IOSR Journal of Nursing and Health Science (IOSR-JNHS)
e-ISSN: 2320–1959.p- ISSN: 2320–1940 Volume 11, Issue 3 Ser. I (May. – June. 2022), PP 58-64
www.iosrjournals.org

Comparative Analysis of Cognitive-Motor Development In People With Autism Spectrum Disorder

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Abstract
This research constitutes an experimental work with aim implement the comparative analysis offshore perceptual-cognitive and motor development in students with autism spectrum disorder (ASD). A total of 40 students participated in this research, issued in three groups, an experimental group made up students with ASD (n= 16), a normotypical group (n= 15) and a group identified of other needs (n= 9), of different age ranges. Study analyze six variables: three perceptive- cognitive variables and three motor variables, what analyzed through non-parametric Kruskal-Wallis Test. Results indicate there´re significant differences forwards study six variables, taking group way as distribution variable, according group type the participants belong; however, comparative data found are less homogeneous regarding different age intervals if age used as distribution variable. Correlations analysis between dimensional groups of cognitive variables, in relation to dimensional group of motor variables, show positive significant relational data found by Pearson correlation.

Key Words
Autism Spectrum Disorder, Cognition- Perception, Semantic Coding, Motor Development.

Date of Submission: 05-05-2022 Date of Acceptance: 19-05-2022

I. Introduction

People with autism spectrum disorder (ASD) characterized by evident limitations in social cognitive processes, basically related to social communication area, restrictive and stereotyped behaviors and peculiar information processing formed by specificities along input, coding, storage and recovery of learning information. These limitations are especially higher it developing significant relationships between concepts and categories of semantic components, which presented from different intensity levels, being 1 low level of need and 3 highest level of need (American Psychiatric Association [APA], 2013).

Already from first studies, performing by Frith (1991), it´s observed behaviors characterized by motor-skills specificities, relatingto basic motor inflexibility and evident space-temporal disorders, as well as, severe limitations into learning process, above all, when learning involves basic motor elements(Williams, Hauser, Purpura, DeLong & Swisher, 2001; Hughes, 1996; Mostofsky, Dubey, Jerath, Jansiewicz, Goldberg & Denckla, 2000; Mostofsky, Goldberg, Landa y Denckla, 2006; Rinehart, Bradshaw, Moss, Brereton & Tong, 2001).

Perceptive- cognitive process functioning is constant recurrent them in currently investigation, since its diagnostic conclusion allows increase more effective intervention.In this sense, hypotheses based on information processing,analyzed through input-response to environment stimuli from time intervals, adapted by Gibbon & Church (1984), show that prefrontal cortex, basal ganglia and, above all, cerebellum functionality, are strongly involved along differential explanatory devices of information processing, also corroborated of other authors (Allen & Muller, 2004; Hollander et al, 2005;Haznedar, Buchsbaum, Hazlett, LiCalzi, Cartwright & Hollander, 2006; Voelbel, Bates, Buckman, Pandina & Hendren, 2006).

Thus, information transmission process measured through reproduction and execution tasks indicates interesting data, Wallace & Happé (2008) and also Allmann et al. (2011),Through respectives comparative study, suggest that people with ASD even show more precise execution, but inadequately estimated the execution-reproduction time of assigned tasks, which lay decrease slightly as duration of task increased,but data most characteristic and most differentiated the experimental group from control group was that within global task performance, there´s tendency set up subdivisions or sub-productions of this same task to get its comprehension whole. These conclusions agree and consistent with central cognitive coherence hypothesis of

Happé (1999) and Nakano, Ota, Kato & Kitazawa (2010), which characterize to perceptual-cognitive process of people with ASD on weak central perceptual coherence or tendency to dissociate category-concepts, subdivided into significant parts to reach progressive understanding, especially if is about new conceptual stimulations regarding information previously meaningful in permanent memory.

Although this processing way can have a highly variable etiology of organic, but also environmental causes, there´re numerous refutable studies supported on genetic basis, owing fundamentally to 15q11-q13 genetic variation; in which, neuronal circuits are affected along development and, although, it´s difficult identify the molecular constituents responsible the developmental interruption, since, at biological level, individual molecules are generally multifunctional nature, subjected multiple combinations to regulate synapses and myelination processing. This process directly affects to relational analysis and learning information transmission (Rennie & Boylan, 2003; Thirumalai,Shubin & Robinson, 2003; Tuchman & Rapin, 2002). Pathological study of neurodevelopment process allows deduce that GABAergic neuronal interactions regulate all excitation/inhibition levels regarding neocortex operation to integrate information coding and, therefore, it influence the quality of information cognitive processing.

This alteration basis could located over cytoarchitecture that includes some prefrontal networks, the temporal cerebral cortices, the hippocampus, the amygdala, the striatum and, above all, the cerebellum functional processing (Barnea-Goraly, Kwon, Menon, Eliez, Lotspeich & Reiss, 2004;Wegiel et al., 2014). In relation the cortex functional areas, it been strongly linked to diagnostic criteria of people with ASD, which are responsible for working memory and spatial memory functioning, likewise of verbal fluency, auditory and verbal attention, joint attentional action, thinking and language developing (Dixon & Christoff, 2014; Dumontheil, 2014). This transmission information alteration related through neuronal circuits is supported to several genetic mutations, specifically owing RAB39b and CHD8 genes, which produce, successively, an alteration of NOTCH2NL gen, that constitutes a specific gene, whose duplicity is recurrent cause assigned to diagnosis of people with ASD (Fiddes et al.,2018; Suzuki et al., 2018).

Studies deep byArteaga, Buritica, Escobar & Pimienta (2015), Falcone et al. (2021), Fingher et al. (2017),show exhaustive analysis of cells type involved this disorder developing. Authors observed that, while neurons number increased considerably in children with ASD, comparing the normotypical control group, however, astrocytes number decreased considerably specifically along prefrontal and cortical areas, located layer II, which has neuronal composition responsible for greater cognitive functional correlation and local connections with other cortical and pyramidal areas, which are responsible for prefrontal activity related memory work or encoding process of incoming memory and information retrieval about.

However, basic element seems found in significant reduction of astrocytes number located in layer II the cerebral cortex, which affects synaptic plasticity and flexibility, in which information and their interactive relationships is distributed. This inter-neural connectivity deficit between remote areas of brain affects, therefore, the learning information integration the perceptual-cognitive level, but also at the levels of quantifiable along motor execution, especially if demand increases the difficulty or execution time (Stewart, Mostofsky, Powell, Simmonds, Goldberg & James, 2009).

Basic hypothesis this research focuses regardingexplanatory elements of perceptual-cognitive theories and neurological development theories interaction,since there´s interaction between particular information processing way in people with ASD, characterized of weakness central cognitive coherence, owing synaptic limitations and related base-specific motor behaviors, so greater the severity of symptomatic signs observed over domains of social communication and stereotypical behaviors, hence, it´ll greater the coherence weakness of information processing and, therefore, operationalized motor signs also.In this sense, this research responds following **general aim**: comparing the perceptual-cognitive-motor dimensions relating belonging groups, formed by group of participants with ASD, normotypical group and one group of people with disabilities other. Participants' age relating with study variables analyzed also.

II. Method

Research design

This study include an experimental analysis based on perceptive-cognitive-motor tests applied: 1) Semantic Integration Scale (SIS) (Ojea& Tellado, 2018), 2) Rhythm Test of Stamback (2013), 3) Labyrinths Test of WISC-IV-R (Wechsler, 2003),and 4) Visual-motor Test of Bender (1984).

Participants

A total of 40 students participated in this study, of which 16 belong to experimental group formed by students with ASD, 15 belong to normal-typical group and 9 to other disabilities group, whose age ranges can see in Table 1.

Table 1: Participants (N= 40).

Count		Age				Total
		0-3 y-o	4-7 y-o	8-11 y-o	12-15 y-o	
Group	Experimental (ASD)	5	6	2	3	16
	Normotypical	0	4	4	7	15
	Disabilitiy Others	2	3	2	2	9
Total		**7**	**13**	**8**	**12**	**40**

Variables

Group and Age variables have used as dependent variables (DV) or grouping variables to analysis of changes found into operationalized dynamic variables.Operative variables are related perceptual-cognitive and motor tests applied. Hence, perceptual-cognitive development have been operationalized on three variables:communication variable (commun), restrictive behaviors (restrictive) and cognitive processes (cognition), observed throughout SIS; while psychomotor processes are made up to three variables: motor imitation processes (imitation), evaluated by Stamback rhythm test, motor rigidity-flexibility (flexibility), analyzed by labyrinth test, and visual-motor execution (reproduction), assessed through Bender's motor-gestaltic test.

Procedure

Once three experimental groups formed, distributed according different age intervals, perceptive-cognitive and motor tests applied. Finally, data analyzed through Kruskal Wallis Test (K-W) non-parametric comparative test to several independent samples regarding all operative variables in relation to group and age variables.

III. Results

This study is limited to small sample, however, for eight elements of whole study, a reliability level of *Cronbach's Alpha* α= .865 (86.5%) is observed, which indicates significant high reliability for data statistics goodness.

Firstly, data found regarding six operative variables analyzed in relation to group type variable with goal to observe if there are significant differences in relation to different participants grouping. Non-parametric measures tests have been used owing small sample of study.

Ranks of significant comparative analysis to several independent samples of K-W found. Data suggest positive significant differences in relation to grouping way, which are greater on ASD group and other disabilities group in relation to normotypical group, while, ASD group in relation to other disabilities group, getting differential ranks relatively smalls (see table 2).

Table 2: Ranksto group way.

	Group	N	Mean Rank
Commun	Experimental ASD	16	29.44
	Normotypical	15	8.03
	Disabilitiy	9	25.39
Restrictive	Experimental ASD	16	30.28
	Normotypical	15	8.00
	Disabilitiy	9	23.94
Cognition	Experimental ASD	16	28.75
	Normotypical	15	8.00
	Disabilitiy	9	26.67
Imitation	Experimental ASD	16	30.47
	Normotypical	15	9.73
	Disabilitiy	9	20.72
Flexibility	Experimental ASD	16	28.56
	Normotypical	15	11.13
	Disabilitiy	9	21.78
Reproduction	Experimental ASD	16	28.88
	Normotypical	15	10.97
	Disabilitiy	9	21.50

Distribution data in accordance with ranges predicts highly significant results along different variables in relation to grouping, being higher among ASD group and other disabilities group, in relation to normotypical group. Indeed, K-W comparative test, taking group variable as grouping variable, let us see the following information (see table 3).

Table 3: K-W test to grouping variable.

	Commun	Restrictive	Cognition	imitation	flexibility	reproduction
Chi-Square	29.86	31.98	30.61	25.23	18.08	19.19
Df.	2	2	2	2	2	2
Asymp. Sig.	.00	.00	.00	.00	.00	.00

As can be seen, critical levels are significant into all variables (sig= .00). Data indicates there´re significant differences in all variables according group setting. Likewise, as indicated the Chi-Square data, scores found are significantly higher over perceptual-cognitive variables: common (29.86), restrictive (31.98) and cognition (30.61), and are lower data in motor variables: imitation (25.23), flexibility (18.08) and reproduction (19.19).

Indeed, when dimensional set level is analyzed, the statistical mean of three cognitive variables (PECOGNIT), in relation statistical mean of three motor variables (MOTOR) clearly significant relational data are found (*r*= .729, sig= .00) (see table 4).

Table 4: Correlations for dimension set.

		PCOGNIT	MOTOR
PCOGNIT	*Pearson Correlation*	1	.72
	Sig. (2-tailed)		.00
	N		40
MOTOR	*Pearson Correlation*		1
	Sig. (2-tailed)		

This same comparative process applied to age variable. Hypothesis regarding motor rigidity increase in relation age rise can see in table 5.

Table5: K-W test to grouping variable:Age.

	Commun	Restrictive	Cognition	imitation	flexibility	reproduction
Chi-Square	6.94	8.27	5.33	.68	.24	.92
Df.	3	3	3	3	3	3
Asymp. Sig.	.07	.04	.14	.87	.97	.81

However, this analysis data is limited. There're significant differences over restrictive variable (sig= .04), as well as differences almost significance over other perceptual-cognitive variables, specifically in common (sig= .07); however, over motor variables, the hypotheses relating with loss of flexibility and visual and audio-motor coordination regarding participants´ age aren´t corroborated. Data found indicate sensitively low critical levels: imitation (sig= .87), flexibility (sig = .97) and reproduction (sig= .81).

Likewise, differential ranges for age variable to whole participants can be seen over Table 6.

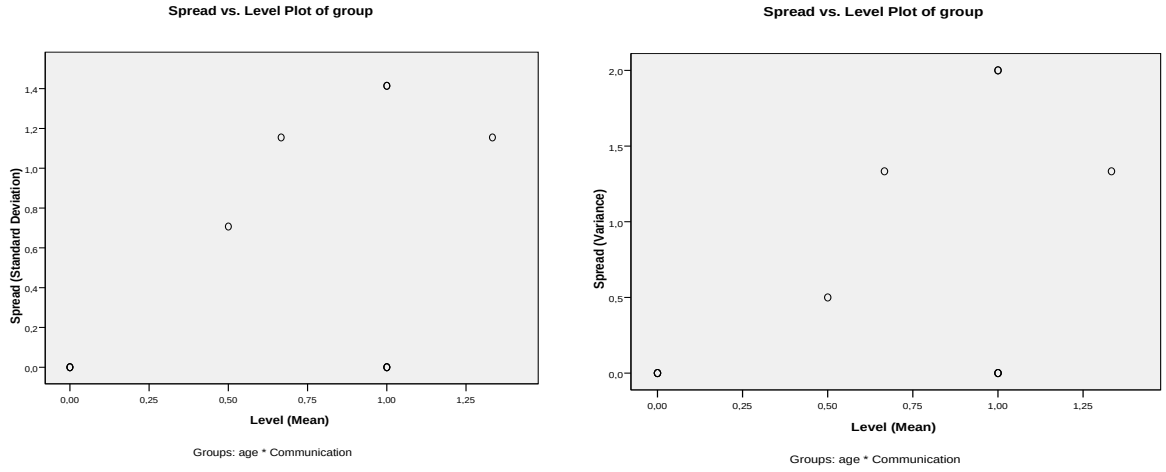
Table6: Ranks to K-W for age variable.

	y-o	N	Mean Rank
Commun	0-3	7	27.86
	4-7	13	23.27
	8-11	8	17.56
	12-15	12	15.17
Restrictive	0-3	7	29.14
	4-7	13	22.92
	8-11	8	16.69
	12-15	12	15.38
Cognition	0-3	7	27.00
	4-7	13	22.27

	8-11	8	19.63
	12-15	12	15.38
imitation	0-3	7	21.93
	4-7	13	19.12
	8-11	8	19.00
	12-15	12	22.17
flexibility	0-3	7	19.86
	4-7	13	20.38
	8-11	8	19.38
	12-15	12	21.75
reproduction	0-3	7	19.14
	4-7	13	19.08
	8-11	8	20.13
	12-15	12	23.08

In general, Graph 1, regarding spread vs. level plot of group (1-2), shows the data setting observed in this study, grouped for group variable, represented by the dispersion diagrams regarding analysis different levels.

Graph 1: Dispersion diagram.



Indeed, in Graph can be seen distant inter-scores, reflected the graph points on the graph, it implies that relationships´ variances are significant different, which are located over height differences; therefore, there´s no horizontal relation. In this sense, it´s possible conclude the variances means size are significant different in this study.

IV. Discussion

Perceptual-cognitive-semantic processing and psycho-motor signs could get quantifiable and observable diagnostic criteria with other communicative-social and restrictive-repetitive behaviors, constituting key elements of disorder specific diagnosis, so psycho-motricity, as well as social-behavior and communication are highly interrelated (Gidley & Mostofsky, 2006).

According the neurophysiology studies, cortex neural circuitry is very light at birth and brain growth will depend on neuronal growth. Thus, during first two years of life, the human brain triples its size and density, which indicates a considerable increase in synaptic connections or neural nodes, which shape the information dynamic circuits. Over these circuits found the sensory behavior capacity, perceptual-cognitive-semantic development and motor functions, among which highlights all levels of basic memory process: 1) immediate memory, 2) coding- working memory, and 3) semantic- permanent memory. Communication, social language, psycho- affective and emotional processes and psychomotor componentsunderlie also. Through the interaction of these elements sets, personal maturational development shaped, so that any alteration located can cause specific needs over personal global development as whole.

Different studies realized(Bailey et al., 1998; Bauman & Kemper; 1994) show people with ASD present a significant reduction into brain neurons number along personal-maturational development;having significant reductions over cerebellar cortex Bcl-2 and in synaptic processes (Fatemi et al., 2001). In this sense,deficits on focal attention, attentional orientation and joint attention found (Harris et al., 1999; Townsend et al., 1999); as well as to cognitive analysis processing, search and problem solving (Pierce & Courchesne,

2001). These needs affect systemically to psychosocial development as whole about, forming specific diagnostic criteria.

Structural analysis of Courchesne et al. (2001) also point out the brain volume and density of children with ASD grows very rapidly up to 3-4 y-o, but, unlike normotypical peers and group to other disabilities of this study, their brain continues develop its volume and density progressively to adolescence age.

In synthesis, people with ASD this decrease is particularly differential affecting the cognitive-motor system specifically and generating immediate consequences along development of neural networks formation or inter-concepts nodes. Interconnection nodes are necessary for information perceptual-cognitive transmission and basic psycho- motor coordination behavior.

These specificities set up the ASD diagnostic basic criteria elements, but, above all, constitute basic indicators to design the fundamental keys to psycho- social and educational intervention.

V. Conclusions

Indeed, this study confirms significant differences to all variables, both perceptual-cognitive set, and motor variables dimension regarding group type, so there´s inter-variable relational specificity of group people with ASD, which facilitate disorder specific relational diagnosis. It´s possible also deduce the high relationship between both set, therefore must design interactive systemic intervention between to both dimensions: perception- cognition and psycho- motor. Two sets are inseparable elements to facilitating individual and social development improvement.

That is, perceptive- cognitive structural concept development is facilitated if it´s complements by related corporal motor experience, generating deeper memory traces and allowing conceptual and categorical coding, semantic storage in permanent memory and subsequent learning information recovery, e. g., texture spatial concept is higher understood if after working this definition, personal touch sensitivity can verify same conceptual meaning bodily-motorically. In this sense, visual-motor concept develops most easily if is complemented the cognitive association of concept, e. g., when learning sheme corporal motor lateralization concept is expressed graphically with finger painting and externalizing cognitively this specific movement is better internalized. However, possibly owing sample small size, the specifically motor variables analyze regarding age variable significant differences were not found, although, indeed, significant differences were observed in relation to some perceptual-cognitive variable like restrictive behaviors variable. Nevertheless,data don´t mean there´re no differences as indicated to *Chi-Square* test, as well as along ranks found to age variable, indicated in Table 5. It can observe that greater differences observed among cognitive ranks comparatively with psycho- bodily motor developmental ranks.

In conclusion, it´s necessary delve into bigger samples to take definitive affirmations regarding findings this study variables relating age group, which constitutes limitation of this study, however, these data are conclusive for group variable, as well as regarding systemic consequences of perceptive- cognitive- motor specific functioning on people with ASD as whole about.

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