Confirmatory Factor Analysis of the Das-Naglieri: Cognitive Assessment System Egyptian Edition: Tests with three Age Groups

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Abstract:

This study aims to measure the psychometric properties of the Das-Naglieri Cognitive Assessment System (D-N CAS-E), and to determine the configural invariance of the four factor theoretical model for the PASS neurocognitive abilities across 3 age-differentiated groups. Confirmatory Factor Analysis (CFA) was conducted to examine the construct validity of the Egyptian version of D-N CAS characteristics among a standardization sample (N=750), normally developed children and late adolescents, divided into 3 different age groups. The current Egyptian sample demonstrated a four factor solution for the PASS neurocognitive abilities among children and adolescents with normal development and different achievement levels. Several fit indices were used including x^2= 34.59 P<.001, df=.88, RMSEA=.012. In addition, the values of AGFI, CFI, and GFI are above .90 and .80 respectively, are indicative for a good fit of the first order PASS model.

All subtests of the battery demonstrated excellent psychometric properties, with acceptable reliability (r=.98, P<.001). Moreover, the results suggested that PASS model and the CAS measures the same constructs with a good fit among various models of different age groups. The findings confirmed, (Naglieri& Das, 1997) the results for which the latent factor of the D-N CAS-E provided the best conceptualization of the underlying interrelations among subtests similar to the original factor structure of the D-N CAS.

Keywords: *Das-Naglieri: cognitive assessment system, Egyptian edition, confirmatory factor analysis, cognitive development, PASS model, Egyptian.*

I. INTRODUCTION

The PASS (Planning, Attention, Simultaneous Processing, and Successive Processing) cognitive processing theory (Das, Naglieri, & Kirby, 1994) can be described as a different approach to re-conceptualization of intelligence based on the neuropsychological work of Luria, A. R. (1966, 1973, 1980, and 1982). It covers a wide spectrum covering developmental and educational psychology for the brain function (Varnhager& Das, 1986). It is based on the view that intelligence is composed of a multi-inter dependent cognitive processes.

Additionally, the functions of the brain that encompass the PASS processes are considered the building blocks of ability conceptualized within a cognitive processing framework. The first functional unit is cortical arousal, which is responsible for regulating the cortical tone and maintaining attentions. The second unit receives, processes, and stores information, encoding it successively and simultaneously. Finally, the third unit provides planning, self-monitoring, and directs mental activity.

According to this theory, planning is a mental process by which the individual determines, selects, applies, and evaluates individuals with solutions to problems. The planning process provides the means to solve problems for which no method or solution is immediately apparent, evaluate effectiveness of a solution, and modify the approach used as needed.

This process is necessary when an efficient and systematic approach to problem solving is required (Naglieri & Das, 1997). It provides an individual with the facility for determining and utilizing an efficient way to solve a problem processing that employs and alters an individual's base of knowledge (Das et al. 1994).

Attention is a mental process by which the individual selectively focuses on particular stimuli while inhibits responses to competing stimuli presented over time. Attention processes require an individual to be focused, selective and effortful.

Simultaneous processing is a mental process by which the individual integrates separate stimuli into a single whole or group (Luria, 1970). The essence of simultaneous processing is that the person must interrelate the elements of the stimuli into a perceptual or conceptual whole. It has a strong spatial and logical-grammatical component.

Successive processing is a mental process by which the individual integrates stimuli into a specific serial order that forms a chain-like progression. The distinguishing quality of successive processing is that each element is only related to those that precede it, and these stimuli are not interrelated. It has a strong serial and syntactic component. All these processes function on the knowledge base which is another vital component of the functioning of the PASS processes.

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It refers to the sum total of a person's experience that has been stored in the memory which is received and processed. An output is programmed, depending on the individual knowledge bases, which represents what could have occurred in all cognitive processes and motor programs.

1. Cognitive Assessment System

The CAS is a multi-dimensional battery designed to measure cognitive functioning based on the PASS model is a multi-dimensional measure of the cognitive functioning based on the PASS theory of intelligence (Naglieri & Das, 1997). The four functioning processes (Planning, Attention, Simultaneous, and Successive) comprise the four scales that make up CAS, which is an individually administered test for children and adolescents ranging from 5 through 17 years of age. The uses of the CAS include diagnosis of learning strengths and weaknesses; classification and evaluating clinical cases (learning disabilities, attention deficit, mental retardation, giftedness); eligibility decisions (meeting state or federal criteria); and consideration of the appropriateness of particular treatment, instructional or remedial programs (Naglieri & Das,1997).

II. EXAMINATION OF CONSTRUCT VALIDITY OF CAS

The four latent-factor theoretical construct validity of the D-N CAS has been empirically confirmed across different language studies, which support the 4 factor PASS solution from a CFA. A three-factor PASS solution was obtained from EFA (e.g., Naglieri & Das, 1997; Maekawa et al., 2007; Papadopoulas et al., 2008; Pérez-Alvarez &Timoneda, 1999; Deng et al., 2011; Dash and Das, 1998).

Furthermore, cross-cultural studies have been studied by (e.g. Naglieri et al., 2007) which compared the performance of referred bilingual Hispanic children on the PASS theory. The results showed that the students scored similarly on their cognitive profiles of bilingual children in both English and Spanish versions, and they earned their lowest scores in Successive Processing and regardless of the language used during test administration; the mean full scale scores and profiles were similar across the languages. Similar to previous cross-cultural studies, (Naglieri et al. 2013) examined the measurement invariance of the D-N CAS in a study with (809) Italian and (1,174) American children. The results of a multi group analysis supported the configural invariance of the D-N CAS factor structure for both the 5-7 and 8-18 year old age groups for the sample who differ on cultural and linguistic characteristics. In addition, Naglieri et al. (2013) concluded that the CAS subtests measure the PASS neurocognitive abilities similarly between groups. Two studies were conducted on the Egyptian population, Ayman,E. (2001), Rasha,M. (2002) which examined the concurrent validation of the D-N CAS, and the results confirmed on the prediction ability in the relation between the CAS Egyptian edition and school achievement.

The purpose of the current study was to examine the psychometric properties of D-N CAS on Egyptian children in an Egyptian context, using the confirmatory factor analysis Amos V.23 across the refined division into different age groups.

III. METHOD

Participants:

The present study used the CAS-E standardization sample, N=750, ranging from ages 8 to 17 years old. They were divided into three age groups: (8-10, 11-13, and 14-17) years old. The sample, selected randomly from different achievement levels, came mostly from middle to upper middle class family levels. None of the participating individuals in this study were identified as having learning, emotional, or sensory disabilities.

Tools:

The PASS Process were assessed with the Das-Naglieri Cognitive Assessment System (Naglieri & Das, 1997). For the purpose of this study, the researchers administered the standard CAS battery, Naglieri and Das (1997) reported good values psychometric for the CAS subscales with average internal consistency values: Planning=.85, Simultaneous=.90, Attention=.84, and Successive=.90.

1. Cognitive Assessment System: Cognitive Processing

The CAS is a standardized test that measures children's mental abilities as defined by the Planning, Attention, Simultaneous and Successive (PASS) theory of cognitive function (Das et al., 1994). The PASS theory, in turn, is based on the work of Luria, whose work linking brain anatomy and function informed much of neuropsychology (Luria, 1966).

Reliability of D-N: CAS for Egyptian sample (Alpha Coefficient) was calculated with split half method and corrected with Spearman Brown formula. The average internal reliability coefficient across all ages of sample N=750, for each one of the scales was (Planning) r=.92, (Attention) r=.90 (Successive) r=.88 and (Simultaneous) r=.91.

Validity:

Construct validity was calculated with confirmatory factor analysis carried out separately in three age groups using Amos (8 to 10, 11 to 13, and 14 to 17 years) on Egyptian sample, in order to assess the internal relationships among the observed variable. The findings of various goodness of fit and incremental indexes indicated a good correspondence.

Planning:

The Planning process is used to allow an individual to select and use different ways and means to resolve a given problem.

The planning process provides the means to solve problems for which no method or solution is immediately apparent. Planning is also important to utilize knowledge and for impulse control. The CAS Planning subtests require the application of different strategies such as Matching Numbers (MN), Planned Codes (PCD), as well as Planned Connections to perform the novel tasks presented (Naglieri, & Das, 1997b)

Attention:

Attention process is used to allow an individual to selectively attend to certain stimulus and inhibits attending to competing stimuli. The successful performance on the CAS Attention subtests requires attention to be focused, selective, sustained,

and effortful through the use of Expressive Attention (EA), Number Detection (ND) and Receptive Attention (RA). The tasks present competing demands on attention therefore require sustained focus over time to identify a target stimuli and avoid distractions. (Naglieri, & Das, 1997b)

Simultaneous

Simultaneous processing involves integrating separate stimuli into a single whole or group. In addition to perceiving parts into a single gestalt, simultaneous processing requires understanding logical-grammatical relationships. Simultaneous subtests in the CAS require the child to perceive objects as a group and to interrelate separate elements into a whole through examination of the stimuli during the activity or through recall.

Nonverbal Matrices (NVM) is a 33-item multiple subtest that utilizes shapes and geometric designs that are interrelated through spatial or logical organization. Children are required to decode the relationships among the parts of the item and choose the best of six options. Each progressive matrix item is scored as correct or incorrect. The raw score is the total number of items correctly answered. The average internal reliability is .89.

Verbal-Spatial Relations (VSR) is composed of 27 items that require the comprehension of logical and grammatical descriptions of spatial relationships. Children are 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"? Would include 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. Children must indicate their answer within the 30- second time limit to receive credit. The raw score is the total number of items correctly answered. The average internal reliability is .83.

Figure Memory (FM) is a 27-item subtest. Children are shown a two- or three- dimensional geometric figure for five seconds. The figure is then removed and the child is presented with a response page that contains the original design embedded in a larger, more complex geometric pattern. Children are asked to identify the original design embedded within the more complex figure. For a response to be scored correct, all lines of the design have to be indicated without any additions or omissions. The total number of correct items is the raw score. The average internal reliability is .89. (Naglieri, & Das, 1997b)

Successive

Successive processing involves working with things in a specific serial order. Perception of stimuli in sequence and the formation of sounds and movements in order are required in successive processing. The Successive subtests in the CAS require the child to either reproduce a sequence of independent stimuli or answer questions based on understanding of syntactic relationships.

Word Series (WS) requires the child repeat words in the same order as stated by the examiner. The test consists of the following nine single-syllable, high- frequency words: Book, Car, Cow, Dog, Girl, Key, Man, Shoe, Wall. There are 27 items which the examiner reads to the child. Each series ranges in length from two to nine words, presented at the rate of one word per second. Each item is scored as either correct if the child reproduces the entire word series in the order presented. The raw score is the total number of items correctly repeated. Word Series average internal reliability is .85.

Sentence Repetition (SR) requires the child repeat 20 sentences that are read to the child. Each sentence is composed of color words (for example, "The blue is yellowing"). The children are required to repeat each sentence exactly as it was presented. Color words are utilized so that the sentences contain little meaning and help reduce the influence of simultaneous processing and accent the demands of the syntax of the sentence. Each item is scored as correct if the sentence is repeated exactly as presented. The raw score is the total number of sentences correctly repeated. The average internal reliability is .84.

Sentence Questions (SQ) is a 21-item subtest that uses the same type of sentences as those in Sentence Repetition. Children (ages 8- 17 only) are read a sentence and then asked a question about the sentence. For example, the examiner says "The blue is yellowing" and asked the following question: "Who is yellowing?" (The answer is "The blue.") Successful completion of this task demands the comprehension of the sentence based on the serial placement of the words. Each item is scored as correct if the child successfully answers the question regarding the sentence. The raw score is the total number of questions answered correctly. The average internal reliability is .84. (Naglieri, & Das, 1997b)

IV. RESULTS

The confirmatory factor analysis (CFA) was conducted using Amos V.23 to examine the measurement invariance of D-N CAS in normal children and adolescents in the Egyptian population. First, the researchers transformed the raw scores for the D-N CAS subtests into Z-scores. Then we tested the four factor PASS model proposed by Das et al (1994) for the whole standardization sample (8-17), and then we divided it into three different age groups (8-10, 11-13, and 14-17). Maximum likelihood estimation procedures were used to analyze the variance/covariance matrix, and the model was evaluated by a set of fit indices that included chi-square value, the goodness of fit index (GFI), and the Adjusted Goodness of Fit Index (AGFI), the Root Mean Square Error of Approximation (RMSEA), the Comparative Fit Index (CFI), the Incremental Fit Index (IFI) the model was fit when the latent structure of the D-N CAS. The results of the CFA in table 1 (appendix) showed that the PASS model fit the data for the standardized sample (8-17) as indicated by x^2=34.59, P<.001 and RMSEA=.012 (<.08).

Table 1: Goodness of fit statistics for Confirmatory Factor Analysis of the CAS students for different age groups.

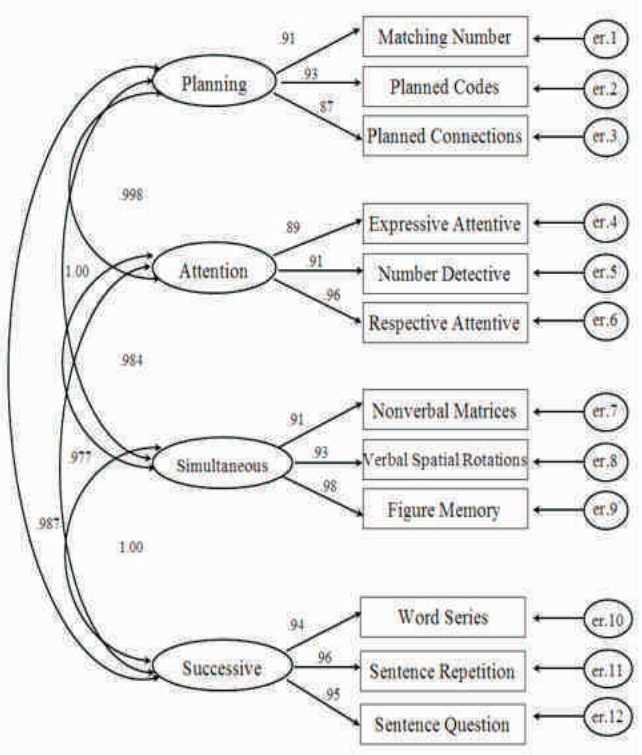
Models	x^2 (df)	x^2 /df	GFI	CFI	AGFI	IFI	RMSEA
Ages 8 - 10	84.9**(48)	1.76	0.93	0.985	0.90	0.98	0.059
Ages 11 - 13	92.14**(48)	1.91	0.91	0.942	0.89	0.95	0.050
Ages 14 - 17	88.62**(48)	1.84	0.976	0.99	0.92	0.962	0.023
Ages 8 - 17	34.59**(28)	1.23	0.987	0.99	0.965	0.99	0.012

Note: DF=degree of freedom; x^2= Chi Square; AGFI=Adjusted Goodness of fit indices; RMSEA=Rood mean Square Error of Approximation; GFI=Goodness of fit index; CFI=Comparative Fit Index; IFI=Incremental Fit Index

*p<.05, **p<.01

The Latent Structure of the D-N CAS

The result of CFA in figure (1) showed that the PASS model fits the data very well for the whole sample (8-17) as indicated by x^2=34.59, p<.001 and RMSEA=.012(<.08).



Moreover, the diagnostic indices for the models presented in table (2), indicate that, GFI and CFI, are both above .90 and the other indices, (AGFI, IFI) are above .85 respectively, which indicates that the four latent factors provide an excellent fit with the patterns of neurocognitive performance observed in the Egyptian participants.

Table 2: Maximum likelihood factor loadings from the CFA are for the different age groups

Subtests	Age Groups			
	8 - 10	11-13	14-17	Total Sample (8-17)
Planning				
Matching numbers	0.68	0.628	0.645	0.91
Planned Codes	0.65	0.557	0.67	0.936
Planned Connect	0.69	0.65	0.687	0.87
Attention				
Express Attention	0.78	0.718	0.45	0.89
Number Detection	0.72	0.677	0.66	0.91
Receptive Attention	0.836	0.604	0.768	0.96
Simultaneous				
Non-verbal Matrix	0.61	0.764	0.53	0.904
Verbal.-Spatial	0.694	0.77	0.761	0.934
Figure Memory	0.66	0.616	0.612	0.878
Successive				
Word Series	0.719	0.55	0.762	0.94
Sentence Repetition	0.816	0.78	0.74	0.96
Sentence Questions	0.57	0.56	0.61	0.945

Furthermore, the results of factor loadings of the data shown in table 2 (appendix) for each subtest on the four latent PASS factors are all above (.40). These findings indicate that the subtest demonstrated appropriate loadings on the latent factors to which they were assigned. Thus, this confirms the theoretical assumption for PASS model and is an indication of the relationship between each subtest and the factors on which the subtests are matching number, planned codes, and planned connections are associated with Planning. Expressive attention, number detection and receptive attention are associated with Attention. Non-verbal matrix, verbal-spatial relations, and figure memory measured Simultaneous Processing, and finally word series, sentence repetition and sentence questions are affiliated with Successive Processing. Moreover, we compared the factor loadings of the data for the D-N CAS along with the standardization of the U.S. sample for each age group (8-10, 11-13, 14-17 years) taken from the D-N CAS manual (Naglieri& Das, 1997 p.54-55). The result suggested that the factor loading for the Egyptian and the U.S. PASS theory are nearly identical.

Test-Retest Reliability

Using test-retest correlation of the D-N CAS subtests was calculated and corrected with Spearman Brown's formula. The correlation Coefficients demonstrates a positive significant correlation. Coefficient range is from .95 to .98, p<.001.

V. DISCUSSION AND CONCLUSION

There were two main aims to this study. First, to re-examine the construct validity of the Das-Naglieri Cognitive Assessment System among the normal Egyptian sample. Second, to investigate the configural invariance of the four latent PASS neurocognitive factors across different age groups. A Confirmatory Factor Analysis Amos V.23 was performed. The major findings of CFA suggest that the latent structure of the Egyptian sample were consistent with the theoretical framework for the PASS neurocognitive model and with D-N CAS among the sample tested (Naglieri& Das, 1997). However, there were various goodness of fit and incremental indices which indicated a good correspondence. The results of the x^2 values and RMSEA values showed that the four-latent factor PASS model had an acceptable fit to the data. The values of other fit indices AGFI, CFI and GFI were above .90 and .80 respectively which is an indication for a good fit (Kline, 2005).

Moreover, the researchers analyzed the variance-covariance matrices for each age, for the comparison of the relative fit of the various models see table (1 in appendix). The factorial results revealed the similarity of factor structures of the Cognitive Assessment System across different age groups; which showed that the (CAS-E) subtests measure the PASS neurocognitive abilities similarly between groups for the Egyptian sample. The present results support (Naglieri& Das, 1997a) who have stated that the PASS Processing model described by Luria is a valuable multi-dimensional model to operationale the assessment of human neurocognitive functioning as measured by the CAS and provides the best conceptualization of the underlying interrelations among the

subtests included in CAS-E. The findings of the present study (i.e. fit indices and the factor loadings of the PASS model) confirmed that the D-N CAS-E can be used to investigate the neurocognitive performance for normal Egyptian children and adolescents, which followed the results of previous studies among diverse cultural and linguistic populations (e.g. Johnson, 2008; Naglieri & Das, 1997; Papadopoulos, Georgiou, Kendeou, & Spanoudis, 2008; Pérez-Alvarez & Timoneda, 1999; VanLuit et al., 2005; Dash & Das, 1998; Moekawa et al. 2007; Deng et al., 2011). Along the lines of other works (Suzuki & Valencia, 1997; Fagan, 2000). The present results supports that the PASS theory of intelligence is based on the assessment of neuropsychologically defined constructs that is conceptualized as the "psychologically and functionally distinct" (Naglieri, Das & Jarman, 1990, p.429), which may have advantages over traditional IQ tests and therefore may be more appropriate for use across students of diverse characteristic as well as different ages.

Apparent limitation of the study are worth mentioning. First, the chosen source of sample for the normal students with different achievement levels in this study was limited to a small demographic region of the whole population; therefore the results of the study are restricted to the regions under investigation mainly the central region. Second, the Egyptian sample may not represent the country on the basis of parental education levels, and it also does not verify the clinical discrimination of D-N CAS within Egyptian schools and clinics, which suggests that further cross validation with a larger sample size is warranted.

Summing up, the researchers have confirmed our assumption of a latent structure for PASS neurocognitive abilities in general, and D-N CAS subtest on the Egyptian population, in particular, which are reliable and valid. Furthermore, it was invariant across different age groups. Future research should be conducted across cultural studies which may make the battery more widely used, resulting in valid measures. In addition, studies should be conducted on theory and D-N CAS on clinical diagnosis and intervention in the Egyptian samples.

The research findings confirmed (Suzuki & Valencia, 1997; Fagan, 2000) which suggested that measuring intelligence using a processing theory could yield a significant difference between groups that differ in cultural and linguistic backgrounds.

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