International Journal of
Current Multidisciplinary Studies
Available Online at http://www.journalijcms.com
Vol. 5, Issue,09(A), pp. 1095-1101,September,2019

IJCMS

RESEARCH ARTICLE

EMPIRICAL JUSTIFICATION OF THE SEMANTIC EVALUATION SCALE ADAPTED TO PEOPLE WITH AUTISTIC SPECTRUM DISORDER

Manuel Ojea Rúa and María Amalia Skoufou

Faculty of Education Sciences, office 11, University of Vigo (32004- Ourense, Spain)

ARTICLE INFO

Received 6th June, 2019
Received in revised form 15th July, 2019
Accepted 12th August, 2019
Published online 28th September, 2019

Keywords:

Autism Spectrum Disorder, Diagnosis, Cognition- Perception.

ABSTRACT

A total of 132 participants have been selected in this research which constitutes an experimental investigation of 3 groups, 1 first group selected by 53 children diagnosed with autism spectrum disorder (ASD), 1 second group include 49 children normotypical (TD) and 1 third group composed of 30 children with Down´s syndrome (SD).

The basic objective of this research is generating empirical evidence of the Semantic Integration Scale (SIS) as a specific diagnostic instrument adapted to people with ASD. The SIS is made up of 6 sub-dimensions: Concepts, Meaning, Hierarquization, Interc-concepts, Nodes and Recovery, than give the concept of perceptual-cognitive semantic dimension, related to permanent memory as a fundamental and specific element for the diagnosis of this disorder.

Data analysis was found through: 1) the Multivariate Tests (d) for contrast the group, age and sex variables, as well as their intercept and interactions, 2) the Tests of Between-Subjects Effects to deduce the comparative levels of group variable regarding the SIS sub-dimensions and, moreover, 3) the Post-Hoc of Tukey- HSD analysis has been studied to deepen over comparative analysis of the 3 groups. Conclusions corroborates that semantic dimension is a differential criterion of the diagnostic process of people with ASD, therefore, it´s possible verify the empirical effectiveness of SIS and improve the reliability of differential diagnosis of individuals with ASD.

INTRODUCTION

The American Psychiatric Association International Classification (APA) [1] affirm the people with ASD have perceptive- cognitive limitations that effect to processing particularities, showing deficits in two dimensions: 1) interaction and social communication, and 2) restrictive behavior. That deficits are combined throughout three intensity sequences or levels, of etiology fundamentally genetic type [2-7].

These limitations have an interrelated effect among basic neuro- psychological parameters of semantic memory, which is based on conceptual structural deficits related to perception, understanding, coding and recovery of the learned information that, generally, shape the processual functioning of system perceptive- cognitive.

For this reason, several diagnostic scales have collected these criteria regarding to both dimensions in order to perform the diagnostic processes of people with ASD. Rivière [8] develop the Autism Spectrum Inventory Scale (ASI), or Bitsika, & Sharple [9] make up the Verification Checklist of the ASD´ Behavior (ASDBC-R), regarding the specific standards criteria for both APA´ dimensions:

1. Interaction and Social Communication Dimension. *Criteria*: 1) social relationships, 2) joint reference abilities, 3) inter- subjective and mentalists abilities, and 4) expressive and receptive communicative dimensions disorders.
2. Restricted Behaviors Dimension. *Criteria*: 1) anticipation, 2) flexibility, 3) activity sense, 4) fiction and imagination, 5) imitation, and 5) activity suspension.

Study have leaded intervention programs based on repeated and progressive learning, which found global positive results, however, concepts learned don´t exhibit outside the learning context itself, limiting the concept learning to specific context, owing to rigidity and deficits in understanding the characteristics shared between concepts learned in an educational specific context and those concepts of typical

*✉ ***Corresponding author:*** **Manuel Ojea Rúa**
Faculty of Education Sciences, office 11, University of Vigo (32004- Ourense, Spain).

environment, since individuals with ASD have important deficits for make relations inter-concepts, likewise between previously learned and new concepts [10].

Previous theoretical premises make up the concept of semantic memory dimension. The global semantic dimension involve two basic aspects: 1) the codification of a new stimulus-concept perceived depends on the progressive sequential approximation of this stimulus with other stimuli- concepts previously learned and 2) the academic learning acquired finds difficulties of relations between concepts and meet difficulties for its after generalization among typical environment development, which is a highly specific perceptual-cognitive development of information processing in people with ASD at three levels: 1) in the initial perceptual level, 2) at conceptual codification process, and 3) over subsequent recovery of the information learned.

These deficits are due that cognitive- executive planning process relate closely on the ability to access the information available in permanent memory, that keep up episodic and semantic memory, which is the place where conceptual essence get its meaning [11, 12].

Hence, learning process is related with interactive relation of all elements that shape the perception, codification and recovery system, lead by active memory or work memory, getting the system processing set and, consequently, any interference may cause heavy limitations over perceptual-cognitive process development.

Well, individuals with ASD have severe limitations in the creation of relationships- links along information processing, which difficult to acquire new information, especially if it is highly complex, that influence, both in the process of planning hypotheses autonomously to lead of one´s own intention, even when it´s based on a previously learned behavior, as in the selection of incoming information, since sometimes the amount of information received is very wide and it´s necessary to establish a successive planning regarding relevance of stimuli that should be processed, if not, the stimulus- conceptual of learning is avoided, making attention needs, sensitive hypersensitivity or, simply, the objective information is lost [13-17].

This whole situation decisively influences the effectiveness of the diagnosis of people with ASD. According to Center for Disease Control [18], currently, the prevalence of this diagnosis is estimated approximately at 1/68 born people, however, the reality of this diagnostic processes is of much lower incidence.

Generally, diagnosis of people with ASD, focus on specific assessment, made- up through measurement scales taken from the two dimensions of APA (op. cit.). In this sense, Shaw & Hatton [19] pick up the most remarkable instruments for evaluation of specific diagnostic processes of individuals with ASD:

1. The *Observation Schedule- Generic Test* "ADOS" [20].
2. The *Autism Diagnostic Interview- Revised* "ADI- R" [21].
3. The *Childhood Asperger Syndrome Test* (CAST) [22].
4. The Gilliam Asperger Disorder Scale (GADS) [23].
5. The Gilliam Autism Rating Scale Test "GARS- 2" [24].
6. The *Autism Spectrum Inventory* "IDEA" of Rivière [25].
7. The *Australian Scale for Asperger's Syndrome* (ASAS) [26].
8. The *Checklist for Autism in Toddlers* (CHAT) [27].
9. The *Modified Checklist for Autism in Toddlers* (MCHAT) [28].
10. The *Autism Screening Instrument for Educational Planning* (ABC) [29].
11. El *Asperger Syndrome Diagnostic Scale* (ASDS) [30].
12. The *Ages and Stages Questionnaire: Social- Emotional* (ASQ-SE) [31].
13. The *Reliability and Item Content of the Baby and Infant Screen for Children with Autism Traits* (BISCUIT): parts 1, 2 and 3 [32].
14. The *Communication and Symbolic Behavior Scales Developmental Profile Infant/ Toddler Checklist* (CSBS-DP) [33].
15. The *Screening for emotional and behavioral delays: The Early Screening Project* (ESP) [34].
16. The *Pervasive Developmental Disabilities Screening Test II* (PDD ST II) [35].
17. The *Social Communication Questionnaire* (SCQ) [36].
18. The *Screening Tool for Autism in Two- Year- Olds* (STAT) [37].
19. The *Temperament and Atypical Behavior Scale* (TABS) [38].

All previous instruments are based on analysis and evaluation of the APA´ dimensions, but it´s necessary to deepen in instruments of assessment of the perceptive- cognitive semantic dimension. Therefore, this research try to experimentally justify an instruments based on the study of this specific cognitive factors related with semantic dimension.

The Semantic Integration Scale (SIS) haven been adapted to individuals with ASD [39], so that assess the way of perception, codification and recovery of information received. In this sense, this research do an empirical study, with main aim of empirically corroborating the SIS as a highly specific diagnostic instrument to evaluation of people with ASD, in comparison with a individuals normotypical group (TD) and, especially, in relation to a group of people with Down syndrome (DS).

METHOD

Design

Accordingly, this research study is based on experimental design of three groups, 1 group formed by students with ASD, 1 group trained by normotypical students and 1 group by students with Down syndrome. The selection of Down syndrome people has been made owing to its genetic etiological condition, which seem the fundamental etiology of ASD people group.

Participants

A total of 132 participants have been selected between 9 and 16 age, distributed in 3 groups, 1 group of people with ASD= 53 (39 men and 14 women), 1 group of normotypical people, compose by 49 participants (27 men and 22 women) and 1 group of people with Down syndrome, consisting of 30 participants (8 men and 22 women). Likewise, 2 age ranges have been picked: 9-12 years and 13-16 years (see Table 1).

Table 1 Participants assignment

Sex			Age		Total
			9-12 years	13-16 years	
Mens	Group	ASD	25	14	39
		TD	14	13	27
		DS	5	3	8
	Total		44	30	74
Women	Group	ASD	8	6	14
		TD	6	16	22
		DS	11	11	22
	Total		25	33	58
Total	ASD				53
	TD				49
	DS				30
Total			69	63	132

Variables

The study´ independent variables (IV) are following:

- *Group* variable: trained by 3 groups: 1 group of individuals with ASD (ASD)= 53; 1 group of normotypic people (TD)= 49; 1 group formed by people with Down syndrome (DS)= 30.
- *Age* variable: distributed in 2 intervals: 9-12 years= 69 participants; 13-16 years= 63 participants.
- *Sex* variable: issued by 2 groups: men= 74 participants; women= 58 participants.

The dependent variable (DV) is formed by 6 sub-dimensions of SIS scale (Ojea & Tellado, op. cit.):

1. Sub- dimension 1: Deficits to conceptual units understanding (Concepts).
2. Sub- dimension 2: Deficits to significant reconstruction (Meaning).
3. Sub- dimension 3: Deficits to conceptual- categories hierarchy (Hierarquization).
4. Sub- dimension 4: Deficits to inter- conceptual relations development (Inter-concepts).
5. Sub- dimension 5: Deficits to setting inter- categories relationships (Nodes)
6. Sub- dimension 6: Deficits to information remind (Recovery).

Variables values

Each Sub-dimension is quantified in 5 values (0: no deficit-8: severe deficit), regarding to the sub-dimensions 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 (see Annex) throughout: 1) participant observation and 2) structured interviews realized to trained staff of educational centers.

Data analysis

Consequential data was found through: 1) the Multivariate Tests (d) for contrast the group, age and sex variables, as well as their intercept and interactions, 2) the Between-Subjects Effects Tests to deduce the comparative levels of group variable regarding the 6 SIS sub-dimensions and, moreover, 3) the Post-Hoc of Tukey- HSD analysis has been studied to deepen over comparative analysis of the 3 groups: ASD, TD and DS.

RESULTS

Multivariate Tests for global comparison

The comparative analysis, performed through the Mulitivariate Tests (d) (see Table 2), show if there´re significant differences between the IV (group, age and sex), in relation to the SIS´ sub- dimensions (DV).

Table 2 Multivariate Tests(d)

Effect	Statistics	Value	F	Hypothesis df	Error df	Sig.	Noncent. Parameter	Observed Power(a)
Intercept	Pillai's Trace	.78	69.01(b)	6.00	114.00	.00	414.08	1.00
	Wilks' Lambda	.21	69.01(b)	6.00	114.00	.00	414.08	1.00
	Hotelling's Trace	3.63	69.01(b)	6.00	114.00	.00	414.08	1.00
	Roy's Largest Root	3.63	69.01(b)	6.00	114.00	.00	414.08	1.00
Group	Pillai's Trace	.50	6.44	12.00	230.00	.00	77.29	1.00
	Wilks' Lambda	.50	7.63(b)	12.00	228.00	.00	91.60	1.00
	Hotelling's Trace	.94	8.86	12.00	226.00	.00	106.37	1.00
	Roy's Largest Root	.91	17.55(c)	6.00	115.00	.00	105.29	1.00
Age	Pillai's Trace	.09	2.04(b)	6.00	114.00	.06	12.25	.72
	Wilks' Lambda	.90	2.04(b)	6.00	114.00	.06	12.25	.72
	Hotelling's Trace	.10	2.04(b)	6.00	114.00	.06	12.25	.72
	Roy's Largest Root	.10	2.04(b)	6.00	114.00	.06	12.25	.72
Sex	Pillai's Trace	.05	1.02(b)	6.00	114.00	.41	6.17	.39
	Wilks' Lambda	.94	1.02(b)	6.00	114.00	.41	6.17	.39
	Hotelling's Trace	.05	1.02(b)	6.00	114.00	.41	6.17	.39
	Roy's Largest Root	.05	1.02(b)	6.00	114.00	.41	6.17	.39
Group * Age	Pillai's Trace	.15	1.6	12.00	230.00	.08	19.37	.83
	Wilks' Lambda	.85	1.60(b)	12.00	228.00	.09	19.21	.82
	Hotelling's Trace	.16	1.58	12.00	226.00	.09	19.04	.82
	Roy's Largest Root	.08	1.61(c)	6.00	115.00	.14	9.69	.60
Group * Sex	Pillai's Trace	.11	1.12	12.00	230.00	.34	13.48	.64
	Wilks' Lambda	.89	1.12(b)	12.00	228.00	.34	13.50	.64
	Hotelling's Trace	.12	1.12	12.00	226.00	.33	13.53	.64
	Roy's Largest Root	.09	1.84(c)	6.00	115.00	.09	11.06	.66
Age* Sex	Pillai's Trace	.03	.60(b)	6.00	114.00	.73	3.60	.23
	Wilks' Lambda	.96	.60(b)	6.00	114.00	.73	3.60	.23
	Hotelling's Trace	.03	.60(b)	6.00	114.00	.73	3.60	.23
	Roy's Largest Root	.03	.60(b)	6.00	114.00	.73	3.60	.23
Group * Age * Sex	Pillai's Trace	.13	1.33	12.00	230.00	.20	15.90	.73
	Wilks' Lambda	.87	1.35(b)	12.00	228.00	.18	16.30	.74
	Hotelling's Trace	.14	1.38	12.00	226.00	.17	16.63	.75
	Roy's Largest Root	.14	2.70(c)	6.00	115.00	.01	16.19	.85

a) Computed using alpha= .05.
b) Exact statistic.
c) The statistic is an upper bound on F that yields a lower bound on the significance level.
d) Design: Intercept+Group+Age+Sex+Group * Age+Group * Sex+Age * Sex+Group * Age * Sex.

Data show significant differences for the Intercept values and group variable in relation to results found to the SIS´ sub-dimensions. Thus, the level of Pillai's Trace (Multivariate Test) for study Intercept a Significance level (Sig.)= .00 (F= 69.1) (The other statistics also show similar data), likewise, it was found a positive significance for Group variable isolated: Pillais´ Trace (Sig . = .00, F = 6.44). Consistently, the group type significantly influenced the results of the scale.

However, in Age and Sex variables isolated there´re no found significant differences in relation to data of the SIS sub-dimensions: Pillai´s Trace: Sig. = .06, F = 2.04 (in Age variable) and Pillai's Trace: Sig = .41, F = 1.02) (for Sex). Neither, significant positive levels was obtained at the intersections of independent variables. Hence, it can be appointed that Age and Sex of participants, didn´t influence the type of answer on SIS.

Between- Subjects comparison of SIS sub- dimensions regarding Group variable

The significance levels regarding differences found between the Group variable and the sub-dimensions of the scale can be seen in Table 3.

Table 3 Tests of Between-Subjects Effects

Source	Dependent Variable	Type III Sum of Squares	df	Mean Square	F	Sig.	Noncent. Parameter	Observed Power(a)
Corrected Model	**Concepts**	**46.09(b)**	**11**	**4.19**	**3.76**	**.00**	**41.40**	**.99**
	Meaning	66.22(c)	11	6.02	8.29	.00	91.23	1.00
	Hieraquization	51.84(d)	11	4.71	4.94	.00	54.33	1.00
	Interconcepts	51.90(e)	11	4.71	6.07	.00	66.77	1.00
	Nodes	80.92(f)	11	7.35	9.78	.00	107.60	1.00
	Recovery	77.96(g)	11	7.08	7.32	.00	80.56	1.00
Intercept	Concepts	289.95	1	289.39	259.99	.00	259.99	1.00
	Meaning	217.13	1	217.13	299.15	.00	299.15	1.00
	Hierarquization	261.51	1	261.51	274.07	.00	274.07	1.00
	Interconcepts	242.68	1	242.68	312.20	.00	312.20	1.00
	Nodes	211.25	1	211.25	280.89	.00	280.89	1.00
	Recovery	305.48	1	305.48	315.66	.00	315.66	1.00
Group	Concepts	36.45	2	18.23	16.37	.00	32.75	1.00
	Meaning	53.44	2	26.72	36.81	.00	73.63	1.00
	Hierarquization	35.27	2	17.63	18.48	.00	36.97	1.00
	Inter-concepts	37.69	2	18.84	24.24	.00	48.48	1.00
	Nodes	61.09	2	30.54	40.61	.00	81.23	1.00
	Recovery	53.75	2	26.88	27.77	.00	55.55	1.00

a) Computed using alpha = .05.
b) R Squared = .258 (Adjusted R Squared = .190).
c) R Squared = .434 (Adjusted R Squared = .382).
d) R Squared = .313 (Adjusted R Squared = .250).
e) R Squared = .359 (Adjusted R Squared = .300).
f) R Squared = .75 (Adjusted R Squared = .426).
g) R Squared =.404 (Adjusted R Squared = .349).

Indeed, in previous table is observed that differences are positive significant for the Group variable in all the SIS´ sub-dimensions, with following Sig. and percent of variance (Squares): Concepts: Sig.= .00 (Squares= 36.45), Meaning: Sig.= .00 (Squares: 26.72), Hierarquization: Sig.= .00 (Squares= 35.27), Inter-concepts: Sig.= 00 (Squares= 37.69), Nodes: Sig.= .00 (Squares= 61.09), Recovery: Sig.= .00 (Squares= 53.75). Therefore, it can be said that between the 3 groups studied: ASD, TD and DS, find significant difference regarding at all sub- dimensions of the SIS.

Post- hoc comparison to group variable along SIS sub-dimensions

Generally, Post-hoc comparative inter-groups analysis confirms previous data (see Table 4).

Table 4 Multiple Comparisons- Tukey HSD

Dependent Variable	(I) Grupo	(J) Grupo	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Upper Bound	Lower Bound
Concepts	ASD	TD	-1.21(*)	.21	.00	-1.71	-.71
		DS	-.82(*)	.24	.00	-1.40	-.25
	TD	ASD	1.21(*)	.21	.00	.71	1.71
		DS	.39	.24	.26	-.19	.97
	DS	ASD	.82(*)	.24	.00	.25	1.40
		TD	-,.9	.24	.26	-.97	.19
Meaning	ASD	TD	-1.50(*)	.17	.00	-1.90	-1.09
		DS	-.90(*)	.19	.00	-1.36	-.43
	TD	ASD	1.50(*)	.17	.00	1.09	1.90
		DS	.60(*)	.19	.00	.13	1.07
	DS	ASD	.90(*)	.19	.00	.43	1.36
		TD	-.60(*)	.19	.00	-1.07	-.13
Hierachization	ASD	TD	-1.31(*)	.19	.00	-1.77	-.85
		DS	-.85(*)	.224	.00	-1.38	-.32
	TD	ASD	1.31(*)	.19	.00	.85	1.77
		DS	.46	.22	.10	-.08	1.00
	DS	ASD	.85(*)	.22	.00	.32	1.38
		TD	-.46	.22	.10	-1.00	.08
Inter-concepts	ASD	TD	-1.35(*)	.17	.00	-1.76	-.93
		DS	-.65(*)	.20	.00	-1.13	-.17
	TD	ASD	1.35(*)	.17	.00	.93	1.76
		DS	.69(*)	.20	.00	.21	1.18
	DS	ASD	.65(*)	.20	.00	.17	1.13
		TD	-.69(*)	.20	.00	-1.18	..21
Nodes	ASD	TD	-1.62(*)	.17	.00	-2.03	-..21
		DS	-.68(*)	.19	.00	-1.15	..21
	TD	ASD	1.62(*)	.17	.00	1.21	..03
		DS	.94(*)	.20	.00	.46	..42
	DS	ASD	.68(*)	.19	.00	.21	..15
		TD	-.94(*)	.20	.00	-1.42	-.46
Recovery	ASD	TD	-1.65(*)	.19	.00	-2.11	-1.18
		DS	-1.01(*)	.22	.00	-1.55	-.47
	TD	ASD	1.65(*)	.19	.00	1.18	2.11
		DS	.64(*)	.22	.01	.10	1.18
	DS	ASD	1.01(*)	.22	.00	.47	1.55
		TD	-.64(*)	.22	.01	-1.18	-.10

Based on observed means.
* The mean difference is significant at .05 level.

Thus, the ASD group differs significantly in all sub- dimensions of SIS scale, regarding to the other 2 groups: TD and SD: Concepts: Sig.= .00, Meaning: Dig= .00, Interconcepts: Sig= .00, Nodes: Sig= .00, Recovery: Sig= .00. This point corroborate that SIS scale is highly specific for the diagnosis of ASD group, being especially important that differences would have been found even regarding the specific group of individuals with Down syndrome (DS).

Otherwise, no significant differences were found between the TD and DS groups in the sub- dimension Concepts: Sig. Sig.= .26, nor in the sub- dimension Hierquization: Sig.= .10, but, the another other SIS´ sub- dimensions are also differentially significant between this 2 groups.

In synthesis, the perceptive- cognitive semantic dimension sets up a differential factor of diagnosis of people with ASD in relation to the normotypical group: TD, as well as, singularly, to the DS group specific.

DISCUSSION

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:

1. Activities on information integration in semantic memory [40].
2. The interaction of information processing regarding to the context [41].
3. Perceptual-visual integration tasks [42].
4. The activities of global information integration processes or gestalt´ theories [43].

In this sense, Plaisted [44] says just that specificity involve an exhaustive explanation of deficits found in the perceptual-cognitive processing of information in people with ASD, that are integrated among the theory of cognitive coherence, conceptual topographic theory and perceptual-cognitive theories, whose most characteristic features are:

1. Deficits in the cognitive assignation stimuli observed as whole, with perceptual tendency to partial cognitive attribution, focused on the concrete.
2. Deficits to spontaneously set up relationships between concepts and their corresponding categories, with special limitations to move in the process of conceptual, inter- conceptual, categorical and inter- categorical classification.
3. Deficits on the recovery of the subsequent information of meanings learned.

In order respond to these studies, Bishop´s ALICC [45,46] concludes with a set of recommendations for future research, in which, highlight following:

1. Carry out a comprehensively Assessment pragmatic and semantic dimensions.
2. Enhance development of pragmatic and semantic language processes as a main aim of the specific intervention in people with ASD.

CONCLUSIONS

Obviously, the perceptive-cognitive process interacts with the observable behaviors of the two dimensions of the APA´ (op. cit.) Classification (op. cit.), since cognitive system elements are related widely with itself along of the information processing cognitive tasks, but, if the evaluation of people with ASD just focuses on the objective behaviors, many people may be left out of this diagnosis, since showing greater subtle behaviors or mild behavioral levels, sometimes, imperceptible. This could explain the difference between the accepted diagnosis prevalence (1/68) regarding the number of cases currently diagnosed, which is lower than pointed data.

For this reason, it´is 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 the 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

This research study is a small and humble analysis complementary of data input, that obviously needs subsequent empirical refutations for the final validation of this results found.

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