DEVELOPMENT PROFILES OF EXECUTIVE FUNCTIONS IN PRESCHOOL AGE: OBSERVATIONAL STUDY IN GENERALIZED DEVELOPMENT DISORDER

Flori Valeria[1], Lettieri Mariangela[2], Prandi Rebecca[3].

[1] *Terapista della neuro e psicomotricità dell'età evolutiva e Direttore dell'attività didattica del Corso di Studi in Tnpee dell'Università degli studi di Milano, sede IRCCS Eugenio Medea di Bosisio Parini (LC);*
[2] *Terapista della neuro e psicomotricità dell'età evolutiva, Associazione Tecnico Scientifica AITNE Associazione Italiana Terapisti della neuro e psicomotricità dell'età evolutiva;*
[3] *Terapista della neuro e psicomotricità dell'età evolutiva.*

KEYWORDS: Generalized Developmental Disorder, Executive functions, Neuro and developmental rehabilitation, Assessment, Preschool.

ABSTRACT

Executive functions (EF) play a fundamental role when it is necessary to implement behaviors aimed at achieving a goal; they are in fact widely studied and described in the literature, especially within neurodevelopment. Maturation of executive functions is described as a key component of typical as well as atypical development; their deficit is found in numerous neurodevelopmental and behavioral disorders. There are studies in literature that are interested in the impairment of executive functions in Autism and Generalized Developmental Disorders (DGS). These disorders include a spectrum of clinical pictures characterized by social impairments, communicative impairments, restricted interests and stereotyped behaviors (Valeri, 2006), (APA - Amerian Psychiatric Association, 2013). However, none of these studies concerns the Italian pre-school population nor does it use assessment tools born in the Italian context; the studies in question also find confirmation above all in research conducted on adolescent and adult patients, while studies conducted with pre-school children provide conflicting results (Griffith, et al., 1999). Both in relation to these contradictory results and to the highly adaptive role of this domain for socio□affective development, learning and quality of life, this study stands as a contribution to the research on executive function disorders on a sample of children with Generalized Developmental Disorder (DGS) in preschool age (3-6 years), with the aim of providing operational reflections for the best practice for functional assessment in the presence of this disorder, adding useful knowledge to Developmental Neuro and Psychomotor Therapist when drafting his own rehabilitation program. To meet the identified objectives, a sample with a diagnosis of Generalized Developmental Disorder (11 subjects) and a control sample, which did not present any neurodevelopmental disorder (39 subjects), were selected. The evaluation tool used is the Battery for the evaluation of executive functions in preschool age (FE-PS 2-6; Usai et al. 2017), intentionally selected among the tools developed in the Italian context and specific for the preschool age. The test results, taken from the Battery reference manual, were subjected to statistical analysis and subsequently to qualitative analysis, aimed at detecting further aspects of interest on the evolutionary profiles. 2 The research results show a difference in the average performance of the subjects belonging to the DGS group, which appear to be globally lower than those of the subjects belonging to the control group. Particular difficulties are found in all inhibition processes and are above all the characteristics of impulsivity and the management of interference. The greatest difficulty in children behavior therefore appears to be present in their ability to initiate a response and to inhibit actions in the service of general goals to be achieved. This difficulty appears as a dysfunctional characteristic in all the age groups covered by our study, as a constant characteristic at all ages to be considered as a maladaptive functional profile.

INTRODUCTION

Executive functions (EF) are a multidimensional construct, which refers to a series of cognitive domains and neuropsychological processes, strongly interrelated, which are recruited when it is necessary to implement behaviors aimed at achieving a purpose as a system of control and management of our behaviors at physical, cognitive and emotional level (Marimpietri et al, 2012). Their role, within the neurodevelopmental development, is widely described in the literature; they are related to formal learning skills, in the logical-mathematical area (Blair & Razza, 2007) and to understanding skills (Johann et al, 2020), but also with socio-emotional and socio-relational development (Hughes & Dunn, 1997) and with mental and physical health (Hall et al, 2010; Miller et al, 2011; Will Crescioni et al, 2011). The maturation of executive functions is described as a key component of typical development but also of atypical one; their deficits are found in numerous neurodevelopmental and behavioral disorders, often comorbid one with each other, such as Attention Deficit and Hyperactivity Disorder, Specific Learning

Disorders and Oppositional Defiant Disorder (Conte & Marzocchi, 2020). There are also many studies in literature that describe impaired executive functions in Autism Spectrum Disorders and in similar conditions such as generalized developmental disorders, which are different clinical situations including a spectrum of clinical features characterized by social impairments, communication impairments, restricted interests and stereotyped behaviors (APA, 2014; Valeri, 2006). Starting from the pioneering works of Damasio and Maurer (1978), it was highlighted how the characteristics of autism are similar to those found in patients with frontal lesions (Ozonoff, 1995; Turner, 1998). Numerous subsequent researches have then confirmed the existence of deficits in executive functions in these patients. Deficits in executive functions have been considered a valid theoretical explanation of autistic symptoms especially for repetitive behaviors and narrow interests but also for deficits in the theory of mind and in shared attention and in social and linguistic impairments (Ciesielski & Harris, 1997; Ozonoff & McEvoy, 1994; Ozonoff et al, 1991; Rumsey, 1985; Rumsey & Hamburger, 1988; Turner, 1998; Valeri, 2006) . However, the empirical evidence and theoretical coherence are not sufficient to demonstrate that deficits in EF are the primary and specific "cause" of autism (Valeri, 2006) and we require further researchs expecially focused to preschool children and to actually conflicting results (Griffith et al, 1999). 3 EF have an important adaptive role for socio-affective development, for learning and for the general quality of life, so they are a possible target and also a tool for the rehabilitative intervention of neurodevelopmental disorders, typical of the Developmental Neuro and Psychomotor Therapist (DNPT); so this study is intended as a contribution to the research about executive function disorders in subjects presenting a generalized developmental disorder, with the ultimate aim to individuate tools and methods to define a profile of cognitive functional development and the adaptive behavior of the young patient, because this is essential for starting his individualized rehabilitation program (Arduino, 2010).

OBJECTIVES OF THE STUDY

The following research aims to analyze executive functions on a sample of children with a generalized developmental disorder (DGS) in preschool age (3-6 years), with the aim of providing operational reflections for the best practice for functional assessment in the presence of this disorders, adding useful knowledge to the neuro and developmental therapists during the drafting of their own rehabilitation program.

METHODOLOGY

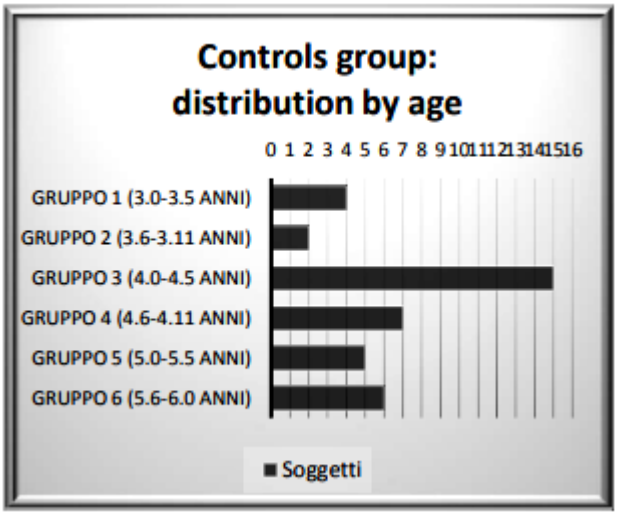
Selection of the sample

At the end of the informed consent procedures, the overall sample of subjects who took part in the research was made up of 11 subjects with Generalized Developmental Disorder (DGS group) and 39 subjects representing the control group. The descriptive characteristics of the sample are shown in Table 1.

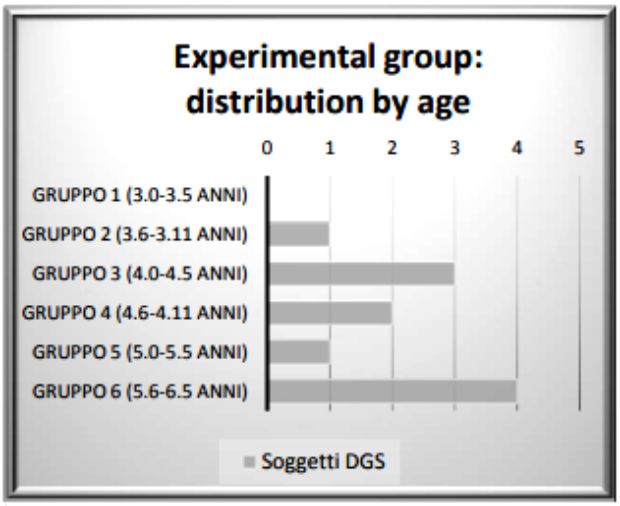
GROUP		N	Minimum age (years.months)	Maximum age (years.months)	Media età (years.months)	Standard deviation (years.month)
Controls	Cronological age	39	3.1	6.0	4.5	0.9
DGS	Cronological age	11	3.6	6.9	4.11	0.11

Table 1: *Descriptive characteristics of the sample*

The 39 subjects included in the control sample have a chronological age between 3 years and 1 month and 6 years, with an average age of 4 years and 5 months. The subjects included in the DGS group have a chronological age between 3 years and 6 months and 6 years and 9 months, with an average age of 4 years and 11 months. The distribution by age in the two groups are not homogeneous by age, this is reported in graphs 1 (control group) and 2 (experimental group).



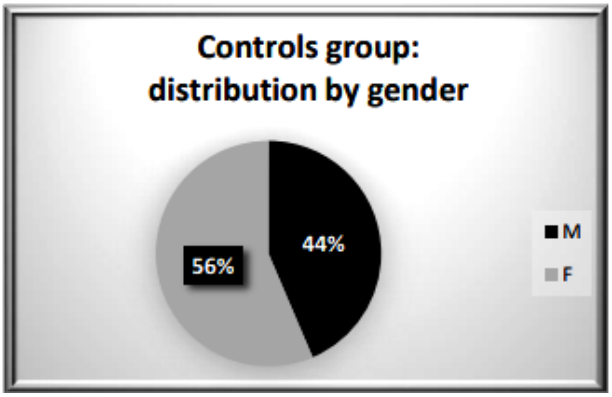
Graph 1: *Distribution by age – control group*



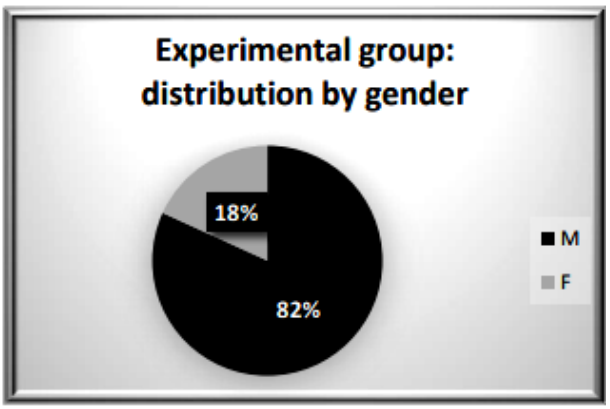
Graph 2: *Distribution by age - DGS group*

In the control group (see Graph 1) there is a prevalence of subjects aged between 4 and 4.5 years, while in the experimental group there is a prevalence of subjects aged between 5.6 and 6.5 years, while younger subjects are absent (range 3.0-3.5). The

distribution by gender in the two groups is also non homogeneous (see Graph 3 and 4); there is a slight prevalence of females in the control sample (see Figure 3) and a clear prevalence of males in the DGS group (see Graph 4), in continuity with the distribution of this disorder in the general population.



Graph 3: *Distribution by gender – controls group*



Graph 4: *Distribution by gender – DGS group*

All selected subjects, who met the study inclusion criteria (n = 39), were subjected to evaluation of their executive profile.

Evaluation tools

To meet the identified objectives, the evaluation tools used in this research were chosen in the Italian context among those specific for the preschool age, our choice was oriented towards the Battery for the evaluation of executive functions in preschool aged (FE-PS 2-6), realized by Usai et al. (2017). FE-PS 2 -6 represents a tool of recent interest in literature, used in the evaluation of the executive system through a series of tests that map the complex dimension and the multi-component activation of this system, describing the development of executive functions during the preschool age (Usai et al, 2017). The Battery is made up of 10 performance tests: 5 of them investigate the inhibition capacity, 2 tests analyze the ability to postpone gratification and 3 tests map the constructs of inhibition, working memory and cognitive flexibility, working simultaneously during a task.

Inhibition tests

I. TRACE A CIRCLE - CONTINUOUS MOTOR RESPONSE INHIBITION TEST

The child have to follow, with his finger, a drawn circle, performing the movement as slowly as possible. He has to do a training test before starting the task. The ability to regulate a motor act requires executive control, expecially the inhibitory type that in preschool age progressively becomes distinguishable from cognitive control. The slowdown time between two consecutive tests is calculated, the first time is the assessment (pursuit) and the second time is the test (slow tracking).

II. STROOP DAY AND NIGHT - VERBAL RESPONSE INHIBITION TEST

The test involves the use of cards with symbols referable to the day and the night. There is a phase of approach and recognition of the images and a second phase of stroop in which the child must pronounce the word "day" at the presentation of the card with the moon and the word "night" in response to the card depicting the sun. The task investigates inhibitory capacity (dominant verbal response inhibition). Accuracy and response time are calculated.

III. THE ELEPHANT AND THE BEAR - MOTOR INHIBITION TEST

The child has to perform some motor actions directed at himself, responding to two puppets, a "bad" bear and a "good" elephant which are moved by the examiner. It is required to carry out only the actions proposed by the elephant (motor response inhibition). The task requires inhibiting or activating a motor response following a rule (Go / No-Go task). The accuracy of the responses is calculated.

IV. COMPARE THE FIGURES - IMPULSIVE RESPONSE AND WORKING MEMORY INHIBITION TEST.

The test involves a visual research activity, the child has to identify a target figure within some distractors. The task investigates the ability to inhibit an impulse response and requires tapping into working memory to maintain target representation while exploring distractors. The number of errors and the average response time are calculated.

V. THE FISH GAME - COMPUTERIZED TEST OF INTERFERENCE MANAGEMENT.

The test requires to indicate the orientation of a fish target placed in the presence of interfering stimuli, in a congruent or incongruent condition. The task investigates the ability to inhibit and manage visual and attentional interference. Accuracy is calculated.

Tests of postponement of gratification

VI. WRAP THE PACKAGE

The child is promised a gift with a request to wait, without looking, while the examiner is busy wrap-

ping it. The task investigates the ability to wait for gratification, to obtain a reward in the presence of a strong motivational impulse. The number of errors (all violations) and the waiting time are calculated.

Complex tests

VIII. THE GAME OF COLOR AND SHAPE - TEST OF INHIBITION AND WORKING MEMORY

The child is asked to classify a series of figured cards, according to three different criteria. The researcher give a feedback to the child about the changing of the criteria. It is a complex task that map the ability to inhibit, the flexibility and the working memory. The accuracy of the responses is calculated.

IX. KEEP IN MIND - WORKING MEMORY UPDATE TASK

The child is invited to name a few series of images and at the end of each to remember the last figure belonging to a specific category. The task investigates the ability to update information in working memory. Accuracy is calculated.

X. FLOWER AND STAR PLAY - COMPUTER TEST OF INHIBITION, WORKING MEMORY AND EMERGING FLEXIBILITY.

This is a computer task; two different stimuli are shown on the computer (a flower and a star); the child has to respond to them following different rules: with the star the child has to push on the same side of the desktop, with the flower he has to push on the other side. The task evaluates the ability to inhibit or activate a specific motor response, also in terms of flexibility, and working memory. Accuracy and average response time are calculated.

Evaluation method

The tests were administered following the indications of the reference manual: presentation of the tasks, subsequent correction and interpretation of the results. The subjects of the control group were evaluated within their own kindergarten, individually and in a designated space suitable for the purpose. The subjects belonging to the experimental group were evaluated within their rehabilitation setting at the presence of their therapists.

Statistical analysis

The test results were subjected to statistical analysis. Descriptive statistics (mean and standard deviation) and the Parametric statistical test t were applied to evaluate significant differences in the comparison between the expected means for age. The raw scores obtained in the different tests by the groups were considered as dependent variables. The significance values were set with

RESULTS

Statistical analyzes were conducted on 50 subjects, 39 with typical development (control group) and 11 with generalized developmental disorder (DGS group), aged between 3 years and 1 month and 6 years and 9 months. Table 2 shows the means and standard deviations related to the FE-PS battery test scores obtained in subjects belonging to the control group. The results are organized by function involved: inhibition, postponement of gratification, complex tests. For the purpose of understanding the cognitive task required of children, the details of the tests performed are reported in the table 2.

Table 3 shows the means and standard deviations related to the scores of the FE-PS battery tests obtained in the subjects belonging to the experimental group (DGS group). The results are organized by function involved: inhibition, postponement of gratification, complex tests.

The data present wide dispersions of the results, evident in the SD values, which occur in both of the groups and in almost all evidence. However, there is also a difference in the average performance of the subjects belonging to the DGS group, which appear to be overall lower than that of the subjects belonging to the control group in all of the tasks. The comparison of the means between the two groups matched by chronological age was then subjected to statistical analysis, to highlight the levels of significance of the differences. 10 The results are presented organized in tables that report the analyzes carried out considering the age group and the type of construct investigated. Each table reports the value of the means and standard deviations of the scores obtained in the tests, together with the values of significance with respect to the expected values (p value fixed for $P<0,05$).

The presentation of the results is organized into two age groups, in relation to the subjects who participated in this study: Table 4 reports the results of the age group between 4 years and 4 years and 11 months (Results 1), and Table 5 reports the results of the age group between 5 years and 6 years and 9 months (Results 2).

Results 1: Comparison of DGS-Controls by age group 4.0-4.11 years Table 4 reports the comparison between the means of the scores obtained in each test of the FE-PS battery by both groups considered (control group and DGS group) for children aged from 4.0 years old to 4.11 years old. The significance value of the comparison between means is fixed for $P<0,05$ The values that reach statistical significance are highlighted by the presence of a star.

Graph 5 reports the means of the control group at all the tests while Graph 6 report the means of the DGS group for children belongin to the age group 4.0-4.11.

GROUP		TEST	N	Minimum	Maximum	Average	Standard deviation
CONTROLS	INHIBITION	Trace a circle - continuous motor response inhibition test	39	0,04	0,62	0,36	0,16
		Stroop day and night - test of inhibition of the verbal response	39	-1	10	1,59	2,72
		Stroop day and night (total control time) – inhibition of verbal response	39	26,87	71,1	39,14	12,62
		Stroop day and night (total stroop time) – inhibition of verbal response	39	27,39	100,01	46,40	16,44
		The elephant and the bear - motor inhibition	39	5	10	9,23	1,63
		Compare the figures - ability to inhibit an impulsive response and working memory	39	0,81	31,4	7,01	6,68
		The fish game (correct answers) - computerized test of interference manage-	33	0	16	9,82	4,79
		The fish game (time) - computerized test of interference management	33	0,73	6,29	1,65	1,03
	POSTPONEMENT OF GRATIFICTION	Wrap the package (violations) – postponement of gratification	39	0	7	1	1,56
		Wrap the package (time) – postponement of gratification	39	9,18	60	47,31	18,10
		The gift - postponement of gratification	39	5,6	240	127,64	99,06
	COMPLEX TESTS	Color and shape - inhibition test and working memory	39	3	24	17,97	4,10
		Keep in mind - working memory update task	39	0	8,5	3,29	2,16
		Flower and star play (correct answers) - simultaneous activation of inhibition and working memory,	39	7	20	12,58	3,92
		Flower and star play (time) - simultaneous activation of inhibition and working memory, emerging flexibility	39	0,32	3,1	1,58	0,70

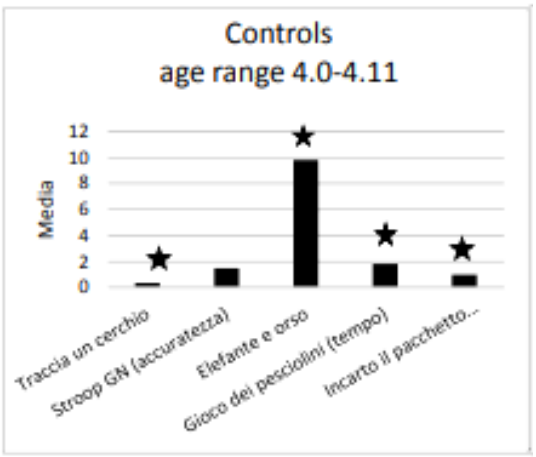
Table 2: *means and standard deviations for each test of the FE-PS battery, in the Control group*

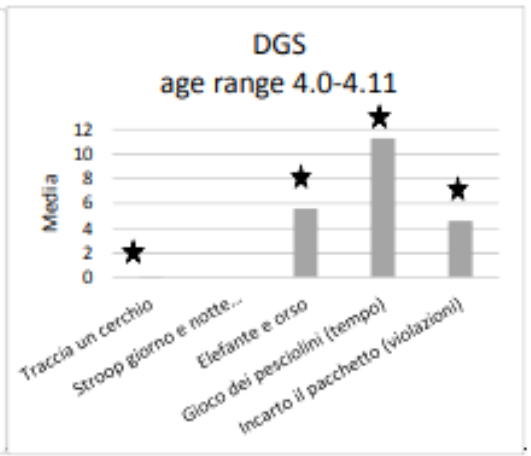
GROUP		TEST	N	Minimum	Maximum	Average	Standard deviation
DGS	INHIBITION	Trace a circle - continuous motor response inhibition test	11	-0,2	0,38	0,15	0,17
		Stroop day and night - test of inhibition of the verbal response	10	-5	5	0,4	3,41
		Stroop day and night (total control time) – inhibition of verbal response	10	29	234	133,44	74,14
		Stroop day and night (total stroop time) – inhibition of verbal response	10	36,6	240	116,162	76,71
		The elephant and the bear - motor inhibition	5	5	7	5,6	0,89
		Compare the figures - ability to inhibit an impulsive response and working memory	7	1,05	17,43	5,25	5,56
		The fish game (correct answers) - computerized test of interference management	10	4	12	9,5	2,37
		The fish game (time) - computerized test of interference management	10	3,05	28,97	10,38	7,30
	POSTPONEME NT OF GRATIFICTION	Wrap the package (violations) – postponement of gratification	10	1	10	4,4	3,17
		Wrap the package (time) – postponement of gratification	10	1	35	11,5	11,89
		The gift - postponement of gratification	10	0	106	32,53	40,06
	COMPLEX TESTS	Color and shape - inhibition test and working memory	11	3	19	10	6,84
		Keep in mind - working memory update task	4	3	4,5	3,5	0,71
		Flower and star play (correct answers) - simultaneous activation of inhibition and working memory, emerging flexibility	10	8	15	11	2,36
		Flower and star play (time) - simultaneous activation of inhibition and working memory, emerging flexibility	10	3,2	13,23	5,86	3,32

Table 3: *means and standard deviations for each test of the FE-PS battery, in the DGS group*

	FE-PS battery tests	GROUP	N	AVERAGE	STANDARD DEVIATION	Significance value
INHIBITION	Trace a circle - continuous motor response inhibition test	Controls	22	0,37	0,18	0,0069*
		DGS	5	0,11	0,19	
	Stroop day and night - test of inhibition of the verbal response	Controls	22	1,50	2,69	0,3527
		DGS	4	0,00	4,16	
	Stroop day and night (total control time) – inhibition of verbal response	Controls	22	39,70	13,07	0,0000*
		DGS	4	138,60	63,73	
	Stroop day and night (total stroop time) – inhibition of verbal response	Controls	22	45,45	17,75	0,0001*
		DGS	4	138,51	94,07	
	The elephant and the bear - motor inhibition	Controls	22	9,82	0,50	0,0000*
		DGS	5	5,60	0,89	
	Compare the figures - ability to inhibit an impulsive response and working memory	Controls	22	6,81	7,34	0,8446
		DGS	3	7,72	8,42	
	The fish game (correct answers) - computerized test of interference management	Controls	22	8,09	4,16	0,4378
		DGS	5	9,60	1,52	
	The fish game (time) - computerized test of interference management	Controls	20	1,84	1,24	0,0003*
		DGS	5	11,28	10,37	
POSTPONEMENT OF GRATIFICTION	Wrap the package (violations) – postponement of gratification	Controls	22	1,00	1,75	0,0029*
		DGS	5	4,60	3,78	
	Wrap the package (time) – postponement of gratification	Controls	22	48,35	18,08	0,0003*
		DGS	5	12,00	13,56	
	The gift - postponement of gratification	Controls	22	136,39	99,87	0,1547
		DGS	4	60,25	53,67	
COMPLEX TSTS	Color and shape - inhibition test and working memory	Controls	22	18,27	1,28	0,0000*
		DGS	5	8,2	6,1	
	Keep in mind - working memory update task	Controls	22	2,5	1,76	0,5611
		DGS	2	3,25	0,35	
	Flower and star play (correct answers) - simultaneous activation of inhibition and working memory, emerging flexibility	Controls	22	11,27	3,1	0,4815
		DGS	4	12	2,74	
	Flower and star play (time) - simultaneous activation of inhibition and working memory, emerging flexibility	Controls	22	1,51	0,73	0,0000*
		DGS	5	6,59	3,96	

Table 4: *Results 1: Comparison between controls and DGS performances matched by chronological age (4.0- 4.11 years)*





Graphs 5 e 6: *Comparison between subject means Controls and DGS to simple inhibition texts for the age range 4.0-4- 11 years .*

In particular, from the comparison between the DGS subjects and the controls, in the age group 4.0-4.11 it is possible to observe that the difference between means is significant in almost all the simple inhibition tests (see graphs 5 and 6). The difference is not significant for the verbal inhibition test alone (Stroop GN), in which however it is noted that the DGS group scores lower than the Control group.
Also the comparison between DGS and Controls in complex tests shows a significant difference between means in the test Keep a mind, a test that requires simultaneous activation of inhibition, working memory and flexibility (see graphs 7 and 8), even if the result is less relevant, as it was obtained from the scores of only two children, in fact it was not possible to administer proof due to lack of cooperation or the absence of the minimum requirements for understanding.

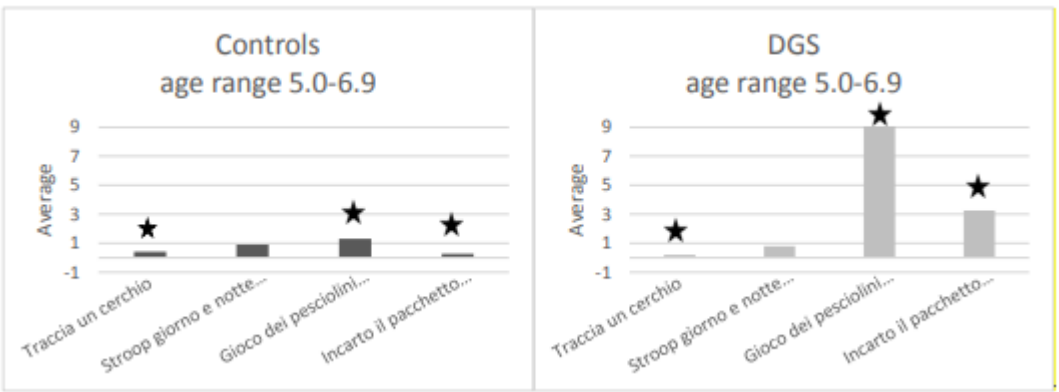
Results 2: Comparison DGS-Controls by age group 5.0-6.9 years

Table 5 reports the comparison between the means of the scores obtained in each test of the FE-PS battery by both groups considered (control group and DGS group) for children aged from 5.0 years old to 6.9 years old. The significance value of the comparison between means is fixed for P <0,05 The values that reach statistical significance are highlighted by the presence of a star.

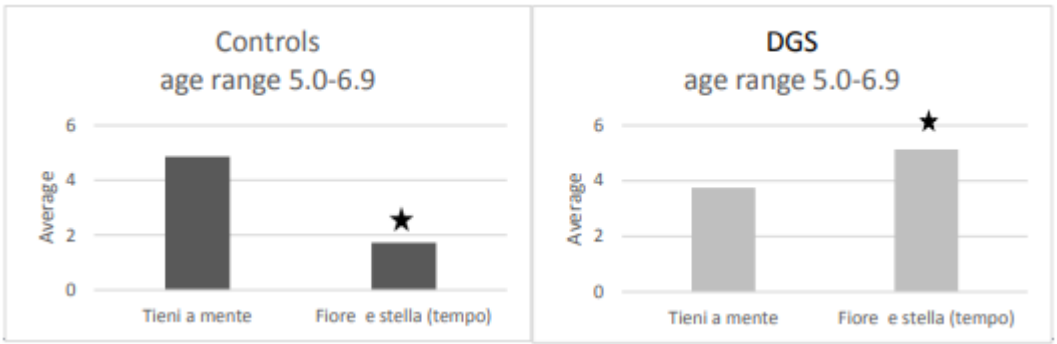
	FE-PS battery tests	GROUP	N	AVERAGE	STANDARD DEVIATION	Significance value
INHIBITION	Trace a circle - continuous motor response inhibition test	Controls	11	0,41	0,08	0,0045*
		DGS	5	0,20	0,18	
	Stroop day and night - test of inhibition of the verbal response	Controls	11	0,91	2,07	0,9388
		DGS	5	0,80	3,56	
	Stroop day and night (total control time) – inhibition of verbal response	Controls	11	30,06	3,67	0,0034*
		DGS	5	109,20	77,68	
	Stroop day and night (total stroop time) – inhibition of verbal response	Controls	11	37,98	7,54	0,0214*
		DGS	5	85,52	62,55	
	The elephant and the bear - motor inhibition	Controls	11	/	/	/
		DGS	0	/	/	
	Compare the figures - ability to inhibit an impulsive response and working memory	Controls	11	10,24	5,31	0,0285*
		DGS	4	3,4	1,99	
	The fish game (correct answers) - computerized test of interference management	Controls	11	13,27	4,15	0,0872
		DGS	5	9,40	3,21	
	The fish game (time) - computerized test of interference management	Controls	11	1,31	0,24	0,0000*
		DGS	5	9,48	3,22	
POST PONEMENT OF GRATIFICTION	Wrap the package (violations) – postponement of gratification	Controls	11	0,27	0,47	0,0006*
		DGS	4	3,25	2,22	
	Wrap the package (time) – postponement of gratification	Controls	11	54,97	9,11	0,0000*
		DGS	4	13,25	12,01	
	The gift - postponement of gratification	Controls	11	151,68	88,90	0,0037*
		DGS	5	10,66	9,18	
COMPLEX TSTS	Color and shape - inhibition test and working memory	Controls	11	20,36	3,2	0,0130*
		DGS	5	13,2	7,12	
	Keep in mind - working memory update task	Controls	11	4,86	2,07	0,4848
		DGS	2	3,75	1,06	
	Flower and star play (correct answers) - simultaneous activation of inhibition and working memory, emerging flexibility	Controls	11	15,18	4,21	0,0200*
		DGS	5	10	1,58	
	Flower and star play (time) - simultaneous activation of inhibition and working memory, emerging flexibility	Controls	11	1,73	0,64	0,0013*
		DGS	5	5,13	2,78	

Table 5: *Results 2: Comparison between controls and DGS performance mat ched by chronological age (5.0- 6.9 years)*

Also the comparison between DGS subjects and Controls in the age group 5.0-6.9 years confirms the same differences between averages already found in younger children (see graphs 9 and 10 and graphs 11 and 12).



Graphs 9 e 10: *Comparison between subject means Controls and DGS to simple inhibition texts for the age range 5.6- 6,9 years*



Graphs 11 and 12: *Comparison between subject means Controls and DGS to complex tests for the age range 5.6 - 6.9 years*

According to the aim of this research that is focused on trying to describe a type of prevalence of the disorder, a qualitative analysis was also conducted on the data of children with DGS, classifying the raw scores into performance levels, according to the indications provided by the reference manual of the FE-PS Battery. The FE-PS battery manual classifies the child's performance as pathological, at the lower limits of normal, sufficient or optimal, based on the percentile scores achieved and it identifies the 5th percentile as the clinical cut-off (threshold limit of the single tests). Therefore, it provides for a classification related to the specific investigation functions: pathological score when lower than the 5th percentile score at the lower limits normally when between the 5th and 25th percentile sufficient score when between the 25th percentile and the 75th percentile optimal score when higher than the 75th percentile The results of the children belonging to the DGS group, organized according to the chronological age (age 4.0-4.11; age 5.0-5.9) were analized considering the function investigated from the single test: motor and verbal inhibition tests (see table 6), behavioral inhibition tests (see Table 7) and complex tests (see Table 8). The results at the lower limits (percentile between the 5th and 25th percentile) are highlighted with an asterisk while the pathological ones (percentile lower than the 5th percentile) with two astherisks.

The qualitative analysis confirms the previously identified levels of attention by extending them to all inhibitory functions: - 40% of subjects are at risk of development (at the lower limits of the norm) in the verbal inhibition test (Stroop GN - accuracy) - 89% of the subjects are at risk of development or in a situation of outright pathology in the time scores of the same test - 60% of the subjects are at risk of development in the motor inhibition test (Elephant and bear) - 71% of the subjects are at risk of development or in a situation of frank pathology in the test of inhibition of impulsive behavior (Compare the figures) - 90% of the subjects obtain a performance configurable as pathological in the time score of the inhibition / interference management test (Fish game) - 50% of the subjects obtain a performance configurable as at risk of development in the score relative to the correct answers of the same test - respectively 56% and 78% of subjects report a

		FE-PS (motor and verbal inhibition tests)				
Group	Subject	Draw a circle	Stroop GN (accuracy)	Stroop GN (control time)	Stroop GN (stroop time)	Elefant and bear
DGS (4.0-4.11)	1	25°-75°	5°-25° *	<5° **	<5°**	5°-25° *
	2	25°-75°	>75°	<5°**	5°-25*	25°-75°
	3	25°-75°	-	-	-	5°-25° *
	4	5°-25° *	>75°	<5°**	<5° **	25°-75°
	5	25°-75°	>75°	<5°**	<5° **	5°-25° *
DGS (5.0-6.9)	6	5°-25° *	5°-25° *	<5°	<5° **	/
	7	25°-75°	5°-25°*	<5°	<5° **	/
	8	25°-75°	>75°	<5°	<5° **	/
	9	5°-25° *	5°-25°*	<5°	5°-25°*	/
	10	<5° **	25°-75°	25°-75°	25°-75°	/

Tabs 6: *Qualitative analysis of the results of the DGS group to motor and verbal inhibition tests*

		FE-PS (behavioral inhibition tests)					
Group	Subject	Compare the figures (time)	Fish game (correct answers)	Fish game (time)	Wrap the package (violations)	Wrap the package (time)	The gift
DGS (4.0-4.11)	1	/	25°-75°	<5° **	<5° **	5°-25° *	/
	2	5°-25°	5°-25° *	25°-75°	5°-25° *	5°-25°*	>75°
	3	/	5°-25° *	<5°**	<5° **	<5° **	<5° **
	4	>75°	5°-25° *	<5° **	25°-75°	25°-75°	>75°
	5	<5° **	25°-75°	<5° **	25°-75°	5°-25°*	>75°
DGS (5.0-6.9)	6	<5° **	25°-75°	<5° **	25°-75°	25°-75°	25°-75°
	7	/	5°-25°*	<5° **	5°-25° *	<5° **	25°-75°
	8	5°-25°	25°-75°	<5° **	5°-25° *	5°-25° *	5°-25°
	9	25°-75°	25°-75°	<5°**	25°-75°	5°-25°*	5°-25°*
	10	5°-25°	5°-25° *	<5° **	-	-	25°-75°

Tabs 7: *Qualitative analysis of the results of the DGS group in the behavioral inhibition tests*

result that can be configured as at risk of development or as pathological in the tests of inhibition of impulsive behavior (I wrap the package violations and time). - 33% of the subjects report a score that can be configured as at risk of development on the test of inhibition of impulsive behavior and postponement of gratification (The gift).
The qualitative analysis confirms the levels of attention identified for simple inhibitory functions also for complex functions: - 70% of subjects obtain a performance that can be configured as at risk of development (at the lower limits of the norm) or in a situation of frank pathology in the play of color and of the form, complex test of inhibition, working memory and cognitive flexibility - 50% of subjects obtain a performance configurable as at risk of development in the game of the flower and the star, complex test that involves the simultaneous activation of inhibition and memory of work; in particular, from the time score of the same test, 80% of the subjects obtain a performance that can be configured as pathological, while the remaining 20% obtains a performance that can be configured as at risk of development.

		FE-PS (Complex tests)			
Gro up	Subject	Color and shape	Keep in mind	Flower and star (correct answers)	Flower and star (time)
DGS(4.04.11)	1	<5° **	-	25°-75°	<5° **
	2	5°-25° *	25°-75°	25°-75°	5°-25° *
	3	5°-25° *	-	25°-75°	<5° **
	4	<5° **	-	5°-25° *	5°-25° *
	5	25°-75°	25°-75°	25°-75°	<5° **
DGS(5.06.9)	6	<5°*	25°-75°	5°-25° *	<5° **
	7	25°-75°	-	25°-75°	<5° **
	8	5°-25° *	-	5°-25° *	<5° **
	9	25°-75°	25°-75°	5°-25° *	<5°*
	10	5°-25° *	-	5°-25° *	<5° **

Tabs 8: *Qualitative analysis of the results of the DGS group to complex tests*

DISCUSSION OF THE RESULTS

The results of the study are useful for verifying the prevalence of executive system disorders in subjects with DGS, which can be compared with those present in literature, in order to verify the prevalence of the executive disorder in this population. The results also provide useful contributions to the description of the executive / disexecuting profiles of preschool-aged children with a Generalized Developmental Disorder, in order to collect useful information for organize the assessment and the rehabilitation plan for these children. The children's performance data highlights the presence of numerous maladaptive profiles of a pervasive type, affecting the general processes of behavior inhibition. The prevalence data of the disorder are higher than those present in literature but the profile of the children with DGS is the similar one (Hill & Bird, 2006; Luna et al, 2007; Ozonoff et al, 2004; Russell et al, 1999). 17 The greatest difficulty in children's behavior seems to be in their ability to initiate a response and to inhibit actions in the service of general objectives to be achieved (Luna et al, 2007). Particular difficulties are founded in all the inhibition processes and they are above all the characteristics of impulsivity and the management of interference. This difficulty appears as a dysfunctional feature in all age groups under our study, like a constant feature at all ages to be considered like a disadaptive functional profile. In order to collecting data about the assessment of these children in the Italian context we can say that the use of the FE-PS evaluation battery has postponed a good level of sensitivity to identify peculiar executive profile of the children. This also confirm the usefulness for the evaluation of behavioral inhibition in children with DGS and in the preschool age.

CONCLUSIONS

n this study we tried to define a developmental profile of executive functions in subjects presenting a generalized developmental disorder in preschool age, with the final aim of identifying good practices for the functional evaluation of young patients. The results obtained from the study corroborate and strengthen the theories that highlight the presence of EF deficiency in this type of patient, which even if they are unable to explain the disorder, they allow us to define some types of maladaptive profiles. This kind of maladaptive profiles are in agreement with what has already been highlighted in the literature who tries to descrive the behavior of the DGS children but also to the studies stating that such adaptive difficulties respond to adequate rehabilitation programs that directly or indirectly support the development of emotional regulation and behavior so important for socio-affective development and formal learning in every child (Blair & Razza, 2007; Hughes & Dunn, 1997; Johann et al, 2020). The data collect emphasize the importance of assessing the executive function also in preschool age, with particular attention to behavioral inhibition, because these functions can be the object of specific rehabilitation intervention to improve them, but also, according to their highly adaptive nature, they are a tool to achieve other objectives of development. The reflections based on the data of the study presented here therefore represent a methodological resource for the therapist, for the definition of good practices for functional diagnosis in the presence of generalized developmental disorder. The results are in fact

particularly significant for the Neuro and Developmental Therapists, who are called above all to define functional diagnoses, which allow to better define the type and characteristics of a present problem, on which they have to define a program of work or a series of therapeutic strategies, according to the aim of their intervention that is focalized to substain the better adaptation of the child to the demands of his environment, in terms of participation and adaptive response to the living environment. 18 In any case, the limits of this project and the consequent possibility of designing significant work prospects for the future are not negligible. The first limit concerns the reduced number of the DGS sample compared to the control group and their distribution by age; future objective could therefore be to expand the present work with a more numerous and equally distributed case series, in order to allow a better analysis and a greater comparison of the results obtained. A further suggestion for expanding the results of the study concerns the possibility of examining a broader case series, which also includes other neurodevelopmental disorders, that share the presence of maladaptive executive profiles, trying to make and expande the same operational reflections.

REFERENCES

APA (2014) DSM-5. Manuale diagnostico e statistico dei disturbi mentali. Milano: Cortina Raffaello.

Arduino, G. M. (2010) Profilo funzionale e presa in carico : esperienze con quattro bambini con disturbo pervasivo di sviluppo. Psichiatria dell'infanzia e dell'adolescenza, 77(2), 303-319.

Blair, C. & Razza, R. P. (2007) Relating effortful control, executive function, and false belief understanding to emerging math and literacy ability in kindergarten. Child Dev, 78(2), 647-63.

Ciesielski, K. T. & Harris, R. J. (1997) Factors related to performance failure on executive tasks in autism. Child Neuropsychology, 3(1), 1-12.

Conte, B. & Marzocchi, G. M. (2020) Profili specifici di funzioni esecutive nei ragazzi con ADHD, DSA o DOP. Psicologia clinica dello sviluppo, 24(3), 401-436.

Griffith, E. M., Pennington, B. F., Wehner, E. A. & Rogers, S. J. (1999) Executive functions in young children with autism. Child Dev, 70(4), 817-32.

Hall, P. A., Crossley, M. & D'Arcy, C. (2010) Executive function and survival in the context of chronic illness. Ann Behav Med, 39(2), 119-27.

Hill, E. L. & Bird, C. M. (2006) Executive processes in Asperger syndrome: patterns of performance in a multiple case series. Neuropsychologia, 44(14), 2822-35.

Hughes, C. & Dunn, J. (1997) "Pretend you didn't know": Preschoolers' talk about mental states in pretend play. Cognitive Development, 12(4), 381-403.

Johann, V., Könen, T. & Karbach, J. (2020) [Formula: see text] The unique contribution of working memory, inhibition, cognitive flexibility, and intelligence to reading comprehension and reading speed. Child Neuropsychol, 26(3), 324-344.

Luna, B., Doll, S. K., Hegedus, S. J., Minshew, N. J. & Sweeney, J. A. (2007) Maturation of executive function in autism. Biol Psychiatry, 61(4), 474-81. 19

Marimpietri, A. E., Carmignani, M. C., Graziani, A. & Sechi, E. (2012) Profili neuropsicologici e Funzioni esecutive nei bambini con Disturbo da Deficit di Attenzione/Iperattività (ADHD) e Disturbo Specifico di Apprendimento (DSA). Psichiatria dell'infanzia e dell'adolescenza, 79(1), 159-177.

Miller, H. V., Barnes, J. C. & Beaver, K. M. (2011) Self-control and health outcomes in a nationally representative sample. Am J Health Behav, 35(1), 15-27.

Ozonoff, S. (1995) Executive functions in autism, Learning and cognition in autism. Current issues in autism. New York, NY, US: Plenum Press, 199-219. Ozonoff, S., Cook, I., Coon, H., Dawson, G., Joseph, R. M., Klin, A., McMahon, W. M., Minshew, N., Munson, J. A., Pennington, B. F., Rogers, S. J., Spence, M. A., Tager-Flusberg, H., Volkmar, F. R. & Wrathall, D. (2004) Performance on Cambridge Neuropsychological Test Automated Battery subtests sensitive to frontal lobe function in people with autistic disorder: evidence from the Collaborative Programs of Excellence in Autism network. J Autism Dev Disord, 34(2), 139-50.

Ozonoff, S. & McEvoy, R. E. (1994) A LONGITUDINAL-STUDY OF EXECUTIVE FUNCTION AND THEORY OF MIND DEVELOPMENT IN AUTISM. Development and Psychopathology, 6(3), 415-431.

Ozonoff, S., Pennington, B. F. & Rogers, S. J. (1991) Executive function deficits in high-functioning autistic individuals: relationship to theory of mind. J Child Psychol Psychiatry, 32(7), 1081-105.

Rumsey, J. M. (1985) Conceptual problem-solving in highly verbal, nonretarded autistic men. J Autism Dev Disord, 15(1), 23-36.

Rumsey, J. M. & Hamburger, S. D. (1988) Neuropsychological findings in high-functioning men with infantile autism, residual state. J Clin Exp Neuropsychol, 10(2), 201-21.

Russell, J., Jarrold, C. & Hood, B. (1999) Two intact executive capacities in children with autism: implications for the core executive dysfunctions in the disorder. J Autism Dev Disord, 29(2), 103-12.

Turner, M. (1998) Towards an executive dysfunction account of repetitive behaviour in autism, in Russell, J. (ed), Autism as an Executive DisorderOxford University Press, 57-100.

Usai, M. C., Viterbori, P., Gandolfi, E. & Traverso, L. (2017) FE-PS 2-6: Batteria per la valutazione delle funzioni esecutive in età prescolare. Trento:Edizioni Centro Studi Erickson.

Valeri, G. (2006) Autismo e Disturbi Generalizzati dello Sviluppo: una rassegna di studi neuropsicologici. Psicologia clinica dello sviluppo, 10(1), 7-42.

Will Crescioni, A., Ehrlinger, J., Alquist, J. L., Conlon, K. E., Baumeister, R. F., Schatschneider, C. & Dutton, G. R. (2011) High trait self-control predicts positive health behaviors and success in weight loss. J Health Psychol, 16(5), 750-9