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Interrelation of the Psychomotor System and the Cognitive Relational Process on Academic Performance in People with Autism Spectrum Disorder

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SUMMARY: Autism Spectrum Disorder (ASD) is a highly heterogeneous specific feature of neurodevelopment, whose general characteristics are defined by two basic dimensions: 1) deficits of communication and social interaction and 2) restrictive and stereotyped behaviours. Both dimensions are complemented by empirical evidence of the highly significant relationships of a predictive kind with the psychomotor functioning, which becomes most evident over development. Just, this research tries to answer to the following general goals: 1) examine the application of specific programs relating to development of basic psychomotor skills in students with several levels of ASD, age and sex, and 2) delimit the incidence of cognitive relationships between the concepts and learning categories.

A total of 99 students have participated in this study, distributed according to ASD level, age and sex. Data have been analysed through the Univariate ANOVA Between-Subjects Effects Test. Results show that both the intersection of psychomotor and cognitive variables (critical sig: .00), as well variables separately (psychomotricity: .00, and relationship: .00), significantly affect to academic performance of students with ASD. Therefore, it can be concluded that relational cognitive components and psychomotor development are essential to facilitate the development of learning in people with ASD, whose R^2 of explicative variance is significantly high: .913, being the adjusted R^2 level: 86.3%. The influence of the fixed variables interactions: ASD level, age and sex have also been studied.

KEYWORDS: Autism Spectrum Disorder. Psychomotricity. Perceptive- Cognitive- Nodal Relationship. Conceptual and Categories. Academic Performance.

INTRODUCTION

ASD is a highly heterogeneous specific feature of neurodevelopment, whose general characteristics are defined by two basic dimensions, related to communication and social interaction needs and restrictive and stereotyped behaviours with different levels of intensity (American Psychiatric Association (APA), 2013) y World Health Organization (WHO), 1993). ASD prevalence reaches one individual to every 59- 54 birth people (Baio, 2018; Kogan et al., 2018; Maenner et al., 2020), while the etiological explicative components are very diverse and multifunctional nature, which include, both to etiological features associated with specific genetic groups, as well as relating to neurophysiological processes and/or environmental contexts.

Indeed, both dimensions delimit the diagnostic specificity of ASD, but this hypothesis is complemented by highly contrasted currently empirical evidence, regarding the presence of a strong significant predictive association of both dimensions with psychomotor fine and gross functioning, which is most visible with along development (Bedford, Pickles & Lord, 2016; Johnson, 2017). These kindnesses have led to characteristic symptomatic whole of systemic and global nature development, shaping more current conceptual approaches configurated by more complex explicative models in which general psychomotor elements interact of human development (Lorber, Del Vecchio & Slep, 2014) with superior cognitive and executive skills (Anderson, 2008), further facilitating interactive causal between the different factors that affect to development of people with ASD.

New developmental hypotheses are analogous to Mutualism model, developed by Van der Maas et al. (2006), which is just based over the existence of a complex and multiple network of cognitive and motor factors that interact with each other, influencing the psychosocial development itself, which can growth their deficits and/or create discontinuities throughout evolutive development, as well as, are agree whit the hypothesis by the Ecological models of Evolutive and Developmental Psychology, whose neurocognitive factors are currently highly also refuted about (Kievit et al., 2017).

Hence, the psychomotor elements have been complemented to ASD diagnosis, which have been studied along recurrently experimental research (Hill, 2004). These studies include, among other specific characteristics concomitant, to different degrees or levels of ASD: self-regulation capacity, control of inhibitory elements, executive planning and cognitive flexibility. Pellicano et al. (2017) also add those other alterations relating to spatial and temporal motor development, which, as they also affirm Diamond (2013), de Vries & Geurts (2015) and Miyake & Friedman (2012), directly influence the factors of inhibition/disinhibition, fluency and flexibility, concept formation and executive planning, which, successively, has a significant incidence too on learning academic processes which can progressively worse if educational preventive programs aren´t applied.

In this sense, there´re multiple currently research that link the linguistic communication capacities to psychomotor skills (Ament et al., 2015; Lloyd, MacDonald & Lord, 2013), so that children with ASD get significantly low scores in language development, both expressive, receptive and phonological, which are highly relating to psychomotor skills developmental, keeping a well-structured basic systemicity to define the ASD symptomatology. Regarding motor needs, Hilton, Zhang, Whilte, Klohr & Constantino, (2012) and Iverson (2010) shape that 83% of children with ASD studied have found compound psychomotor scores with significant deviations from mean regarding to the normotypical group. Therefore, it already early childhood, research show interrelationships between psychomotor skills and language, being able set significant predictive criteria for ASD diagnoses at risk, which is already observable early as 18 months of age and, after, incidences the acquisition of language skills from 3 years old (Coleman, Weir, Ware & Boyd, 2013; Wang, Lekhal, Aarø & Schjølberg, 2014).

But, studies on psychomotricity not only referencing to predictive analyses of deficits in fine psychomotor skills (Deserno et al., 2023), but also to deficits in gross psychomotor skills (Leonard, Bedford, Pickles, Hill & BASIS Team, 2015). Gross motor skills have proven be a fundamental explicative element by interaction with psychological emotional processes development, which are mightily relating to social interaction capacities and social communication processes, so, e.g., the presence of deficits in gross psychomotor skills have been shown to be highly predictive of subsequent symptomatic groups to diagnosis of ASD on later evolutive phase (Mody et al., 2017).

Likewise, psychomotor skills are linked the adaptive functioning to context and the quality of life of people with ASD and it constitutes significant predictive variables by communication and social interaction needs (Bremer & Lloyd, 2016; Crippa et al., 2021; Mosconi & Sweeney, 2015; Sacrey, Zwaigenbaum, Bryson, Brian & Smith, 2018), which has been rightly quantified through the processes of systematic behavioural observation (Cook, 2016; Wilson, McCracken, Rinehart & Jeste, 2018). Indeed, data have shown highly atypical basic motor criteria over general movement of people with ASD, characterized by structural rigidity and deficits in visual- psychomotor coordination. These needs rise when ASD´ diagnostic intersects with lower cognitive skills and cognitive levels (Peterson, Janz & Lowe, 2008; Savage, Tomaszewski & Hume, 2022).

In this sense, MacDonald, Lord & Ulrich (2014) have concluded that psychomotor skills affect to effectiveness of school performance, being more deficit if the higher psychomotor deficit, which, in general, these authors point about 9.5 months behind their chronological age. This delay is evident in curricular components, being very perceptible in writing, owing the coordination needs in pencil handle and the specific presence of hypotonia and psychomotor rigidity symptomatic (Alaniz, Galit, Necesito & Rosario, 2015; Broun, 2009; Johnson et al., 2015), with which these needs not only affect the executive motor planification, but also incidence along whole cognitive processing system, influencing to all educational- academic area.

With these basic hypotheses, the particular specific needs in the psychomotor system is greatly demonstrated, as well as the relationships of psychomotor particularities with the language and the cognitive system development, shaping a global systemic set of integral human development in people with ASD. Thus, the existence of a highly significant relationship between the cognitive process and psychomotor variables in people with ASD have been found, that affect to general development process and, therefore, curricular- school learning. For this reason, there´s a growing needs the application of interactive programs that integrate motor and linguistic content and cognitive processes to ease their overall development (Ketchesona, Felzer-Kim & Hauckb, 2021).

Interactive programs must implicitly design goals it integrating psychomotor and linguistic subject-matter; therefore, it´s fundamental to design programs that integrate the psychomotor- linguistic and cognitive items with specific academic development that will be most effective if more they are related itself throughout along evolutive development. For this reason, the school curriculum, especially inside early childhood, must be complemented with functional basic psychomotor subject-matter within the curricular- school goals, in order to help cognitive- perception-coding processing to comprehensive development duly adjusted to educational specific needs of students with ASD.

Also, these integrated programs must allow the joined modelling of motor and language processes with perceptive- cognitive domains of development and, both, with curricular- school development, setting a circular model of development that overstep to linear cognitive models of previous neuro- psychologic theories.

Therefore, this study tries to respond the following main aims: 1) analyse the application of specific programs related to basic psychomotricity development in students with different levels, age and sex in people with ASD diagnosis, 2) delimit the influence of the significant cognitive-nodal relationships between the concepts and conceptual- categories of learning, 3) verify the existing correlations between the psychomotor elements, the relational-cognitive-nodes factors and the curricular- school performance variable.

METHOD

Research design

This study is a quasi-experimental analysis based over one ad hoc survey, in which the variables- goals quantification have been requested through by continuous scale 1-10, being 1 (nothing developed) and 10 (fully developed). Data have been analysed by psychometric means tests through the univariate general linear model isolated regarding the dependent variable (DV) to: 1) fixed variables and 2) dynamic variables or factors. Finally, the correlations between all study variables are also measured.

Participants

A total of 99 students have participated in this study, whose distribution by ASD level, sex and age can be seen in Table 1.

Table 1: study participants (N: 99).

sex			*age*							
			0-3 y-o	*3.1-6 y-o*	*6.1-9 y-o*	*9.1-12 y-o*	*12.1-15 y-o*	*15.-18 y-o*	*>18.1 y-o*	*Total*
guys	*diagnosis*	*level 1*	3	6	3	8	14	5	4	43
		level 2	0	2	1	2	7	0	0	12
		level 3	0	2	8	2	8	2	0	22
	Total		3	10	12	12	29	7	4	77
girls	*diagnosis*	*level 1*		0	1	0	3	1	2	7
		level 2		4	5	0	0	0	0	9
		level 3		0	2	2	0	2	0	6
	Total			4	8	2	3	3	2	22

Thus, in this study 77 students with ASD guys have been participated, 43 of 1-level, 12 of 2-level and 22 of 3-level, and 22 girls, 7 of 1-level, 9 of 2-level and 6 of 3-level (Total: 99).

Variables

The study has been organized into two groups of variables:

I) Fixed variables, which are related to: 1) level or degree of ASD (diagnosis), 2) participants sex (sex) and 3) participants age (age).

II) Dynamics variables, formed by: 1) psychomotor variable (psychomotricity), 2) the development of relational-cognitive-nodes between information (relationship), and 3) the curricular- school learning processing (learning).

The learning variable has been thoughtful like dependent variable (DV).

Values regarding the fixed variables can be seen in Table 2.

Table 2. Fixed variables values.

Variables	*Values*
ASD level	1-level 2-level 3-level
Sex	guys girls
Age	0-3 y-o 3.1-6 y-o 6.1-9 y-o 9.1-12 y-o 12.1-15 y-o 15.1-18 y-o >18.1 y-o

Dynamic variables have been quantified throughout a continuous scale: 1 (any)-10 (full) (see Table 3).

Table 3. Dynamic variables values.

Variables	*Values*									
psychomotricity	1	2	3	4	5	6	7	8	9	10
relationship	any	very	low	half	lower	upper	half	high	very	full
learning (DV)		low		low	half	half	high		high	

Procedure

Throughout the last scholar course different interviews have been performed, both in writing and in person or by phone, regarding to the research aims and subject- matter, in order try to define the psychomotor action area and the development of cognitive-nodal-relationships, regarding to curricular-school goals effectiveness of students with ASD, along different educational schools of Spain.

In this study has been reflected the analysis psychometric statistical conclusion.

RESULTS

Study results are presented organized in several sections of the analysis: 1) the reliability level of the data found, 2) the ANOVA analysis for the fixed and dynamic variables, and 3) the correlation of Pearson for all analysis elements.

Reliability level of data analysis.

The reliability level has been found throughout Cronbach's Alpha test (α) (see Table 4) and the associated ANOVA analysis to Cronbach's Alpha (see Table 5).

Table 4. Cronbach's Alpha Reliability Statistics.

Cronbach's Alpha	*Cronbach's Alpha based on standardized items*	*Nº of items*
.615	.419	6

Table 5. ANOVA with Cochran's Test.

		Sum of squares	*Df.*	*Mean square*	*Cochran's Q*	*Sig.*
Between people		646.60	98	6.59		
Within people	Between items	2171.49	5	434.29	314.72	.00
	Residual	1243.83	490	2.53		
	Total	3415.33	495	6.90		
Total		4061.93	593	6.85		

μ= 4.0101.

Indeed, α total reliability level is not very high for 6 study elements: .615, owing because this study sample is not very greatly, however, the ANOVA test the Cochran analysis associated to α reliability statistic allows refuse the basic hypothesis that sample´ means are same regarding to 6 elements studied of analysis (sig: .00), which eases the statistical effectivity of subsequent results.

ANOVA values to fixed variables.

The incidence of fixed variables about DV: learning has been analysed wear the univariate general linear model analysis throughout the Between-Subjects Effects Test (see Table 6).

Table 6. Test of Between- Subjects Effects to fixed variables.

Dependent Variable: learning

Source	*Type III sum of squares*	*df*	*Mean square*	*F*	*Sig.*
Corrected Model	359.44(a)	24	14.97	6.65	.00
Intercept	1486.73	1	1486.73	660.54	.00
diagnosis	28.18	2	14.09	6.26	.00
sex	7.57	1	7.57	3.36	.07
age	19.24	6	3.20	1.42	.21
diagnosis* sex	13.92	2	6.96	3.09	.05
diagnosis* age	28.58	7	4.08	1.81	.09
sex* age	46.99	5	9.40	4.17	.00
diagnosis* sex* age	9.39	1	9.39	4.17	.04
Error	166.55	74	2.25		
Total	3705.00	99			
Corrected Total	526.00	98			

a) *R* squared= .683 (adjusted *R* squared= .581).

Data found allow the following conclusions to be made up. The intercept analysis and model effects as whole, that´s, the incidence of the 3 fixed factors: diagnosis, sex and age, are correlated with a significant critical statistic level (corrected model: .00 and the associated intercept: .00), which means that statistical total sum of 3 fixed variables contributes to explain the significant differential data found over DV: learning, with a R^2 specific explicative level: .683, being R^2 corrected level: 58.1%.

However, according the variable kind the influence found is differently if the variables are considered separately. Hence, ASD diagnosis level has shown a decisive influence on learning variable variability (diagnosis: .00), while the sex and age variables don´t have had a significant influence if are considered separately (sex: .07 and age: .21).

The partial group of variables formed by diagnosis and sex there is a positive influence on data variability of DV (sig: .05). The correlation between sex and age also have formed a significant whole (sig.: .00), while the variables group: diagnosis and age does not significantly influence on the DV data (sig: .09).

ANOVA values for dynamic variables.

This item constitutes this study fundamental share, since it allows observe if the diynamic- aleatory variables: psychomotricity and relationship, significantly affect the DV: learning.

To perform this analysis, the ANOVA Univariate Between-Subjects Effects Test was used (see Table 7).

Table 7. Test of Between-Subjects Effects to dynamic values.

Dependent Variable: learning

Source	*Type III sum of squares*	*Df.*	*Mean square*	*F*	*Sig.*
Corrected Model	480.30(a)	36	13.34	18.10	.00
Intercept	1233.04	1	1233.04	1672.93	.00
psychomotricity	41.52	10	4.15	5.63	.00
relationship	51.77	8	6.47	8.78	.00
psych* relationship	36.88	18	2.04	2.78	.00
Error	45.69	62	.73		
Total	3705.00	99			
Corrected Total	526.00	98			

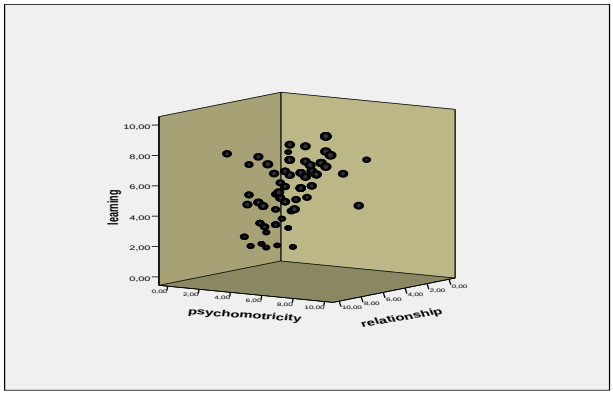
a) *R* squared = .913 (adjusted *R* squared = .863)

Data is conclusive, the intersection and the variables isolated, as well as the interaction between all variables have found a significantly affect over DV: learning.

Hence, the intersection- intercept has found a critical level: .00, as well as the psychomotricity variable (sig: .00) and relationship variable (sig: .00). All interactions have found significant critical level (sig: .00). Therefore, it can be able concluded that relational perceptive- cognitive-nodes components and the fine and gross psychomotor development are highly related with the

curricular-school components: learning, whose R^2 explicative level is significantly high: .913, being R^2 adjusted level: 86.3% of explicative variance on DV.

In synthesis, data imply a significantly high level of incidence on DV: learning, which corroborates the initial hypotheses of this study main aim. The visual observation of 2 dynamic factors explicative variance over DV: learning, can be seen in Graph 1.



Graphic 1. Image of explicative variance.

Indeed, it can be seen as both factors present an explicative centralization (blackheads accumulation), with greater light concentration the relationship variable than psychomotricity variable.

Indeed, ANOVA analysis for 2 factors when both are located in the aleatory analysis of the SPSS statistical, variables have also found a significant critical level, but level has been slightly better for relationship variable (sig: .00), than in psychomotricity variable (sig: .04).

Correlations between the six analysis elements.

The correlational levels for all study variables have been found throughout the Pearson Correlation statistic (*r*) (see Table 8).

Table 8. Correlation de Pearson to 6 elements.

		diagnosis	*sex*	*age*	***psych.***	***relationship***	***learning***
diagnosis	*r*	1					
	Sig. (2-tailed)						
sex	*r*	.11	1				
	Sig. (2-tailed)	.27					
age	*Pearson Correlation*	-.13	-.062	1			
	Sig. (2-tailed)	.19	.540				
psychomotricity	***r***	**-.061**	**.058**	**-.204(*)**	**1**		
	Sig. (2-tailed)	**.54**	**.56**	**.04**			
relationship	***r***	**-.163**	**.130**	**-.098**	**.752(**)**	**1**	
	Sig. (2-tailed)	**.10**	**.20**	**.33**	**.00**		
learning	***r***	**-.282(**)**	**.067**	**-.092**	**.842(**)**	**.746(**)**	**1**
	Sig. (2-tailed)	**.00**	**.51**	**.36**	**.00**	**.00**	

** Correlation is significant at .01 level (2-tailed).

* Correlation is significant at .05 level (2-tailed).

Relevant data has been found over relationships between DV: learning, regarding to the dynamic factors: psychomotricity and relationship, whose correlations were highly significant for .01 level (psychomotricity: 84.2% and relationship: 74.6%), being both significant critical levels (sig: .00).

Likewise, the interaction between relationship and psychomotricity shows a significantly high correlational level (75.2%, sig: .00).

On other, regarding the fixed variables, a significant relationship of DV: learning, with diagnosis variable has found to .01 level (28.2%, sig: .00).

All other fixed variables and their interactions have not found to the correlational effects significant scores.

CONCLUSION

This study verifies the existence of a significant relationship between the effectiveness of teaching-learning processing and a programmatic structure based by creation of cognitive-relationship-nodes and the significant relationships between concepts and conceptual-categories in order allow the development of neural-cognitive connections in people with ASD diagnosis. But, above all, this study leaves advancement along most global ambit of evolutive development, thus when these perceptual-cognitive- relationships are associated to global fine and gross psychomotor developmental, shaping a whole systemic group to improve the curricular-school performance.

Hence, it is obvious that systemic of perceptive- cognitive functioning is highly contrasted research but it has always been recurring research regarding to general basic psychological cognitive processes, but, now, it has shown that it´s also been necessary the fine and gross psychomotor movement development greatly related to improve the conceptual - curricular-academic development.

Indeed, themselves psychomotor programs development are fundamental subject-matter to improve global human development, however, their conceptual relationship can be highly vital to academic- school learning, e. g. following math equation (3+2)-1= 4 made on paper, it can be experienced in the psychomotor scope through a specific task: three children are placed in line linked by hand, after two other child join them (3+2= 5), all children turn hand in hand, they turn together in a circle, suddenly, a child lets go of this circle and, therefore, subtracts one child (3+2)-1= 4. Now, children have been able live the previous math equation functional way throughout the psychomotricity, which, also, increases the comprehensive significance of new learning proposed, that it´ll be more effective the more it is related to previously learned subject-matter.

It is also important to highlight that diagnosis level constitutes a basic element of variance explicative incidence of data found over DV: learning, as well as the interaction of ASD level by age and sex of the study participants, therefore, it must review the relational functional programs applied to different specific characteristics of each student with ASD, advancing towards relational- global- systemic specific programs agreed their own needs within an inclusive teaching-learning.

DISCUSSION

Liu, Capistran & ElGarhy (2021) and MacDonald, Lord & Ulrich, (2013) have signalled it is fundamental design global- relational educational programs of psychomotor scheme with curricular-school aims, with the intention interact the learning of communication and social interaction skills and psychomotor development; but, it is not just the interactions related to ASD specific symptomatic dimensions are important, besides these relational- psychomotor programs be implemented regarding to curricular- school learning, since this interaction has shown have a decisive influence on final academic- school performance.

Thus, when people with ASD get involved in interactive psychomotor programs, they have improved not just fine and gross specific psychomotor behaviour, but it also influences on cognitive development and the global- academic improvement (Bartlo & Klein, 2011).

This relational association allows a considerable rise in opportunities for social and communication learning of people with ASD, especially along development earliest ages. Indeed, Choi, Leech, Tager -Flusberg & Nelson (2018) have shown that related development of psychomotor skills in babyhood with ASD improved the frequency of these infants' interactions within their families and eased development of language, social communication and behavioural.

And, although these data must be given with some carefulness, since there aren´t many scientific verifications about, Office of Head Start's model (OHS) (Head Start, 2018; 2020) has focused on the preparation of psychomotor skills correlated by phonological, social language, emotional, perceptive-cognitive-relational and academic-school development, which set up an integrated process like whole, being a highly predictor of afterwards educational- school development.

In this sense, Best, Miller & Naglieri (2011), Gustavsen, (2017) and Miller et al. (2017), have trained that psychomotor development domain was mightily related to academic-curricular-school progress in students with ASD. Authors affirm there is a close relationship between working memory skills of the perceptive- cognitive processing with reading-writing and math abilities, both mechanical and comprehensive, which growth along the last academic courses of primary education.

Just, an applied model of preventive preparation for curricular- school process must include that goals and subject- matters-contents educational are highly related to fine and gross psychomotor skills and relational perceptual-cognitive-nodes of neuro-psychological information processing (Izuno-Garcia, Jellinek, Rosenbrock, Keller-Margulis & Mire, 2022; Lambourne et al., 2013).

However, as this research has shown, it is essential these programs include a specific interaction between the perceptive-cognitive- nodal development related with psychomotor area significantly and functionality way, to strengthen the conceptual and categorial codification in people with ASD (Ojea, 2022).

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In synthesis, an integrated and global- systemic program must include, between other aspects, five general goals:

1) Develop basic general fine and gross psychomotor skills, according to the specific needs of people with ASD.
2) Set relationships between the psychomotor aspects and the general learning goals and their subject- matters.
3) Engage basic psychomotricity as a functional mediator of learning processes, above all, in early childhood.
4) Specify the meaning of learning processes, nearing the new goals to previously acquired subject- matters, throughout the psychomotricity area as a coding relationship.
5) Intervene to set up interactive cognitive neural nodes of conceptual and categorical knowledge.

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