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A Neuropsychological Intervention Study of Intellectual Activity in an Adolescent with Autism Spectrum Disorder

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ABSTRACT

Background. Autism Spectrum Disorder (ASD) is characterised by difficulties in social communication and restrictive, repetitive patterns of behaviour. ASD represents a spectrum of functional manifestations, involving varying levels of severity in intellectual activity and social interaction. Adolescence involves various physical and cognitive changes, as well as increased social demands. The historical-cultural neuropsychology framework provides an effective theoretical and methodological approach to establish the level of functional development of brain mechanisms and allows for the description of the individual manifestation of the disorder.
Objective. This study aims to describe the neuropsychological evaluation and intervention process from a historical-cultural perspective in a case of ASD during adolescence.
Study Participants. A 12-year-old, male student with delays in language acquisition and socialisation, as well as psychomotor challenges. These difficulties led to a diagnosis of Global Developmental Delay, ASD, and Attention Deficit Disorder by a child psychiatrist.
Methods. A neuropsychological intervention programme was implemented based on the principles of the historical-cultural approach. The programme specifically focused on the development of the affective-emotional sphere, in particular socio-affective communication, and on improving the understanding of oral and written information.
Results. Among the results obtained, there was an improvement in expressive and receptive language, with an increase in the use of gestures, facial expressions, and eye contact, fostering more effective communication. The adolescent also demonstrated a greater understanding of social and emotional situations, as well as progress in understanding abstract concepts and problem-solving.
Conclusions. The results obtained support the efficacy of neuropsychological interventions based on the historical-cultural perspective to improve the quality of life for individuals with ASD.

Keywords: autism, adolescence, neuropsychology, neuropsychological intervention, historical-cultural perspective

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INTRODUCTION

Autism Spectrum Disorder (ASD) is a neurodevelopmental disorder characterised by a broad range of cognitive impairments. These impairments typically manifest themselves as difficulties in social interaction and communication, as well as restricted and repetitive patterns of behaviour, interests, or activities [1] (Gökçen et al., 2016; Happé, Frith, 2020). The fifth edition of the Diagnostic and Statistical Manual of Mental Disorders (DSM-5)[1] (APA, 2014) indicates that ASD is characterised by significant deficits in social communication and interaction, presenting in various ways. These may include, but are not limited to, delays in, or absence of, spoken language, unusual language patterns, and difficulties understanding and using nonverbal communication. Additionally, individuals with ASD often exhibit restricted, repetitive patterns of behaviour, interests, or activities, such as stereotyped movements, insistence on sameness, and hyper- or hypo-reactivity to sensory input.

Early symptoms of ASD often manifest in difficulties with fundamental social skills, such as eye contact, joint attention, imitation, and recognizing and expressing emotions (Behrmann et al., 2006; Mundy, 2017). These deficits can significantly impact language acquisition, which may be delayed or used in atypical ways. Additionally, children with ASD may exhibit social withdrawal, difficulties forming peer relationships, limited responses to adult requests, repetitive behaviours, and intolerance of change (Justicia, Sánchez, 2015).

While many adolescents with ASD continue to exhibit core features of the disorder, the developmental trajectory can be variable. Some individuals experience symptom improvement, while others may experience worsening symptoms. Positive changes often include improvements in communication and social skills, as well as reductions in repetitive behaviours. It is important to note that the course of ASD during the transition from childhood to adolescence is influenced by various factors, including symptom severity, cognitive abilities, and the type, frequency, and timing of interventions (Baghdadli et al., 2012; Schall, Todd, 2010).

Cognitive development in individuals with ASD can also vary widely, ranging from severe impairments to abilities that are near or above average in specific domains. According to Martos-Pérez (2006), cognitive deficits are linked to limitations in the development of shared awareness, which is essential for understanding and responding to social situations, such as object use and social interactions, in early development. Furthermore, cognitive development is connected to the development of social cognition, which encompasses the mental processes that enable individuals to modulate their behaviour within social contexts and make inferences about others' intentions and dispositions (Adolphs, 2001; León, Cárdenas, 2017). These abilities are the result of complex interactions between multiple neural processes involving both cortical and subcortical structures (Adolphs, Tranel, 2003; Blakemore, Mills, 2014; Engell et al., 2007).

Joint attention is a fundamental social cognitive skill that facilitates information exchange between individuals (Mundy, 2017). This ability to communicate one's intentions and needs, even without verbal language, is reinforced by the motivation to maintain social interactions and enhances the cognitive ability to coordinate one's perspective with that of others (Mundy, 2017). Consequently, deficits in joint attention during language acquisition can hinder a child's interactions with caregivers, who play a crucial role in language development (Adamson et al., 2017). At the cognitive level, these deficits can manifest in impairments of essential psychological functions such as symbolic thought, self-awareness, learning, and language development (Kanne et al., 2011).

Given the aforementioned, paying close attention to the development of verbal language from early childhood is crucial in the neuropsychological approach to ASD. This is because this higher-order psychological function is both affected by early developmental abnormalities and is a significant contributing factor to the individual's social interaction difficulties, which often become more pronounced during adolescence (Tager-Flusber et al., 2005). As Vygotski argued, language is a fundamental aspect of child development, extending beyond communication to mediate all psychological processes and facilitate the development of consciousness (Vygotski, 1996). This allows for the understanding of meaning as a personal reflection of significance and provides a means for the development of higher-order psychological functions.

Considering the preceding, neuropsychology, as a scientific discipline, investigates the neural basis of higher cognitive functions and provides a framework for studying the impairments experienced by individuals with ASD, as well as for developing clinical interventions. Therefore, neuropsychology offers a methodological approach for creating individualized intervention plans that address the specific neuropsychological profiles of individuals with ASD.

Specifically, the historical-cultural neuropsychological perspective offers a viable alternative for treating adolescents with ASD. Unlike approaches that focus on the symptoms of the disorder, this perspective aims to identify the underlying causes of the specific difficulties experienced by each individual. This facilitates the development of individualised intervention plans (Cinta, Almeida, 2016; González-Moreno et al., 2012; Morales et al., 2011).

In this regard, Solovieva et al. implemented a neuropsychological intervention programme with a 16-year-old adolescent diagnosed with ASD (Solovieva et al., 2012). The intervention goals focused on strengthening the mechanisms of regulation and control of voluntary activity, as well as simultaneous spatial analysis and synthesis, which were identified as functionally deficient in the initial assessment. These authors report that following the intervention, favorable results were found in the indicated mechanisms. Additionally, the authors report positive changes in the identification of emotional states, the structure of oral language, and a decrease in verbal stereotypies, among others.

[1] American Psychiatric Association. (2014). Manual Diagnóstico y Estadístico de los Trastornos Mentales (DSM-5) (5a ed.). Arlington: American Psychiatric Association Publ.

Based on the aforementioned, this study aims to describe the process of neuropsychological assessment and intervention from a historical-cultural perspective in a case of adolescent ASD, along with the results obtained from this intervention.

STUDY PARTICIPANTS

A 12-year-old, right-handed male student from a private school in Puebla, Mexico, was referred for a neuropsychological assessment. The referral was made by his mother due to concerns regarding his social skills, difficulties with written instructions, and reading comprehension. His developmental history indicated delays in language acquisition and socialisation, as well as psychomotor challenges. These difficulties led to a diagnosis of Global Developmental Delay, ASD, and Attention Deficit Disorder by a child psychiatrist.

METHODS

Instruments

The assessment instruments were grounded in a historical-cultural neuropsychological perspective. A qualitative neuropsychological evaluation was conducted to identify the underlying neural mechanisms responsible for the difficulties. The assessment focused on the analysis of the following neuropsychological mechanisms: phonemic hearing, kinesthetic-tactile integration, visual and auditory-verbal retention, sequential motor organisation, simultaneous spatial analysis and synthesis, regulation and control of activity. Additionally, academic performance and intellectual activity were assessed. The following instruments were used: Neuropsychological Assessment Protocol for Adults (Quintanar, Solovieva, 2013), Verification of Academic Success in Adolescents (Solovieva, Quintanar, 2018), and Evaluation of Intellectual Activity in Adolescents and Adults (Solovieva, Quintanar, 2018).

The Neuropsychological Assessment Protocol for Adults (Quintanar, Solovieva, 2013) was used to assess a wide range of cognitive functions, including attention, memory, language, and executive functions. The Verification of Academic Success in Adolescents (Solovieva, Quintanar, 2017) provided a comprehensive evaluation of the participant's academic skills, while the Evaluation of Intellectual Activity in Adolescents and Adults (Solovieva, Quintanar, 2018) focused on higher-order cognitive processes such as problem-solving and reasoning.

Procedure

The procedure began with a clinical interview with the adolescent's mother and an initial neuropsychological evaluation, followed by neuropsychological intervention, and concluded with a final neuropsychological evaluation. The initial and final evaluations were conducted in four sessions. The first three sessions were dedicated to the administration of assessment instruments, while the fourth session involved providing feedback and explaining the results to the mother. An electroencephalogram (EEG) was included in the initial evaluation and was conducted at the Institute of Neuropsychology and Psychopedagogy of Puebla A.C. and evaluated by an expert. The final evaluation was carried out by a neuropsychologist who was not involved in the initial evaluation or treatment process. Evaluation and intervention sessions were 60 minutes in duration and took place at the University Unit of Neuropsychology of the Puebla University Hospital. The intervention process consisted of 35 sessions, held twice a week over a four-month period.

Initial assessment results

During the assessment sessions, the adolescent displayed cooperation in completing the proposed tasks. However, his verbal language was observed to be structured but very limited, and he exhibited a lack of eye contact. He did not initiate conversations, and his responses to questions were markedly concise. Neuropsychological assessment results revealed adequate functional development of cortical brain mechanisms. Nevertheless, significant alterations in social behavior were identified, along with deficits in social-affective communication.

The primary alterations observed in language were related to the pragmatic aspects of both verbal and written language. In expressive language, adequate articulation and syntax were identified, although language production was very limited. He exhibited difficulty in lexical retrieval, often circumlocution to find words. Intonation was aprosodic. The adolescent displayed a lack of eye contact and spontaneous facial expressions, maintaining a neutral expressivity. In receptive language, he required paraphrasing or elaborated explanations to comprehend verbal instructions.

Regarding reading and writing, the adolescent demonstrated adequate syntactic structure in his written work, although his spontaneous writing was also very concise. His oral reading was fluent but aprosodic. As for text comprehension, he could access the literal meaning, but not the deeper meaning. In understanding written instructions, like his oral comprehension, he had trouble, requiring verbal guidance from the evaluator to facilitate understanding.

Regarding intellectual activity, difficulties were observed in recognising emotions, with the individual identifying only literal and explicit information. The adolescent exhibited significant difficulties in understanding and representing abstract information, both graphically, orally, and in writing. EEG data evidenced an adequate functional state of cortical structures, with a pathological functional state in subcortical structures of limbic system.

Intervention program

The neuropsychological intervention programme was structured according to the principles of neuropsychological correction as articulated within the historical-cultural framework (Quintanar, Solovieva, 2008; Solovieva, Quintanar, 2014, 2019). The primary objective was to facilitate the development of those neuropsychological functions that had been identified as functionally impaired. Core principles underlying this approach include: 1) the concept of building upon existing strengths to remediate weaknesses, 2) a gradual process of mediation and internalization of actions that engage the targeted mechanisms, 3) the utilization of the zone of proximal development to create accessible activities that the patient can accomplish with adult guidance, 4) aligning interventions with the dominant activity characteristic of the patient's developmental stage, and 5) providing a structured framework for action, involving the expansion or contraction of actions based on their constituent operations.

The neuropsychological correction program activities focused on promoting optimal development of the affective-emotional sphere, particularly in relation to social-affective communication, as well as fostering comprehension of the meaning and significance of oral and written information (see Table 1).

Table 1

Structure of the neuropsychological correction program and examples of intervention tasks at each stage

Stage	Objective	Sample Activities
Stage 1	To develop oral language and pragmatics, with perceptual support.	— Encouraging use of social conventions and creating a daily journal with emotional labeling. — Playing games involving giving verbal instructions to locate objects. — Guessing objects based on gestures and characteristics. — Describing personal photographs of significant experiences. — Differentiating between cordial prosody (soft, medium, and loud voices) and choosing the appropriate tone for different situations. — Using emotional prosody by narrating recordings of TV shows, sports games, and short stories, with a prior model.
Stage 2	To foster understanding of situations with emotional content, with perceptual support.	— Classifying cards of positive and negative emotions, as well as different people showing the same emotion. — Identifying different emotions and where they are felt in the body. — Identifying emotional situations in photographs and selecting the corresponding emotion. — Identifying the meaning of conventional gestures. — Identifying the feelings reflected in melodies and songs, mediating high and low notes through colors and symbols. — Working with comics, where the child assigns possible dialogues based on the analysis of the situation.
Stage 3	To promote optimal development of intellectual activity focused on understanding meaning and significance, from a logical-verbal perspective.	— Using accents and their relationship to word meaning. — Reading narrative and descriptive texts, analyzing characters, events, morals, and emotional situations. — Developing a plan for a text, identifying the main idea in each paragraph and the emotional situation presented. — Working with proverbs, sayings, jokes, and puns, guiding the generation of possible meanings and interpretations.

Outcomes of a neuropsychological correction program

Following the implementation of the intervention program, favorable changes were identified in the following areas. Regarding language, the adolescent exhibited a more expanded language use, continuing the proposed conversation beyond providing concrete answers to the given questions. The conversation demonstrated turn-taking and the use of questions to verify if the evaluator was following his discourse. The adolescent maintained eye contact and displayed slight social smiles, additionally

accompanying his speech with facial expressions and nonverbal sounds to exemplify his explanations. There were rare instances of difficulty accessing vocabulary, with this difficulty being limited to uncommon words. One area where he continued to show difficulty was the lack of spontaneity in using social conventions such as greetings and goodbyes.

Regarding the comprehension of situations with emotional content, during tasks involving analysis of artistic paintings, the adolescent successfully recognised the depicted emotions. Additionally, he improved in interpreting the ensemble of elements within an image to arrive at a general concept (for example, he mentioned concepts such as journey, war, love, affection, pain, millionaire).

The intervention resulted in notable improvements in the adolescent's literacy skills. He demonstrated a better understanding of written texts, being able to identify main ideas and express them in his own words (see Table 2). His spontaneous writing became more fluent and elaborated. The adolescent also showed increased ability to follow both verbal and written instructions, with minimal support required. While challenges with prosody persisted, overall reading comprehension improved.

Table 2

Written narrative before and after the neuropsychological correction program. Instruction: "Write what you did yesterday"

	Executions	Description
Before intervention	*"Having fun with my classmates during classwork"* *"Having fun playing soccer with my friends during soccer practice"* *"Eating pizza with my family and watching TV for a while"*	Writing in list or bullet form, not narrative.
After intervention	*"Yesterday I got up early, did my sports activities and also when I got home I did my homework and we went out to eat, then we returned home, I finished my homework and went to sleep"*	He writes a narrative in a more displayed way. He uses syntactic connectors to create a time sequence. He completes the task without help from neuropsychologist.

Regarding intellectual activity, the adolescent showed a notable improvement. When asked to represent abstract concepts, he achieved a better representation of these, including contextual elements, even achieving their representation in a symbolic form (see Figure 1). Below is an analysis of the pre- and post-intervention executions shown in Figure 1, considering both the graphic execution and the verbal description given by the patient for each requested concept.

Prior to intervention, the adolescent demonstrated a literal and isolated understanding of each individual word in the phrase "*Delicious dinner*" (In Spanish the adjective "delicious" sounds similar to "rich") failing to construct a comprehensive understanding of the concept as a whole. Post-intervention, he exhibited a more integrated comprehension, successfully combining both words into a unified concept.

Regarding the concept of "Justice", before the intervention the adolescent was unable to graphically represent the concept and only drew a person saying the word "justice". In the subsequent execution he made a graphic representation that included the use of a symbol of good, which he associated with justice as a moral value.

In the concept "Hungry Child" he initially makes an ambiguous graphic representation of the concept, the image itself does not contain clear information related to the given concept. In the later execution, a child is also depicted with a facial expression that denotes suffering, but in this case a contextual element related to it is included, specifically a food vendor.

In the concept of "Lie," during the initial execution, the graphic representation lacks elements that facilitate the interpretation of the concept. In the subsequent execution, an abstract graphic representation of the concept is achieved by proposing an image that, on its own, conveys the concept.

For the concept of "Health," the initial execution involves a literal representation of a common expression people in Mexico use in response to a sneeze. In the subsequent execution, the concept is implicitly conveyed through the graphic representation and its explanation, as it depicts a situation where a person seeks to alleviate an illness, which inherently implies the attainment of health.

In the concept of "Cold Night," the initial execution ambiguously and partially represents a nighttime scene. In contrast, the subsequent execution not only depicts the night more clearly but also conveys the sensation of cold through what a person might be experiencing.

Finally, in the understanding of fables, the adolescent was able to grasp the moral with the use of materialised assistance, that is, by narrating the story using tangible representations of the characters and scenes, accompanied by movements and sounds. In the task of interpreting proverbs, he managed to comprehend some of them without assistance, although he still demonstrated difficulty understanding the majority.

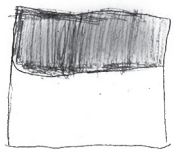
	Before intervention		**After intervention**	
Concept	**Pictogram**	**Description**	**Pictogram**	**Description**
Delicious dinner		*"He is having dinner because he has a lot of money"*		*"Spaghetti because it's delicious"*
Justice		"Justice"		*"Good is winning, because it has done justice"*
Hungry child		*"He is hungry"*		*"The child is looking at the food and is hungry"*
Lie		"*He is telling him a lie"*		*"A lie, because cars can't fly"*
Health		"He sneezed and the other one said ¡health!"		*"He is sick and goes to the doctor"*
Cold night		"A cold night"		"A cold night, he is cold"

Figure 1

Representation of abstract concepts before and after the neuropsychological correction program

DISCUSSION

In the scientific literature, a notable gap is identified in the study of application of neuropsychological interventions for individuals with ASD (Sánchez-Ceballos et al., 2021), a gap that becomes even more evident in interventions targeting adolescents (Gabbatore et al., 2021). Neuropsychological interventions typically rely on pre-designed programmes tailored for the broader ASD population. This highlights the importance of developing individualised intervention programmes for this age group, considering both their specific functional characteristics and their psychological age. This approach has been adopted by researchers such as Solovieva et al., as well as in the present study (Solovieva et al., 2012).

The intervention was aimed at fostering the development of skills for affective social communication, as well as enhancing the understanding of the meaning and sense of verbal and written information. This was achieved by considering the external and mediated organisation of actions to facilitate their internalisation. Based on the therapeutic work conducted, favorable outcomes were observed in language, socialisation, emotional expression, and intellectual activity.

In terms of language, improvements were noted in both expressive and receptive language, particularly in the pragmatic component, with increased eye contact, social smiles, and the use of facial expressions to accompany speech. These findings align with previous reports in the literature (Gabbatore et al., 2021; Solovieva et al., 2012). Improvements were also observed in the comprehension and expression of emotionally charged situations, as well as in intellectual activities involving the understanding of meaning and sense, as reflected in the comprehension of morals and the representation of abstract concepts (Solovieva et al., 2012).

These results had a direct impact on the adolescent's daily life. With a greater understanding of the social and emotional aspects encountered in various everyday situations, the adolescent improved his independence in navigating social environments. The mother reported increased independence in the adolescent's ability to carry out school-related activities.

It is important to note that the historical-cultural neuropsychological approach represents an alternative for conducting individualised evaluation and intervention processes. This approach enables a detailed analysis of each patient's neuropsychological functioning to identify the underlying neuropsychological mechanisms responsible for the observed difficulties. It goes beyond merely observing symptoms that lead to the assignment of a "label," which groups individuals with ASD into a category encompassing a broad spectrum of symptomatic expressions.

Thus, in accordance with the principles of neuropsychological correction, the intervention process is designed based on the functional impairments identified during the evaluation. Additionally, it considers specific developmental aspects, such as psychological age and the structuring of intervention tasks in relation to the corresponding leading activity, while also considering the gradual internalisation process of mental actions.

CONCLUSIONS

In summary, the obtained results highlight the neuropsychological correction methodology proposed from the historical-cultural approach as an effective alternative for addressing the impairments observed in the case of an adolescent diagnosed with ASD.

The findings underscore the necessity of considering individuals with ASD as unique subjects who, beyond sharing certain symptomatology with others on the spectrum, exhibit specific neuropsychological functioning characteristics and particular developmental aspects. These require an evaluation and intervention process that emphasises their individual particularities.

The importance of placing greater emphasis on neuropsychological intervention for adolescents with ASD is also emphasized, even if they have previously received some form of intervention. This is due to the emergence of new needs driven both by their stage of development and by the evolving demands of their environment.

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