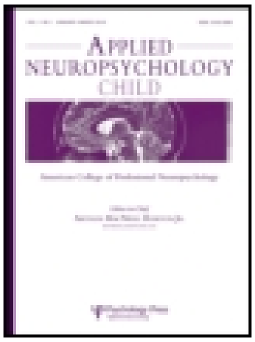

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Analysis of Internal and External Validity Criteria for a Computerized Visual Search Task: A Pilot Study

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Inhibition is one of the main executive functions, because of its fundamental role in cognitive and social development. Given the importance of reliable and computerized measurements to assessment inhibitory performance, this research intends to analyze the internal and external criteria of validity of a computerized conjunction search task, to evaluate the role of perceptual inhibition. A sample of 41 children (21 females and 20 males), aged between 6 and 11 years old ($M = 8.49$, $SD = 1.47$), intentionally selected from a private management school of Mar del Plata (Argentina), middle socio-economic level were assessed. The Conjunction Search Task from the TAC Battery, Coding and Symbol Search tasks from Wechsler Intelligence Scale for Children were used. Overall, results allow us to confirm that the perceptual inhibition task form TAC presents solid rates of internal and external validity that make a valid measurement instrument of this process.

Key words: *children, conjunction search task, perceptual inhibition, TAC, validity*

Executive Functions (EF) are a set of high-level mental processes that help regulate thoughts, behaviors and emotions in situations that require concentration and when automatic, overlearned responses are insufficient (Diamond, 2013; Espy, 2004). Presently, most of the focus is on EF as multidimensional constructs, which is why the literature refers to a set of executive "functions" or "processes" that can be thought of as totally (Carlson & Moses, 2001; Pennington, 1997) or partially separable from one another (Miyake et al., 2000). There is, however, consensus in regarding working memory, cognitive flexibility, and inhibition as the principal executive components (Diamond, 2013; Miyake et al., 2000).

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Since the 1990s, research on inhibition has been gradually increasing. This is probably due to a heterogeneous set of factors, such as the importance attributed to this mechanism by current theories on cognitive development and change (Dempster, 1991; Harnishfeger, 1995), the discovery of inhibition's neuroanatomical substrate in the prefrontal cortex (Bunge, Dudukovic, Thomason, Vaidya, & Gabrieli, 2002; Nee, Wager, & Jonides, 2007) and the discovery of its central role in selective attention (Bjorklund & Harnishfeger, 1990; Müller, Zelazo, Hood, Leone, & Rohrer, 2004). Various fruitful lines of research have emerged, chief among them the analysis of inhibition's role in the acquisition of social and cognitive competencies during childhood and adolescence (Bull, Espy, & Wiebe, 2008; Clark, Pritchard, & Woodward, 2010; Moffitt et al., 2011), the development of various models of the structure of inhibition (see Friedman et al., 2006; Howard, Johnson, & Pascual Leone, 2014), and the development of methods and paradigms based on recent inhibition models (Friedman et al., 2006; Miyake et al., 2000; Nigg, 2000).

Inhibition, like other executive processes, contributes in a direct and differential way to the achievement of our goals and objectives. Its principal function is to detain, halt or diminish the activation of those behaviors, emotions and thoughts that tend to impose themselves forcefully and can therefore interfere with the achievement of our objectives (Friedman et al., 2006; Miyake & Friedman, 2012; Nigg, 2000). Interestingly, some authors propose that executive control capabilities such as inhibition, can vary in regard to domains of functioning (perception, emotion, cognition and behavior) as well as by area of involvement (intrapersonal, interpersonal, symbol system, and environment) (see McCloskey's model of Executive Functions, in McCloskey, Perkins, & Van Divner, 2009).

Without inhibitory control, we would be at the mercy of our impulses and those environmental and contextual factors that drive us in a certain direction or to a specific place, making it impossible for us to change our behavior or way of thinking (Diamond, 2013). In general terms, the inhibition function seems to be implied in mental health, psychological wellbeing and people's quality of life (Bauer & Baumeister, 2011; Moffitt et al., 2011; Scholer & Higgins, 2011). In children, it is closely associated with academic performance (see St Clair-Thompson & Gathercole, 2006; Stevens & Bavelier, 2012), actively intervening in the efficient realization of school activities (Best, Miller, & Jones, 2009).

While there is a heated debate as to the one- or multidimensional structure of inhibition, the literature tends to identify perceptual, cognitive, and behavioral inhibition as the principal inhibitory types, each with well differentiated functional and operative characteristics (Hasher & Zacks, 1988; Nigg, 2000). Briefly, perceptual inhibition is responsible for suppressing the interference generated by distracting environmental stimuli, cognitive inhibition works by deactivating irrelevant representations and thoughts that are active in the attentional focus, and lastly behavioral inhibition suppresses inadequate and prepotent motor responses (Diamond, 2013).

Interest in determining inhibition's structure is tied to the discussion about the methods and paradigms used to evaluate the different inhibitory types. Nowadays, Confirmatory Factor Analysis (CFA) is considered one of the most adequate statistical methods to verify the validity of the different inhibition models (Friedman & Miyake, 2004). Techniques that use direct measures such as correlation are inappropriate given that the absence of correlation does not necessarily imply the independence of components that integrate a construct (Borsboom, Mellenbergh, & Heerden, 2004; Miyake & Shah, 1999). Low reliability and the problem of impurities in executive measures are the two principal factors for this situation (see Miyake et al., 2000; Ven, Kroesbergen, Boom, & Leseman, 2013). The CFA requires the use of multiple measures for each factor, and therefore the majority of studies include at least three measures per inhibitory type (see Friedman et al., 2006; Miyake & Friedman, 2012; González Osornio, & Ostrosky, 2012). Unfortunately, a diverse set of computerized measures that may allow a valid and reliable measure of the different inhibitory types is unavailable in our field. This hampers the collection of empirical evidence to validate a multidimensional approach on executive functions through the measurement of the different types of implied processes. For this reason, it is important to have a set of reliable and valid measures to evaluate each inhibitory type.

The abovementioned issues make clear a series of problems related to the evaluation of executive functioning, specifically inhibitory functioning: (a) batteries specifically designed and adapted to measure the development of each executive function in depth are scarce (Injoque Ricle, Calero, Alloway, & Burin, 2011; Marino, 2010); (b) many scales tend to evaluate various processes at the same time, which makes it impossible to measure each process independently; (c) some batteries use overlapped measures, such as the evaluation of cognitive inhibition with an elevated demand for WM, which creates problems when interpreting test results (Dehn, 2010); (d) tasks that are traditionally administered to adult populations cannot be merely simplified so as to be applied to child populations because these types of adaptations tend to affect the psychometric validity of the task (Garon, Bryson, & Smith, 2008); and (e) many EF tests have weak psychometric properties (Bishop, Aamodt-Leeper, Creswell, McGurk, & Skuse, 2001).

In summary, the problem relative to the nature of inhibition is identical to the one which was set in the case of EF and is known as the *unity and diversity problem* (or the nonunitary-unitary approach) (Garon et al., 2008; Miyake et al., 2000). The low reliability and the executive-measures impurity problem are the two major factors responsible for this situation (Miyake et al., 2000). Therefore, based on the previously discussed issues, a software program was developed in order to assess the different self-regulation processes: Cognitive Self-Regulation Task Battery (or *Tareas de Autorregulación Cognitiva, TAC*, in Spanish) (Introzzi & Canet Juric, 2014).

The tasks that comprise the TAC have been designed based on a series of experimental paradigms that have been extensively validated in the field of cognitive and experimental psychology, and its main feature is the attempt to reduce to the fullest extent the participation

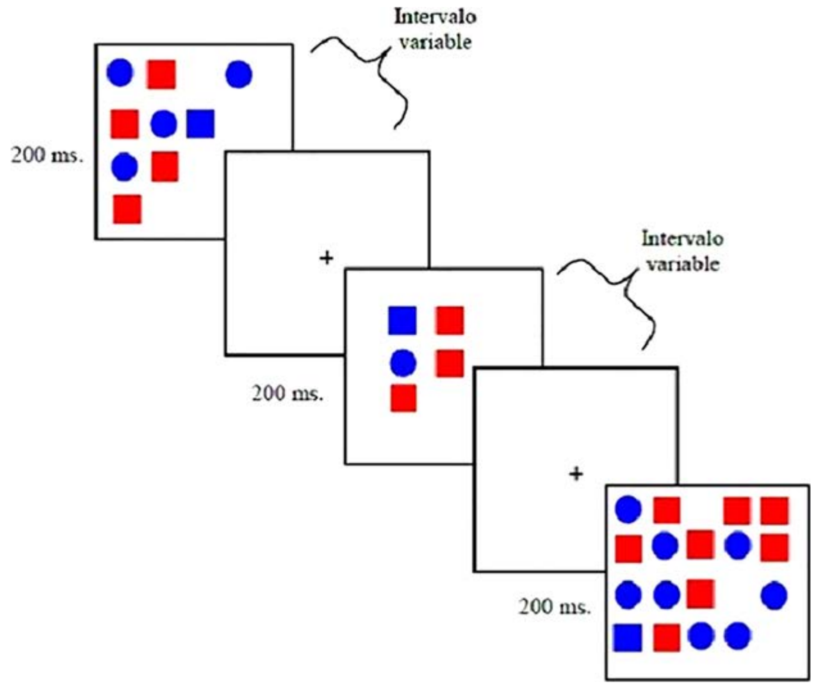

FIGURE 1 Conjunction Visual Search Task of the TAC. Example of 3 trials taken from one block with 8, 4, and 16 distractors with target. Target: blue square. From Introzzi, Canet Juric, Montes, López, and Mascarello (2015).

of other executive and nonexecutive processes. From a multifactorial inhibition model, a perceptual inhibition task was designed and developed. The TAC provides a Conjunction Visual Search (CVS) task to evaluate perceptual inhibition (see Figure 1). In visual search paradigms, the main objective is to search for and identify one or more target stimuli among other distractor stimuli. In computerized tasks, several trials are usually presented with a variable number of distractor stimuli among which the target may or may not be present, and the participant is to press one of two keys to signify the target's presence or absence. The traditional performance indices are reaction time (measured in milliseconds) and response precision (number of correct responses). The complexity of the task is increased by the number of stimuli (distractor and/or target) presented in each trial (van den Heijden, 1992); thus, the greater the number of distractors, the greater the interference is assumed to be, and consequently the greater the demand on inhibitory functioning (Poole & Kane, 2009). Furthermore, the longer the response times (RT) and the higher the percentage of errors, the lesser the efficiency of perceptual inhibition (Darowski, Helder, Zacks, Hasher, & Hambrick, 2008; Treisman & Sato, 1990). However, it should be mentioned that in some instances a participant might reduce the response time to the detriment of response precision in order to perform the task more rapidly, while in other instances he/she might increase the response time to improve response precision (Proctor & Vu, 2006). This effect, which involves an inverse relationship between two variables, is known as trade-off and it is an important consideration in the methodological design of studies that evaluate EF, as well as in the interpretation of results (Kreutzer, Caplan, & DeLuca, 2011).

For these reasons, and considering the existing limitations in the evaluation of the various inhibitory types, in addition to the need for valid measures for this purpose, this study seeks to examine different validity types for the TAC task designed to evaluate perceptual inhibition in children between the ages of 6 and 11. Hence, we shall estimate: (1) the task's *internal validity*, by analyzing whether the performance indicators concur with the theoretical postulations of the paradigm on which the task is based; and (2) the task's *convergent type of external validity,* by comparing performance indicators with those obtained in tests that evaluate the same process.

METHODS

Participants

The sample consisted of 41 children (21 girls and 20 boys) between the ages of 6 and 11 ($M = 8.49$; $SD = 1.47$), selected via intentional sampling of an available population of 68 children at a private school of middle socioeconomic status in the City of Mar del

Plata, Argentina. This selection was based on the correctness of both the paper-and-pencil and computerized task for each child. Also, the socioeconomic status of the sample was obtained by means of the Hollingshead Social Status Index (Spanish version, Navarro-Guzmán, 2005) which was completed by parents and/or caregivers of each subject. This allowed valuing the socioeconomic status for each family. The mean score of the entire sample fell into the middle socioeconomic status range, according to their occupations and/or professions (most of them possesses a secondary or higher education level, and engage in commercial activities, or have a small business office). The sample was split into three groups: Group 1 (G1) comprised of children in the first grade ($n = 15$) with an average age of 6.78 year ($SD = 0.31$); Group 2 (G2) comprised of children in the third grade ($n = 18$) with an average age of 8.79 years ($SD = 0.37$); and Group 3 (G3) comprised of children in the fifth grade ($n = 8$) with an average age of 10.71 years ($SD = 0.34$). We considered including correspondence between age and grade, in order to avoid bias from grade repeater and adopt the use of a common criterion in all groups: academic grade level (6–7 years old in first grade, 8–9 years old in third grade, and 10–11 years old in fifth grade). Before the analyses were carried out, 3 cases were eliminated due to anticipatory responses greater than two Standard Deviations, assuming a normal distribution of response time. RTs were calculated based on correct responses.

The following inclusion criteria were employed: nonrepeating students; not undergoing psychological or psychiatric treatment at the time of the evaluation; and no precedent of a learning or developmental disability according to reports provided by teachers.

Instruments

This study used the CVS task from the computerized Battery TAC, to evaluate perceptual inhibition. As mentioned previously, the task is based on the Treisman and Gelade (1980) CVS experimental paradigm. This task asks the participant to identify the presence or absence of a target stimulus (blue square, 0.8 cm on a side) that appears mixed in with a set of similar distractors (blue circles with diameters of 0.8 cm and red squares of 0.8 cm on a side) over the course of several trials. Before each trial, a cross appears on the screen for 200 milliseconds, the participant types a response and the next trial appears automatically. The stimuli are distributed randomly in a matrix of 7×6 cells, 9.5 cm wide and 8 cm high. The task consists of a block of 10 practice trials, followed by three blocks of 40 trials each. In each block, the trials are defined by the number of distractors. Thus, there are four sets of 10 trials with 4, 8, 16 and 32 distractors per block. For each trial, the participant is to respond as quickly and precisely as possible, typing "Z" if the target is present and "M" if the target is absent.

The main performance indices are average reaction time (RT) and the percentage of correct responses for each block, broken down by the number of distractors. The longer the response times (RT) and the greater the percentage of errors, the lesser the efficiency of perceptual inhibition (Darowski et al., 2008). The average execution time across the entire sample was 2 minutes 59 seconds ($SD = 48$ seconds); in first graders was 3 minutes 35 seconds ($SD = 58$ seconds), in third graders was 2 minutes 51 seconds ($SD = 29$ seconds), and in fifth graders was 2 minutes 18 seconds ($SD = 22$ seconds).

Additionally, we employed the Wechsler's Intelligence Scale for Children (WISC-IV), which consists of a battery to measure cognitive capabilities and has been widely used and reviewed (Wechsler, 2005). We selected two subtests: Coding (CD) and Symbol Search (SS), because they are widely known in our environment, and so clinical psychologists and researchers often use them for both selective attention and inhibition assessment. In CD, the child copies figures paired with geometric shapes (ages 6–7 yr) or numbers (ages 8–16 yr); first the child must attend to the shape or number and then copy the corresponding figure in a limited amount of time. On the other hand, in SS, the child must indicate, in a limited amount of time, if one or many target symbols coincide with a group of search symbols. Both target and search group lengths depend on age. Both tasks were selected because they involve attention, activation of goals, ignoring distractors, visual perception, motivation, and tolerance to repetitive tasks (Baumann & Burin, 2007; Cayssials, 1998; Lezak, 1995). It is important to note that, in the case of WISC-IV, this study used a regional version developed for the City of Buenos Aires and its suburbs (Argentine adaptation of WISC-IV, Taborda, Brenlla, & Barbenza, 2011).

Procedures

The evaluation instruments were administered on an individual basis by a professional specially trained for that purpose. For this, professionals assessed a pilot sample ($n = 10$) and detected minor issues with the task, which were corrected before assessing participants of the present study. All the professionals were psychologists from the Faculty of Psychology of the National University of Mar del Plata, and they received training during two weeks. The order in which the instruments were administered was counterbalanced. Informed consent was sought from parents and/or caregivers, and the children were asked for their consent to participate in the study. The study was implemented following the ethics guidelines that cover activities aimed at furthering knowledge of psychological processes in human beings (Law 11044 of the Province of Buenos Aires), the procedures recommended by the American Psychological Association, the principles established under the International Convention on the Rights of the Child and National Law 26061 and Provincial Law 13298 on the Comprehensive Promotion and Protection of the Rights of the Child, as well as CONICET's guidelines on ethical behavior in the Social Sciences and Humanities (2857/06).

Data Analysis

The data were processed and analyzed with free-access statistics software. The analysis was divided in various stages. First, exploratory analyses were undertaken with normality tests and shape indices (Asymmetry and Kurtosis). Second, descriptive statistics were obtained for each variable and grade level, and for the sample as a whole. Third, in order to study internal validity criteria, an One-way Analysis of Variance (ANOVA) was undertaken, as well as *t*-test for related samples. Fourth, in order to analyze external validity criteria, we conducted correlations among the perceptual inhibition tasks, including the RT4 index as a co-variable to control for the processing speed effect on task performance. Based on these results, we undertook a chi-square test of independence (χ^2) and tested differences between means per grade level.

RESULTS

Internal Validity Testing

First we analyzed the two main internal validity criteria of the paradigm on which the task is based (Treisman & Gelade, 1980; Treisman & Sato, 1990).

Criterion 1: Average RT increases and the percentage of correct responses decreases as the number of distractors increases.

To verify that the task met this criterion, a one factor repeated measures ANOVA (within subjects) was performed. Four levels were defined for the *number of distractors* factor: 4, 8, 16, and 32 distractors. The dependent variables were average reaction times (RT) and the percentage of correct responses. Significant interactions between the percentage of correct responses and the number of distractors (within subjects factor) were obtained [$F(2, 35) = 89{,}24$, $p < .05$, effect size = .48] as well as between RTs and number of distractors [$F(2, 35) = 1918{,}88$, $p < .05$, effect size = .95]. The results show that as the number of distractors increased, the RTs tended to increase while the percentage of correct responses tended to decrease (see Table 1), thus meeting this validity criterion.

Criterion 2: Presence of longer average RTs in cases when target is absent compared to cases when target is present.

To verify that the task met this criterion, a *t*-test for related samples was performed in order to compare RT averages and correct response averages in trials with 4, 8, 16, and 32 distractors in which the target was and was not present. As shown in Table 2, when the target was absent, average RTs were significantly longer than when the target was present ($p < .05$, in the four blocks), thus meeting this validity criterion.

We then carried out a reliability analysis on the performance indicators (Precision and RT) for each target condition based on the number of distractors in the CVS task using Cronbach's alpha ($\alpha = .79$). This value guarantees a high degree of reliability in the task scores. The RTs are shown to contribute to the Visual Search Task reliability, since it can be observed that Cronbach's alpha decreases if these items are eliminated. Results indicate that RTs contribute to the reliability of the task, more than precision does.

Lastly, to determine if there was a trade-off between response speed and precision, we performed correlations between the RTs and incorrect responses by number of distractors. We analyzed both errors of commission and omission. The results show that there were no significant correlations between the RTs and errors in any of the sets (4 distractors: $r = .234$, $p = .170$; 8 distractors: $r = .149$, $p = .386$; 16 distractors: $r = .317$, $p = .059$; 32 distractors: $r = .079$, $p = .645$). This means there was no trade-off between speed and precision in any of the task's sets.

External Validity: Convergent Validity Testing

As previously mentioned, the evidence for convergent validity was to be represented by relatively moderate and significant correlations between the results obtained from the same group of participants in the two WISC-IV tasks and the main performance indices in the CVS task. For this reason, we analyzed the correlations between the task's Precision and RT indices, and the raw scores in WISC-IV's CD and SS subtests. For children in first grade, the results show a marginally significant correlation between SS and Precision when 32 distractors were present ($r = .644$, $p = .061$). In the case of children in third grade, marginally significant correlation was found between CD and Precision when 4 distractors were present ($r = -.496$, $p = .060$) and a significant correlation between CD and RT when 8 distractors were present ($r = -.539$, $p = .038$). For children in fifth grade, high correlations were found between SS and RT when 16 ($r = -.817$, $p = .047$) and

TABLE 1
Accuracy Indices and RTs by Grade Level and Number of Distractors

		Accuracy				Average RT			
GROUP	*N° of distractors*	M	SD	*Asymmetry*	*Kurtosis*	M	SD	*Asymmetry*	*Kurtosis*
1	4	92.22	6.72	−.41	−.83	1521.42	284.66	.73	−.49
	8	92.78	5.47	−1.16	1.59	1701.92	562.37	1.80	2.93
	16	82.22	9.57	−.90	.14	1834.58	453.98	1.48	2.51
	32	70.83	11.11	−1.30	2.83	2099.92	746.54	1.86	4.30
2	4	95.10	4.58	−1.39	1.84	1205.94	174.82	.66	−.58
	8	94.12	4.64	−.63	.03	1305.18	238.40	1.17	2.27
	16	91.96	4.72	−.65	−.79	1459.76	233.72	.19	.05
	32	78.82	10.67	−.09	−.35	1723.59	425.61	.74	.90
3	4	96.19	3.56	−.77	.26	1004.14	112.04	−.02	−.51
	8	92.38	7.87	−.59	−1.38	1125.29	230.40	.81	−.06
	16	95.24	4.24	−.22	−1.72	1131.43	178.17	−.05	−.90
	32	85.24	9.79	−.79	3.07	1338.00	273.12	.17	−.99
TOTAL	4	94.35	5.33	−1.02	.49	1271.86	281.76	1.03	.94
	8	93.33	5.52	−.84	.13	1402.44	430.33	2.26	6.86
	16	89.35	8.35	−1.44	2.44	1520.86	401.34	1.41	3.64
	32	77.41	11.63	−.51	.91	1774.06	588.58	1.89	5.78

Note. 1 = 1st grade; 2 = 3rd grade; 3 = 5th grade.

32 ($r = -.913$, $p = .011$) distractors were present, and marginally significant correlation between CD and RT when 32 distractors were present ($r = -.787$, $p = .063$).

To further this analysis, we looked at the following indices: differences in the average correct-response percentage for 4 and 32 distractors and differences in average RTs for 4 and 32 distractors, because it is always necessary, in any interference task, to have a baseline, which in this case is the performance of the children when 4 distractors are present (see Friedman & Miyake, 2004; Miyake et al., 2000). Based on these analyses, we considered that low correlations between these tasks could be the product of their nature or a characteristic of these tasks more so than a reflection of perceptual inhibition (keeping in mind that neither CD nor SS exclusively evaluate the inhibition process). For this reason, the distribution of the RTs and the precision indices require transformations to achieve normality. For the RT and precision measures, two indices were selected based on the lowest and highest number of distractors (4 and 32), which are the distractor conditions with the greatest distribution variability. The results show significant correlations between SS and the difference in precision between the 4 and 32 distractor conditions ($r = -.356$, $p = .036$).

To determine if the percentage differences of the perceptual inhibition variables for the children in each group and their performance was statistically significant, and to also test the hypothesis that children with a good performance in the SS task also did well in the computerized task, we undertook a Chi-square test (χ^2) to explore the performance of subjects on the tests based on the criterion of percentage cutoffs of 25, 50, and 75. First, we explored the relationship between the precision index on the CVS and performance in CD. Precision scores were grouped based on whether the precision difference with 4 and 32 distractors was inferior to the mean, indicating good task performance, or superior, indicating poor performance. The SS scores were grouped in the same manner. The results confirm a statistically significant association ($\chi^2 = 7.18$, $p = .027$) between performance in the CVS and SS tasks. Those

TABLE 2
Descriptive Statistics and t-Test for Related Samples in Order to Compare Average RTs When the Target is Present Versus When the Target is Absent, Shown Here by Number of Distractors

	Number of Distractors											
	4			*8*			*16*			*32*		
Target Condition	M	SD	t	M	SD	t	M	SD	t	M	SD	t
Present (RT)	10845	2197.20	.192*	11640	2617.96	3.333*	12436	2454.07	.041*	14727	3587.02	.639*
Absent (RT)	11242	2327.65		12229	2906.91		13798	3697.21		17074	5507.14	

*$p < .05$. RT expressed in milliseconds.

participants with good precision index results in the CVS task also performed well in the SS task. Similarly, these initial results provide empirical evidence in support of discriminant validity for the CVS task with respect to the differentiation of high and low levels of perceptual inhibition performance (interference control) in children.

DISCUSSION

The aim of this study was to obtain validation data for a computerized task that evaluates perceptual inhibition. To this end, the TAC's Conjunction Visual Search task was administered to children aged 6 to 11, together with other paper-and-pencil tasks (Coding and Symbol Search tasks from WISC-IV).

In the first stage—the evaluation of the CVS task's psychometric properties—we performed an analysis of the two main internal validation criteria for the paradigm on which the task is based (Treisman & Gelade, 1980; Treisman & Sato, 1990; Wolfe, Cave & Franzel, 1989). The first criterion indicates that RT averages increase and the percentage of correct responses decreases as the number of distractors is increased. The second criterion indicates that a higher RT average is to be expected when the target is absent compared to when it is present. The results show that as the amount of distractors is increased, the RTs also increase, while the percentage of correct responses tends to decrease. With respect to the results that show differences when the target is present versus when it is absent (Table 3), some researchers have interpreted the increase in RT related to the number of distractors as evidence that the search advances stimulus by stimulus, until the target is located (Treisman, 1988; Treisman & Gelade, 1980; Treisman & Gormican, 1988; Wolfe, 1994, 1998; Wolfe et al., 1989). The difference found in our results would indicate that in those trials in which the target is absent, the subject has to examine each element to confirm that the target is indeed not present; on the other hand, in trials where the target is present, the subject must examine on average only half of the elements to locate the target (Wolfe et al., 1989). The data from the CVS task appear to be consistent with the empirical evidence that is currently available.

TABLE 3
Cronbach's Alpha for the Conjunction Visual Search of the TAC

Performance indices by number of distractors	*Multiple correlations*	*Cronbach's alpha if item is eliminated*
Precision 4	.542	.815
Precision 8	.341	.815
Precision 16	.704	.816
Precision 32	.504	.816
Average RT 4	.868	.724
Average RT 8	.880	.695
Average RT 16	.917	.692
Average RT 32	.925	.718
Cronbach's alpha based on standardized items		.799
Total Cronbach's alpha		.664

In the following stage, we evaluated the trade-off between response speed and precision. The complex relationship between an individual's willingness to respond slowly and commit fewer errors versus his/her willingness to respond rapidly and commit more errors is described as the trade-off between speed and precision; the trade-off is the inverse relationship between these two variables: for example, an optimal performance in terms of precision would be associated with slower responses. In Huang-Pollock, Carr, and Nigg (2002), it was found that the trade-off between speed and precision occurred neither in adults nor children. This means that there may be cases of high speed and precision, simultaneously, or little of both. In the present study, we did not observe a trade-off between speed and precision in the different sets that comprise the CVS task, thus indicating that a subject's approach to the task (whether he/she prioritizes speed in execution over precision, or the inverse) did not affect the performance of perceptual inhibition for the task.

Taken collectively, these results confirm that the perceptual inhibition task of the TAC battery has internal validity indices that validate it as an instrument to measure perceptual inhibition.

We also sought evidence of the task's convergent external validity through a correlation analysis and then a hypothesis of independence analysis. The correlations found between the CD and SS raw scores and the CVS task show evidence in support of convergent validity. In this regard, the correlation between SS and the precision differences with 4 and 32 distractors allows us to observe an increase in the precision of perceptual inhibition functioning based on the age of the subject.

Lastly, we turn to the impact of this study. As previously mentioned, it is important to have a set of reliable and valid instruments to measure each inhibitory process. Consequently, it is important to have an instrument that can adequately evaluate perceptual inhibition, which has a leading role in the early stages of human development. In this regard, we found evidence of adequate reliability and validity indices for a task designed to evaluate perceptual inhibition in school aged children. A contribution that stems from this point is the potential to use this task in studies that seek to evaluate the validity of inhibitory or executive models utilizing CFA, given that this technique requires the use of a significant number of measures for each factor. On the other hand, having a reliable and valid task makes it possible to independently evaluate perceptual inhibition, not only in the context of research of EF, but also in a diagnostic process.

However, there are some limitations in this study that must be considered. We note that the generalization of these results is limited, mainly because of two issues. Firstly, the participants of this study were a group of middle-income children, all of them attending the same private school. This is an important issue to be taken into account, because the sample assessed is demographically homogeneous, thus limiting the generalization of the results to more diverse populations. In order to be able to generalize these results, a future study must include a far more heterogeneous sample.

Secondly, another limitation is that the sample size is relatively small. Although, in this pilot study the CVS task has shown adequate reliability and validity, these results should be taken carefully, as providing preliminary empirical support to the task. In order to be able to establish strong reliability and validity levels, which may allow its use in future research as well as diagnostically in clinical settings, it would be necessary to replicate this result in a larger sample.

Additionally, the fact that this is an intentional sample is a potentially contributing factor to the limited ability to generalize the results. In a future study, it would be necessary to use a randomized sample, thus solving this difficulty.

Overall, this study provides preliminary support of reliability and validity of the task in a relatively small and homogeneous sample of subjects, and requires replication in larger, more heterogeneous populations.

We cannot stress enough the importance of having an evaluation battery like the TAC, with its completely computerized system and a design that offers an attractive environment that is not only stimulating for the subject being evaluated, but is also easy to administer and provides the evaluator with results that are easy to interpret. The CVS task used in this study is part of that evaluation battery and has those features, which, in addition to the reliability and validity indices presented here, make it a task of great importance when it comes to evaluating inhibitory functioning, particularly perceptual inhibition.

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