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BRIEF REPORT

Brief Report: Cognitive Performance in Autism and Asperger's Syndrome: What are the Differences?

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Abstract Autism spectrum disorders include autistic and Asperger's Syndrome (AS), often studied in terms of executive functions (EF), with controversial results. Using Planning Attention Simultaneous Successive theory (PASS; Das et al. in Assessment of cognitive processes: the PASS theory of intelligence. Allyn and Bacon, Boston, MA, 1994), this research compares the cognitive profiles obtained by the Cognitive Assessment System (CAS; Naglieri and Das in Cognitive assessment system. Riverside, Itasca, IL, 1997) of 15 subjects with typical development, 18 with autistic disorder and 20 with AS. Results highlight lower profiles for children with autistic and AS compared with typical development and even lower Planning and Attention processes for the group with autistic disorders than that with Asperger's. Subjects with Asperger's diagnosis do not differ from those with typical development as regards Simultaneous and Successive processes. Results are discussed in the light of current studies about EF.

Keywords Autism spectrum disorders · Executive functions · Cognitive processes · PASS theory · Cognitive Assessment System

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Cognitive Performance in Autism and Asperger's Syndrome

Pervasive developmental disorders are a diagnostic class of DSM IV-TR (American Psychiatric Association [APA] 2000) that comprises different disorders including autism spectrum disorders (ASD). This term is applied to autistic disorder, and Asperger's Syndrome (AS), as well as to pervasive developmental disorders not otherwise specified. AS differs from autistic disorder because of the absence of cognitive and language delay and of its onset before the age of three (McPartland et al. 2012). Recently, the DSM-V (APA 2012) suggested changing the criteria of classification of these disorders, cancelling their differentiation and classifying them as autism spectrum disorder, characterized by impairment of communication and social interaction. This proposal has opened scientific debate about the usefulness of these criteria and some authors (Frazier et al. 2012; Mandy et al. 2012) have underlined their sensitivity. Other authors (McPartland et al. 2012; Worley and Matson 2012) have instead suggested that the proposed changes alter the diagnostic construct of ASD, by focusing on criteria previously used only for autistic disorder: the absence of differential diagnostic subtypes and the presence of more stringent criteria may be a problem for those who, according to the DSM IV-TR (APA, 2000), could be classified as children with AS. According to Kupfer and Regier (2011) the proposal for a single category of autism spectrum disorder results from data suggesting that the entire spectrum share a pathophysiological substrate and this classification is not expected to modify the prevalence rate but to make more clear the diagnosis (Kupfer et al. 2013). Starting from this similar substrate, the comprehension of the differences in the specific functioning and impairments of children with autistic or AS seems to be relevant (Rinehart et al. 2002), most of all for most useful intervention programs. As highlighted by Kaland et al. (2008), an extensive body of research has focused on the characteristic impairment of ASD, studying the executive functions involved, with important and promising involvement of neuropsychological and neuroimaging aspects (Sanders et al. 2008).

The term *executive functions* (EF) is an umbrella term (Chan et al. 2008; Elliott 2003) that describes the many abilities and functions necessary for adequate problem-solving of a future goal (Jurado and Rosselli 2007; Ozonoff et al. 1991): Denckla (1996), using a neuropsychological perspective, underlined the future tense as the distinctive characteristic of EF constructs. These abilities are cognitive flexibility, inhibition, impulse control and planning (Hill 2004; Joseph and Tager-Flusburg 2004). As highlighted by Elliott (2003), the key concept behind EF is not very clear but it is possible to summarize it as the result of the coordinated operation of different processes required to attain a goal in a flexible way (Fontaine and Nolin 2012; Funahashi 2001). These processes refer to planning and executive aspects of attention (Denckla 1996) so that EF may be defined as higher-order cognitive functions that enable us to formulate goals and plans, to choose and initiate actions, to monitor and change behaviors (Aron 2008). These aspects imply the decisive role of frontal-subcortical circuits (Denckla 1996). Looking at these definitions, we can see the important role played by Luria's studies (Chan et al. 2008): in fact, as highlighted by Zelazo and Frye (1998), research into the development of EF derives from the theoretical and empirical works of Luria (1966, 1973), who studying the frontal lobes syndrome, highlighted their role in cognitive and behavioral control (Suchy 2009). As underline by Purdy (2011), contribution of Luria is the first theory about EF.

In Luria's theory (1966, 1973) cognitive functioning is guaranteed by the presence, in the human brain, of three basic functional units. The first unit is responsible for the arousal of the cortex and it is associated with the brain stem, diencephalon, and medial regions of the hemispheres. The second is responsible for processing information and it is associated with parietal, temporal and occipital lobes posterior to the central sulcus. The third unit is responsible for the planning of behavior and its monitoring and change; it is regulated by the frontal lobes. The Planning, Attention, Simultaneous, Successive (PASS) theory of intelligence, proposed by Das et al. (1994), identified four cognitive processes located in these three functional units. The first process, Planning, is defined as the subject's ability to make, monitor and change a plan, and it is located in the third unit. The second process, Attention, is the ability to focus the cognitive activity on specific stimuli, inhibiting response to competitive stimuli, and it is located in the first unit. Simultaneous describes the ability to understand relationships between things that constitute a whole and Successive describes the ability to work with information in a specific order. These last two are located in the second unit. These processes could be evaluated with the Cognitive Assessment System (CAS; Naglieri and Das 1997), an instrument that seems to offer a reliable (Sparrow and Davis 2000) and culture-free (Kroesbergen et al. 2010; Naglieri et al. 2013) measure of cognitive functioning and is reputed to be an instrument useful for measuring EF in children and adolescents (Chan et al. 2008). The CAS allows us to obtain a cognitive profile of a subject and to analyze the presence of strengths and weaknesses in the four processes, relative and cognitive too. In the CAS, a relative strength is a high score in a process relative to other processes, and a relative weakness is a low score in a process relative to other processes. When a relative strength exceeds a score of 110 it can be defined as a cognitive strength, whereas a relative weakness that scores under 90 is a cognitive weakness.

The application of CAS in clinical and educational contexts has provided useful suggestions for understanding clinical disorders. Interesting data concern Attention Deficit/Hyperactivity Disorder (AD/HD; Goldstein and Naglieri 2008; Naglieri et al. 2004; Kroesbergen et al. 2003), learning disabilities (Keat and Ismail 2011; Taddei et al. 2009), and other developmental disorders (Kroeger et al. 2001) and stimulating ideas concern the design of remedial programs (Hayward et al. 2007; Naglieri et al. 2010; Naglieri and Johnson 2000). For example, some authors (Kroesbergen et al. 2003) have underlined weaknesses in Planning and Attention in the profile of children with AD/HD and in children with learning disabilities there is evident weakness in the Successive process (Joseph et al. 2003; Kroesbergen et al. 2003; Taddei et al. 2011). Although several studies about cognitive functioning in terms of PASS theory have provided important suggestions for the comprehension of different developmental disorders, the application of this theory and its facilitation of the comprehension of autistic and AS appear not to be as widespread. Recently, Taddei et al. (2012), comparing two small groups, one composed of subjects with AD/HD and one comprising subjects with AS, presented the first explorative results which suggest that subjects with AS are characterized by a cognitive profile with lower functioning in terms of attention, suggesting the possibility of identifying a specific cognitive profile for this diagnosis.

Several studies interested in the EF implicit in ASD have, in fact, suggested that children with autistic disorder have significant difficulty in global information processing, showing instead a good performance in local information processing Happé and Frith (2006). This particular style could explain the good performance of these children in memory tasks of exact sounds (Heaton 2003) and visual search (O'Riordan et al. 2001). Coldren and Halloran (2003), who studied children with ASD, underlined that monitoring of response, which refers to the ability to evaluate, monitor and adjust one's own behavior according to specific goals (Robinson et al. 2009; Thakkar et al. 2008), appears particularly weak, and Katagiri et al. (2012) identified a problem with the inhibitory mechanism that results in difficulties in switching from local to global stimuli. Some executive dysfunctions can explain the everyday problems of children with ASD, for example the weakness in cognitive flexibility can explain repetitive behaviors and limited interests (Geurts et al. 2009), but Christ et al. (2007) suggest that the role of impairment in other EF, as inhibitory control, remains unclear. Specifically referring to AS, some studies have underlined a particular cognitive functioning of these subjects, characterized by a lesser performance in tasks that involved focused or sustained attention and an impairment in cognitive flexibility (Kaland et al. 2008). Instead other researchers (Hayashi et al. 2008), have underlined that children with AS have better fluid reasoning abilities even than children with typical development and better visual attention than children with an autistic disorder (Kleinhans et al. 2013). Consistently with what has been shown by some authors (McCrimmon et al. 2012; Van Eylen et al. 2011), results of different studies are not homogeneous, perhaps because of a difference between the instruments used, theoretical frames, definitions and research methodologies; as noted by Bauman and Kemper (2005) many different theories to explain autistic disorder have been proposed but delineation of the areas and processes of the brain involved is a topic of much debate. Therefore, it is evident that, for better comprehension of EF in a clinical setting, it is necessary to use a clear theoretical frame and a coherent research methodology. From this perspective, whereas the study of EF has its origin in Luria's work (Zelazo and Frye 1998), the PASS theory, inspired by the latter, could constitute a clear theoretical frame that is able to provide an adequate research methodology and consequently to evaluate and differentiate ASD. As pointed out above, different kinds of EF seem to be involved in ASD and a different PASS cognitive profile could be assumed. In particular, it is possible to hypothesize that:

1. Since subjects with ASD show executive dysfunction (Geurts et al. 2009; Kaland et al. 2008) they should also show a failure in cognitive processes and so their PASS scores at CAS should be lower than those of subjects with typical development.
2. Since subjects with AS differ from those with autistic disorder in terms of cognitive performance (DSM IV-TR, APA, 2000) their cognitive profiles should indicate this difference. Therefore, the PASS scores at CAS should be better in subjects with AS than in those with autistic disorder, particularly in the areas of Planning and Attention, which, in the light of Denckla (1996), could be the processes more implicit in executive functioning.

Therefore, the present study intends to explore the cognitive functioning of subjects with autistic and AS in terms of PASS processes, highlighting the contribution of this evaluation to the comprehension of executive functioning in these subjects. The specific aims of this study are to compare the cognitive functioning of subjects with AS, autistic disorder and typical development, highlighting the differences between these groups to provide a contribution to the comprehension of the cognitive and executive dysfunction implicit in this diagnostic area.

Methods

Participants and Selection Methods

We collaborate with local units of childhood and adolescence neuropsychiatry related to the National Health System and located in north-central Italy in order to supervise the use of CAS in the clinical evaluation of children. For this reason we collect the data about the CAS of children with a diagnosis made by NHS. After informed consent is given by parents, children are assessed by psychologists trained by us to the use of CAS. All information about assessed children is entered in a dataset. The dataset contains personal information, scores for all evaluations, and the diagnostic codes. All information is anonymized to protect the evaluated children. From these recording data we selected the cases for this study, using as inclusion criteria the presence of a diagnosis of autistic disorder (DSM IV-TR code 299.00 and International Classification Disease-10 [ICD-10; WHO, 2008] code F 84.0) or AS (DSM IV-TR code 299.80 and ICD-10 code F 84.5). Only subjects without comorbidities and with the CAS evaluation performed no more than 12 months earlier were selected.

The total data selected covered 53 subjects, aged from 7 to 17, undergoing treatment at national health services. Eighteen of these fulfilled the diagnostic criteria of autistic disorder (F 84.0) and 20 satisfied the criteria for AS (F 84.5), according to DSM IV-TR (APA 2000). In schools of the same geographical area we enrolled 15 voluntary subjects without physical or mental diseases, similar to the other groups regarding age and gender, who constituted the group with typical development. As shown in Table 1, groups did not differ in a statistically significant way for age ($F = 0.62$; $p = .540$) or gender ($V = 0.22$; $p = .260$).

Table 1 Description of groups by gender and age: frequencies, mean and SD

	Gender		N	Age
	Male	Female		Mean (SD)
Typical development group	10	5	15	12.00 (2.85)
Autistic disorder (F 84.0)	16	2	18	13.17 (3.47)
AS (F 84.5)	14	6	20	12.95 (3.03)
Total (N)	40	13	53	12.75 (3.12)

Instruments

Records were selected from the database containing personal and clinical information such as gender, age, diagnosis, DSM code and ICD-10 code. All subjects had a CAS evaluation. CAS (Naglieri and Das 1997) is composed of four process scales, Planning (P), Simultaneous (Si), Attention (A) and Successive (Su), and one complete scale (CS). In Table 2 are reported all subtests and examples of items. It offers a measure of general cognitive functioning and a specific cognitive profile that consider all four processes.

Statistical Analysis

The CAS scores were standardized using the test norms and cognitive profiles calculated. All data were subjected to descriptive analyses and the differences in the cognitive profiles between clinical groups evaluated. In particular, because the data of CAS violate the assumption of normality and homogeneity of variance, we used a non-parametric test to compare the mean profile of the three groups, the Kruskall–Wallis test for independent samples, and Dunnett's post-hoc comparison.

Results

Descriptive analyses highlighted the different mean cognitive profiles for the three groups (Fig. 1). As regards the first group, typical development, these children showed a mean score at Complete Scale, Planning, Simultaneous, Attention and Successive between 90 and 109, in the average category, as shown in Table 3. This profile is in line with that of the normative Italian sample that presents values near 100 (SD = 15) in all scales (Taddei and Naglieri 2005).

Children with autistic disorder showed the lowest profile: mean score at Complete Scale, Planning, Simultaneous, Attention and at Successive were far below average, being less than 69 (Table 3).

Subjects with AS showed a lower mean profile than children with typical development but a higher profile than

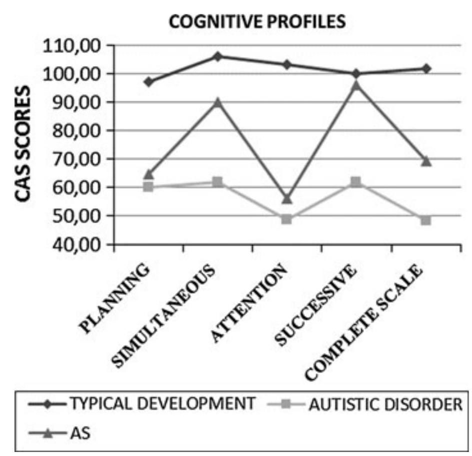

Fig. 1 PASS cognitive profiles of children with typical development, and autistic and AS

Table 2 Description of Cognitive Assessment System (CAS)

Scale	Planning	Attention	Simultaneous	Successive
Subtest	Matching numbers	Expressive attention	Nonverbal matrices	Words series
	Planned codes	Numbers detection	Verbal-spatial relations	Sentence repetition
	Planned connections	Receptive attention	Figure memory	Speech rate or sentence questions
Example	The examiner gives to the subject a page with letters arranged in seven rows and eight columns. In the top of the page, every letter is coupled with a code. Children have to complete the entire page of codes choosing the most efficient strategy	The examiner shows a page with names of colors writing with different colors of ink. The subjects have to say the colour of ink and not read the color (a variant of Stroop effect). If the subject see "RED" written with green ink, has to say "GREEN"	The examiner shows to the subject a page with six illustrations and a printed question referred to the spatial relations between objects illustrated are presented to the subject. "Show me the triangle to the left of the circle" the subject has to choose the correct answer, indicating one of the six drawings	The examiner reads a series of words. "Book-Car-Dog" the subjects has to repeat the words in the same order

Scales, subtests and examples of items

Table 3 CAS scores of subjects involved in the study: mean and SD

	M (SD)		
	Typical development	Autistic disorder	AS
Planning	97.27 (8.44)	60.17 (17.95)	64.85 (16.58)
Simultaneous	106.27 (14.74)	61.94 (19.71)	90.25 (16.55)
Attention	103.40 (10.06)	48.61 (13.03)	56.20 (13.76)
Successive	100.13 (10.34)	61.83 (22.10)	96.10 (13.85)
Complete scale	101.73 (11.27)	48.50 (19.05)	69.40 (12.23)

Table 4 Differences in cognitive processes between the three groups: Dunnett's post-hoc comparisons

Dependent variable	Group	Group	Mean difference	*p*
Planning	Typical development	AS	**32.42**	.000
		Autism	**37.10**	.000
	Autism	AS	–4.68	.788
Simultaneous	Typical development	AS	16.02	.028
		Autism	**44.32**	.000
	Autism	AS	**–28.31**	.000
Attention	Typical development	AS	**47.20**	.000
		Autism	**54.79**	.000
	Autism	AS	–7.59	.244
Successive	Typical development	AS	4.03	.853
		Autism	**38.30**	.000
	Autism	AS	**–34.27**	.000
Complete scale	Typical development	AS	**32.33**	.000
		Autism	**53.23**	.000
	Autism	AS	**–20.90**	.001

Statistically significant differences are in boldface

those with autistic disorder. In particular, at Complete Scale, Planning and Attention the mean scores were far below the average, but the scores at Simultaneous and Successive were in the mid-range (Table 3).

As shown in Table 4, the groups differed in a statistically significant way; particularly, typical developmental subjects showed higher scores in Planning, Attention and Complete Scale than subjects with Asperger's diagnosis and in all scales than those with autism. Subjects with autism showed lower scores for Simultaneous, Successive and Complete Scale than those with AS.

Discussion

The data highlight some relevant aspects about the cognitive functioning of ASD. As hypothesized, subjects with autistic or AS showed lower cognitive functioning than subjects with typical development, but interesting differences are detectable.

Compared with subjects with typical development, those with AS differed, in a statistically significant way, only in Planning and Attention processes. Children with AS showed higher scores than those with autistic disorder, not only in general cognitive functioning but also in Successive and Simultaneous processes. Simultaneous and Successive processes of these subjects are similar to those with typical development, providing a possible explanation for some areas of good performance such as visual search (O'Riordan et al. 2001) and memory of exact position of a sound in the complete range of sound (Heaton 2003). In particular, the good level of the Simultaneous process could explain these children's fluid reasoning ability, as underlined by Hayashi et al. (2008). Simultaneous processing is, as mentioned above, responsible for comprehension of relations and so involves the capability to recognize specific patterns in more complex schemas and understand verbal-spatial relations correctly. The fact that this process operates better in children with AS than those with autistic disorder suggests a clinical consideration about the difference in processing information of these two groups and suggests the possibility to use different remedial programs.

Similarities between children with autistic and AS have implications. Planning appears particularly weak, consistently with what has been shown by Coldren and Halloran (2003), in both children with autistic and AS, but the cognitive weakness with the lowest score is identifiable in Attention, consistently with the inhibitory problem evidenced by Katagiri et al. (2012) that is more evident in subjects with autistic disorder, in line with Kleinhans et al. (2013). The weakness in Attention could explain the low cognitive flexibility which was observed by Kaland et al. (2008); poor ability to focus the cognitive activity on specific stimuli and inhibiting response to competitive stimuli could explain the difficulty in switching from local to global stimuli that clarify repetitive behaviors and stereotypic interests (Geurts et al. 2009). As hypothesized, CAS cognitive profiles are different for the three groups and seem to differentiate, in the complex context of ASD, children with autistic disorders from those with AS. From a PASS theory perspective, cognitive processes are the neuropsychological foundation of all cognitive activities and finalized behaviors and they are even useful for explaining executive functioning (Zelazo and Frye 1998). These initial results are discussed only from an explorative point of view because of the small size of the sample and the lack of evaluations carried out by concurrent instruments, but they suggest relevant aspects that could be further developed. The PASS theory could be a coherent theoretical and methodological frame for the evaluation of cognitive functioning and its contribution to the better comprehension of clinical differences in ASD could be relevant in terms of confirming the relation between cognitive functioning evaluation and EF. The role of Planning and Attention seems to be crucial not only in differentiating between ASD but also in explaining the behavioral aspects of these disorders and that these two processes could be relevant to the neuropsychological bases of EF involved in ASD with regard to the involvement of specific brain regions and processes (Volkmar and Pauls 2003). Understanding the cognitive functioning of subjects with AS compared with those with autistic disorders could suggest a useful way to adopt specific methods of intervention, as done for other disorders such as AD/HD (Kroesbergen et al. 2003) and learning disabilities (American Psychiatric Association 2000). The understanding of cognitive functioning may constitute an essential aid to psychologists, not only in terms of assessment but also and especially in terms of PASS-oriented intervention programs able to operate on the specific weakness of subjects with autistic or AS.

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