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Autism Spectrum Disorders: A Literature Review of Traditional Therapies and Emerging Treatment Frontiers.

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Abstract

Autism Spectrum Disorders (ASD) are pervasive neurodevelopmental disorders characterized by atypical behavioral features and significant heterogeneity in clinical presentation. The term "spectrum" highlights the variability in symptom frequency, intensity, and quality among affected individuals. ASD is recognized as one of the most prevalent neurodevelopmental conditions, with an incidence of 1–1.5% in children. Diagnosis is multidisciplinary, relying on developmental history, behavioral observation, and standardized assessment tools, with early identification being crucial for optimal intervention. Traditional therapeutic approaches, particularly educational and habilitative interventions, aim to enhance adaptive functioning, communication, and social interaction. Applied Behavior Analysis (ABA) and the TEACCH program represent established evidence-based interventions, employing behavioral principles and structured teaching methods to address deficits and promote autonomy. Recent advances include non-invasive brain stimulation techniques targeting symptom remission by modulating neural activity in specific brain regions. This review summarizes the current literature on traditional therapies and explores emerging treatment frontiers for ASD.

Introduction

Autism spectrum disorders are pervasive developmental disorders characterized by atypical behavioral features. The term “spectrum” refers to the distribution of the frequency of a given problematic behavior, which varies over time and in its intensity of manifestation. This means that the dimension of autism refers to individuals who present heterogeneous clinical characteristics. Each person with autism is unique, as there are multiple combinations of this syndrome, which presents itself as a structurally similar manifestation but differs in the intensity, quality, and quantity of symptoms. In autism, non-invasive brain stimulation methods focus on symptom remission and are used to modulate neuronal activity in specific brain areas that produce atypical behaviors. These methods include transcranial magnetic stimulation and transcranial electrical stimulation.

Definition of Autism Spectrum Disorders

Autism Spectrum Disorders (ASD) are recognized as one of the most prevalent neurodevelopmental disorders. Since the 1960s, epidemiological studies on autism spectrum disorders have increased, highlighting a substantial rise in these disorders in the general population. This increase is attributable to the use of more precise diagnostic tools. ASD has an incidence of 1–1.5% in children, making it a very frequent medical condition in child neuropsychiatry (Centers for Disease Control and Prevention, 2012). These disorders arise around the third year of life and tend to compromise the individual's life on multiple levels, such as social and communication domains, presenting a repetitive, restricted, and stereotyped repertoire of activities and interests (Vicari et al., 2012). They are characterized by a developmental deficit that causes impairments in personal functioning (social, academic, or occupational). These disorders are part of neurodevelopmental disorders, a set of conditions that arise during the developmental period and tend to manifest before the start of elementary school. ASD belongs to biologically determined neurodevelopmental disorders, diagnosed based on behavioral symptoms that appear within the first three years of life with a wide and different variety, more evident in children up to two years of age or after the age of two. The range of developmental deficits varies from very specific limitations in learning or executive function control to global impairments of social skills or intelligence. They frequently present in comorbidity with other disorders; for example, individuals with ASD often have intellectual disability (intellectual developmental disorder). In some disorders, the clinical picture includes symptoms of excess, but also deficits and delays in achieving expected developmental milestones. For example, a diagnosis of ASD is made only when the characteristic deficits in social communication are accompanied by excessively repetitive behaviors and a restricted range of interests. It is important to emphasize that these disorders, while structurally similar, present differences in quality, quantity, and intensity.

Since autism is a heterogeneous disorder with multiple causes and a degree of variability in symptom severity, it is necessary to specify that there are three different levels of severity. The level of severity is based on the impairment of social communication and restricted, repetitive behavior patterns (DSM-5). The first level requires mild support.

Diagnosis of Autism Spectrum Disorders

Diagnosis is primarily made through anamnesis, paying particular attention to core behaviors and developmental history through observation in a variety of different contexts (Baird, Cass, Slonims, 2003). The diagnostic process involves several specialists (psychiatrist, neurologist, psychologist, pediatrician, speech therapist) and also requires the use of a battery of assessment tests, objective tests that can be used to determine the level of development in language, behavior, and communication skills (Faggioli et al., 2014). The medical team formulates the diagnosis by examining the child's developmental history and behavior. Instrumental and laboratory investigations (such as EEG, brain MRI/CT) are often used to exclude other pathologies. Sometimes, video recordings of daily behaviors are also used to identify the child's behavioral patterns and to fill in assessment forms to understand the basic functions of autistic subjects.

As already highlighted, it is important to diagnose children with ASD as early as possible so that they receive the services and support they need to reach

their full developmental potential. This process requires several steps. The first step is developmental monitoring, an active and continuous process aimed at observing the child's development, how they are growing, and whether they have reached typical developmental milestones or at least the skills that most children achieve by a certain age, such as play, learning, language, behavior, and movements. Observations can be semi-structured, and interaction with the child is established to determine their mental age. Subsequently, developmental screening is carried out, allowing for a more detailed examination of the child's development. Developmental screening is a regular procedure during some medical visits; in fact, the American Academy of Pediatrics (AAP) recommends screening for both development and behavior during regular well-child visits at 9 months, 18 months, and subsequently at 30 months. Since ASD is common and can be diagnosed as early as 18 months of age, standardized screening and continuous developmental monitoring at 18 and 24 months continue to be recommended in primary care. The Diagnostic and Statistical Manual of Mental Disorders (DSM-5) has divided the main symptoms into two domains: communication and social interaction, and restricted and repetitive behavioral patterns. To diagnose ASD according to DSM-5, diagnostic criteria must be met, so at least two of the four symptoms associated with restrictive and repetitive behaviors must be present, as well as deficits in communication and social interaction, with onset in early childhood and subsequent impairment of daily functioning. DSM-5 places importance on symptoms related to sensory processing, including sensory symptoms such as hyper- or hypo-reactivity to sensory input or unusual interests in sensory aspects of the environment, such as apparent indifference to temperature; sensitivity to noises and sounds, or taste; apparent indifference to physical pain, and intense interest in objects. It also introduces specific areas for intellectual and language functioning. Additionally, DSM-5 indicates that a diagnosis can also be made at older ages, when the demands of the social or school environment may lead to functional limitations or impairment of daily life (Hyman, Levy, Myers, 2020).

It is therefore important to conduct a good family history and to carry out both qualitative and quantitative behavioral observations. However, it is not possible to identify a generic diagnosis for autism, as each diagnosis will refer to a specific deficit aspect of the syndrome, and not all techniques are effective for everyone. Diagnosis therefore requires a comprehensive and multidisciplinary approach, as it is a diagnostic and functional assessment aimed at planning educational and habilitative intervention.

Traditional Treatments in Autism

The most effective treatment consists of a series of targeted interventions that can offer comprehensive support to the individual and their family. These treatments aim to increase a person's ability to interact with their environment and to achieve optimal adaptation through a process of learning and enhancement of the person's inherent resources. The therapeutic plan, consequently, must be adapted based on the personal development of the individual in need, thus enabling the creation of a suitable functional plan. For this treatment plan to be effective, it must not be limited to childhood but must continue into adulthood to allow the individual to consolidate what has been learned; furthermore, ASD requires a new educational phase with every change in the living environment, due to difficulties in generalizing learning. The most im-

portant type of intervention is educational-habilitative, which aims at the acquisition and learning of both general and specific skills, so that the child can best adapt to the environment.

Therefore, the global educational project aims to improve quality of life and well-being, increasing individual autonomy, communication skills, and social interaction.

Applied Behavior Analysis

As autism is a disorder with a behavioral basis, the type of intervention will predominantly be educational-habilitative. The Applied Behavior Analysis (ABA) method represents the most well-known behavioral approach. The theoretical foundations of ABA lie in conditioning, from Pavlov's classical conditioning to Burrhus F. Skinner's operant conditioning, in which operant behavior is under the control of consequences; any behavior produces consequences that, in turn, will influence, increasing or decreasing, the future probability of that same behavior occurring in similar environmental conditions. Therefore, the ABA method constitutes operant conditioning as it acts on voluntary behavior and works by motivating the patient. The purpose of this approach is to propose targeted interventions to improve socially significant behaviors. From a behavioral perspective, autism is a syndrome characterized by behavioral deficits and excesses that can be modified through individualized and programmed interactions with the environment. To modify a behavior, it is necessary to know and define accurately and precisely the task to be modified, understand the function of the behavior, and measure the behavior. Logically, it is better to modify one behavior at a time. Reference is made to the ABC principle (Antecedent-Behavior-Consequence) (Carradori et al., 2017), which allows for a faithful description of the behavior and the events preceding and following it. The main technique of ABA intervention is errorless learning, in which the person is helped to perform the desired behavior so that they can enact it without errors. The use of prompts, which are supplementary stimuli that control the desired behavior but are not part of the final stimulus (Touchette et al., 1984), is fundamental, followed immediately by fading, which consists in gradually reducing the aids so that the person can produce the desired behavior independently.

The intervention uses behaviorist-derived strategies, employing a basic operational strategy or "task analysis." Task analysis consists of breaking down the target behavior into simpler behaviors, defining a behavioral sequence to be implemented within the procedure. Within task analysis, three phases can be identified (Roccella, 2015). In the first phase, initial formulation of behavioral objectives occurs, which must define the behavior to be enacted, identifying the conditions in which it should occur and clarifying measurement criteria. The second phase involves a systematic analysis of all the simple behaviors that make up the behavioral chain that allows the target task to be performed; to make measurement as objective as possible, the behavior is broken down into small observable units. The final phase consists of accurately measuring the child's baseline behavior.

There are also two other teaching strategies called NET (Natural Environment Teaching) and DTT (Discrete Trial Teaching). The main difference between these two teaching strategies lies in the environment; in NET, the work environment is organized, and the subject's motivations are used to create learning opportunities, with a specific rein-

forcement delivered connected to the subject's response, while in DTT, the environment is determined and well-structured to teach a specific skill, where reinforcement is not necessarily connected to the ongoing activity (Foxx, 2021).

To increase communication skills, targeted interventions are used, such as methods within ABA training like Augmentative and Alternative Communication (AAC). AAC uses images, signs, and tools to compensate for deficits in people who have difficulty using spoken language, thus serving to increase communication deficits in an alternative way to vocal verbal language. AAC uses communication through image exchange (PECS, Picture Exchange Communication System) and through signs. These two strategies have pros and cons: PECS requires more time and has less similarity to vocal verbal language, while signs are faster and more similar to vocal verbal language (Roccella, 2015).

In any case, all strategies aim to achieve the child's ability to learn independently from interaction with the environment.

Treatment and Education of Autistic and Related Communication Handicapped Children (TEACCH)

Another cognitive-behavioral intervention is the TEACCH program (Treatment and Education of Autistic and Related Communication Handicapped Children). The term "TEACCH program" refers to the organization of services for autistic individuals, which entails a comprehensive approach both "horizontally" and "vertically"-that is, at every moment of the day, throughout the year, across all periods of life, and for the entire lifespan (Vicari et al., 2012; Roccella, 2015). This is a psychoeducational program whose fundamental aim is to promote the individual's development, social integration, and autonomy, taking into account the specific deficits associated with ASD. The goal of this program is to increase the level of autonomy in personal, social, and occupational life through educational strategies that enhance the abilities of people with ASD. Ultimately, the objective is to ensure, as much as possible, that adults with ASD can live with other members of society in the least restrictive environment possible, actively participating in community life, integrating, and adapting to the environment in an autonomous and independent manner (Roccella, 2015).

According to the core theory of the TEACCH approach, adapting the environment to the individual and gradually presenting challenges is a way of respecting the person's uniqueness (Vivanti, 1999). This approach is not strictly behavioral, although it utilizes behavioral techniques such as reinforcement. It falls within the cognitive-behavioral field and is a structured educational system that includes spatial organization-dividing spaces according to their function and designing the physical environment with clear visual boundaries for each area, each designated for a specific activity. This visual organization of the workspace helps the child act independently. Daily activities are organized using schedules or agendas, which serve to anticipate and visualize all daily activities, thereby avoiding or limiting problems with temporal orientation and organization.

The organization of the physical environment is crucial: the workspace must be well-organized with clearly defined areas, and it is essential that each space is dedicated to a single activity. Therefore, defining spaces and their functions is important. The cues provided by the space must be consistent

with the activities performed there and with the skills being taught.

The TEACCH method has been shown to improve motor skills, cognitive abilities, social functioning, and communication in children with ASD (Vicari et al., 2015). To develop a psycho-educational and habilitative project, a thorough diagnostic and functional evaluation is necessary, which is performed using standardized tests and scales such as the CARS (Childhood Autism Rating Scale), the WECHSLER scales (e.g., WISC and WAIS, which are intelligence tests), and the PEP-3 (Psycho-Educational Profile), which has two versions: PEP-R (Psycho-Educational Profile-Revised) for children and AAPEP (Adolescent and Adult Psycho-Educational Profile) for adolescents and adults.

Early Start Denver Model (ESDM)

The ESDM (Early Start Denver Model) is an early developmental intervention model with a socio-relational basis that integrates highly precise behavioral and naturalistic teaching techniques, drawing from cognitive-behavioral methodologies. It aims to foster initiative and social engagement in the child. As a relational approach, ESDM views development as an interpersonal process, mediated by the quality of relationships; thus, the child's learning occurs through interaction with adults and the environment (and if the environment is lacking, this will be reflected in the development of the neuro-functional system) (Roccella, 2015).

It is an organized and systematic project, consisting of a program that identifies the skills to be taught, which typically characterize early childhood development, and a set of specific teaching procedures. The main goal of this intervention is to build routines (which are intrinsically motivating and provide natural opportunities to develop skills) of shared activities, starting from the child's initial interests and systematically incorporating the objectives to be achieved. The focus is on motivation, reducing extrinsic reinforcement. Through play, learning occurs that is capable of modifying social interaction skills that the child does not currently possess.

Practically, ESDM consists of a curriculum specifying what should be taught and the relevant domains, as well as educational strategies-how to teach all areas of the curriculum-following cognitive-behavioral methods and the ABC methodology. The ESDM model involves full parental participation, as this is considered best practice for early intervention. Together with the team, parents define the intervention goals and generalize intervention techniques to everyday contexts such as the home. The model also includes learning strategies aimed at improving communication and managing maladaptive behaviors, including which strategies to use in the case of problem behaviors.

In conclusion, ESDM is an early intervention focused on the social disability associated with ASD; early identification allows for intervention at an age when developmental processes can still be modified. For this reason, early stimulation of social interactions with others is encouraged, as it allows work within a temporal window when mental functions are still maturing, thereby minimizing core autism symptoms, maximizing functional independence and quality of life, and reducing parental stress (Roccella, 2015).

Cognitive-Behavioral Approach

The cognitive-behavioral approach posits a deep relationship between feelings, thoughts, and behav-

iors, asserting that emotional problems are largely the result of dysfunctional beliefs that persist over time and therefore must be identified and challenged. Cognitive-Behavioral Therapy (CBT) has several characteristics: it is scientifically grounded, as controlled studies have demonstrated its efficacy; it is goal-oriented and collaborative, with therapist and patient working together to establish the treatment plan and objectives, ensuring regular reviews to verify progress. They work together to develop strategies that the individual can use to solve their own problems, identifying and questioning specific thought patterns underlying emotional and behavioral issues. CBT is brief, practical, and concrete, aiming to resolve specific problems (Vicari et al., 2012; Roccella, 2015).

In the late 1990s, Tony Attwood adapted CBT to autism spectrum disorders, noting many shared features with the cognitive, emotional, and relational characteristics of individuals with ASD. He provides a scientific explanation of emotions and suggests strategies for cognitive control of emotions. The intervention focuses on teaching behavioral, cognitive, and emotional skills to modify thoughts and behaviors that trigger negative emotional states such as anxiety, depression, and anger. The CBT intervention program, modified to meet the cognitive and sensory needs of ASD patients, addresses both emotional and cognitive aspects and is divided into several phases: assessment of mood disorder severity, emotional education and cognitive restructuring, stress management, self-monitoring activities, and planning to practice new cognitive strategies and skills (Pasin, 2018).

A randomized controlled study by Jonathan Weiss (associate professor, Department of Psychology, York University) demonstrated that CBT can improve emotional regulation in children with ASD. Children with ASD often struggle to regulate their emotions and are overwhelmed by anger, anxiety, and depression. Weiss argues that CBT can intervene to modify and improve these children's ability to tolerate emotions. In the study, 68 children aged 8–12 and their parents were randomly assigned to two groups: one received immediate treatment, while the other waited. The treatment consisted of time-limited CBT, using computer programs, games, and tools to help the child build emotional skills. These tools enabled children to face challenging situations and manage their emotions independently. Parents participated as co-therapists. Researchers monitored the children before and after treatment; results showed that the first group improved their emotional management skills compared to the waiting group. Thus, through CBT and other educational-habilitative interventions, children can build and manage autonomy, enabling social life and the regulation of affective states and social relationships (Morgia, 2018).

Developmental Individual Relationship-Based Model (DIR)

The Developmental Individual Relationship-Based Model (DIR), developed by Stanley Greenspan and Serena Weider (Greenspan & Weider, 2006), is a bio-psycho-social, developmentally based model and therapeutic practice, designed as an intervention for children with ASD and beyond. This model pays great attention to the uniqueness of each patient, creating individually tailored interventions, since the same diagnosis in different children often presents very differently. Tailoring the intervention thus enables the creation of an individualized developmental model (Guiot et al., 2012).

The intervention is based on the idea that, for a specific activity, it is essential to start from the child's interests, as precisely orienting the child's interests can lead to emotional activation, helping the child build a sense of self that will aid in relating to people and the world (Venuti, 2014). With its features, the DIR model is designed to allow parents, clinicians, and teachers to plan and individualize treatment programs based on the child's strengths and interests. DIR activities are designed to promote social, emotional, and intellectual growth according to six developmental levels: regulation and shared attention (the basis for subsequent development); the ability to relate to others (requiring commitment and trust from both therapist and child); intentional two-way communication (creating reciprocal interactions between child and therapist, following a circular, child-led flow); the ability to solve social problems, regulate mood, and form a sense of self (building on previous levels to equip the child with necessary problem-solving tools); the creation and elaboration of symbols and ideas (using imaginative play to communicate desires and ideas, developing specific verbal language); and building bridges between ideas, logical and emotional thinking, and the sense of self (enabling the child to make logical connections between ideas) (Guiot et al., 2012).

Typically, these developmental levels are achieved spontaneously by children by age four or five; for children with ASD, reaching these milestones is more complex, so the focus is often on the first three levels, enhancing emotional-functional abilities (Guiot et al., 2012; Hollister Sandberg et al., 2016). The intervention technique most often associated with this model is called Floortime, which aims to create emotionally meaningful educational interactions to promote the acquisition of the six developmental abilities. This technique focuses on the child's natural interests, respecting their individual profile and developmental stage, and promoting intentionality (Guiot et al., 2012). The name derives from the fact that key therapeutic activities are often carried out as games on the floor, ensuring the child can interact independently while always considering the developmental objectives.

Music Intervention in ASD

A study suggests that music can increase communication in children with ASD, positing that improved communication skills may be linked to increased connectivity between the auditory and motor regions of the brain. Researchers from UdeM's International Laboratory for Brain, Music and Sound (BRAMS) and McGill's School of Communication Sciences and Disorders (SCSD) conducted a three-month clinical trial involving music-based interventions with 51 children aged 6–12 years with ASD. Parents completed questionnaires on their children's communication and social skills and described symptom severity. Children underwent MRI scans to establish baseline brain activity and were then randomly assigned to two groups: one with music intervention, the other without. The sessions lasted 45 minutes. Both groups worked with a therapist in a bidirectional interaction; however, in the first group, the children sang and played instruments, while the second group did not engage in musical activities. Parents observed that children in the first group exhibited significant improvements in communicative abilities and also in the quality of family life, compared to those in the second group. Nevertheless, neither group reported a reduction in symptom severity. MRI evidence showed an increase in connectivity between auditory and motor areas and a reduction

in connectivity between visual and auditory areas, suggesting that the improvements in communicative abilities in the children of the musical group may be the result of this connectivity, which serves to integrate sensory stimuli from the environment and is fundamental for social interactions. The results of this research demonstrate that musical intervention during school age in children with ASD can lead to improvements in communicative abilities and is capable of increasing brain connectivity. The results are observable only after 8–12 weekly sessions, but to replicate these findings, it will be necessary to employ different therapists to assess whether the effects persist in different environments. In any case, no changes were observed regarding autistic symptoms (Manna, 2018).

Non-Invasive Brain Stimulation Techniques (NIBS)

It is possible to stimulate the brain without the need for deep electrodes (Dehaene, 2022). Non-invasive brain stimulation techniques consist of modulating the activity of certain areas by activating or inhibiting the threshold of excitability or neuronal firing (Rossi, 2020). These techniques influence neuronal states by altering the membrane potential of neurons. Under normal conditions, this membrane potential is at rest and thus remains stable; when NIBS are used, the state of the neuron is modified through electrical currents that promote or inhibit the generation of an action potential. All these techniques are therefore able to produce a shift of charges at the cellular level, thereby modifying the membrane potential.

Among the most commonly used techniques are transcranial magnetic stimulation (TMS), which is based on the depolarization of neuronal membranes through electromagnetic induction that leads to the initiation of action potentials in the stimulated area; and tES (transcranial electrical stimulation), which includes all NIBS methods that use weak transcranial currents to modulate the neuronal activity of the brain. Through these low-intensity stimulations, a change in the membrane potential state is induced, altering ionic flows and obtaining a variation in the response threshold of the stimulated neurons, with a consequent modulation of the neuron's response (Bolognini et al., 2015).

TMS and tES differ as they elicit two different neuronal responses: TMS is a neurostimulation technique because, depending on whether the stimulation is delivered above or below threshold, it can evoke an action potential or not; whereas tES are neuromodulation techniques, as they modulate postsynaptic potentials but cannot initiate an action potential.

To precisely localize the area to be stimulated, neuronavigation systems have been introduced (Bolognini et al., 2015), which allow TMS to be guided by integrating data on brain structures obtained from individual MRI scans. The coil is positioned exactly above the area to be stimulated based on the patient's anatomical images. In the absence of individual patient data, some neuronavigation systems use a template, that is, an average brain model obtained through warping, which involves digital image manipulation procedures.

Thanks to neuronavigation, it is possible to determine the exact localization of the target area to be stimulated, with the possibility of reproducing the stimulation with high precision, both in sessions where the patient requires stimulation at different times and in long sessions where it is necessary to

keep the coil on the same point of the scalp (Bolognini et al., 2015).

Conclusions

Autism Spectrum Disorders are complex, heterogeneous conditions requiring early, multidisciplinary diagnosis and individualized intervention. Traditional treatments, particularly educational and behavioral approaches such as ABA and TEACCH, remain the gold standard, focusing on enhancing adaptive, communicative, and social skills. These interventions must be tailored to the individual's developmental profile and sustained throughout life to ensure optimal outcomes. Recent advances, including non-invasive brain stimulation techniques, offer promising avenues for symptom modulation and warrant further investigation. Ongoing research is essential to refine existing therapies and explore innovative treatment strategies, with the ultimate goal of improving quality of life and functional independence for individuals with ASD and their families.

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