunities for all; (2) Substantially increasing health financing and the recruitment, training, and retention of health personnel in developing countries; (3) Strengthening the capacity of all countries, particularly developing countries, for early warning, risk reduction, and national and global health risk management (United Nations, 2015).

Reports from the Organisation for Economic Co-operation and Development and other consultative bodies have highlighted that educators in Portugal identify the need for further training and knowledge in the fields of special education and Early Intervention for developmental disorders (OECD, 2014). This need is especially relevant given the importance of identifying developmental difficulties as early as possible and ensuring timely, evidence-informed responses.

One of the main scientific foundations for Early Intervention is neuroplasticity, understood as the brain’s capacity to establish, reorganise, and strengthen neural connections in response to experience. Numerous studies have shown that the infant brain presents a particularly high density of neural connections around 24 months of age, after which some connections become more robust and are consolidated through learning, while others may be weakened or eliminated depending on environmental stimulation and experience (Cabral, 2021; Lent, 2019). In this sense, neuroplasticity can be understood as “the property of the nervous system that is at the root of education” (Lent, 2019), since learning depends on the brain’s ability to form, retain, and functionally use new memories.

From this perspective, the teacher–student relationship, or mediation, in Vygotsky’s terms (Vygotsky, 1993), plays a central role in learning. Lent (2019) describes this process as an interaction between two brains. Such interaction is particularly crucial in early childhood, when children have not yet developed more complex strategies for “learning to learn”, such as consolidated referential language or reading. According to Lent (2019), the first years of life constitute a critical period during which the nervous system is especially sensitive to specific, planned, and meaningful environmental stimuli.

A research team at Johns Hopkins University investigated 12- and 19-month-old infants to examine the presence of disjunctive syllogism, a form of logical deduction that, according to Piagetian assumptions, would only emerge after 24 months of age. The team, led by Cesana-Arlotti (2018), through an ingenious experiment using eye tracking, observed evidence of this ability in one-year-old children. Given these and other early developmental findings, typical infant development may provide important indicators for the design of early intervention strategies for neurodevelopmental disorders.

Among neurodevelopmental disorders, Autism Spectrum Disorders (ASD) are the ones with the highest prevalence (Maenner, 2020). A recent study published in *JAMA Pediatrics* reported an ASD prevalence estimate in the United States of 1 in 30 children and adolescents aged 3 to 17 years (Li et al., 2022). ASD is a developmental disorder with an innate biological basis (Baron-Cohen et al., 1994; Ramachandran, 2014; Tomasello, 2003) characterized by: 1) Qualitative impairment of social interaction and communication and 2) Commitment to the imagination, with the presentation of restricted and repetitive patterns of behaviour, interests, and activities (American Psychiatric Association, 2013). Several studies have emphasised the importance of

early warning signs and Early Intervention as protective factors and/or as mechanisms for reducing the impact of neurobiological developmental disorders (Anderson et al., 2011; Herbert et al., 2007). Primary Health Care is, or should be, a privileged context for the early identification of these developmental difficulties, allowing intervention to begin as early as possible. This intervention, in turn, should consider the biological markers of development, such as eye contact, smiling in response to the other person's smile, pointing, and using referential language, among other behaviours considered typical for each of the initial stages of development. These behaviours can be observed by parents and reported through early developmental surveillance instruments (Barbaro & Dissanayake, 2012).

Some clinical approaches for Autism Spectrum Disorder propose that children should first learn social skills and communication behaviours in therapeutic settings and later generalise these skills to other contexts of interaction (Anderson, 2023). However, the generalisation of acquired skills remains a relevant challenge, particularly when learning occurs in highly structured or artificial environments. In this regard, naturalistic approaches have gained increasing relevance. A naturalistic context refers to a real-world setting in which behaviours, interactions, and events occur as they naturally would, without artificial manipulation or interference. This perspective is central to naturalistic inquiry, which seeks to understand phenomena within their specific contexts. Nature-based interventions, in turn, must take place in natural outdoor settings and may provide opportunities for spontaneous interaction, communication, social engagement, and learning in ecologically valid environments (Schreibman et al., 2015; Shanahan et al., 2019).

Despite advances in screening and surveillance, the average age of ASD identification remains relatively late. Even in countries such as Australia, where universal screening has been intensified, children are often identified between four and six years of age (Garg et al., 2018). For this reason, it is essential to develop and implement early detection instruments that are sensitive to changes in children's early behaviour, so that intervention can also occur at an early stage (Barbaro et al., 2011; Barbaro & Dissanayake, 2012).

Given this context, it is important to seek intervention programs that recognise the first two years of life as the most important for the direction that the child's development will take. In this sense, the present study aims to find out if there are social skills and communication intervention programs for children with ASD that use real-world contexts as spaces for Early Intervention.

SUMMARY OF ANALYSED PROGRAMS

We used electronic bibliographic databases, such as Scopus (n=234), Medline/PubMed (n=88), The Cochrane Library (n=25), Embase (n=124), and Clinical Trials (n=1).

Titles and/or abstracts of identified studies were independently screened by two reviewers to determine whether they potentially met the eligibility criteria for intervention programs in social skills and communication in infants up to 24 months of age and toddlers. The full texts of these potentially eligible studies were retrieved and independently evaluated for eligibility by two reviewers. Any disagreements regarding study eligibility were resolved through discussion.

The inclusion criteria were as follows: (1) the use of a training program for social and communication skills; (2) children diagnosed with ASD; (3) an intervention program for children with ASD; (4) provided by day care professionals, teachers or families; (5) outcome intervention.

Exclusion criteria were: (1) training program for other skills, such as executive functions or special skills; (2) children without a diagnosis of ASD or with another diagnosis; (3) programs called intervention, but with the purpose of diagnosis/identification of ASD; (4) provided by specialists/ therapists; (5) outcome diagnosis/identification.

The bibliographic search in the electronic databases identified 472 articles, of which 455 records remained after removing duplicates. Out of this total, 55 mentioned some type of early intervention for children diagnosed with ASD or with signs of ASD in their titles. Whenever the study abstracts revealed that it was about the identification, detection, or diagnosis of ASD, the abstracts were excluded according to the PICO technique (Population, Intervention, Comparison, and Outcome) (Stern et al., 2014).

After applying the PICO technique, the remaining 400 articles were submitted to the following exclusion criteria: 372 articles were excluded because they described studies involving populations other than infants up to 24 months and/or interventions delivered by individuals other than parents or caregivers. Nine articles were excluded because they were systematic reviews. According to the outcome criterion, 44 articles were excluded because they addressed other types of studies that did not include intervention programs for children with ASD. Thirty articles were excluded despite presenting studies with infants and dealing with early intervention programs, because they focused on skills such as Executive Functions, for example, and not on Social Skills or Communication. Some articles (46) were excluded based on more than one criterion, leaving 6 for this analysis. The selected articles are listed in Table 1.

To examine language trajectories and placement outcomes for children with ASD receiving Early Intensive Behavioural Intervention (EIBI), Frazier et al. (2021) observed 131 children: 114 males and 17 females between 1.4 and 5.9 years old. All children had a confirmed ASD diagnosis and were enrolled in a site EIBI program at an academic medical centre. Language measures were collected at baseline and 6, 12, 18, 24, and 36 months post-EIBI initiation. The authors sought to identify predictors of overall Language Trajectories and to estimate sub-group trajectories representing distinct patterns of growth. Demographic variables, including age at EIBI initiation and sex, as well as clinical characteristics, such as ASD severity, verbal intelligence quotient, and non-verbal intelligence quotient, were considered in the analysis. Language outcomes were assessed after six months of intervention. The findings indicated that initial assessment of verbal language abilities and early access to intervention were strong predictors of both language development trajectories and later academic placement outcomes.

Gaffrey et al. (2020) investigated developmental delays in non-social skills as the potential product of altered caregiver-infant interactions using Eye-tracking Systems. The study involved 14 baby-mother dyads with infant ages ranging from 14.2 to 19.9 months. Caregivers and infants sat facing each other at a small table. Caregivers sat on the floor such that their eyes and heads were at approximately the same distance from the tabletop as those of the infants. Both caregivers and infants wore head-mounted eye trackers. Each eye-tracking system included an infrared camera, mounted on the participant's head and directed toward the right eye, which recorded eye images, as well as a scene camera that captured events from the participant's perspective. Each eye-tracking system recorded both the egocentric view video and the eye in head position (x and y). Data on the context for children's learning were collected before and after a brief intervention mediated by professionals; results suggested that multiple pathways of joint attention, particularly the systematic directing of the child's gaze, can modify the interaction/learning context of in cases of ASD.

Table 1 – Summary of analyzed studies

Article	Aims	Sample	Procedures	Findings
Frazier et al., Journal of Autism and Developmental Disorders, 2021	To examine language trajectories and placement outcomes for children with ASD receiving Early Intensive Behavioural Intervention (EIBI)	131 children; 114 male, 17 female, between 1.4 and 5.9 years old. All the children had confirmed ASD diagnoses and were enrolled in a site EIBI program at an academic medical center	Language measures were collected at baseline at 6, 12, 18, 24, and 36 months post-EIBI initiation. The assessment of language measures was performed after six months of intervention	The initial assessment of verbal language and early intervention were considered strong predictors for both the language learning trajectory and the academic trajectory of the assessed children
Gaffrey et al., Development and Psychopathology, 2020	To conceptualize developmental delays in nonsocial skills as the potential product of altered caregiver-infant interactions through Eye-tracking Systems	14 baby-mother dyads with ages ranging from 14.2 to 19.9 months	Caregivers and infants sat across from each other at a small table. Caregivers sat on the floor such that their eyes and heads were approximately at the same distance from the tabletop as those of the infants. Both caregivers and infants wore head-mounted eye trackers. Both caregiver and infant eye-tracking systems include an infrared camera - mounted on the head and pointed to the right eye of the participant	Data on the context for children's learning were collected before and after the brief intervention mediated by professionals and demonstrated that multiple pathways of joint attention, particularly the systematic directing of the child's gaze, can modify the context of interaction/learning in cases of ASD
Gangi et al., Child Development, 2021	To identify children in the early stages of symptom onset and allow for early intervention before the full disorder has developed	281 children between 6 and 36 months; 46 children with ASD; Infant siblings of children with ASD (high-risk siblings) or	Infants with high and low risk for ASD were followed prospectively between 6 and 36 months of age;	Babies between 6 and 36 months old, and siblings of children with ASD, show it in the look of an adult's face, with differences between 6 and

Article	Aims	Sample	Procedures	Findings
	through the coding of adult-child interactions	without ASD (low-risk siblings) were part of larger longitudinal studies. High-risk infants had at least one older sibling with ASD, confirmed using the ASD criteria on both the ADOS-2 and the SCQ	Gaze to adult faces or play interaction was coded Cohort 1: Participants were seated on the parent's lap at a table, and the examiner was seated in a chair on the opposite side of the table facing the child; Cohort 2: Participants were seated in a highchair fitted with a tray and the examiner was seated in a chair facing the child	12 months. This corroborates that the behavioral signs of ASD are the first methods of life of 2 years and can determine the developmental trajectories of findings in samples of children who have not yet been diagnosed with ASD
Gevarter et al., Augmentative and Alternative Communication, 2021	To verify the effects of the training program Naturalistic Communication for Early Intervention for parents in a context of linguistic diversity	9 participants; 3 children with ASD or early signs of ASD; 3 English-speaking Latinx parents; 3 early intervention providers. At least one parent was proficient in English; the child receiving services had an ASD diagnosis or screened as high risk for ASD (scores 8–20) on the M-Chat Revised with Follow-up, and the child had minimal vocal speech (less than 15 words)	A brief training program in Naturalistic Developmental Behavioral Intervention (NDBI) with three participant triads. All sessions took place in families' homes. Parents were asked to use preferred materials (e.g., toys, activity-based items, foods, drinks) that they would normally use to engage their child during everyday activities	All three families increased the number of complete targeted communication shifts, and all three children had lower rates of unwanted communication responses such as screaming or crying. Participating children with early signs suggestive of ASD also had increased target communication responses
Romano and Schnurr, Topics in Early Childhood	To train peer coaches in Early Intervention Caregiver Coaching Practices to conduct professional development with fidelity;	9 Early Interventionists; 18 families; 18 children younger than 30 months at the beginning of the study	Sessions using Zoom web conferencing – Videos with narration on key components of the intervention model;	All feedback sessions were rated with greater than 80% fidelity in the feedback protocol.

Article	Aims	Sample	Procedures	Findings
Special Education, 2022	To identify if there is a functional relationship between the peer coach's practice during home-based Early Intervention sessions; To evaluate the pre-post gains in communications scores during the EI's Professional Development		Twice home visits per month during the study; Zoom conference to discuss the content/ using a standardized set of slides with a protocol to guide the conversation; Definition of a goal; Discussions; and Coaching feedback sessions	It was possible to verify a functional relationship between the intervention and the use that the families demonstrated of the key indicators of the FGRBI. All children made gains in their communication skills during the study
Sterrett et al., Young Exceptional Children, 2023	Naturalistic Developmental Behavioral Intervention (NDBI) is evidence-based and is a framework to create lessons to teach preverbal social communication in a classroom context. The goals of this article are to provide educators an overview of the basic principles of NDBI, to offer a practical developmental assessment, and to provide a framework to develop lesson plans for early social communication goals in inclusive early education contexts for students with ASD	1 teacher; 3 students, including a child with ASD	There are three sections: early interactional skills with adults; joint attention skills (conventional gestures) and joint attention skills (declarative gestures); Preverbal communication and social engagement skills were evaluated; Systematically delivers instruction. Must include a clear definition of the outcome; exact steps for instruction consisted and repeated implementation and active participation by the student; Teach in a meaningful social context designed to promote generalization with natural reinforcement	With this approach, preverbal social communication goals are then more easily assessed, taught, and integrated within a classroom setting

Legend: ASD, Autism Spectrum Disorder; EIBI, Early Intensive Behavioral Intervention; NDBI, Naturalistic Developmental Behavioral Intervention; EI, Early Intervention; FGRBI, Family Guided Routines Based Intervention

Gangi et al. (2021) identified children in the early stages of symptoms, and this allowed for early intervention before the full disorder developed. The authors coded adult-child interactions in a sample of 281 children aged between 6 and 36 months, of whom 46 were diagnosed with ASD. Infant siblings of children with ASD (high-risk siblings) and infant siblings of typically developing children with no family history of ASD (low-risk siblings), were part of larger longitudinal studies. High-risk infants had at least one older sibling with ASD, confirmed using the ASD criteria on both the Autism Diagnostic Observation Schedule, 2nd Edition (ADOS-2) and the Social Communication Questionnaire (SCQ). Low-risk infants had an older sibling(s) who were typically developing and no family history of ASD, confirmed by an Intake Screening Questionnaire and scores below the validated cutoffs for ASD on the SCQ, a widely used par-report measure with satisfactory psychometric properties (e.g., 60%-92% sensitivity and 52%-92% specificity) for distinguishing ASD vs. non-ASD across studies. Infants with high and low risk for ASD were followed prospectively between 6 and 36 months of age. Gaze directed toward adult faces or play interaction were coded. In the first cohort, children were seated on the parent's lap at a table, with the examiner seated opposite the child. In the second cohort, children were seated in a highchair fitted with a tray, while the examiner sat facing the child. During this activity, the parent was seated behind and to the side of the examiner and was asked to read or complete paperwork in order to avoid interacting with the child. The findings showed differences in gaze to adult faces between 6 and 12 months of age among infants who later presented ASD-related outcomes. These results support the view that early behavioural signs of ASD may emerge within the first two years of life and may contribute to the identification of distinct developmental trajectories in children who have not yet received a formal ASD diagnosis.

Gevarter et al. (2021) conducted a study to verify the effects of the Naturalistic Communication for Early Intervention training program for parents within a linguistic diverse context. The study included nine participants: three children with ASD or early signs of ASD, three English-speaking Latinx parents, and three early intervention providers. At least one parent in each family was proficient in English. The children receiving services either had a diagnosis of ASD or had screened as high risk for ASD on the Modified Checklist for Autism in Toddlers, Revised with Follow-Up (M-CHAT-R/F), with scores between 8 and 20. In addition, all children had minimal vocal speech, defined as fewer than 15 spoken words. The intervention consisted of a brief manualised training programme based on Naturalistic Developmental Behavioural Interventions (NDBI), implemented with three participant triads. All sessions took place in the families' homes. Parents were encouraged to use preferred materials, such as toys, activity-based items, foods, and drinks, that they would typically use to engage their children during everyday routines. Training materials included video models and visual supports. The video models consisted of three training videos ranging from 2 to 8 minutes in length. A planning tool was used collaboratively by participants and the researcher to identify target communication behaviours, potential activities or items likely to elicit those behaviours, strategies for creating or capturing communication opportunities, and procedures for waiting for or prompting the target behaviours. All three families increased the number of complete targeted communication exchanges, and all three children showed reduced rates of undesirable communication responses, such as screaming or crying. Children with early signs suggestive of ASD also demonstrated increased target communication responses.

Romano and Schnurr (2022) investigated the training of peer coaches in Early Intervention caregiver-coaching practices, with the aim of supporting professional development with fidelity.

The study sought to determine whether there was a functional relationship between the intervention and peer coaches' practices during home-based Early Intervention sessions. It also examined variations in the use of Family-Guided Routines-Based Intervention (FGRBI) across study phases and evaluated pre–post gains in children's communication scores during Early Intervention professional development. Participants included nine early interventionists, 18 families, and 18 children younger than 30 months at the beginning of the study. The intervention included Zoom-based web-conferencing sessions, narrated videos addressing key components of the intervention model, and two home visits per month throughout the study. Zoom conferences were used to discuss content through a standardised slide set and a protocol designed to guide the conversation. The intervention procedures included goal definition, discussion, and coaching feedback sessions. All feedback sessions achieved fidelity ratings above 80% according to the feedback protocol. The findings indicated a functional relationship between the intervention and families' use of key FGRBI indicators. In addition, all children demonstrated gains in communication skills over the course of the study.

Sterrett et al. (2023) described Naturalistic Developmental Behavioural Intervention (NDBI) as an evidence-based framework for designing instructional activities to teach preverbal social communication skills in classroom contexts. The goals of this article were to provide educators with an overview of the basic principles of NDBI, to offer a practical developmental assessment tool, and to provide a framework to develop lesson plans for early social communication goals in inclusive early education contexts for students with ASD. Participants included one teacher and three students under 69 months of age, one of whom had ASD. The intervention addressed three main domains: early interactional skills with adults, joint attention skills involving conventional gestures, and joint attention skills involving declarative gestures. Preverbal communication and social engagement skills were assessed. Lessons were systematically planned according to five components: instructional outcome, teaching steps, repeated practice, progress monitoring, and instructional variation. As part of the NDBI framework, a checklist was developed to help teachers establish developmentally appropriate treatment targets and monitor progress without relying exclusively on norm-referenced scores. The framework emphasised the systematic delivery of instruction, clear definitions of target outcomes, repeated implementation, and active student participation. Instruction was embedded in meaningful social contexts designed to promote generalisation through natural reinforcement. This approach may facilitate the assessment, teaching, and integration of preverbal social communication goals within classroom settings.

FINDINGS

Early Intensive Behavioural Intervention, Eye-tracking Systems, Coding of Adult-Child Interactions, Naturalistic Communication Training for Early Intervention, Early Intervention Caregiver Coaching Practice, and Behaviour Therapy for Social Skills Training constituted the core components of the programmes identified.

These programs were those that presented interventions in naturalistic contexts, namely settings in which the adults responsible for the care or education of children with ASD were also those who carried out the systematic interventions. The duration of the selected programmes varied substantially, ranging from short periods of observational assessment, such as those

involving eye-tracking methodologies applied to dyads, to longitudinal follow-up designs lasting several months. Across all studies, the central focus was the potential to modify the quality of social and communicative interactions between adults and children with ASD through systematic intervention.

The prospective nature of some studies, - whether through surveillance protocols for neurodevelopmental disorders or the inclusion of siblings of children with ASD even before they show clear signs of autism -, suggests that, although ASD prevention cannot be claimed, early intervention may be understood as a form of harm reduction.

It is important to note that the selected programmes combined systematic and naturalistic features: systematic because they can be described and replicated in other intervention contexts and in that they are implemented in home or school environments rather than in clinical settings, where behavioural interventions are more commonly delivered. This approach aligns with evidence from typical development, in which learning predominantly occurs within every day, real-life contexts.

DISCUSSION

The present study shows that naturalistic early intervention programmes for children with ASD up to 24 months of age are effective in improving infants' social and communication skills.

Consistent with previous literature, ASD is conceptualised as a neurobiological condition that primarily affects social interaction (Tomasello, 2003; Zwaigenbaum et al., 2005). From this perspective, social skills and verbal communication constitute the core human expressions of interaction.

In infants with typical development, social skills emerge spontaneously and are not explicitly taught. Human infants are biologically predisposed to engage in eye contact with their mothers or caregivers, respond to smiles, and share attention towards objects or events, without prior systematic instruction.

In contrast, for infants with ASD, these skills require systematic teaching. Such systematic teaching must take place as early as possible when the plasticity of the baby's brain allows connections that are damaged to be 'restored' through interactive experiences (Mozolic-Staunton et al., 2020). In medicine, a biomarker is defined as a measurable indicator of the presence or severity of a disease or physiological condition. More generally, a biomarker is anything that can be used as an indicator of a particular disease state or some other physiological state of an organism. In studies on ASD, biomarkers are behavioural expressions that appear at certain moments in the child's life and that explain the typicality of development so that the absence of these behaviours indicates the need for intervention (Barbaro & Yaari, 2020).

It is also important to highlight that, although the search for this literature review focused on ecological intervention programs for children with ASD, relevant studies grounded in *Applied Behaviour Analysis* (ABA) approach were also considered. This inclusion is justified, first, by the fact that ABA is the intervention model with the largest body of evidence-based research and, second, because it often involves longitudinal treatment approaches. Such longitudinal monitoring is essential in ASD intervention, particularly when the aim is to identify behavioural

gains over time. These gains may help distinguish children with ASD from those presenting delays in verbal language development or other developmental disorders who may respond positively to intervention over time (Barbaro & Yaari, 2020).

On the other hand, studies that considered the contribution of behaviour analysis to the formulation of ecological or naturalistic intervention approaches were included (Frazier et al., 2021; Gangi et al., 2021; Romano & Schnurr, 2022; Sterrett et al., 2023). These approaches are characterized by systematic intervention proposals that can be implemented in real-life contexts, that is, in the environments where the child naturally experiences learning, such as at home and at school. Although the Eye-Tracking System (D-ET) is not, strictly speaking, an intervention programme, it was included in the present review because it represents an effective method for assessing the functionality and quality of the child's interaction with their interlocutor (Gaffrey et al., 2020).

In this sense, Gaffrey et al. (2020) observed 14 infants aged between 14.2 and 19.9 months using D-ET and demonstrated that avoiding the baby's gaze and reacting to the caregiver can produce a context that makes learning difficult for children. These findings led the investigators to propose a of short-term early intervention model focused on restoring gaze attunement in infants with ASD-caregiver dyads. An important factor to be highlighted in this investigation is the dialogic nature of early developmental interactions, reinforcing the idea that both the caregiver and the infant with ASD fulfil their roles in the dynamics of the relationship. Developmental psychology has long addressed parental responsiveness to the 'non-binding' behaviour of infants with developmental disorders, noting that caregivers tend to adjust their responses when infants show behaviours such as reduced cuddling, excessive crying, limited requests for interaction, or avoidance of gaze attunement (Bowlby, 1997; Winnicott, 1987). Studies involving siblings of children with ASD have also confirmed previous findings regarding genetic factors associated with ASD and have shown that early differences may be identified between 6 and 12 months of age (Gangi et al., 2021).

These studies are particularly relevant because they draw attention to the importance of early intervention, especially since a decline in gaze direction can be detected at very early stages of development. Based on this early identification, it becomes possible to design systematic activities aimed at restoring joint attention skills, including naturalistic play-based proposals, as reported by Berman and Rappaport (2010).

Finally, ecological studies show that systematic work with caregivers can modify the caregiver behaviour in ways that support improvements in social and communication skills in infants up to three years of age diagnosed with ASD. These studies also proved to be very relevant for identifying delays in early language development, particularly by quantifying the number of words the child can produce at the beginning of the intervention. This evidence supports the idea that very young children with typical development are able to construct numerous expressions from a finite number of learned words.

Some limitations should also be acknowledged. Although the present review aimed to include only ecological studies, evidence from studies using the ABA approach was also considered, as this approach has a broader body of scientific evidence and offers important contributions to the debate on intervention in ASD. In addition, due to the characteristics and heterogeneity of the included studies, it was only possible to present a qualitative synthesis of the results. Therefore, further research is needed on early intervention programmes based on naturalistic

approaches to address social communication deficits in ASD. More studies are also required on the training of primary healthcare professionals involved in child health, such as those working in childcare and paediatrics, as well as on the training of educators in early development.

CONCLUSION

The present study indicates that early intervention programs for children with ASD that incorporate ecological or naturalistic interaction contexts are effective in enhancing social and communication skills. Some intervention programmes reinforced the premise that actions targeting social skills and communication within home or school environments must be systematically planned and implemented. While clinical outcomes remain important in guiding the developmental trajectories of children with ASD, clinical settings alone are often unable to reproduce the level of systematic and contextualized intervention required to minimise delays in social behaviour and communication. There is, therefore, need for more Early Intervention programs addressing social communication deficits in ASD and other neurodevelopmental disorders. Additionally, further studies are required on the training of healthcare professionals involved in child health, such as those working in childcare and paediatrics, as well as on the training of educators in early childhood development.

Although the studies included in this review report promising outcomes, it would be important to reflect and investigate whether these gains are sustained across the development course of children with ASD. It would also be relevant to discuss how naturalistic interventions can be adapted to different cultural contexts and to address issue related to the costs and accessibility to this type of intervention.

REFERENCES

- American Psychiatric Association, D. (2013). *Diagnostic and statistical manual of mental disorders: DSM-5* (Vol. 5). American psychiatric Association Washington, DC. https://www.academia.edu/download/38718268/csl6820_21.pdf
- Anderson, L. K. (2023). Autistic experiences of applied behavior analysis. *Autism*, 27(3), 737–750. <https://doi.org/10.1177/13623613221118216>
- Anderson, V., Spencer-Smith, M., & Wood, A. (2011). Do children really recover better? Neurobehavioural plasticity after early brain insult. *Brain*, 134(8), 2197–2221. <https://doi.org/10.1093/brain/awr103>
- Barbaro, J., & Dissanayake, C. (2012). Developmental Profiles of Infants and Toddlers with Autism Spectrum Disorders Identified Prospectively in a Community-Based Setting. *Journal of Autism and Developmental Disorders*, 42(9), 1939–1948. <https://doi.org/10.1007/s10803-012-1441-z>
- Barbaro, J., Ridgway, L., & Dissanayake, C. (2011). Developmental Surveillance of Infants and Toddlers by Maternal and Child Health Nurses in an Australian Community-Based Setting: Promoting the Early Identification of Autism Spectrum Disorders. *Journal of Pediatric Nursing: Nursing Care of Children and Families*, 26(4), 334–347. <https://doi.org/10.1016/j.pedn.2010.04.007>
- Barbaro, J., & Yaari, M. (2020). Study protocol for an evaluation of ASDetect—A Mobile application for the early detection of autism. *BMC Pediatrics*, 20(1), 21. <https://doi.org/10.1186/s12887-019-1888-6>
- Baron-Cohen, S., Cohen, D. J., & Tager-Flusberg, H. (1994). *Understanding Other Minds—Perspectives from Autism*. Oxford University Press.

- Berman, T., & Rappaport, A. (2010). *Brincar para crescer. 201 atividades projetadas para ajudar sua criança especial a desenvolver habilidades sociais fundamentais*. Tubarão: Cpiart.
- Bowlby, J. (1997). *Attachment and Loss—Attachment*. Pimlico.
- Cabral, P. (2021). *O Paradoxo do Cérebro—Memória, autismo, identidade*. Temas e Debates.
- Cesana-Arlotti, N., Martín, A., Téglás, E., Vorobyova, L., Cetnarski, R., & Bonatti, L. L. (2018). Precursors of logical reasoning in preverbal human infants. *Science*, 359(6381), 1263–1266. <https://doi.org/10.1126/science.aao3539>
- Frazier, T. W., Klingemier, E. W., Anderson, C. J., Gengoux, G. W., Youngstrom, E. A., & Hardan, A. Y. (2021). A Longitudinal Study of Language Trajectories and Treatment Outcomes of Early Intensive Behavioral Intervention for Autism. *Journal of Autism and Developmental Disorders*, 51(12), 4534–4550. <https://doi.org/10.1007/s10803-021-04900-5>
- Gaffrey, M. S., Markert, S., & Yu, C. (2020). Social origins of self-regulated attention during infancy and their disruption in autism spectrum disorder: Implications for early intervention. *Development and Psychopathology*, 32(4), 1362–1374. <https://doi.org/10.1017/S0954579420000796>
- Gangi, D. N., Boterberg, S., Schwichtenberg, A. J., Solis, E., Young, G. S., Iosif, A.-M., & Ozonoff, S. (2021). Declining Gaze to Faces in Infants Developing Autism Spectrum Disorder: Evidence From Two Independent Cohorts. *Child Development*, 92(3), e285–e295. <https://doi.org/10.1111/cdev.13471>
- Garg, P., Ha, M. T., Eastwood, J., Harvey, S., Woolfenden, S., Murphy, E., Dissanayake, C., Williams, K., Jalaludin, B., McKenzie, A., Einfeld, S., Silove, N., Short, K., & Eapen, V. (2018). Health professional perceptions regarding screening tools for developmental surveillance for children in a multicultural part of Sydney, Australia. *BMC Family Practice*, 19(1), 42. <https://doi.org/10.1186/s12875-018-0728-3>
- Gevarter, C., Groll, M., Stone, E., & Medina Najar, A. (2021). A parent-implemented embedded AAC intervention for teaching navigational requests and other communicative functions to children with Autism Spectrum Disorder. *Augmentative and Alternative Communication*, 37(3), 180–193. <https://doi.org/10.1080/07434618.2021.1946846>
- Herbert, J., Gross, J., & Hayne, H. (2007). Crawling is associated with more flexible memory retrieval by 9-month-old infants. *Developmental Science*, 10(2), 183–189. <https://doi.org/10.1111/j.1467-7687.2007.00548.x>
- Lent, R. (2019). *O Cérebro Aprendiz—Neuroplasticidade e Educação* (1st ed.). Atheneu.
- Li, Q., Li, Y., Liu, B., Chen, Q., Xing, X., Xu, G., & Yang, W. (2022). Prevalence of Autism Spectrum Disorder Among Children and Adolescents in the United States From 2019 to 2020. *JAMA Pediatrics*, 176(9), 943–945. <https://doi.org/10.1001/jamapediatrics.2022.1846>
- Maenner, M. J. (2020). Prevalence of Autism Spectrum Disorder Among Children Aged 8 Years—Autism and Developmental Disabilities Monitoring Network, 11 Sites, United States, 2016. *MMWR. Surveillance Summaries*, 69. <https://doi.org/10.15585/mmwr.ss6904a1>
- Mozolic-Staunton, B., Donnelly, M., Yoxall, J., & Barbaro, J. (2020). Early detection for better outcomes: Universal developmental surveillance for autism across health and early childhood education settings. *Research in Autism Spectrum Disorders*, 71, 101496. <https://doi.org/10.1016/j.rasd.2019.101496>
- OECD. (2014). Education at a Glance 2014: OECD Indicators. *Education at a Glance, 2014*. <https://doi.org/10.1787/eag-2014-en>
- Ramachandran, V. S. (2014). *O que o cérebro tem para contar - Desvendando os mistérios da natureza humana* (1st ed.). Zahar.
- Romano, M., & Schnurr, M. (2022). Mind the Gap: Strategies to Bridge the Research-to-Practice Divide in Early Intervention Caregiver Coaching Practices. *Topics in Early Childhood Special Education*, 42(1), 64–76. <https://doi.org/10.1177/0271121419899163>

- Schreibman, L., Dawson, G., Stahmer, A. C., Landa, R., Rogers, S. J., McGee, G. G., Kasari, C., Ingersoll, B., Kaiser, A. P., Bruinsma, Y., McNerney, E., Wetherby, A., & Halladay, A. (2015). Naturalistic Developmental Behavioral Interventions: Empirically Validated Treatments for Autism Spectrum Disorder. *Journal of Autism and Developmental Disorders*, 45(8), 2411–2428. <https://doi.org/10.1007/s10803-015-2407-8>
- Shanahan, D. F., Astell-Burt, T., Barber, E. A., Brymer, E., Cox, D. T. C., Dean, J., Depledge, M., Fuller, R. A., Hartig, T., Irvine, K. N., Jones, A., Kikillus, H., Lovell, R., Mitchell, R., Niemelä, J., Nieuwenhuijsen, M., Pretty, J., Townsend, M., van Heezik, Y., ... Gaston, K. J. (2019). Nature-Based Interventions for Improving Health and Wellbeing: The Purpose, the People and the Outcomes. *Sports*, 7(6), 141. <https://doi.org/10.3390/sports7060141>
- Stern, C., Jordan, Z., & McArthur, A. (2014). Developing the Review Question and Inclusion Criteria. *AJN The American Journal of Nursing*, 114(4), 53. <https://doi.org/10.1097/01.NAJ.0000445689.67800.86>
- Sterrett, K., Freeman, S., Hayashida, K., Kim, J. J., & Paparella, T. (2023). Assessing and Improving Preverbal Social Communication: Teacher-Led Naturalistic Behavioral Developmental Interventions. *Young Exceptional Children*, 26(2), 77–91. <https://doi.org/10.1177/10962506211039829>
- Tomasello, M. (2003). *Origens culturais da aquisição do conhecimento humano*. Martins Fontes.
- United Nations. (2015). *Transforming our World: The 2030 Agenda for Sustainable Development*. United Nations.
- Vygotsky, L. S. (1993). *Pensamiento y Lenguaje*. Siglo Veinte.
- Winnicott, D. W. (1987). *Babies and their mothers* (1st U.S. ed.). Addison-Wesley.
- Zwaigenbaum, L., Bryson, S., Rogers, T., Roberts, W., Brian, J., & Szatmari, P. (2005). Behavioral manifestations of autism in the first year of life. *International Journal of Developmental Neuroscience*, 23(2–3), 143–152. <https://doi.org/10.1016/j.ijdevneu.2004.05.001>