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Cognitive Assessment System (CAS): Psychometric studies with Portuguese children from 7 to 15 years

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Abstract: The Cognitive Assessment System (CAS) is a new measure of cognitive abilities based on the *Planning, Attention, Simultaneous* and *Successive* (PASS) Theory. This theory is derived from research in neuropsychological and cognitive Psychology with particular emphasis on the work of Luria (1973). According to Naglieri (1999) and Naglieri and Das (1997), the PASS cognitive processes are the basic building blocks of human intellectual functioning. *Planning* processes provide cognitive control, utilization of processes and knowledge, intentionality, and self-regulation to achieve a desired goal; *Attention* processes provide focused, selective cognitive activity and resistance to distraction; and, *Simultaneous* and *Successive processes* are the two forms of operating on information. The PASS theory has had a strong empirical base prior to the publication of the CAS (see Das, Naglieri & Kirby, 1994), and its research foundation remains strong (see Naglieri, 1999; Naglieri & Das, 1997). The four basic psychological processes can be used to (1) gain an understanding of how well a child thinks; (2) discover the child's strengths and needs, which can then be used for effective differential diagnosis; (3) conduct fair assessment; and (4) select or design appropriate interventions. Compared to the traditional intelligence tests, including IQ tests, the Cognitive Assessment System (CAS) has the great advantage of relying on a modern theory of cognitive functioning, linking theory with practice.

In this paper we present the studies of the Portuguese adaptation of CAS with a sample of 240 elementary and middle school students. The aim of this work is to obtain the psychometric properties of the instrument, using the traditional psychometric parameters and non-metric multidimensional scaling techniques (SSA). Besides the Confirmatory Factor Analysis data were analyzed through Louis Guttman's SSA - a non-metric multidimensional scaling (MDS) procedure. CFA and SSA confirmed the psychometric qualities of CAS and identified the subscales and dynamic relationships between them. Finally, we discuss the findings and its implications for future use of CAS with Portuguese population.

1. Introduction

Since the initial formulation of the Binet and Wechsler scales, there has been a consolidation of thinking that intelligence is what these tests measure. It is important to consider, however, that the fact that IQ tests have remained stable during the 20th century does not contradict the evidence that the tests can be effective as measures of general intelligence. Where IQ tests fail is in situations when more information than the general IQ score is needed. In today's context, the content of the general intelligence test does not allow for sensitivity to the specific cognitive problems that underlie, for example, learning disabilities and attention deficits (Naglieri, 1999).

During the 20th century, but especially during the latter half, considerable research has been conducted on the construct of intelligence. In particular there has been much examination of specific abilities that extend beyond the concept of general, undifferentiated intelligence. But in the 1960s, in particular, a growing number of cognitive theorists studied neuropsychology, neuroscience, and higher mental processes. Described as the cognitive revolution (Naglieri, 1999), this movement had a substantial influence in theoretical psychology and more recently in applied psychology. The impact of the cognitive revolution was first felt with the publication of the Kaufman Assessment Battery for Children (Kaufman & Kaufman, 1983) and most recently with the publication of the CAS in 1997. These tests are based on cognitive, neuropsychological, and factorial views of intelligence studied by contemporary psychologists and have therefore been described as "non-traditional" because of the intent to link theory and practice (Naglieri & Das, 1997).

The CAS is a new measure of cognitive abilities based on the Planning, Attention, Simultaneous and Successive (PASS) theory. The PASS model is a neuropsychological and information-processing theory of cognition, and the CAS is the only test based entirely on this theory (see Das, Naglieri & Kirby, 1994 for more information).

The PASS theory is an alternative to approaches to intelligence that have traditionally included verbal, nonverbal, and quantitative tests. Not only does this theory expand the view of what "abilities" should be measured, but it also puts emphasis on basic psychological processes and precludes the use of verbal achievement-like tests such as vocabulary.

This PASS (Planning, Attention, Simultaneous and Successive) model of intelligence makes use of Luria's three functional units that are said to "work in concert, and necessary for any type of mental activity" (Naglieri & Readon, 1993).

According to Luria's PASS theory, there are three types of cognitive processes responsible for mental activity associated with three functional units of the brain. These processes refer to the mental activities which involved attention (first unit), simultaneous and successive processing (second unit), and planning (third unit) cognitive processes. The first functional unit, located in the brain stem and reticular activating system, provides the brain with the appropriate level of arousal or cortical tone for focused attention and resistance to distraction. The second functional unit (occipital-parietal and frontal-temporal areas of the brain) is responsible for "receiving, analyzing and storing information" using simultaneous and successive processing. The third functional unit is located in the frontal lobes of the brain and is responsible for planning, including the programming, regulation, and verification of behavior (Luria 1973, p. 67). This provides the capability for behavior such as asking questions and problem solving and the capacity for self-monitoring (Das et al., 1994).

Planning is a cognitive process that involves selecting and using strategies in decision making and problem solving. According to Naglieri and Das (1997), "planning is a mental process by which the individual determines, selects, applies, and evaluates solutions to problems". This process requires the ways to solve problems of varying complexity and may involve attention, simultaneous, and successive processes as well as knowledge. According to Naglieri (1999) planning is central to all activities in which there are both intentionality and a need for some method to solve a problem. This process includes self-monitoring and impulse control as well as plan generation. Planning processes are involved in many school tasks.

Attention is a cognitive process that involves focus and concentration to stimulus when there are distractions. This functional unit concerns self directing, information selecting and persistence of responding. Naglieri and Das (1997) describe attention as "a mental process by which the individual selectively focuses on particular stimuli while inhibiting responses to competing stimuli presented over time". This process stresses on the demand of the tasks that involve focused, selective, sustained and effortful activity. According to Naglieri (1999), *focused attention* refers to directed concentration toward a particular activity. While *selective attention* requires the inhibition of responses to distracting stimuli. *Sustained attention* refers to the variation of performance over time which can be influenced by the different amount of effort required.

Simultaneous is a cognitive process which integrates several different stimuli into a whole. In this process, individual have to acquire the ability of making connections between the pieces to be an overall concept. According to Naglieri and Das (1997), "Simultaneous processing is a mental process by which the individual integrates separate stimuli into a single whole or group". The important key of this process is that the person must see how all the separate elements are interrelated in a conceptual whole. Simultaneous processing has strong spatial and logical dimensions for both nonverbal and verbal content. The spatial aspect refers to the perception of stimuli as a whole.

Successive is a cognitive process which applying existing information in more specific requirements. This process demands respondents to remember or use information that follows in a strict, defined order, especially serial and syntactical information. Naglieri and Das (1997) describe successive processing as “a mental process by which the individual integrates stimuli into a specific serial order that forms a chain-like progression”.

The PASS processes form an inter-related system of cognitive processes or abilities that interact with an individual’s base of knowledge and skills. For example, the child, in the early stages of reading, might use Planning processes when making decisions about what to read, finding the first page, and determining how to decode each word. Attention is needed to focus on the appropriate stimulus and ignore distraction. Simultaneous processing is involved in seeing the sentence as a whole, and Successive processing is used to decode words and comprehend information on the basis of syntax or ordering of events. All PASS processes are involved, but at any point there may be a shift in the contribution each is making to the particular goal (Naglieri & Readon, 1993).

In order to operationalize the PASS theory, Naglieri and Das (1997) developed the CAS following a systematic and empirically based method to obtain efficient measures of the PASS processes that could be individually administered. There were several basic assumptions and goals when development of the CAS, which are as follows:

1. A test of intelligence should be based on a theory of ability;
2. The concepts of IQ, intelligence, aptitude, ability, or any other similar terms should be replaced with the concept of cognitive processes;
3. Before being considered as the foundation for a test, a possible theory of cognitive processing should be based on a sizable research base and have been proposed, tested, modified, and shown to have several types of validity;
4. A theory of cognitive processes should inform the user about those specific abilities that are related to academic successes and failures, have relevance to differential diagnosis, and provide guidance to the selection and/or development of effective programming for intervention;
5. A test of cognitive processing should evaluate an individual through items that are as free from acquired knowledge as possible.

The CAS was standardized on a sample of children representative of the U.S. on the basis of race, gender, parental education, geographic location, community setting, and educational placement. The standardization sample was comprised of 2,200 children aged 5 to 17 years. The average Basic Battery reliability coefficients are as follows: Full Scale (.87), Planning (.85), Attention (.84), Simultaneous (.90), and Successive (.90) (Naglieri & Das, 1997).

Numerous studies have shown that measures of processes PASS enjoy construct validity and are related significantly with academic performance. Naglieri (1999) summarized much of this research and concluded that tests based on the PASS theory: (i) are sensitive to the problems shown by children with attention deficit disorder and reading recoding disabilities; (ii) relate to academic achievement; and (iii) have relevance to intervention and instruction.

The purpose of this study was to examine the structure of CAS with a Portuguese sample of 240 elementary and middle school students, using the traditional psychometric parameters and non-metric multidimensional scaling techniques (SSA). We will verify if the construct of constructs of planning and attention as described in the PASS theory of information processing are interdependent processes, questioning the separation of planning and attention processes. Consequently a three dimensional model would be better than a four-factor model, implying the key focus is to treat planning and attention as a variation of speed. If a three dimensional model would result confirmed we will give support to the argument recently advanced by Kranzler, Keith, and Flanagan (2000), which essentially faults the Das-Naglieri Cognitive Assessment System (CAS; Naglieri & Das, 1997) as being unrepresentative of the four cognitive constructs of planning, attention, simultaneous, and successive processing.

Several factor analytic methodologies were utilized to assess the underlying structure of the CAS and provide support for the test`s validity. Confirmatory factor analysis included the assessment of the fit of the PASS model and the comparison of the PASS model to alternative models. Besides the Confirmatory Factor Analysis data were analyzed through Louis Guttman's SSA - a non-metric multidimensional scaling (MDS) procedure.

2. Method

2.1. Participants

The sample included 240 students (120 boys, 120 girls), ages 7 to 15 (M = 10.44 years; SD = 2.63 years), from the general education classes of elementary and middle schools in Portugal. Roughly, equal samples were taken from each of four grades: 2nd year of elementary school (age 7/8, n=60), 4th year of elementary school (age 9/10, n=60), 6th year of middle school (age 11/12, n=60) and 9th year of middle school (age 13/15, n=60). None of the participants was receiving special education services.

2.2. Instrument

The Cognitive Assessment System (CAS) was developed to assess the PASS cognitive processes of children and adolescents (Naglieri & Das, 1997). The basic CAS battery consists of 8 subtests. The PASS processes are reflected in four scales that include the following subtests: *Planning*: Matching Numbers (MN) and Planned Codes (PC); *Attention:* Expressive Attention (EA) and Number Detection (ND); *Simultaneous:* Nonverbal Matrices (NVM) and Verbal-Spatial Relations (VSR); and Successive: Word Series (WS) and Sentence Repetition (SR). PASS scale scores are based on an equally weighted composite of the subtests underlying each respective scale. Naglieri and Das (1997) stated that the PASS scale scores can be used to identify cognitive processing strengths and weaknesses. The Full Scale (FS) score is based on an equally weighted aggregate of the PASS subtests and is interpreted as an estimate of overall cognitive functioning. Further information on the PASS theory, organization of the scales, and development of subtests can be found in the *Interpretative Handbook* (Naglieri & Das, 1997, p.1-25). Additional information can be found in Das, Naglieri & Kirby (1994) and in Naglieri (1999).

2.3. Procedure

The school director, teachers and parents authorized the study. All sub-tests of CAS were administered and scored according to standardisation guidelines as prescribed in the respective test manual. The administration time is approximately one hour (one session).

3. Results

3.1. Descriptive statistics and reliability analysis

Table 1 shows the statistical indices (means, standard deviations, skewness and kurtosis) of the raw results obtained for the 8 subtests from Basic Battery CAS, namely: *Planning:* Matching Numbers (MN) and Planned Codes (PC); *Attention:* Expressive Attention (EA) and Number Detection (ND); *Simultaneous:* Nonverbal Matrices (NVM) and Verbal-Spatial Relations (VSR); and Successive: Word Series (WS) and Sentence Repetition (SR). All the subtests have an adequate Skewness and Kurtosis values (bellow 3 and 7, cf. Kline, 1998), which indicate that the results follow a normal distribution.

To study reliability the internal consistency analysis was used by the split-half method for all Simultaneous and Successive subtests. These coefficients were corrected using the Spearman-Brown formula. Test-retest reliability was considered the most appropriate reliability estimate for the Planning and Attention subtests because these tests involved time. The coefficients ranging from .77 to .92, with an average reliability of .83 (see Table 1). These reliability coefficients also meet the standards suggested by Bracken (1987).

Table 1. Descriptive statistics and reliability for the CAS subtests (based on raw data)

CAS Subtests	Mean	SD	Skewness	Kurtosis	Reliability
Planning: MN	9.98	4.648	1.357	3.077	.89
Planning: PC	53.92	27.759	1.228	1.793	.90
Simultaneous: NVM	18.70	5.809	.173	-.940	.92
Simultaneous: VSR	16.16	3.595	.511	.341	.79
Attention: EA	43.53	16.114	.796	1.242	.84
Attention: ND	53.16	18.347	.635	.336	.77
Successive: WS	10.88	2.583	.645	.822	.79
Successive: SR	7.63	2.263	.078	-.308	.77

3.2. Construct Validity

The progression of scores across age is "a major criterion employed in the validation of a number of traditional intelligence tests" (Anastasi, 1988, p. 153). For this reason, these values are presented in Table 2. The raw scores presented in table 2 demonstrate that the CAS subtests show appropriate changes with age.

Table 2. CAS subtest Mean Raw Score Changes by Age for the Sample (N = 240)

Ages	N	MN	PC	NVM	VSR	EA	ND	WS	SR
7/8	60	5.57	28.68	14.37	14.40	29.97	34.78	9.80	6.40
9/10	60	8.17	40.50	16.90	15.23	37.02	46.13	10.12	7.05
11/12	60	10.93	58.40	19.50	16.45	45.07	58.80	11.32	8.28
13/15	60	15.25	88.08	24.02	18.55	62.05	72.93	12.27	8.80

In Table 3 we presented the correlations (*Pearson product-moment coefficient*) between the standardized results of the CAS subtests.

These correlations provide information about the interrelationships among the various CAS subtests. The results show the evidence of the convergent and discriminant validity.

Table 3. Intercorrelations of CAS Subtests Scores (N = 240)

CAS Subtests	1	2	3	4	5	6	7
Planning: MN	1						
Planning: PC	.40**	1					
Simultaneous: NVM	.28**	.21**	1				
Simultaneous: VSR	.14*	.18**	.35**	1			
Attention: EA	.28**	.26**	.30**	.33**	1		
Attention: ND	.43**	.41**	.18**	.17**	.31**	1	
Successive: WS	.22**	.17**	.27**	.32**	.23**	.09	1
Successive: SR	.33**	.24**	.32**	.33**	.28**	.21**	.72**

* = P< 0.05 ** = P< 0.01

With the purpose of verifying if the CAS structure stayed in the study population, we applied Confirmatory Factor Analysis (CFA). The analysis has been performed with AMOS 21.0. The data was previously standardized. We used the procedure of Maximum Likelihood (ML) as an estimation method, which is better suited in terms of the statistical processing for relatively small samples (200 to 500 subjects). Fit indices chosen were chi-square analysis, CFI (*Comparative Fit Index*), TLI (*Tucker Lewis Index*), RMSEA (*Root Mean Square Error of Approximation*) and AIC (*Akaike Information Criterion*), taking the indices suggested in the literature (Bentler, 1992; Marôco, 2010). We've considered the following values indicative of good fit: CFI and TLI $\geq .90$; $\chi 2/gl \leq .02$ and RMSEA $< .08$. The values of AIC are used for comparing models it is desirable to obtain low values, usually associated with most suitable models (MacCallum and Austin, 2000).

As displayed in the Figure 1, the model derived from the PASS theory provided a acceptable factor structure (χ^2 (14) = 28,553, p = .012, χ^2 / df = 2.040, CFI = 0967; GFI = 0.971, RMSEA = .066, P [rmesea <0.05] = .202). To highlight that all the factorial weights are beyond .05 and $R^2 > 0.25$. The four factors have significant positive correlations, there is a strong correlation between the Planning and Attention (r =. 99).

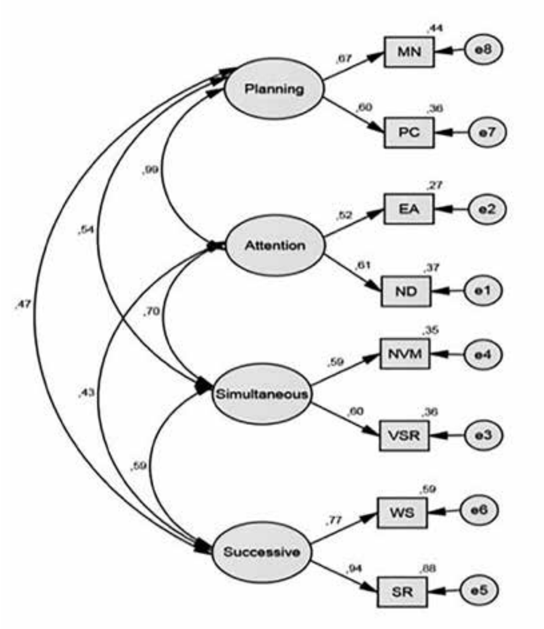

Fig. 1. Confirmatory Factorial Model PASS

Confirmatory factor analysis was used also to assess the comparative fit of two kind of models: (i) Hierarchical and (ii) Non-hierarchical. First, we propose to test the hierarchical model (PASS + g) with our sample. In accordance to Kranzler and Keith (1999) studies, based on Confirmatory Factor Analysis to look at CAS tests, revealed that "they do not support the construct validity of the CAS", suggesting that the constructs measured by CAS are related and that planning and attention are indistinguishable. These authors (p. 26) also believe that "planning and attention are indications of processing speed" and that "successive scale is a measure of short-term memory."

The test of hierarchical model (PASS + g), using CFA are provided in Table 4, and shows values of chi-square and RMSEA higher and CFI and TLI values lower. The lowest AIC for non-hierarchical PASS model indicates that this model is more suitable; underline the arguments from Naglieri and Das (1995).

Table 4. Comparison of Models of the CAS.

Models	x^2	*df*	x^2/df	TLI	CFI	RMSEA	AIC
PASS model	28.553*	14	2.040	.934	.967	.066	72.553
Hierarchical PASS model	42.907*	16	2.682	.894	.939	.084	82.907

Second, we test several non-hierarchical models: a one-factor model – all subtests comprising one factor; a two-factor model – Planning and Attention subtests comprising one factor and Simultaneous and Successive subtests including a second factor [(PA)(SS)]; a three-factor model – Planning and Attention subtests involving one factor, Simultaneous subtests comprising a second factor, and Successive subtests a third factor [(PA)SS]; and the four-factor PASS model. Results from these analyses are provided in Table 5.

Table 5. Comparison of Models of the CAS

Models	x^2	*df*	x^2/df	TLI	CFI	RMSEA	AIC
(PASS)	147.979**	20	7.399	.595	.711	.164	179.979
(PA)(SS)	58.802**	19	3.095	.868	.910	.094	92.802
(PA)SS	31.239*	17	1.838	.947	.968	.059	69.239
PASS	28.553*	14	2.040	.934	.967	.066	72.553

*$p<.05$ **$p<.01$

The chi-square values, TLI and RMSEA for the one factor model indicated poor fit to the data. Each successive model displayed a decrease in the chi-square values. The four factor PASS model resulted in the lowest chi-square values; but, the (PA)SS model presents the highest values of TLI and CFI and lower RMSEA. AIC values indicate that the model (PA)SS is the most suitable (see Table 5).

As we could observe, these results afford support for a four or three factor PASS solution. This distinction between the three and four factor solution, previously stated by experimental versions of CAS designed according to the PASS theory (Kranzler & Weng, 1995a, 1995b; Naglieri & Das, 1995). The decision to derive separate Planning and Attention Scales has been based on theoretical, empirical, and clinical grounds.

As example, we could mention Luria (1973) that differentiated between the first functional unit responsible for cortical tone and "specialized forms of activation or of directed selective attention" (p.265) and the third functional unit, which deals with the creation of plans and verification of activity. Another contribution derives from Barkley (1996) which proposes that behavioural disinhbition plays the central role in attention-deficit/hyperactivity disorders and the several executive functions are secondarily impaired, including one that is critically related to planning.

Naglieri and Das (1997, p. 59) summarize that distinction underlining that: "planning and attention have been described as separate but interwoven processes, and the CAS results mirror this complex relationship". According to Naglieri and Das (1997), the application of four constructs separately according to the theoretical perspective described in PASS Theory, has a considerable clinical utility, especially with studies conducted with special groups (such as mental retardation, learning disabilities, traumatic brain injuries, attention deficit disorders and for severe emotional disorders). The results of such studies suggest the importance of the distinction between planning and attention, as well as simultaneous and successive processes to make assessment and to plan intervention.

3.3. SSA

In order to verify that the empirical structure of the Cognitive Assessment System (CAS) is a new measure of cognitive abilities based on the P*lanning, Attention, Simultaneous* and *Successive* (PASS) Theory data were analysed using Louis Guttman's SSA - a non-metric multidimensional scaling (MDS) procedure. SSA (Smallest Space Analysis our Similarity Structure Analysis; Guttman, 1968) is a technique for structural analysis of similarity data. It provides a metric representation of nom-metric information based on the relative distances within a set of points. Each variable is represented by a point in a Euclidean space of one or more dimensions. The points are plotted in the space of smallest possible dimensionality which preserves the rank order of the relations.

The distance among the points are inversely related to the observed relationships among the variables as defined by the correlations coefficients. When the correlation between two variables is high, the distance between them should be relatively small; on the other end, when the correlation between two variables is low, the distance between their geometric points should be relatively large. This method has been successfully applied in various studies to verify structural hypotheses (e.g., Canter, 1986; Guttman, 1959).

When the SSA dimensionality is higher than two, the program prints out a series of two dimensional plots of the multidimensional configuration. The structure of the relationships among items can readily be examined by considering the configuration of the points. When there is an a priori definitional framework suggested, it is possible to examine whether the space can be partitioned into regions that reflect the facets and their elements. The division into regions is accomplished by introducing partition lines according to the facet definition of the items.

In the previous analysis using Confirmatory factor analysis results supports a non-hierarchical model for a four or three factor PASS solution [PASS and (PA) SS, respectively). Based on these results we would expect to find a non-ordered partition with Planning and Attention subtests very close together in one region. Another aspect not detected by CFA is the fact that some subtest involve words (3:

Successive-Word Series, *Successive*-Sentence Repetition and *Successive*-Verbal-Spatial Relations) and not involving words (5: *Simultaneous*-Nonverbal Matrices, *Planning*-Matching Numbers, *Planning*-Planned Codes, *Attention*-Expressive Attention and *Attention*-Number Detection). We would also expect in this case a separation in two regions of this type of facet.

Figure 2 presents a two-dimensional projection of the SSA space derived from the intercorrelation matrix (Monotonicity Coefficient – see Table 6) of the eight substests of the Cognitive Assessment System (CAS). As we expected the structural organization of the SAC's subtests shows a configuration of polar type, which implies the absence of a sequence, consisting of three distinct regions; a region where the subtests of the Planning and Attention Scales, another region with the Successive Scale subtests and third region with Simultaneous Scale subtests. This structural organization in which the Planning and Attention subtests located together in one region, had already been detected in the Confirmatory Factor Analysis, having been discussed as well.

Table 6. Intercorrelations among the eight subtests of the Cognitive Assessment System (CAS) (Monotonicity Coefficient)

Subtests	1	2	3	4	5	6	7	8
1. Successive: Sentence Repetition	100							
2. Successive: Word Series	89	100						
3. Attention: Number detection	32	15	100					
4. Attention: Expressive Attention	44	36	50	100				
5. Simultaneous: Verbal-Spatial Relations	37	31	9	33	100			
6. Simultaneous: Nonverbal Matrices	47	41	26	44	45	100		
7. Planning: Planned Codes	38	27	58	40	18	33	100	
8. Planning: Matching Numbers	46	33	59	47	15	46	51	100

Decimals were omitted

The nature and content of the tasks that constitute the subtests of Planning and Attention may justify their proximity, as the results in these subtests depend not only on the number of right answers but also on the runtime, which requires processing speed. On the other hand, they are all nonverbal content subtests.

Given the spatial placement of the Successive Scale's subtests, it appears that besides these subtests belonging to a clearly defined region which is detached from the others, the distance between these two subtests is minimal, given that they exhibit a strong correlation. A possible explanation could be that these subtests present identical nature and content (repetition of words and repetition of phrases).

On the other hand, the Simultaneous Scale subtests appear in the same region but slightly apart from each other: the Nonverbal Matrices subtest is nearer the Planning and Attention Scales because of their non-verbal nature; and the Verbal-Spatial Relations subtest is more distanced from all others, since it has a verbal content (which brings it closer to the Successive Scale subtests) and requires at the same time the establishment of spatial relationships, as the Nonverbal Matrices subtest does. Thus a further facet it is possible to be detected: items involving verbal content and items involving non-verbal content. On the right side of the map verbal content items and on the left side non-verbal content items.

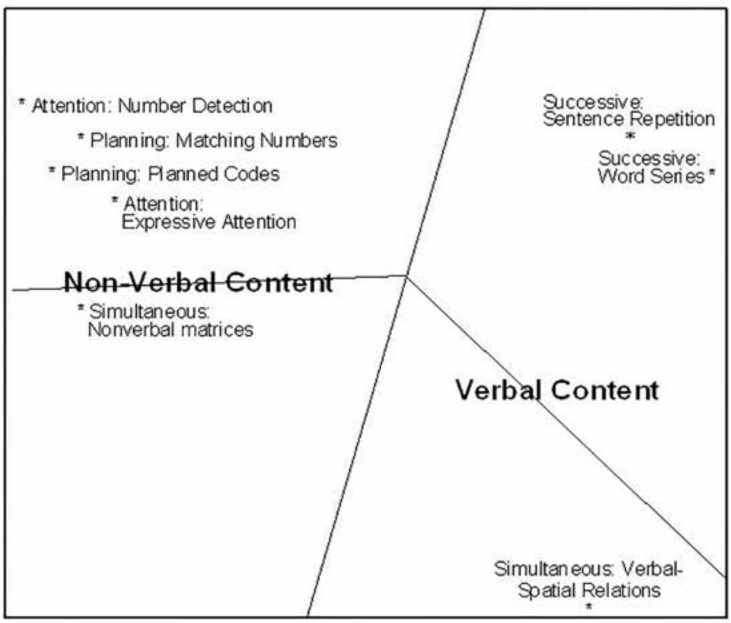

Fig. 2. SSA Map of the eight subtests of the Cognitive Assessment System (CAS) (2-D, coefficient of alienation .08).

4. Discussion

By observing the results obtained through CFA and SSA it can be seen that the hypotheses were basically supported by the empirical data. The type of unordered axial partitioning indicates that we cannot point out a subtest as more important than the others, they are all equally important for the structure in question, considering a non-hierarchical organization.

It is interesting also to point out that the constructs of planning and attention as described in the PASS theory of information processing are interdependent processes, questioning the separation of planning and attention processes. A three dimensional model (Kranzler et al. 2000) seems better than the previously established four-factor model (Naglieri & Das, 1997), implying the key focus is to treat planning and attention as a variation of speed.

We can question in such a way a four-factor model as less strong, suggesting that there is good reason to choose the three-factor model that combines attention with planning, that it is possible to be clearly confirmed in the SSA map.

In the end, facet analysis based on Intercorrelations among CAF items, revealed the underlying empirical structure of the PASS Theory confirming what we found in CFA and and expanding our knowledge about the Cognitive Assessment System (CAS). Thus, notwithstanding there are some similarities between CFA and SSA as both were applied in order to explore the structure of items, nevertheless a facet approach using SSA allowed a deeper understanding of this structure, being more parsimonious and allowing to reach more holistic conclusion from the results.

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Appendix

Planning Scale.

Matching Numbers (MN) consists of four pages, each containing eight rows of six numbers per row. The child is instructed to underline the two numbers in each row that are the same. Numbers increase in length from one digit to seven digits across the four pages, with four rows for each digit length. Each item has a time limit. The subtest score is based on the combination of time and number correct for each page.
Planned Codes (PC) contains two pages, each with a distinct set of codes and arrangement of rows and columns. A legend at the top of each page shows how letters correspond to simple codes (e. g. , A, B, C, and D correspond to OX, XX, OO, and XO, respectively). Each page contains seven rows and eight columns of letters without codes. The child is instructed to fill in the appropriate code in the empty box beneath each letter. On the first page, all the As appear in the first column, all the Bs in the second column, all the Cs in the third column, and so on. On the second page, letters are configured in a diagonal pattern. The child is permitted to complete each page in whatever fashion he or she wishes. The subtest score is based on the combination of time and number correct for each page.

Attention Scale.

Expressive Attention (EA) uses two different sets of items depending on the age of the child. Children 8 years and older are presented with three pages. On the first page, the child reads color words (i. e. , BLUE, YELLOW, GREEN, and RED) presented in quasi-random order. Next, the child names the colors of a series of rectangles (printed in blue, yellow, green, and red). Finally, the words BLUE, YELLOW, GREEN, and RED are printed in a different color than the colors the words name. The child is instructed to name the color ink the word is printed in rather than to read the word. Performance on the last page is used as the measure of attention. The subtest score is based on the combination of time and number correct.
Number Detection (ND) consists of pages of numbers that are printed in different formats. On each page, the child is required to find a particular stimulus (e. g. , the numbers 1, 2, and 3 printed in an open font) on a page containing many distractors (e. g. , the same numbers printed in a different font). There are 180 stimuli with 45 targets (25% targets) on the pages. The subtest score reflects the ratio of accuracy (total number correct minus the number of false detections) to total time for each item summed across the items.

Simultaneous Scale.

Nonverbal Matrices (NVM) is a 33-item subtest that uses shapes and geometric designs that are interrelated through spatial or logical organization. The child is required to decode the relationships among the parts of the item and choose the best of six options to occupy a missing space in the grid. Each matrix item is scored as correct or incorrect. The subtest score is based on the total number of items correctly answered.
Verbal-Spatial Relations (VSR) consists of 27 items that require the comprehension of logical and grammatical descriptions of spatial relationships. The child is shown items containing six drawings and a printed question at the bottom of each page. The items involve both objects and shapes that are arranged in a specific spatial manner. For example, the item, "Which picture shows a circle to the left of a cross under a triangle above a square?" includes six drawings with various arrangements of geometric figures, only one of which matches the description. The examiner reads the question aloud, and the child is required to select the option that matches the verbal description. The child must indicate his or her answer within a 30-s time limit. The subtest score reflects the total number of items correctly answered within the time limit.

Successive Scale

Word Series (WS) requires the child to repeat words in the same order as stated by the examiner. The test consists of the following 9 single-syllable, high-frequency words: Book, Car, Cow, Dog, Girl, Key, Man, Shoe, Wall. The examiner reads 27 items to the child. Each series ranges in length from 2 to 9 words. Words are presented at the rate of 1 word per second. Items are scored as correct if the child reproduces the entire word series. The subtest score is based on the total number of items correctly repeated.
Sentence Repetition (SR) requires the child to repeat 20 sentences that are read aloud. Each sentence is composed of color words (e. g. , "The blue is yellowing"). The child is required to repeat each sentence exactly as presented. To help reduce the influence of simultaneous processing and accent the demands of the syntax of the sentence color words are used so that the sentences contain little semantic meaning. An item is scored as correct if the sentence is repeated exactly as presented. The subtest score reflects the total number of sentences repeated correctly.

Facet Theory

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Editora UFPE

Facet Theory (FT) is a meta-theory for designing structural and other theories in the behavioral sciences.
Basic assumptions of FT are that social and behavioral concepts are complex constructs and that their study, therefore, requires a systematic design for defining observations and for examining the correspondence between the observations and the theory. Because such a definitional design should facilitate the evaluation of systematic relations between the data and the theory, it should lead to cumulative results. In the above sense, FT is a systematic approach for coordinating theory and research.
FT comprises the universe of observations, the population of respondents, and the range of observations. It stratifies these universes by facets and integrates the design by means of a mapping sentence which guides the construction of items and the formulation of hypotheses. Finally, particular multivariate data analysis methods (such as SSA, POSAC, MSA) have been developed to test these hypotheses.
Facet Theory has been successfully applied to a large number of research areas where it has significantly contributed to the discovery and refinement of empirical laws.
Our aims in this book are:
1) To review recent and innovative research results arising from the application of the Facet Theory approach to complex social and psychological issues;
2) To present methodological advances in comparative studies and applications of Similarity Structure Analysis (SSA), Multidimensional Scalogram Analysis (MSA), Factor Analysis (FA), Confirmatory Factor Analysis (CFA), Partial Order Scalogram Analysis (POSAC), and other multivariate procedures and techniques related to FT;
3) To present theoretical advances in Facet Theory and related approaches;
4) To present new reflections on the role of Facet Theory in modern science and in the emergence of new scientific paradigms.

Editors

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