Semantic Integration Scale to People Diagnosis with Autism Spectrum Disorder

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SUMMARY

This study's basic aim is evaluating the Semantic Integration Scale (SIS) to give a specific complementary differential instrument in relation to information processing shape of people with autism spectrum disorder (ASD) and, therefore, facilitate the differential diagnosis of people with ASD regarding normotypic people.

A total of 376 participants have been selected between 10 and 16 age, distributed in 2 groups, 1 experimental groups formed of people with ASD= 156 and 1 normotypical control group, composed by 220 participants.

The conclusive differential analysis of the comparative level between experimental and control group, corresponding to 6 subdimensions of SIS, carried out through t-test for 2 independent samples, it´s concluded the comparative data are significantly different between both groups: experimental and control group, which allows deducing the specificity of this Scale like complementary diagnosis adapted to people with ASD.

KEY WORDS: Autism Spectrum Disorder, Diagnosis, Semantic Integration.

INTRODUCTION

The American Psychiatric Association International Classification (APA, 2013) affirm the people with ASD have perceptive- cognitive limitations that effect to processing particularities and agree that people with ASD present specific educational needs at 3 levels of intensity over 2 basic dimensions: I) interaction and social communication, and II) restrictive behavior. Well, generally, diagnosis of people with ASD, focus on specific assessment, made- up through measurement scales taken from the two APA´ dimensions, hence, Shaw & Hatton (2009) pick up the most remarkable instruments for evaluation of specific diagnostic processes of individuals with ASD.

However, Baez et al. (2020), through a review of work by Dajani, Llabre, Nebel, Mostofsky & Uddin (2016) point out the specific needs of people with ASD are better explained from structure of executive function than from behavior indices, concerning to analysis of whole cognitive processes that organize the behavior directed towards a concrete final, which has a fundamental impact along development of daily life. In their conclusions, they show precisely how people with ASD present greater limitations in executive function development activities, regarding their peers of control group formed by normotypic participants,

which affects both the acquisition of new conceptual learning and the process of recuperation and application of previously learned information, which evidence the consistency of the influence of perceptual-cognitive processes as explicative hypotheses of information processing particularities in people with ASD. These limitations of people with ASD are specified in basic needs to establish meaningful relationships and neurologic nodes between incoming knowledge and previously acquired information in memory, which generates difficulties to store semantic information in permanent memory (Zager, Wehmeyer & Simpson, 2012). These basic theoretical assumptions conclude the importance of the cognitive processes analysis that make around semantic integration of informative essence to facilitate the transfer of the encoded stimuli to permanent memory and, hence, let such the posterior information recuperation, likewise the generalization process and its application in daily practice. For this reason, it´s must the different levels of executive processing perform the information semantic integration functions, from initial perceptual-sensory process, the attribution and conceptual coding, the creation of inter-relational networks and nodes, the deed to semantic memory, the ensuing recovery and, finally, its application to practical life. Empirical studies based on perceptual-cognitive theories and executive function ease the information processing understanding in people with ASD, which verify their main characteristic is the difficulty in semantically integrating the perceived learning to get content meaningful and, therefore, mechanic and automatic learning is constituted as main learning factor. This particularity of people with ASD implies the perseverance of multiple errors throughout information processing and evident limitations over conceptual coding (Lezak, Howieson & Loring, 2004; Stelzer, Andrés, Canet-Juric & Introzzi, 2016; Ben- Itzchak, Abutbul, Bela, Shai & Zachor. 2016; Harrison, Shipstead & Engle, 2015; Lifter, Foster- Sanda, Arzamarski, Briesch & McClure, 2011; Maister & Plaisted- Grant, 2011; Walsh, Creghton, & Rutheford, 2016).

Also, in this same line of research, the specificity of the perceptual-cognitive semantic process in people with ASD has been widely studied along different explicative theoretical hypotheses, throughout: -activities on information integration in semantic memory (Tager- Flusberg, 1991), -the interaction of information processing regarding to the context (Happe, 1997) [41], -perceptual-visual integration tasks (Mottron, Burack, Iarocci, Belleville & Enns, 2003), - the activities of global information integration processes or gestalt´ theories (Hoy, Hatton & Hare, 2004). Just, therefore, there´re many studies follow based on establishing reliable scales to search specific diagnostic instruments to evaluating the cognitive processing specificity in people with ASD with advance of discriminate a specific differential diagnosis. Camodeca, Todd & Croyle (2020) analyze the investigated internal consistency reliability and criterion validity of diagnostic Scale for participants with ASD (ASDS) in sample of 120 children, 54 with ASD and 66 normotypic children. Their conclusions show significant mean differences between both groups along all scores, hence they have found specific criteria of cognitive functioning in people with ASD in relation to normotypic peers.

Asimismo, Wang, Hedley, Bury & Barbaro (2020) carried out a general search study of different recent databases (2015-2018) published about instruments to detecting the autism diagnosis. In the synoptic Table number 2 suggests different Scales it analyze the perceptual-cognitive levels and behavioral processing.

Thus, in this research study it´s quite about assessing the SIS (see Annex), developed by Ojea & Tellado (2018) and, it assessed also by Ojea & Skoufou (2019). SIS include 6 subdimensions that make perceptive-

cognitive items of semantic information processing along 5 levels of intensity to facilitate understanding of executive functioning development, from conceptual comprehension, the elaboration of conceptual categories, the creation of nodes or inter-informational links and the information recuperation, with purpose to shape an empirical study to give a differential complementary specific diagnostic instrument to assess of people with ASD, regarding with individuals normotypical group, with following general aims:

1. Assess a specific Scale to complementary differential diagnosis in people with ASD.
2. Set if there´re differences between the experimental group and control group regarding variable age and sex of participants in study.
3. Specify the differential values of people with ASD regarding normotypic group about Scale subdimensions.

METHOD

Design

This research study is based on experimental design of 2 groups, 1 experimental group formed by students with ASD and 1 control group composed by normotypical students.

Participants

A total of 376 participants have been selected between 10 and 16 years old, distributed in 2 groups, 1 experimental group and 1 control group (see Table 1). Experimental group is formed of people with ASD= 156, which 85 men, 39 from 9-12 years and 46 from 13-16 years, 71 women, 45 from 9-12 years and 26 from 13-16 years. Normotypical group is composed by 220 participants, which 108 men, 48 from 9-12 years and 60 from 13-16 years, 112 women, 48 of 10-12 years and 64 from 13-16 years.

Table 1: Participants assignment (N= 376).

Sex			Years old		Total
			9-12	13-16	
Men	Experimental group	ASD	39	46	85
	Control group	TYPICAL	48	60	108
	Total		87	106	193
Women	Experimental group	ASD	45	26	71
	Control group	TYPICAL	48	64	112
	Total		93	90	183

Study variables

Categorized variables of this study are following:

- **Group**: group type, involving of 1 experimental group (people with ASD) and 1 control group (normotypic people).

- **Age**: participants age, formed by 2 age groups, 1 group of 9-12 years old and 1 group to 13-16 years old.
- **Sex**: participants´ genre-sex: male and female.

Other variables are integrated of 6 Scale subdimensions with following designation:

- **I) Concepts**: conceptual units understanding.
- **II) Meaning**: significant reconstruction.
- **III) Hierarchization**: conceptual- categories hierarchy.
- **IV) Inter-concepts**: inter- conceptual relations development.
- **V) Nodes**: inter- concepts and categories relationship.
- **VI) Recovery**: information reminds.

Variables values

Each subdimension is quantified in 5 values (0: no deficit- 4: severe deficit) it correspond with doubles scores on Scale: 0-2-4-6-8, regarding to subdimensions items criterion around the continuous scores corresponding to SIS´ values.

Procedure

All participants have been valued with the SIS by a questionnaire carried out in different educational schools throughout: 1) participant observation and 2) structured interviews realized to trained staff of educational centers.

Data analysis

Data was found through: 1) statistical reliability of whole Scale, through the Cronbach's Alpha test, and 2) comparative analysis for group variable regarding study variables draw on *t- tests of 2 independent samples*.

RESULTS

Reliability analysis of whole Scale, found by Cronbach's Alpha (α) test, show high confidence statistical power of study: α = .832 (83.2% reliability) for 9 items integrated (see Table 2).

Table 2. Reliability Statistics (N= 376).

α	Nº of Items
.832	9

Differential analysis between both groups, experimental group and control group, was found by means of comparative *t-test of 2 independent samples*. Data indicate that, globally, significant differences are found along whole of Scale specific variables, excepting for “sex” variable, which, however, confirm this study initial hypothesis since it´s confirmed in whole Scale dynamic variables (6 subdimensions) (see Table 3).

Table 3: Independent Samples Test.

		levene's Test for equality of variances		t-test for equality of means						
		F	Sig.	t	df	**Sig. (2-tailed)**	Mean	Std. Error	95% Confidence Interval	
									Lower	Upper
Age	Equal variances assumed	102.97	.00	-5.43	37	.00	-.24	.04	-.33	-.15
	Equal variances not assumed			-5.26	299.87	.00	-.24	.04	-.33	-.15
Sex	Equal variances assumed	8.88	.00	-1.80	37	.07	-.09	.05	-.19	.00
	Equal variances not assumed			-1.80	357.35	.07	-.09	.05	-.19	.00
Concepts	Equal variances assumed	2.60	.10	-12.39	37	.00	-1.09	.08	-1.27	-.92
	Equal variances not assumed			-12.30	343,.86	.00	-1.09	.08	-1.27	-.92
Meaning	Equal variances assumed	32.13	.00	-3.82	37	.00	-.41	.10	-.62	-.20
	Equal variances not assumed			-3.97	369.62	.00	-.41	.10	-.61	-.20
Hierarquization	Equal variances assumed	51.10	.00	-2.47	37	.01	-.29	.11	-.52	-.06

	Equal variances not assumed			-2.57	369.38	.01	-.29	.11	-.51	-.06
Inter-concepts	Equal variances assumed	1.61	.20	-3.65	37	.00	-.38	.10	-.59	-.17
	Equal variances not assumed			-3.71	371.236	.00	-.38	.10	-.59	-.18
Nodes	Equal variances assumed	69.94	.00	-22.05	37	.00	-1.92	.08	-2.09	-1.74
	Equal variances not assumed			-23.81	307.48	.00	-1.92	.08	-2.07	-1.76
Recovery	Equal variances assumed	125.53	.00	-1.96	37	.05	-.23	.12	-.47	.00
	Equal variances not assumed			-2.09	335.08	.03	-.23	.11	-.45	-.01

Conclusive data is reviewed below. Regarding "age" variable, for Levene significant critical level (Sig= .00), which indicates non equality- homogeneity of variances, it´s possible conclude that experimental group and control group are differ significantly agreed to "age" variable of participants (Sig= .00, F= 102.97). Indeed, as displayed in Table 4, scores mean found is significantly lower in experimental group: mean (μ)= .59, statistical deviation (σ)= .493, regarding control group (μ= .83, σ= .374), in which, scores of students between 9-12 years old are significantly lower relative to general skills: μ= .34, σ= .476 the 13-16 years old age group (μ= .64, σ= -481).

"**Sex**" variable, with Levene significant level (Sig= .00), however, no significant differences are found in critical level rely on group way (Sig= .07, F= 8.88).

Regarding all dynamic subdimensions of Scale (6 items) was found significant differences in critical level according the group type (see Table 4).

"**Concepts**" variable, with Levene's variances equality (Sig= 10), shows significant differences between experimental group and control group participants (Sig= .00, F= 2.60). Indeed, experimental group participants keep significantly lower scores in statistical process (μ= 1.37, σ= .883) the normotypic people group (μ= 2.47, σ= .831).

"**Meaning"** variable, for Levene´s variances unequality (Sig= .00), suggests differences over significance level: Sig= .00 (F= 32.13). Likewise, experimental group (individuals with ASD) get significantly lower scores, with higher deficit (μ= 1.43, σ= .834), than normotypic peers: μ= 1.85, σ= 1.180).

"**Hierarquization"** variable, with different variances (Levene: Sig= .00), evidences meaningful differences over critical level: Sig= .01 (F= 51.10), being lower statistical mean in experimental group (μ = 1.83, σ= 9.14), than control group: μ = 2.12, σ= 1.298).

"**Inter-concepts"** variable, for Levene's variances equality (Sig= .20), points out meaningful differences to critical level: Sig= .00 (F= 1.61), with experimental group statistical mean: μ= 1.67 (σ = .937) regarding control group: μ = 2.06, σ= 1.088.

"**Nodes"** variable, of Levene´s variances no equality (Sig= .00), shows significant differential level: Sig= .00 (F= 69.94). This variable show especially important differences between both groups, in which experimental group display significantly lower scores and higher deficits (μ = .66, σ= .476), regarding control group participants (μ = 2.58, σ= 1.038).

"**Recovery"** variable, of Levene´s variances no equality (Sig= .00), exhibits differentially significant critical level: Sig= .03 (F= 125.53), with significantly lower scores in experimental group participants (μ= 2.01, σ= .755), than group control participants: μ= 2.25, σ= 1.389.

Table 4. Group differential statistics.

Variables	*Group*	*N*	*Mean*	*Std. Deviation*	*Std. Error Mean*
Age	ASD	166	.59	.493	.038
	TYPICAL	210	.83	.374	.026
Sex	ASD	166	.40	.491	.038
	TYPICAL	210	.49	.501	.035
Concepts	ASD	166	1.37	.883	.069
	TYPICAL	210	2.47	.831	.057
Mean	ASD	166	1.43	.834	.065
	TYPICAL	210	1.85	1.180	.081
Hierarquization	ASD	166	1.83	.914	.071
	TYPICAL	210	2.12	1.298	.090
Inter-concepts	ASD	166	1.67	.937	.073
	TYPICAL	210	2.06	1.088	.075
Nodes	ASD	166	.66	.476	.037
	TYPICAL	210	2.58	1.038	.072
Recovery	ASD	166	2.01	.755	.059
	TYPICAL	210	2.25	1.389	.096

CONCLUSIONS

Variables it makes up the semantic structure of analysis perceived and encoded by executive processing cognitive system give significant differences between the experimental group participants, regarding their

peers from control group. These scores are related to higher deficits and significantly lower abilities in experimental group individuals along all subdimensions of SIS. But, scores are especially different in to variable: "nodes", which link with develop of relationships between learning contents than influence specially offshore devolve of semantic information to encode over long-term memory and their consequences regarding information recuperation processes, which confirms initial hypothesis that people with ASD present highly specific particularities in information processing way, especially in relation to elaboration of semantic networks between concepts and conceptual categories, found in results of "nodes" variable.

Hence, learning process requires that information perceived can be right related to information previously learned and accessible in permanent memory; otherwise, simply, information incoming will quickly be lost. Therefore, people with ASD have needs to establishing relationship nodes of information available, which explains the need of individuals with ASD regarding recovering process learning and, thus, they exhibit deficits in processes of generalization, as well as learning adaptation to context, just like that seems that one learning made is necessary learn again every time the context is changed or slightly modified. This situation owing to mechanic processing carried out, in which it hasn´t been realized significant relational links codified of previous and coming information. Just, for this reason, scores regarding recovery subdimension are also significantly lower in people with ASD, which isn´t owing to specific mnesic deficits, but enough to specific deficits in relation to information semantic attribution process and their relationships established in permanent memory, since significant networks, themselves, it´ll deed as subsequent links to ease the information recovery learned, otherwise, we will do just mechanical process of the learning stimuli, which is very cognitively costly, which can generate, hence, important deficits for application of learnings along daily practice.

This analysis, then, allows conclude the 6 subdimensions of SIS become complementary nuclear predictors for diagnostic differential discrimination of people with ASD, regarding gather aspects derived from conceptual cognitive attribution of information incoming and existing, the creating relationships between these concepts, the grouping into conceptual categories, the attribution of neurologic links and, finally, subsequent recovery for application to everyday life. For this reason, this Scale can be accepted a valid and reliable instrument to assess the processing specificity in people with ASD; however, it´d not imply the SIS Scale envelops diagnostic process isolated in strict sense, but it´d be as diagnosis´ complementary basis further to specific diagnostic instruments, current statistically verified, such *Observation Schedule-Generic Test* "ADOS" or *Autism Diagnostic Interview- Revised* "ADI- R" *Test*; mainly, when said instruments get borderline data throughout differential diagnosis process.

For this reason, it´s needful to take attention to the diagnostic factors related to the perception- cognitive semantic dimension for specific diagnosis of people with ASD. Therefore, semantic integration is a specific nuclear criterial element to improve diagnosis´ effectiveness, in order at supporting diagnosis specific analysis, according the heterogeneity model, with main aim to decrease of basic errors in the initial evaluation processes of people with ASD, mostly, when this analysis is performed at early age.

In summary, study includes the cognitive semantic integration dimension as a differential diagnosis factor, hence the APA´ dimensions should incorporate to diagnostic process of individuals with ASD the following specific processual dimensional sequence (1 (low level of ASD)- 3 (high level of ASD), which are indicated

according to correspondence with APA´ (op. cit.) levels:

1) **Level 3**: Analysis of concept parts.
2) **Level 2**: Concepts´ partial analysis, with a tendency to establish meanings.
3) **Level 1**: Analysis with meaning of concepts, with difficulties for their categorization. Limitations to set up inter- categories relationships.

STUDY LIMITATIONS

Assessment studies require obiously great samples, which is always hardness in people with specific educational needs, therefore, it´s must keep up in this research line to generate greater reliability about ASD differential diagnostic processes. Also, this research study should be understood that SIS Scale constitutes a diagnosis complementary instrument it doesn´t replace specific diagnostic tests of ASD.

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ANNEX

SEMANTIC INTEGRATION SCALE (SIS)

SUB-DIMENSION 1: **CONCEPTS**

Deficits in the comprehension of conceptual units.

1.1. There´s not significant conceptual units understanding.	8
1.2. There´s concretion of conceptual units' parts.	6
1.3. There´s conceptual units' analysis.	4
1.4. Conceptual units are understood, but with tendency to subdivide units into its parts..	2
1.5. There´s no qualitative deficit.	0

SUB-DIMENSION 2: **MEANING**

Deficits for the reconstruction of meaningful concepts.

2.1. There´s no parts (units) reconstruction.	8
2.2. External help is need to stimulus reconstruction.	6
2.2. Stimuli parts reconstruction is carried out with learned relationships.	4
2.4. Stimuli parts are reconstructed as from relationships created.	2
2.5. There´s no qualitative deficit.	0

SUB-DIMENSION 3: **HIERARQUIZATION**

Deficits in conceptual- categories hierarchy.

3.1. There´s no belonging understanding.	8
3.2. There´s category construction is limited to some concepts.	6
3.3. External help is need to indicate units´ belonging level to categories.	4
3.4. There's awareness of belonging, but it´s difficult assign an unit to its category.	2
3.5. There´s tendency to concepts hierarchize in corresponding category.	0

SUB-DIMENSION 4: **INTER-CONCEPTS**

Deficits to inter- conceptual relations development (nodes).

4.1. No competences of relationships meaning between concepts.	8
4.2. Don´t creates relationships, but understands similarities and differences between concepts.	6
4.3. External help is needed to create relationships among concepts.	4
4.4. Relationships are used between two concepts if its're previously learned.	2
4.5. There´s no limitations to form relationships between two new concepts.	0

SUB-DIMENSION 5: **NODES**

Deficits to setting inter- categories relationships.

5.1. There´s no understanding relationship between conceptual categories.	8
5.2. Two different conceptual categories are understood, but it´s not able to attribute relationships.	6
5.3. External help is required to establish relationships.	4
5.4. It´s given learned relationships to different conceptual categories.	2
5.5. Relationships are created between different conceptual categories.	0

SUB-DIMENSION 6: **RECOVERY**

Deficits to information remind.

6.1. There´s information recovery, but it´s very limited.	8
6.2. External help is needed to facilitate information retrieval.	6
6.3. There´s information recovery, but from concrete concept.	4
6.4. There´s information recovery, from learned relationship.	2
6.5. There´s no qualitative deficit.	0

Source: Ojea & Tellado (2018).