Performance of 2146 Children Ages 5 to 15 with Learning and Behavioral Dysfunction on the Das Naglieri Cognitive Assessment System

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ABSTRACT

This study aims to measure the psychometric properties of the Das Naglieri Cognitive Assessment System (DN-CAS), to examine the construct validity of the Catalan-Spanish version, and to determine its clinical utility in a large bilingual Catalan-Spanish sample (n = 2146). Participant age ranged from 5 years to 15 years old (female 56%). 472 of them were between 5 and 7 years old, 1050 of them were between 8 and 11 years old, and 624 of them were between 12 and 15 years old. The clinical discrimination of the DN-CAS was examined by comparing children with learning difficulties (n = 1160) and behavioral dysfunction (n = 986). A four-factor solution for cognitive performance was demonstrated. The current four-factor structure of the DN-CAS was similar to the original four-factor structure of the test. Furthermore, planning and attention are the most interdependent processes (r > .05, p < .001), and instead successive is the most independent process. Additionally, the DN-CAS, particularly successive and simultaneous, appear as development-related whereas planning and attention are more independent of age. Also, underperformance is mainly linked to successive and instead overperformance is clearly linked to simultaneous. And planning and attention are less susceptible to deviation from the norms independently of age, which is an advantage because intervention is basically based on planning. Finally, an "N" pattern is described in relationship to emotional dysfunction, therefore it represent a marker of emotional dysfunction.

Key Words: ASS, DN-CAS, Cognitive development, Emotional dysfunction, Bilingualism

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Introduction

The Das Naglieri – Cognitive Assessment System (DN-CAS) (Das *et al.*, 1994) has been applied to various educational and clinical settings, learning disabilities, ADHD, developmental disabilities, reading difficulties, mathematical learning, and so on (Perez-Alvarez *et al.*, 2006; 2009a; 2009b). It has proved to be useful not only for assessment but also for intervening in the children's cognitive weakness, which in turn, resulted in academic improvement.

The DN-CAS has been widely applied in North America and has also been standardized in different languages, such as Spanish (Das *et al.*, 2000), Dutch (Kroesbergen *et al.*2003), Greek (Papadopoulos *et al.*, 2009; 2015), and Chinese (Deng *et al.*, 2011). In these studies, the construct validity of the DN-CAS's PASS (planning, attention, simultaneous, successive) model has been empirically confirmed. As far as we know, no study on DN-CAS with the sample size of our study has been so far reported. We know that studies with a large sample size warrants generalization whereas those with a smaller sample are subject to greater sampling error.

The study of cognitive function has interested to numerous researchers in the field of developmental psychology. Cognitive skills are thought to underlie

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the development of higher-order cognitive functions, such as planning, problem resolution, and reasoning, which are core functions of intelligence (Bornstein *et al*., 2013; Dan Cai *et al*., 2016; Das and Georgiou, 2016; Das and Misra, 2015; Das *et al*., 1996; Kroesbergen *et al*., 2003). However, it has not so far been reported a study of DN-CAS on development.

Of particular interest is the relationship between DN-CAS and emotion (Perez-Alvarez and Timoneda-Gallart, 2007; 2014; 2015; Perez-Alvarez *et al*., 2013). It is worth pointing out that the concept of emotion processing has been interpreted in several different ways. In our view, the basic concept underlying the emotional processing is that the root of self-esteem (confidence) and self-concept (beliefs) is subconsciously memorized and neurologically encoded such that negative feeling is encoded as a threat of danger and fear. This means that emotional dysfunction can be expressed in different ways of behaviors. From this conception, we can affirm that an intervention based on strategic techniques and resources of indirect communication (metaphor) and ericksonian hypnosis is an excellent option.

Another point is bilingualism. Although several recent studies have been conducted on cognitive functions in bilingualism, few studies have been carried out on neuropsychological functioning of bilingual children and no studies on bilingual children with specific learning disorder (SLD) or behavioral problems. The effects of bilingualism has been investigated and contradictory results has been so far reported (Hakuta, 1986; Naglieri *et al*., 2007; Riva *et al*., 2017).

The purpose of this study was to examine the psychometric properties and clinical utility of the DN-CAS on Catalan-Spanish bilingual children with behavioral dysfunction or learning disabilities. We hypothesized that the four-factor structure of the DN-CAS would be replicated. Second, we hypothesized that differences in PASS processing would be found, comparing learning with behavioral dysfunction. Third, from many years of expertise and experience with DN-CAS, we hypothesized that development (age) would somehow influence the results of the DN-CAS. Finally, from our experience with DN-CAS, we hypothesized a particular pattern of PASS processes would be a marker of emotional dysfunction.

Method

Design and participants

The current study used a retrospective, observational method to examine a large clinical sample of DN-CAS. The sample was representative of the population of children and adolescents that routinely present to clinical services. In total, 2146 DN-CAS pertaining to 2146 subjects were recruited. Participant age ranged from 5 years to 15 years old (female 56%). 472 of them were between 5 and 7 years old, 1050 of them were between 8 and 11 years old, and 624 of them were between 12 and 15 years old. These groups correspond to three school developmental periods. Data were collected between January 2000 and December 2015. The sample is representative of a country developed economically. All the subjects were Catalan-Spanish bilinguals.

1160 DN-CAS were from subjects with DSM-5 diagnostic criteria for specific learning disability (SLD). Criterion A: symptoms of learning difficulties have persisted for at least 6 months despite the provision of extra help or targeted instruction. Criterion B: the affected academic skills are substantially and quantifiably below those expected for age and cause impairment in academic, occupational, or everyday activities, as confirmed by individually administered standardized achievement measures and comprehensive clinical assessment. Criterion C: age at onset of problems during the school-age years, although may not fully manifest until young adulthood in some individuals. Criterion D: disorders such as intellectual disabilities, uncorrected auditory or visual acuity problems, other mental or neurological disorders as well as adverse conditions like psychosocial adversity, lack of proficiency in the language of instruction, and inadequate instruction were ruled out. All participants spoke their native language (Catalan-Spanish bilinguals). Specific learning disability means a disorder in using language, spoken or written, that may manifest itself in an imperfect ability to listen, think, speak, read, write, spell or to do mathematical calculations. The term does not include learning problems that are primarily the result of visual, hearing or motor disabilities, of mental retardation, of emotional disturbance, or of environmental, cultural or economic disadvantage.

986 DN-CAS were from subjects with DSM-5 diagnostic criteria for conduct disorder.

A working diagnosis within the ambit of DSM-5 was carried out. The inclusion criteria reflected the pragmatic design of the study. Girls often display distinct forms of problematic behavior within the externalizing spectrum, such as covert and relational forms of aggression (e.g., lying, ostracizing peers, spreading rumors) whereas boys more often exhibit overt behaviors, externalizing problems, such as physical violence, impulsivity, aggression, and combativeness. Data from academic achievement were informed by the school teachers. We think that taking teachers´ judgment into consideration is significant to ensure the validity of findings. The teachers were asked to rate the proficiency of each subject with respect to several skills. Each subject was assigned an academic performance score between 1 and 10 such that the lower score, the higher significant the dysfunction.

The evaluators had over 5 years postgraduate experience working with a wide and varied client group including children and young people with social, emotional and behavioral difficulties. Each participant received three assessment sessions. A medical screening was carried out to rule out any psychiatric or neurological illness. As needed, the following studies were carried out: ophthalmological exploration, otorrinolaringology exploration, videoelectroencephalography, somnography, both auditory and visual event-related potential, cardiological examination, and thyroid study. Subjects were excluded if they had any disease and/or medications. Participants each assented to the study, and informed written consent was obtained from a parent/guardian. Prior to testing, written consent is normally obtained from the parents or guardians of the children under 18 years old.

Measures: DN-CAS

All subjects (n = 2146) were administered translated and validated for local population the DN-CAS battery. This battery assesses PASS processing, namely, Planning, Attention, Successive and Simultaneous. Tests of planning are: matching numbers, planned codes, and planned connections. Those of attention are: expressive attention, number detection, and receptive attention. Simultaneous tests are: nonverbal matrices, verbal-spatial relations, and figure memory. Successive ones are: word series, sentence repetition, sentence question (from 8 to 17 years) and successive speech rate (from ages 5 to 7 years). Each of the four PASS scales yields a standard score with a normative mean of 100 and a standard deviation (SD) of 15. For three subtests in each of the four scales, the mean is 10 and the SD is 3. Matching numbers requires children to devise a strategy to find and underline two numbers that are the same in a row. The numbers increase in length from one digit to seven digits. Planned codes show distinct set of codes and arrangements of rows and columns. A legend at the top of each page shows how letters correspond to simple codes (e. g., A, B, C, D correspond to OX, XX, OO, XO, respectively). Children must fill in the appropriate codes in empty boxes beneath each letter in any efficient manner (plan). Planned connections require children to efficiently connect numbers in sequence or numbers and letters in alternating orders. Expressive attention demands children to name the color of ink in the words, blue, yellow, green, and red that are printed according to Stroop phenomenon. Number detection consists of pages of numbers in different formats. Children are required to find, for instance, numbers 1, 2, and 3 on a page containing many distractors (e. g., the same number printed in different fonts). The child's performance is timed and it takes into account accuracy (correct minus false detections). Receptive attention demands the child identify letter pairs that meet specified criteria among many letter pairs that do not. Non-verbal matrices shows shapes and geometric designs that are interrelated through spatial or logical organization. Verbal-spatial relations show drawings and a printed question; for instance, "which picture shows a circle to the left of a cross under a triangle above a square?" Figure memory requires the child to identify a geometric design when it is embedded in a complex figure. Word series demands the child to repeat words in the same order as stated by the examiner. Sentence repetition requires the child to repeat sentences, such as "the blue is yellowing" that are read aloud by the examiner. Sentence questions (for those aged from 8 to 17 years) uses the same previous sentences, but in a different manner. Children have to read a sentence and are then asked a question about the sentence. For example, the sentence: "The blue is yellowing". The question: "who is yellowing?" The answer: "the blue." Successive speech rate requires the child to repeat a series of words in a particular linear order.

Procedure

The participants took the tests individually in a quiet classroom. The tests were administered by a trained senior graduate. Each assessment lasted approximately one and a half hours, with several minutes of rest between the different subscales. The administration order was fixed, and the score for each subtest was computed according to the DN-CAS manual (Naglieri and Das, 1997).

As part of a research project entitled Cognitive and Emotional Processing in the Light of Neuroscience, the protocol was approved by the local ethical committee of XXXs with protocol number R2/15.10.35. We obtained written informed consent from all participants' parents as long as under 18 years.

Data analysis: Statistical analysis

From our database, we took a random subsample of 100 participants (47 boys and 53 girls) considered to be normal children, that is, without clinical dysfunction. 33 subjects were 5-7 years old, 33 subjects were 8-11 years old, and 34 subjects were 12-15 years old. This subsample was used to compare the rate of "N" pattern with the original sample of the study.

We checked normal distribution adjustment by the Shapiro–Wilk test. Principal component analysis, Varimax Rotation, was conducted to test the factor structure of the DN-CAS in the sample. We performed a univariate ANOVA entering task scores as the dependent variable on the sample. Differences were tested with F statistic. Post hoc analyses were conducted using Tukey and Games-Howell tests according to Levene's test. Chi-Square and the Pearson correlation coefficient analysis was computed where appropriate. Statistical analysis was performed using the SPSS 22.0 package

Results

Factor structure

The first step was to investigate the factor structure of the DN-CAS by using Principal Component Analysis, Varimax Rotation, that is, a statistical technique used by the authors of the original factor structure of the test (Das *et al.*, 1994). We did the analyses first for the whole sample (N = 2146), then separately for the three age-groups that we classified, namely, from 5 to 7 (N = 472), from 8 to 11 (N = 1050), and from 12 to 15 years (N = 624). This classification was based on significant stages of development.

The factor structure for the whole sample (Table 1) indicated that the DN-CAS consisted of four factors.

As complementary analysis, the Pearson correlation coefficients were found (Table 2).

Cohen's criteria were applied to judge the Pearson correlation coefficients (weak correlation: r ≥ 0.10, moderate correlation: r ≥ 0.30, and strong correlation: r ≥ 0.50). The results of the correlational analysis indicated strong correlation (r ≥ 0.50) between Planning and Attention. In turn, it showed that Simultaneous correlated moderately with Planning and Attention (rs ranged from 0.37 to 0.45) and Successive correlated weakly with Attention (rs ranged from 0.27 to 0.28) in the age-group 5-11 years old, but did it moderately (r = 0.43) in the age-group 12-15 years old.

Table1. Principal Components Analysis

Varimax Rotation n = 2146				
Variable	**1**	**2**	**3**	**4**
Matching numbers	,741	,130	,114	,288
Planned codes	,780	,109	,136	,216
Planned connections	,720	,122	,246	,249
Expressive attention	,139	,184	,109	,789
Number detection	,431	,035	,214	,676
Receptive attention	,455	,067	,148	,704
Nonverbal matrices	,266	,104	,741	,080
Verbal-spatial relations	,030	,262	,693	,203
Figure memory	,163	,165	,744	,101
Word series	,092	,798	,206	,114
Sentence repetition	,206	,771	,183	,098
Sentence question	,036	,799	,117	,053
Planning	,906	,149	,204	,310
Attention	,417	,116	,191	,878
Simultaneous	,197	,230	,937	,169
Successive	,129	,959	,206	,109
Eigenvalue	7,000	2,508	1,496	1,001
Variance explained	43,75%	15,68%	9,35%	5,94%

Factor 1, *Planning*. Factor 2, *Successive.* Factor 3, *Simultaneous.* Factor 4, *Attention.* The eigenvalues of the four factors were, in descending order, 7.00, 2.50, 1.49, and 0.95, accounting for 43.75%, 15.68%, 9.35%, and 5.94% of the variances, respectively. The four factors together accounted for 74.72% of the variance. As shown, all items loaded highly on the factor with values ranging from 0.67 to 0.95. The four-factor solution was also found in subtotal samples. That is, the same holds true after separating the participants into age-groups.

Table 2. Correlation between PASS processes in each group of age

Group 5 to 7				
Processes	**Planning**	**Simultaneous**	**Attention**	**Successive**
Planning	-------	.459**	0.633**	0,305**
Simultaneous	-------	-------	0,422**	0,390**
Attention	-------	-------	-------	0,287**
Group 8 to 11				
Processes	Planning	Simultaneous	Attention	Successive
Planning	-------	0,447**	0,666**	0,304**
Simultaneous	-------	-------	0,379**	0,455**
Attention	-------	-------	-------	0,272**
Group 12 to 15				
Processes	Planning	Simultaneous	Attention	Successive
Planning	-------	0,450**	0,711**	0,432**
Simultaneous	-------	-------	0,474**	0,493**
Attention	-------	-------	-------	0,438**

Note: **P<001

ANOVA and analysis of CAS performance.

The second step was to search differences in PASS scores between the different groups aforementioned. For this purpose, the data were submitted to one way ANOVA (Table 3).

The results revealed statistically significant effect for group in *planning* (F =100.899, p= .000), *attention* (F=7.855, p=.000), *simultaneous* (F = 59,625, p = .000), and *successive* (F=11.080, p=0.000). That is, there was statistically significant difference among the three age-groups in the case of *planning, attention, successive,* and *simultaneous* as determined by ANOVA. A Levene's test for equality of variance was conducted and found that the assumption of homogeneity of variance was met for *successive* (p = .159), but not for *planning* (p= .001), *attention* (p = .029), and *simultaneous* (p = .003). Post hoc analyses were conducted using Tukey's test for *successive* and Games-Howell for *planning, attention,* and *simultaneous.*

We can see that *planning* and *attention* are better in 5-7 years old group, worse in 8-11 years old group, and even worse in 12-15 years old group. That is, the older, the worse result will be. In turn, *simultaneous* is better in 5-7 and 8-11 years old groups than in 12-15 years old group. And, on the other hand, *successive* is better in 8-11 years old group than in 5-7 and 12-15 years old group.

A complementary analysis of the rate of cases by aging, according to DN-CAS performance (Table 4) was carried out.

Performance is classified as -1DS, -2DS, + 1DS, and + 2 SD processing. Note: PLAN, planning; ATT, Attention; SIM, Simultaneous; SUCC, Successive.

From direct observation (Table 4), we can find and guess what frequencies, isolated or in combination, are relevant in comparison to each other. After guessing, we can summarize as follows:

A. - 2 SD performance; distribution of cases according to age.

5-7 years old (N=476)

[SUCC] = 41 (8.61%) versus [PLAN + ATT + SUCC] + [ATT + SUCC] + [PLAN + SUCC] + [PLAN + ATT] + [PLAN] + [ATT] + [SIM] = 22 (4.62%)

Compared with the rest of processes, *successive* clearly appears as the most susceptible process to statistically significant deficit (χ^2 = 6.13, p = .013).

8-11 years old (N=1050)

[PLAN + ATT + SUCC] + [ATT + SUCC] + [PLAN + SUCC] + [SUCC] = 73 (6.95%) versus [PLAN + ATT] + [PLAN] + [ATT] + [SIM] = 53 (5.04%)

Compared with the rest of processes, *successive*, alone or in combination with *planning* or *attention*, appears as the most susceptible process to statistically non-significant deficit (χ^2 = 3.37, p = .066).

12-15 years old (N=624)

[PLAN + ATT + SUCC] + [ATT + SUCC] + [PLAN + SUCC] + [SUCC] = 57 (9.13%) versus [PLAN + ATT] + [PLAN] + [ATT] + [SIM] = 51 (8.17%)

Compared with the rest of processes, *successive*, alone or in combination with *planning* or *attention*, appears as the most susceptible process to statistically non-significant deficit (χ^2 = 0.36, p = .545).

In sum, in this category (-2SD), *successive* appears as the most susceptible to deficit, but the degree of deficit is maximum in 5-7 years old group, less in 8-11 years old, and less in 12-15 years old,

Table 3. Cognitive processes by aging. ANOVA

PASS Process	Age	N	Mean	DS	F	*p*	Tukey/Games-Howell
Planning	5-7	472	99,61	16,57	100,899	0,000	5-7 > 8-11 > 12-15 8-11 > 12-15
	8-11	1050	93,65	14,26			
	12-15	624	87,05	13,60			
Simultaneous	5-7	472	102,93	12,75	7,855	0,000	5-7 > 12-15 8-11 > 12-15
	8-11	1050	102,29	14,84			
	12-15	624	99,81	15,14			
Attention	5-7	472	101,61	15,93	59,625	0,000	5-7 > 8-11 > 12-15 8-11 > 12-15
	8-11	1050	94,85	15,07			
	12-15	624	91,67	14,49			
Successive	5-7	472	86,30	14,07	11,080	0,000	5-7 < 8-11 8-11 >12-15
	8-11	1050	89,56	13,37			
	12-15	624	87,32	13,83			

Table 4. Rate of cases by aging, according to DN-CAS performance

- 2 SD process distribution of cases according to age			
	5-7 years old (n = 472)	8-11 years old (n = 1050)	12-15 years old (n = 624)
PLAN+ATT+SUCC	2	6	6
ATT+SUCC	2	6	0
PLAN+SUCC	2	0	**17**
PLAN+ATT	0	6	**13**
PLAN	8	**17**	**21**
ATT	6	**26**	**15**
SUCC	**41**	**61**	**34**
SIM	2	4	2
TOTAL	63	126	108
- 1 SD process distribution of cases according to age			
	5-7 years old (n = 472)	8-11 years old (n = 1050)	12-15 years old (n = 624)
PLAN+ATT+SUCC	20	44	53
ATT+SUCC	19	33	16
PLAN+SUCC	7	36	30
PLAN+ATT	7	50	53
PLAN	17	58	55
ATT	8	52	13
SUCC	**85**	**177**	**85**
SIM	8	13	8
TOTAL	171	463	313
+ 2 SD process distribution of cases according to age			
	5-7 years old (n = 472)	8-11 years old (n = 1050)	12-15 years old (n = 624)
PLAN+ATT+SIM	2	2	0
PLAN+ATT	2	2	0
PLAN+SIM	0	2	0
ATT+SIM	0	0	1
PLAN	18	2	0
ATT	9	5	3
SUCC	1	3	0
SIM	7	**23**	**18**
TOTAL	21	39	22
+ 1 SD process distribution of cases according to age			
	5-7 years old (n = 472)	8-11 years old (n = 1050)	12-15 years old n = 624)
PLAN+ATT+SIM	19	16	2
PLAN+ATT+SUCC	1	3	0
PLAN+SUCC+SIM	1	0	0
ATT+SUCC+SIM	0	1	4
PLAN+ATT	27	21	2
PLAN+SUCC	2	0	0
PLAN+SIM	14	17	3
ATT+SIM	14	17	15
SUCC+SIM	1	0	0
PLAN	25	23	6
ATT	45	43	17
SUCC	8	12	4
SIM	**140**	**140**	**69**
TOTAL	297	293	122

Performance is classified as -1DS, -2DS, +1DS, and +2 SD processing. Note: PLAN, planning; ATT, Attention; SIM, Simultaneous; SUCC, Successive.

such that the less age the most deficit will be. One can interpret that successive matures (improves) across the period 5- 15 years old.

B.- 1 SD performance; distribution of cases according to age.

5-7 years old

[SUCC] + [PLAN + ATT + SUCC] + [ATT + SUCC] + [PLAN + SUCC] = 131 (27.52%) versus [PLAN + ATT] + [PLAN] + [ATT] + [SIM] = 40 (8.40%).

Compared with the rest of processes, *successive*, alone or in combination with *planning* or *attention*, appears as the most susceptible process to statistically significant deficit ($\chi^2 = 59.03$, $p = .000$).

8-11 years old

[SUCC] + [PLAN + ATT + SUCC] + [ATT + SUCC] + [PLAN + SUCC] = 290 (27.61%) versus [PLAN + ATT] + [PLAN] + [ATT] + [SIM] = 173 (16.47%).

Compared with the rest of processes, *successive*, alone or in combination with *planning* or *attention*, appears as the most susceptible process to statistically significant deficit ($\chi^2 = 37.92$, $p = .000$).

12-15 years old

[SUCC] + [PLAN + ATT + SUCC] + [ATT + SUCC] + [PLAN + SUCC] = 184 (29.48%) versus [PLAN + ATT] + [PLAN] + [ATT] + [SIM] = 129 (20.67%)

Compared with the rest of processes, *successive*, alone or in combination with *planning* or *attention*, appears as the most susceptible process to statistically significant deficit ($\chi^2 = 12.89$, $p = .000$).

In sum, in this category (-1SD), *successive* appears as the most susceptible to deficit, without statistically significant differences across the age 5-15 years old.

C. + 2 SD performance; distribution of cases according to age.

5 – 7 years old

[PLAN + ATT + SIM] + [PLAN + ATT] + [PLAN + SIM] + [PLAN] = 22 (4.62%) versus [ATT] + [SUCC] + [SIM] = 17 (3.57%)

Compared with the rest of processes, *planning*, alone or in combination with *attention* or *simultaneous*, appears as the most susceptible process to statistically non-significant high performance ($\chi^2 = 0.66$, $p = .413$).

8-11 years old

[SIM] = 23 (2.19%) versus [PLAN + ATT] + [PLAN] + [ATT] + [SUCC] = 12 (1.14%) ($\chi^2 = 3.51$, $p = .060$).

[SIM] + [PLAN + ATT + SIM] + [PLAN + SIM] + [ATT + SIM] = 27 (2.57%) versus [PLAN + ATT] + [PLAN] + [ATT] + [SUCC] = 12 (1.14 %)

Compared with the rest of processes, *simultaneous*, alone or in combination with *planning* or *attention*, appears as the most susceptible process to statistically significant high performance ($\chi^2 = 5.87$, $p = .015$).

12-15 years old

[SIM] = 18 (2.88%) versus [ATT + SIM] + [ATT] = 4 (0.64%)

Compared with the rest of processes, *simultaneous*, alone, appears as the most susceptible process to statistically significant high performance ($\chi^2 = 9.06$, $p = .002$).

In sum, in this category (+ 2SD), *simultaneous* appears as the most susceptible to high performance, but the degree of high performance is maximum in 12-15 years old group, less in 8-11 years old, and less in 5-7 years old, such that the most age the most performance will be. One can interpret that *simultaneous* matures (improves) across the period 5- 15 years old.

D. + 1 SD performance; distribution of cases according to age.

5-7 years old

[SIM] = 140 (29.41%) versus [PLAN + ATT + SUCC] + [PLAN + ATT] + [PLAN + SUCC] + [PLAN] + [ATT] + [SUCC] = 108 (22.68 %)

Compared with the rest of processes, *simultaneous*, alone, appears as the most susceptible process to statistically significant high performance ($\chi^2 = 5.58$, $p = .018$).

[SIM] + [PLAN + ATT + SIM] + [PLAN + SUCC + SIM] + [ATT + SUCC + SIM] + [PLAN + SIM] + [ATT + SIM] + [SUCC + SIM] = 189 (39.70%) versus [PLAN + ATT + SUCC] + [PLAN + ATT] + [PLAN + SUCC] + [PLAN] + [ATT] + [SUCC] = 108 (22.68 %)

Compared with the rest of processes, *simultaneous*, in combination with *planning* or *attention* or *successive*, appears as the most susceptible process to statistically significant high performance ($\chi^2 = 32.10$, $p = .000$).

8-11 years old

[SIM] = 140 (13.33%) versus [PLAN + ATT + SUCC] + [PLAN + ATT] + [PLAN + SUCC] + [PLAN] + [ATT] + [SUCC] = 102 (9.71)

Compared with the rest of processes, *simultaneous*, alone, appears as the most susceptible process to statistically significant high performance ($\chi^2 = 6.37$, $p = .011$).

[SIM] + [PLAN + ATT + SIM] + [PLAN + SUCC + SIM] + [ATT + SUCC + SIM] + [PLAN + SIM] + [ATT + SIM] + [SUCC + SIM] = 191 (18.19 %) versus [PLAN + ATT + SUCC] + [PLAN + ATT] + [PLAN + SUCC] + [PLAN] + [ATT] + [SUCC] = 102 (9.71)

Compared with the rest of processes, *simultaneous*, in combination with *planning* or *attention* or *successive*, appears as the most susceptible process to statistically significant high performance ($\chi^2 = 31.41$, $p = .000$).

12-15 years old

[SIM] = 69 (11.05%) versus [PLAN + ATT] + [PLAN] + [ATT] + [SUCC] = 29 (4.64%)

Compared with the rest of processes, *simultaneous*, alone, appears as the most susceptible process to statistically significant high performance ($\chi^2 = 18.06$, $p = .000$)

[SIM] + [PLAN + ATT + SIM] + [ATT + SUCC + SIM] + [PLAN + SIM] + [ATT + SIM] = 93 (14.90%) versus [PLAN + ATT] + [PLAN] + [ATT] + [SUCC] = 29 (4.64%)

Compared with the rest of processes, *simultaneous*, in combination with *planning* or *attention* or *successive*, appears as the most susceptible process to statistically significant high performance ($\chi^2 = 37.21$, $p = .000$).

In sum, in this category (+ 1SD), *simultaneous* appears as the most susceptible to high performance, but the degree of high performance, although something higher in 12-15 years old (note *p* value), is rather equally distributed.

To sum up the complementary analysis of the rate of cases according to performance by aging, we can conclude two relevant points of practical implication. The first point we need to make is that PASS underperformance is mainly linked to *successive*. One other point is that PASS overperformance is mainly linked to *simultaneous.*

Clinical discrimination of the DN- CAS

The third step was to analyze differences in PASS scores between learning problem group (N = 1160) and behavioral dysfunction group (N = 986) to investigate the clinical discrimination of the DN-CAS. For this purpose, the data were also submitted to one way ANOVA that did not show statistically significant differences.

The "N" pattern

The fourth step was to verify the rate of "N" pattern and its associations (Fig. 1).

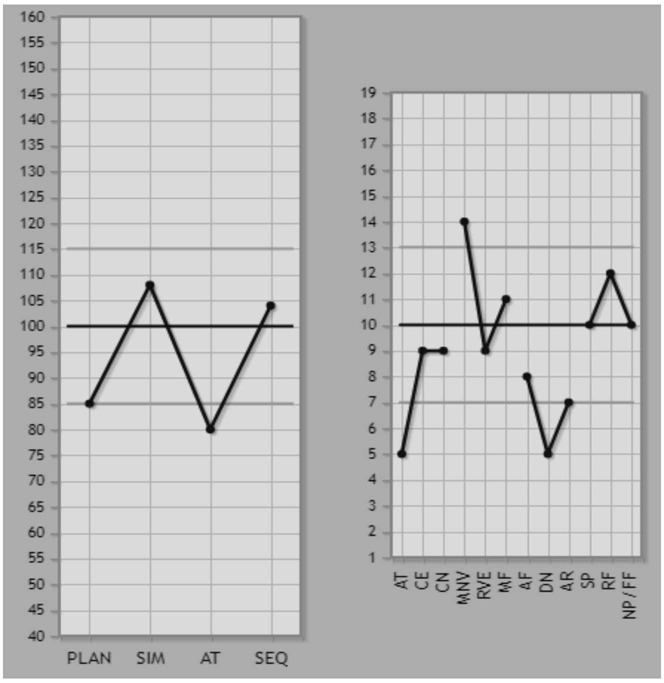

Figure.1 The "N" PASS pattern on the left and on the right a difference larger than one standard deviation between the subtests assessing the same process (i.e., planning, attention, simultaneous, or successive processing). PLAN is *planning*, SIM is *simultaneous*, AT is *attention,* and SEQ is *successive.* On the right, the subtests for each test

The "N" pattern consists of a performance pattern in which the planning standard score is below 85, the simultaneous score clearly above 85, the attention score lower than the simultaneous score, and the successive score in between the attention and simultaneous scores, altogether drawing the "N." The rate of "N" profile was significantly higher among participants with behavioral problems or learning difficulties in comparison to normal children (n = 100). Both learning ($\chi^2 = 5.716$, $p = 0.016$) and behavioral subjects ($\chi^2 = 5.580$, $p = .018$) showed higher rate of "N" pattern at statistically significant level.

On analyzing the rate of "N" pattern according to age, the relationship between the age- groups was statistically significant, $\chi 2 = 10{,}287$, $p < .006$. The percentages of "N" pattern were 2.1% for 5-7 years old, 5.8% for 8-11 years old, and 5.6% for 12-15

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years old. As we can easily to deduce at a glance, the statistically significant difference must be between 5-7 years old and 8-11 years old (χ^2 = 9,974, *p* = .002) and between 5-7 years old and 12-15 years old (χ^2 = 8,315, *p* = .004). That is, the "N" pattern is significantly higher in 8-11 years old and 12-15 years old groups.

A retrospective analysis of all the cases with "N" pattern was carried out. All the clinical histories were analyzed to verify the diagnosis of emotional dysfunction and the response to emotional intervention. Response was defined as a change of this "N" pattern as a consequence of emotional intervention in the sense that *planning* gains score at least to the level of *simultaneous*, thus undoing the "N" pattern. The *planning* has been demonstrated to be clearly influenced by the emotional state. 85% of the cases with the "N" pattern met this criterion.

Discussion

We hypothesized that the four-factor structure of the DN-CAS would be replicated. In agreement with our expectations, that is it (Table 1). Also, *planning* and *attention* appear as two independent processes, contrary to those who combine *planning* and *attention* into one factor (Deng *et al*., 2011). These factor analytic findings are supportive of the PASS model (Naglieri and Das, 1995). In clinical setting, the internal structure of the DN-CAS Catalan-Spanish version is similar to the original, which allows us to ratify the equivalence of the adapted version with the original version. This fact of the factor structure replication is not new. What it is new is the replication in a clinical large sample (n = 2146). Additionally, a complementary correlation analysis (Table 2) supported that *successive* clearly shows the lower *r* score in comparison to *planning, attention, and simultaneous.* We can say that *successive*, although correlated, is the less correlated process and therefore it woks more independently. In contrast, the higher *r* score is *planning* positively correlating with *attention*. A strong correlation means that one value is highly dependant on another, therefore we can assume that they are codependent conditions.

However, contrary to our expectations, statistically significant differences in PASS processing were not found, comparing learning with behavioral dysfunction. Theoretically, we would expect the opposite. However, although each subject met criteria for being included in one or the other group, we can assume that the learning and behavioral groups are not exclusive in the sense that learning is frequently associated with behavioral problems or vice versa. In other words, one subject can meet criteria for learning group and be associated with behavioral problems without criteria for inclusion in behavioral dysfunction group. We can infer that a particular PASS score can be found in a subject with criteria, but also without criteria for being included in a specific group. This can be interpreted as a random distribution of the CAS PASS scores throughout the whole sample.

Throughout the discussion, a third point must be addressed. From many years of expertise and experience with the DN-CAS, we hypothesized that development (age) would somehow influence the results of the DN-CAS. Based on the results obtained and the statistical analysis conducted, we can see (Table 3) that *planning* and *attention* are better in 5-7 years old group, worse in 8-11 years old group, and even worse in 12-15 years old group. That is, the older, the worse result will be. We postulate that this trend has to do with the fact that the role of emotional factor increases with age, and *planning – attention* are more sensible to emotion than the other processes. The process of emotional maturity is necessary for personal growth. In turn, *simultaneous* is better in 5-7 and 8-11 years old groups than in 12-15 years old group. And, on the other hand, *successive* is better in 8-11 years old group than in 5-7 and 12-15 years old group. Concerning *simultaneous* and *successive,* to some degree we must simply admit that this is so, without being able to explain the fact fully.

To further investigate the rate of cases according to performance by aging, the results, as shown in Table 4, show: (a) The younger, the higher deficit of *successive* can be in category -2SD. Therefore, one can interpret that successive matures (improves) across the period 5- 15 years old. (b) The older, the higher performance on *simultaneous* can be in category + 2SD. One can interpret that *simultaneous* matures (improves) across the period 5- 15 years old. Additionally, we can conclude two relevant points of practical implication. The first point we need to make is that PASS underperformance is mainly linked to *successive*. One other point is that PASS overperformance is mainly linked to *simultaneous.* In summary, some kind of cognitive maturation across ages 5-15 years old can be inferred for *successive* and *simultaneous* in categories -2SD and + 2SD. We can speculate on the role of distant connections that typically strengthen with age (Sripada *et al*., 2014). The fact that *successive* stands out is in consonance with correlational results (Table 2) where we can see that *successive* clearly shows the lower *r* score in comparison to *planning, attention, and simultaneous.*

What is striking to us is that *planning* and *attention (selective attention)* do not stand out in any category and in any age-group (± 1/2 SD in processes), which can be interpreted as they are the two PASS processes less susceptible to deviation from the norms, independently of age. Thanks to the introduction of neuroimaging technology together with novel child-appropriate methods in developmental research, we currently know that the development of executive (planning) skills occurs much earlier than was previously thought (Conejero and Rueda, 2017; Dehaene-Lambertz and Spelke, 2015; Doria *et al*., 2010; Huang *et al*., 2015). On the other hand, it has been shown that selective attention at 7–12 months of age predicts general intelligence and academic achievement at age 21 years (Fagan *et al*., 2007).

This fact is an advantage because the PASS intervention is based on training *planning* (strategies) such that we can almost always count on *planning* and *attention* for the purpose. *Planning* is specifically involved in high-level cognitive functioning, such as decision making. Theoretically and practically, PASS intervention is focused on *planning* in order to improve it, which subsequently implies potential amelioration of *successive* and/or *simultaneous* as a good side effect. The positive collateral effect is based on improvement of strategies (*planning*) used to solve a problem requiring *successive* or/and *simultaneous* (Das, 1994; Das *et al*., 1994; Mayoral-Rodriguez *et al*., 2015). This is true even in the case of high *simultaneous.* From many years of experience with DN-CAS we can affirm that *successive* is significantly more resistant to intervention than the rest of processes. This is a relevant practical implication.

A further area of discussion concerns the "N" pattern (Fig.1) and the relationship between *planning* and *emotion.* The concept of emotion processing has been interpreted in several different ways. In our view, the basic concept underlying the emotional processing is that the root of self-esteem (confidence) and self-concept (beliefs) is subconsciously memorized and neurologically encoded such that negative feeling is encoded as a threat of danger and fear. From many years of expertise and experience with DN-CAS (evidence-based practice), we have verified that an "N" pattern is associated with emotional dysfunction, and that this "N" pattern changes as a consequence of emotional intervention (Perez-Alvarez and Timoneda, 2007; 2014) in the sense that *planning* gains score at least to the level of *simultaneous* , thus undoing the "N" pattern. Our clinical experience is consistent with the idea that the "N" PASS pattern and a difference larger than one standard deviation between the subtests assessing the same process (i.e., planning, attention, simultaneous, or successive processing) are both indicators of a likely emotional dysfunction, that is, emotional block (Fig. 1). Conclusively, this pattern allows us to distinguish between children with behavioral dysfunction or learning disabilities associated with emotional dysfunction and normally developed children.

It is widely accepted that emotional-behavioral problems can be cause or consequence of cognitive dysfunction. Emotional state is widely regarded to be related to learning proficiency, therefore emotional dysfunction may be present in both cognitive group and behavioral group. Our findings highlight a facet of the cognitive-emotion association that may shape new thinking and new implications for clinical conceptualizations. Our concept is that externalizing problems manifest primarily as aggression, rule-breaking, and general delinquency, but such problems stem from core negative emotions such as anger, frustration, and futility, all of which conceptually overlap with threat (Mano *et al*., 2017). In fact, this core negative emotions underlie lack of motivation, low self-esteem, negative feelings and lack of interest toward school. It is conceivable that negative emotions (e.g., anger, frustration) that underlie externalizing expressions interfere with higher cognitive systems (Calvo and Eysenck ,1996). There is growing consensus that emotion contributes to academic functioning and vice versa. Children become overwhelmed by negative emotions, they may find themselves worrying about evaluative judgments from others. Such evaluative thoughts (however inaccurate) may be particularly stirring for children with externalizing tendencies, as they may feel provoked to "actout" and retaliate against teachers, parents, and/or peers during academic activities (Jalongo and Hirsh, 2010).

The association between cognitive dysfunction and emotional-behavioral problems leads to some implications. One implication is that directly remediating a child's cognitive abilities may in turn lead to an improvement in emotional functioning and vice versa. Children who experience positive emotions during academic activities are more likely to learn more. Therefore it seems reasonable to recommend emotional-behavioral treatment in any case. Taking into account that *planning*, but not the rest of PASS processes, has been demonstrated to be clearly influenced by emotional state, and on the other hand, both cognitive and emotional dysfunction are frequently associated to *planning* dysfunction, we can always focus our intervention on ameliorate *planning.*

Both externalizing (e.g., anger, combativeness) and internalizing problems (e.g., sadness, anxiety) have been observed among children with both cognitive or emotional dysfunction (Mugnaini *et al*., 2009; Willcutt and Pennington, 2000). Notably, children tend to report stress in the contexts of teacher interactions and performance testing (Alexander-Passe, 2008), both of which are central to academic functioning in general. Emotional problems have been found to particularly disrupt reading comprehension, learning, and decision-making. Evidence suggests that anxiety is particularly disruptive to higher order cognitive functions, which are critical for the comprehension of text, but also for decision-making. And reading comprehension is linked to planning (Das and Georgiou, 2016; Das and Misra, 2015; Das *et al*., 1996; Das *et al*., 2000) and *planning* is linked to emotion. A meta-analytic review suggested that emotional-behavioral problems among those with cognitive dysfunction do not decline but instead persist into adulthood (Klassen *et al*., 2011).

Some points need to be discussed about bilingualism. Our results come from a sample of bilingual children. The subjects of the clinical sample had an adequate knowledge of both Catalan and Spanish languages evaluated through clinical observation conducted by speech therapists, information supplied by their teachers, and finally that all the children have been educated in a Catalan school for at least 3 years. Concerning cognitive functions and bilingualism, if previous studies were oriented to cognitive disadvantages of bilingualism, further studies instead support the hypothesis of positive effects of bilingualism (Hakuta, 1986.) Concerning DN-CAS, a study demonstrated that the cognitive profiles of bilingual Hispanic children were similar in both the English and Spanish version of the DN-CAS (Naglieri *et al*., 2007). In a recent study, the results support the hypothesis of a weakness in metalinguistic abilities in bilingual children with specific learning disorders (Riva *et al*., 2017).

Some limitations of the study are worth mentioning. Particularly, academic outcome was all based solely on teacher report. Some other form of outcome would have helped strengthen the study, and we strongly recommend this be considered for future research. On the other hand, more extensive longitudinal research would be needed to examine individual differences in developmental trajectories. Further longitudinal studies exploring development throughout the life-span may serve to understand cognitive measures. Results of our study need to be confirmed by further research but we believe that if these results are confirmed they must be taken into strong consideration in order to make diagnosis and treatment. A purist would scarcely regard the basic proofs as rigorous in the form given, but we believe that we have indicated its nature and something of its importance.

In conclusion, the major findings of the current study show that the current Catalan-Spanish clinic sample demonstrated a four-factor solution for cognitive performance on the DN-CAS among the children tested. As far as we know, no study on the DN-CAS with a large clinic sample size (n = 2146) has been so far reported. This study confirms that the four basic cognitive processes of the PASS model function in clinical settings and can be measured among diverse cultural and linguistic populations. Additionally, this study supports that *planning* and *attention* are the most interdependent PASS processes, and on the contrary *successive* is the most independent PASS process as can be inferred from correlational analysis. Second, our findings suggest that the DN-CAS is related with development. In particular, this seems true for both *successive* and *simultaneous* whereas *planning* and *attention* are more independent of age. Third, another practical point is that PASS underperformance is mainly linked to *successive*, whereas PASS overperformance is mainly linked to *simultaneous.* Fourth, the fact that *planning* and *attention* appear as the two PASS processes less susceptible to deviation from the norms independently of age is an encouraging finding because intervention is basically based on *planning* training. Finally, the "N" pattern means a useful contribution to the practical application in clinical setting. Information is needed about the nature of this cognitive-emotional relation. This type of research will very likely help to identify not only individual profiles of children at risk of cognitive difficulties, but also environmental factors (emotion) that may serve as protective factors for the optimal development of the cognitive function.

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