2022, Vol. 22, No. 2
ISSN 1667-4545
Recuperado de https://revistas.unc.edu.ar/index.php/revaluar

Laboratorio de Evaluación Psicológica y Educativa
Facultad de Psicología - Universidad Nacional de Córdoba

Evidence of validity of the Remotely-administered Visual Search Task

Evidencias de validez de la Tarea de Búsqueda Visual administrada remotamente

Matías Jonás García * [1], Eliana Vanesa Zamora [1], Yesica Aydmune [1], Ana Comesaña [1], Isabel María Introzzi [1]

1 - Instituto de Psicología Básica, Aplicada y Tecnología (IPSIBAT), Universidad Nacional de Mar del Plata -CONICET. Mar del Plata, Argentina.

Recibido: 10/05/2022 **Revisado:** 30/05/2022 **Aceptado:** 01/06/2022

Abstract

Perceptual inhibition is the executive process that contributes to selective attention by attenuating or reducing the interference effect generated as a result of distracting stimuli present in the environment. Due to the COVID-19 pandemic and other factors, it has been shown that there is a need for tools designed and validated in our environment that enable the assessment in non-face-to-face contexts. For this reason, this study aimed to provide empirical evidence of the internal validity and reliability of a Computerized Conjunction Visual Search (CVS) task. For this purpose, 97 adults aged between 30 and 35 (M = 32.21; SD = 1.73; 75% females) were assessed under a remote-synchronic administration. The results obtained showed adequate reliability and validity, and that the test respects the postulates of the visual search paradigm on which it is based and that its remote administration form is comfortable for users.

Keywords: *perceptual inhibition, internal validity, reliability, remote administration, conjunction visual search*

Resumen

La inhibición perceptual es el proceso ejecutivo que contribuye a la atención selectiva atenuando o disminuyendo el efecto de interferencia que generan los estímulos distractores presentes en el ambiente. Debido a la pandemia COVID-19 y a otros factores, se ha puesto de manifiesto la necesidad de contar con herramientas diseñadas y validadas en nuestro medio que permitan la evaluación en contextos no presenciales. Por este motivo, el objetivo de este trabajo fue obtener evidencias empíricas de validez interna y confiabilidad de una tarea informatizada de Búsqueda Visual Conjunta (BVC). Para ello, se realizó una evaluación a 97 personas adultas de entre 30 y 35 años (M = 32.21; DS = 1.73; 75% género femenino) bajo una modalidad de administración remota y sincrónica. Los resultados obtenidos mostraron una confiabilidad y validez adecuadas, y que la prueba respeta los postulados del paradigma de búsqueda visual en la que se sustenta y que resulta cómoda para los usuarios en su formato de administración remota.

Palabras clave: *inhibición perceptual, validez interna, confiabilidad, administración remota, búsqueda visual conjunta*

***Correspondencia a:** Matías Jonás García. Tel.: +543813157302. E-mail: matiasjonasg@gmail.com

How to cite: García, M. J., Zamora, E. V., Aydmune, Y., Comesaña, A., & Introzzi, I. M. (2022). Evidence of validity of the Remotely-administered Visual Search Task. *Revista Evaluar*, *22*(2), 30-46. Retrieved from https://revistas.unc.edu.ar/index.php/revaluar

Participaron en la edición de este artículo: Fiorella Garabano, Andrea Suárez, Eugenia Barrionuevo, Florencia Ruiz, Mónica Serppe, Ricardo Hernández, Alicia Molinari.

Introduction

The multidimensional approach to inhibition. Relevance of its assessment

Executive functions (EFs) are a top-down set of cognitive processes involved in the deliberate and voluntary control of behavior, cognition, and emotions (Diamond & Ling, 2020; Miyake & Friedman, 2012). These processes are activated in new and complex situations that demand cognitive effort where automatic, over-learned responses are insufficient (Diamond, 2013; Introzzi et al., 2020). Evidence has shown that EFs have a significant impact on quality of life. This is due to their involvement in learning and academic achievement, psychological and physical health, social life, and work efficiency, among other domains (e.g., Jacob & Parkinson, 2015; Duckworth, Taxer, Eskreis-Winkler, Galla, & Gross, 2019). The main components of EFs include working memory, cognitive flexibility and inhibitory control (Diamond, 2013; Diamond & Ling, 2020; Miyake et al., 2000). Nevertheless, in recent years it has been postulated that inhibitory control is not an unidimensional process but that related inhibitory processes which have their distinctive operational characteristics are identified (Introzzi et al., 2021). This conception of inhibitory control has been called *multidimensional approach* (e.g., Delalande et al., 2020; Introzzi, Canet-Juric, Aydmune, & Stelzer, 2016), which postulates that inhibitory control processes not only have a primary function of mitigating the effect of interference (Zamora, Richards, Canet-Juric, Aydmune, & Introzzi, 2020), but also particular characteristics that differentiate them from each other. In general, there are three inhibitory processes: perceptual inhibition, cognitive inhibition, and behavioral inhibition (e.g., Friedman & Miyake, 2004; Introzzi et al., 2021). Several studies suggest that they exhibit specific developmental trajectories (e.g., Aydmune, Introzzi, Olaechea, & López-Ramón, 2022; Gandolfi, Viterbori, Traverso, & Usai, 2014; Vadaga, Blair, & Li, 2016), that are differentially involved in numerous complex cognitive functions and activities of daily living (e.g., Borella, Carretti, & Pelegrina, 2010), and that are particularly impaired in various psychopathological disorders (e.g., Christ, Kester, Bodner, & Miles, 2011; Mammarella et al., 2017) and neurodegenerative diseases (Hazlett, Figueroa, & Nielson, 2015). This shows the necessity and relevance of using techniques designed and validated in our region that allows us to assess each inhibitory process independently.

Cognitive Self-regulation Tasks: An assessment approach from a multidimensional perspective in a remote administration modality

The assessment of inhibitory processes from a multidimensional perspective is not an easy challenge. The proposed tasks must be attractive, easy to understand, presented analogously, and they must not be too long, to avoid the fatigue of the person being assessed. The literature often reports tasks with a large number of trials (e.g., Logan, 1994; Oberauer, 2001), which, coupled with the fact that inhibitory tasks (and executive tasks in general) require significant cognitive effort, can generate fatigue and affect participant performance (Aydmune & Introzzi, 2018). In addition, due to the particularities of each inhibitory process, they must show high demand or requirements for the process, with minimal or low demand for another, or other executive functions (e.g., cognitive flexibility or working memory). In this sense, the Cognitive Self-regulation Tasks -TAC- set (Introzzi & Canet-Juric, 2019) is a technological innovation for several reasons. First, since the beginning, it has been

designed according to a multidimensional model that assumes not only the existence of different EFs (working memory, inhibition, and cognitive flexibility) but also of different inhibitory processes. Therefore, for the design and proposal of activities for each of the tasks, widely used and validated experimental paradigms have been selected, which allow for the specific evaluation of each EF (working memory, cognitive flexibility, and inhibitory processes: behavioral, cognitive, and perceptual inhibition). Second, the TAC is a fully computerized tool. All instances of the assessment process (socio-demographic data entry, test administration, and data collection for scores) are performed automatically using a computer with internet access (Drasgow & Mattern, 2006). This provides certain benefits in comparison to pencil-and-paper tests, including greater control and accuracy in item administration, greater efficiency in scoring and response storage, faster and more efficient psychological reporting, less chance of data entry error, and a more motivating environment and appearance (Medrano & Pérez, 2018). Third, due to the nature of the tasks proposed and the responses required, all of the TAC tasks can be used to assess children from 6 years old to adults over 80 years old. And fourth, due to the characteristics previously mentioned, the TAC test could be used in a remote psychological assessment context, which means that it does not require the direct, face-to-face intervention of the tester. Remote psychological assessment is relevant in the studies with mobility-restricted populations or people who reside far away and have difficulty traveling to the clinic. The recent pandemic context has also demonstrated the importance of this type of assessment (Brearly et al., 2017; Marra, Hoelzle, Davis, & Schwartz, 2020). Although there is a need for neuropsychological assessment tools that support this mode of administration (e.g., Brearly et al., 2017), no studies have yet been conducted in this regard. Thus, this study aims to analyse the psychometric properties of scores on the remotely administered version of the Visual Search task for the assessment of perceptual inhibition in a population of young adults

Conjunction Visual Search: The TAC task for the assessment of perceptual inhibition

Perceptual inhibition (PI) is the inhibitory process involved in the initial stages of information processing, reducing the arousal level generated by distracting environmental stimuli that interfere with the ongoing task. Hence, it helps to control the input of irrelevant information into consciousness or attentional focus (Friedman & Miyake, 2004; Hasher, Zacks, & May, 1999). It is therefore considered an essential component of selective attention, as it permits relevant information to be highlighted, increasing processing efficiency (e.g., Treisman & Gelade, 1980; Treisman & Sato, 1990). So, the more efficient the inhibitory process is, the faster and more effective the selective attention is supposed to be. Moreover, PI is also strongly implicated in several complex cognitive functions such as mathematics performance (Stolte et al., 2019), reading comprehension (Borella et al., 2010; Borella & de Ribaupierre, 2014; Stevens & Bavelier, 2012), fluid intelligence (Aydmune, Introzzi, & Zamora, 2020; Darowski, Helder, Zacks, Hasher, & Hambrick, 2008; Stelzer, 2014), planning, and cognitive flexibility (Davidson, Amso, Anderson, & Diamond, 2006; Diamond, 2013, 2016).

For the foregoing reasons, we consider that it is important to develop tools designed and validated in our environment which enable us to assess this process specifically. TAC's Visual Search (VS) is a task that serves this purpose. Although it has sufficient empirical evidence of validity and

reliability in the face-to-face administration modality (e.g., Comesaña, Richard's, & Vido, 2019; Richard's et al., 2017a), its psychometric properties have not been analyzed in the remote administration modality.

Evidence of validity and reliability of Visual Search scores in a remote administration version

The VS task has been designed based on the Conjunctive Visual Search (CVS) paradigm proposed by Treisman and Gelade (1980) within the integrative feature theory approach (e.g., Treisman & Gelade, 1980; Treisman & Sato, 1990; Introzzi et al., 2017). In this paradigm, participants must identify the presence or absence of a target -blue square- that is presented among a variable set of distractor stimuli -red squares and blue circles. The stimuli consist of double conjunctions, defined by the combination of two visual features: shape and color. Furthermore, all distractors have one of these visual characteristics in common with the target, a condition that guarantees the visual interference effect and thus the involvement of the PI. The proposed activity is simple, the participant must press one of two keys as quickly as possible depending on the presence or absence of the target (See methodology for more details).

The CVS paradigm suggests the existence of two main effects widely replicated in the literature and based on feature integration theory: *the presence or absence effect of the* target and *the number of distractors effect*. The presence or absence effect of the target is characterized by better performance in trials or conditions in which the target is present compared to those in which it is absent. Prediction assumes the existence of an exhaustive, sequential and obligatory search. In other words, it proceeds in the visual scene by checking one element at a time and it is completed when the target is detected. Thus, when the target is absent, it is assumed that all elements must be examined; whereas when the target is present it is necessary to examine, on average, half of the elements of the visual presentation before identifying the target. In consequence, according to this proposal, performance in tests where the target is present is expected to be significantly lower than in those where it is absent. The effect of the quantity of distractors is characterized by a decrease in search performance for conjunctions (e.g., a blue square target, between red squares and blue circles, distractors) that depends on the number of distractors added. It is assumed that this decrease is more pronounced as the number of distractors increases, and it is explained by the effect of visual interference (Treisman & Sato, 1990; Introzzi et al., 2017).

Consequently, scores obtained with a task designed based on the CVS paradigm should be consistent with these two main effects, which would provide evidence of the construct (internal) validity of the test. In the VS task, this kind of validity evidence has been obtained in a face-to-face administration modality in typically (Richard's et al., 2017a) and atypically (Richard's et al., 2017b) developing children, adolescents, adults and older adults (Introzzi et al., 2020, 2021; Richard's, Introzzi, Zamora, & López-Ramón, 2022). However, the literature emphasizes that researchers should not assume the equivalence of two different forms or versions of the same tool (Medrano & Pérez, 2018). Consequently, it should not be assumed that the reliability and validity evidence of the instrument obtained in a face-to-face administration context will also be found in the virtual or remote administration modality. Therefore, the present study seeks to obtain empirical evidence of VS scores in a remote administration modality in adults so that it can be used in assessment processes in different contexts

of psychology and other disciplines in the areas of health and education. This aim is part of a larger project to analyze the psychometric properties of different TAC tests in a remote administration modality in different age groups. In this research, it was decided to focus on young adults, as this population is familiar with the use of computers and the internet. In addition, at this age, executive functioning reaches a plateau in its development and its maximum level, while impairment of other functions is usually not observed. Although TAC can be administered without great difficulty in children and older adults, it is considered more appropriate to begin to explore remote administration with young adults.

Methods

Participants

We conducted this study with an instrumental design (Montero & León, 2002) using an independent, non-probabilistic, intentional, snowball sample of adults (N = 97), residents of Mar del Plata, between 30 and 35 years old (M = 32.21; SD = 1.73), 51.5% of whom identified themselves as female. In terms of educational level, all participants had at least a high school education. 71% reported finishing their university studies and 21% reported incomplete university studies.

The inclusion of participants in the sample was decided based on information obtained in a short ad hoc survey designed for this research (see procedure). In addition, inclusion criteria were considered as follows: 30-35 years old, no neurological and/or psychiatric diagnosis, 12 years or more of formal education, normal or corrected vision and hearing (conditions necessary to perform the proposed activities), a desktop or laptop computer with a 14" or larger screen and stable internet connection of more than 1 megabyte. We excluded participants with psychopathological symptoms or those under psychopharmacological treatment, and with uncorrected visual or hearing difficulties.

Procedure

To constitute the sample, community members aged between 30 and 35 were invited to participate. A "snowball sampling" or "participant-driven sampling" was conducted (Heckathorn, 1997; Watters & Biernacki, 1989). First, a Google form was distributed via email and social networks (Facebook, Twitter, WhatsApp, Telegram and Instagram) inviting people to participate in the study, explaining the main objectives, requirements, and activities involved, the voluntary nature of participation, and the confidentiality of the results and the information obtained. Those interested were subsequently contacted and asked to sign an informed consent form as a fundamental condition for their participation in the study. In the same form, a short ad hoc survey was presented to collect data about inclusion criteria, and the Symptom Assessment-45 Questionnaire (SA-45) was presented in its Spanish version, to collect information about psychopathological symptomatology. In the next contact, a video conference meeting was arranged in which the VS task and the questionnaire were administered.

Instruments

Visual Search Task. The VS task is part of the computer-based system TAC (Introzzi & Canet-Juric, 2019) for the assessment of executive functioning (working memory, inhibitory processes, and cognitive flexibility). This task has been designed based on the CVS paradigm (Treisman

& Gelade, 1980). It consists in determining the presence or absence of a target stimulus (blue square) that is presented mixed among a variable set of distractor stimuli (red squares and blue circles). The stimuli consist of double conjunctions, which are defined by the combination of two visual characteristics: shape and color. In addition, all distractors share one of these visual features with the target, a condition that guarantees the visual interference effect and thus the engagement of the PI.

The task includes a block of 10 practice trials, followed by three blocks of 40 trials respectively. Every block contains 10 trials for condition (according to the number of distractors = 4, 8, 16, or 32). The 40 trials were randomly distributed in every block; 50% of trials in each block presented the target and the rest were absent. In each trial, the participant has to provide an answer, whether affirmative or negative, as quickly and accurately as possible, by pressing the appropriate key ("Z" key if the target is present and "M" key if the target is absent). After the answer is given, the following trial is shown.

Performance measures. Task performance is obtained through the percentage of correct responses (response accuracy) and the mean response time (RT) for each distractor condition. It is important to note that the register of RT is obtained just for correct answers. When performance is assessed through the RTs and accuracy independently, differences in performance can result from the speed of response, accuracy, or the interaction between the two factors. Therefore, to obtain a better index of performance in these tasks, a single measure combining both factors has been proposed. The inverse efficiency index (EI), results from the ratio of RT and accuracy (Christie & Klein, 1995). This index compensates for the relationship between speed and accuracy, which is why several studies have chosen to include it as one of the main performance indicators (e.g., Comesaña et al., 2019; Introzzi et al., 2020; Zamora et al., 2020). Its interpretation is simple: higher indexes (expressed in RT) suggest a worse performance on the task.

In addition, the task has a section to assess the speed of processing (SP) which is administered immediately before or independently of the per-

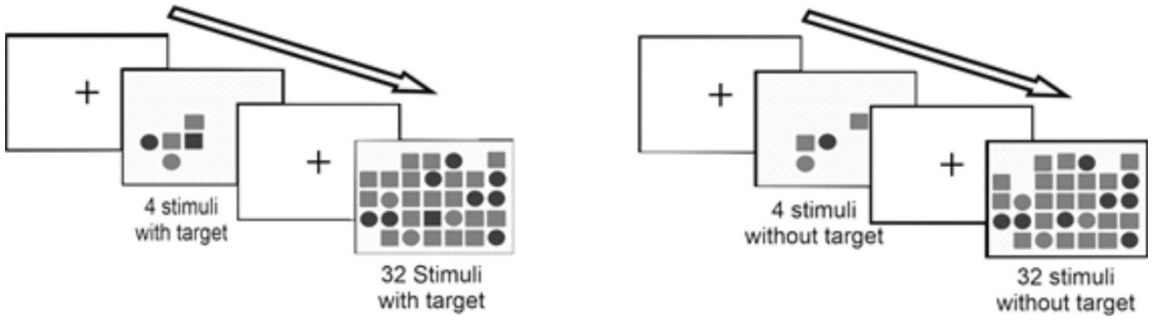

Figure 1

Visual Search. The figure (left) shows two consecutive trials. The first one with 4 distractors and the second one with 32 distractors. In both trials the target is present. The figure on the right shows two consecutive trials where the target is absent. The first with 4 and the second with 32 distractors.

ceptual inhibition task. The SP task is similar in every aspect to the inhibition task (task instructions, stimuli, presentation, and response keys) except that no distractors are presented (e.g., in this task there is only one stimulus per trial). Therefore, it provides a measure of SP but also functions as a baseline score for the computation of a PI index (Introzzi et al., 2020). This section consists of 10 practice trials and 20 assessment trials, which allow the recording of the two main performance indices: RT and accuracy. As in the conjunction search task, 50% of the trials presented the blue square and the other 50% a red square or a blue circle.

Given the absence of distractors, the task allows the intervention of other processes such as visual search and PI to be minimized, ensuring that SP can be assessed with minimal intervention from them. The literature also recommends the use of difference scores to quantify the interference produced by more difficult task conditions (Mullane et al., 2009). For computing these scores, the mean RT of trials with interference is usually subtracted from those where there is little or no interference. Without such a subtraction a high or low score could be attributed to the speed or slowness of the subject's response. In the present task, the difference between the mean RT in the no-distractor condition (SP task) and the mean RT in the 4-distractor condition was used to obtain this index. Thus, higher scores indicate less efficient interference control. Table 1 presents the description and abbreviation of the performance indices used in this study.

Ad-hoc questionnaire to assess the functioning of the Visual Search task in the synchronous remote administration mode. A short and simple ad-hoc questionnaire was designed and administered to participants to collect data on several issues related to the general functioning of the VS task in the remote administration mode and some specific characteristics of the task.

One set of items was constructed to obtain information about the difficulty perceived regarding the actions that participants had to take, after the administration of VS task. This set of administrative procedures is normally done by the examiner in the face-to-face administration mode, but in the remote mode, it must be done by the person being assessed. Specifically, questions were asked about access to the web page on which TAC and VS tasks are inserted; access using the username and password provided by the researcher; search and selection using their full name (previously uploaded in the system). Participants recorded their answers on a Likert scale where they had to mark the degree of difficulty (low, medium, or high).

Other items were designed to explore a set of questions related to understanding the instructions, the type of activity they were asked to do and the type of response required. Therefore, the following questions were asked: *Were you able to understand what you were asked to do in the task? Did you find the practice instance of the task useful? Did it allow you to understand better what you were asked to do? Were you able to visualize the indications and text presented on the screen adequately? Were you able to distinguish the stimuli presented on the screen clearly?* To answer these questions, participants had to choose between two response options: *Yes* or *No*. In addition, they had to answer whether they found the indication or signalling regarding the keys to be pressed to give their answer easily, understandable or confusing.

To analyze perceived effort related to the different conditions of the task and the opinion regarding length or extension, four items were elaborated. Concerning the difficulty level of the task, we asked whether the difficulty increased

Table 1
Main Performance indexes of the Visual Search task.

Description of index and abbreviation	Index abbreviation	Index calculation
Medium RT in the 4-distractor condition	TR4	Not applicable
Medium RT in the 8-distractor condition	TR8	
Medium RT in the 16-distractor condition	TR16	
Medium RT in the 32-distractor condition	TR32	
Response accuracy in the 4-distractor condition	PREC4	
Response accuracy in the 8-distractor condition	PREC8	
Response accuracy in the 16-distractor condition	PREC16	
Response accuracy in the 32-distractor condition	PREC32	
Inverse efficiency index 4-distractors condition	EI4	TR4/Prec4
Inverse efficiency index 8-distractors condition	EI8	TR8/Prec8
Inverse efficiency index 16-distractors condition	EI16	TR16/Prec16
Inverse efficiency index 32-distractors condition	EI32	TR32/Prec32
Difference between medium RT in the SP Task and medium RT in the 4-distractor condition	IDif	TRmedioVP - TR4

progressively throughout the task, whether all parts of the task were of equal difficulty, whether the difficulty decreased as the task progressed, and whether some parts of the task were more difficult than others but were mixed. Concerning cognitive effort, we asked whether all parts of the task required the same cognitive effort or whether the effort was related to the number of stimuli (more stimuli, more effort; fewer stimuli, less effort). Finally, perceived accuracy and time were assessed visually. The subject had to choose between four boxes showing the four test conditions. Most subjects stated that they were more accurate in the conditions with fewer stimuli and that the conditions with more stimuli took longer (Figure 2), which was in line with the assumptions of the baseline paradigm.

Data analysis

First, the internal consistency of the task was estimated by the split-half method, using the Spearman-Brown correction (Cohen & Swerdlik, 2009). The reliability of RT was calculated for each block. Thus, the consistency within each block was estimated and then the results were averaged to obtain the total reliability, with the

Table 2

Descriptive statistics of the main indexes of the Visual Search task.

	M	SD	Skewness	Kurtosis	Kolmogorov-Smirnov
Response accuracy with no distractors	94.69	13.06	-4.1	19.22	.35*
Response accuracy in the 4-distractor condition	97.87	2.50	-1	0.54	.30*
Response accuracy in the 8-distractor condition	97.93	3.51	-2.9	13.66	.34*
Response accuracy in the 16-distractor condition	96.90	3.47	-0.9	0.27	.25*
Response accuracy in the 32-distractor condition	92.44	7.01	-1	0.47	.19*
Medium RT with no distractor	786.46	173.73	1	3.62	.08
Medium RT in the 4-distractor condition	844.70	135.11	0.7	1.43	.05
Medium RT in the 8-distractor condition	901.44	140.73	0.3	0.16	.06
Medium RT in the 16-distractor condition	1040.67	193.25	0.9	1.57	.09*
Medium RT in the 32-distractor condition	1348.31	295.82	1	1.01	.13*
Difference in accuracy between the 4 and 32-distractor condition	5.4305	7.09	0.9	0.68	.19*
Difference in RT between the 4 and 32-distractor condition	503.61	222.33	1.2	1.18	.13*
Reverse efficiency without distractors	8.69	3.89	5	30.02	.25*
Inverse efficiency with 4 stimuli	8.62	1.33	0.6	1.24	.05
Inverse efficiency with 8 stimuli	9.21	1.43	0.3	-0.07	.07
Inverse efficiency with 16 stimuli	10.75	2.05	1	2.06	.10*
Inverse efficiency with 32 stimuli	14.61	3.09	0.9	0.98	.15*

Note. * $p < .05$

understanding that each block has the same conditions (4, 8, 16 and 32 distractors).

To obtain internal validity evidence for VS in the remote administration modality, it was analyzed whether the results allowed verifying the presence of the two main experimental effects linked to the Conjunction Search paradigm derived from the feature integration theory (e.g., Treisman & Sato, 1990) based on which the task was designed. For this purpose, the distribution

of the data was analyzed according to centrality, skewness, and kurtosis (Table 2). When it was confirmed that in general, they do not adjust to a normal distribution, we chose to use the Friedman test for related samples, with the Wilcoxon rank test to analyze post hoc pairwise analysis to contrast the two main assumptions of the task.

Furthermore, because the change in the mode of administration (face-to-face or remote) could affect the psychometric properties (validity, reliability, norms) of the tests (Medrano & Pérez, 2018), the responses to the ad hoc questionnaire (see Instruments) were analyzed by calculating the percentages obtained for each response mode.

Ethical considerations

The implemented protocols were approved by an ethics committee (in this first version of the manuscript its name has been omitted to avoid providing data that could identify the authors) and all the established ethical guidelines were respected. Moreover, the ethical principles and guidelines outlined in the code of conduct of the American Psychological Association (APA, 2017) for the implementation of scientific research in psychology were followed. After reading the information about the project, clarifying their doubts, and signing the informed consent form, people could access the assessment instruments and participate in the study. As mentioned before, participation was voluntary and could be interrupted at any time without giving reasons. The information obtained in the tasks and questionnaires was treated confidentially to protect the identity of the participants. All personal data were associated with an alphanumeric code that was used in the database. In addition, the information was stored on servers and computers that satisfy computer security requirements. The data collected is used only for academic and scientific purposes by National Law 25.326 on the protection of personal data.

Results

Evidence of validity

Internal validity. The task paradigm (Treisman & Gelade, 1980) is based on two fundamental premises. Analyses of these are developed below:

Presence/absence effect of the target. Medium RT was analyzed in the conditions in which the target is absent and present. These data were compared in each of four conditions (4, 8, 16, and 32) in the task. For this, Wilcoxon signed-rank test was used. The effect size was calculated for each pair by dividing the z-score obtained by the square root of the number of observations (Pallant, 2007). The results show that there would be significant differences between the RTs that contain the target and those that do not, in all four conditions (Table 3). In addition, the effect size observed increases as the number of stimuli becomes larger.

Effect of the number of distractors. To test this hypothesis, the study was conducted using mean RTs, accuracy and the IE index for each condition. Friedman's test for related samples was applied, with Wilcoxon's rank test to analyze post hoc pairwise behavior. Accuracy and RT were compared for no-distractor (SP) condition and the four test conditions, finding significant differences in accuracy ($Q(4) = 74.87$; $p < .05$) and RTs ($Q(4) = 326.4$; $p < .05$). Next, the same test was performed for the inverse efficiency indices in the four conditions and the no-distractor condition, with significant differences ($Q(4) = 302.8$; $p < .05$). Subsequently, Wilcoxon's rank test was ap-

Table 3

Wilcoxon signed-rank test (W) for RT by presence or absence of the target.

	4				8			
Target	**M**	**SD**	**W**	*r*	**M**	**SD**	**W**	*r*
Present (RT)	826.89	145.51	-2.62*	.26	865.89	130.29	-5.34*	.54
Absent (RT)	862.34	156.43			937.28	171.3		
	16				**32**			
Target	**M**	**SD**	**W**	*r*	**M**	**SD**	**W**	*r*
Present (RT)	945.64	146.50	-7.81*	.79	1123.1	212.16	-8.38*	.85
Absent (RT)	1133.4	266.39			1551.4	429.1		

Note. * $p < .05$; r = effect size.

plied to observe pairwise associations (Table 4). Regarding accuracy, the Wilcoxon test showed that there would be no significant associations in the pairs with no distractors-C16 and C4-C8, i.e., the difference in medians between the results of these conditions would be due to a random chance and cannot be associated with a tendency. Accuracy, RTs, and inverse efficiency indices for all other conditions were shown to follow a trend. Additionally, the effect size was notably larger for reaction times than for accuracy.

Remote assessment access questionnaire. The questionnaire was designed to provide evidence of construct validity and consisted of a series of items related to the level of difficulty in accessing the platform and understanding the instructions, as well as the extent and perceived effort during the task.

The perceived difficulties of accessing the platform, access to the website, logging in with username and password, search, and selection of the participant by full name were specifically evaluated using an ordinal scale with three response categories (*high*, *medium*, or *low*). In general, the perceived difficulty was *low*: 91.9% for the difficulty of accessing the page; 96.5% for the login with username and password, as well as for the search for users by name and surname.

For questions aimed at obtaining comprehension information on the different instances of the task, a dichotomous scale (yes/no) was used. Most subjects responded affirmatively to questions related to the instructions (100%); the practice instance (97.7%); the indications during the test (100%); the stimuli presented (97.7%); and the indications regarding the keys to be used (97.7%). Regarding the task length, it was rat-

Table 4
Wilcoxon signed-rank test for accuracy, RT, and inverse efficiency index, according to the number of distractors.

	Accuracy		RT		Inverse efficiency index	
Pairs	**W**	*r*	**W**	*r*	**W**	*r*
ND – C4	-2.04**	.20	-4.68**	.47	-3.12**	.31
ND – C8	-2.36**	.23	-6.63**	.67	-5.43**	.55
ND – C16	-0.19	.01	-8.04**	.81	-7.3**	.74
ND – C32	-3.7**	.30	-8.5**	.86	-7.82**	.79
C4 - C8	-0.32	.03	-6.84**	.69	-6.34**	.64
C4 - C16	-2.49**	.25	-8.54**	.86	-8.54**	.86
C4 - C32	-6.61**	.67	-8.55**	.86	-8.55**	.86
C8 - C16	-2.29**	.23	-8.48**	.86	-8.32**	.84
C8 - C32	-6.62**	.67	-8.55**	.86	-8.55**	.86
C16 - C32	-5.78**	.58	-8.55**	.86	-8.55**	.86

Note. ** $p < .05$; *r* = effect size; ND = no-distractor condition.

ed by 62.8% of the participants as *short* and by 37.2% as *not too short and not too long*, on a three-choice ordinal scale, where no participant answered that the task was *too long*.

As regards perceived effort in the task, the following were assessed: perception of cognitive effort about the number of stimuli, perception of the accuracy of their response in the different conditions, and perception of the time required to complete the task under the different conditions. Regarding task progression, 64% perceived that *the level of difficulty of the task increases progressively as the task progresses* and 31.4% that *some parts of the task are more difficult than others and are mixed throughout the task* (corresponding to the correct answer in this case). Regarding cognitive effort, 70% indicated that *more stimuli required more attention or cognitive effort* (which is in line with the visual search paradigm used) and 24.4% indicated that *all parts of the task required the same attention or cognitive effort*.

Perceived accuracy and time were assessed visually. The subjects had to choose between four boxes showing the four test conditions. Most subjects stated that they were more accurate in the conditions with fewer stimuli and that the conditions with more stimuli took longer (Figure 2), in line with the premises of the visual search paradigm.

Reliability

RT reliability was estimated using a split-half method with Spearman-Brown correction.

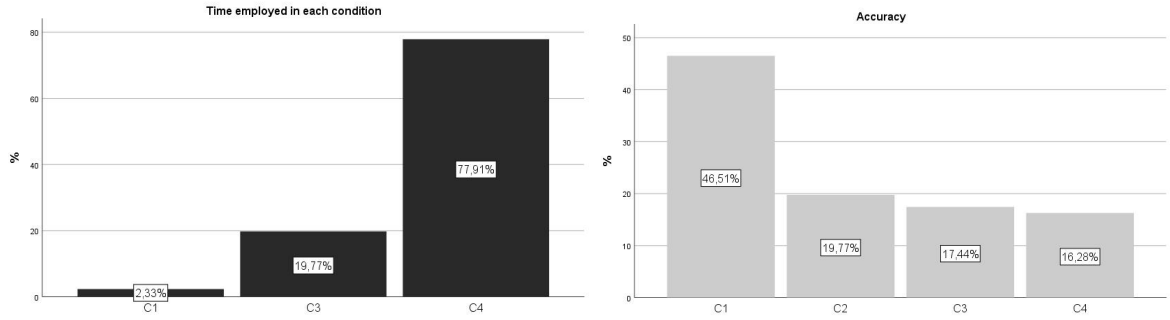

Figure 2
Perception of accuracy and performance time in each visual search task condition.

For this purpose, two computations were made. First, internal consistency was calculated for all items without discriminating the block to which they belong (r_s = .94). Second, the internal consistency of each block was calculated. Each block contained the same number of stimuli belonging to the four conditions (4-8-16-32). All blocks exhibited a consistency similar to the total (block 1, r_s = .88; block 2, r_s = .83; block 3, r_s = .78). Finally, the consistency of all blocks was averaged (r_s = .83). The results obtained for the RTs can be interpreted as excellent for all scores, except for block 3, where substantial consistency was found (Cicchetti & Sparrow, 1981; Fleiss, 1981).

Discussion

This study aimed to obtain evidence of construct validity of the VS task (Introzzi & Canet-Juric, 2019), using a remote administration modality. The study was conducted with a sample of adults aged between 30-35 who were administered the task and an ad hoc questionnaire. Although the task has been adapted and validated in the local population, no studies of its remote administration have been recorded. To achieve this purpose, firstly, evidence was obtained on the reliability of the task in its remote administration. Secondly, to obtain evidence of construct validity, the two main postulates of Treisman and Gelade's (1980) visual search paradigm were tested.

The first criterion of the paradigm indicates that the average RTs increase, and the percentage of correct responses decrease as the number of distractors increases. The second criterion indicates that a higher RT mean is to be expected when the target is absent compared to when it is present. The results showed that as the number of distractors increases, the RTs also increase, while the percentage of correct answers tends to decrease. Regarding the results showing differences when the target is present versus absent, some researchers have interpreted the increase in RT related to the number of distractors as evidence that the search progresses stimulus by stimulus until the target is located (Treisman, 1988; Treisman & Gelade, 1980). The observed difference in the results would indicate that on trials where the target is absent, the subject examines each item to confirm that the target is not present. In contrast, on trials where the target is present, the subject must examine on average only half of the items to locate the target (Wolfe, Cave, & Franzel, 1989). The findings of the remote task seem to be consistent with the empirical evidence so far, as in

each condition subjects gave faster responses in presence of the target than in absence of the target. Moreover, the task generated higher interference when the number of distractors was higher (see review Richard's et al., 2022). The analysis of the ad hoc questionnaire answers suggests that participants had neither difficulty accessing the platform and the task, nor in understanding the instructions and prompts during the task.

As mentioned above, it is important to have a reliable and valid set of instruments to adequately assess PI given its importance in different domains. Due to the pandemic, many tools for assessing cognitive processes -especially those based on pencil and paper- have been insufficient, given the impossible nature of face-to-face encounters. In the modern world and with IT development, we consider essential the adjustment of tests to a remote administration environment. In this respect, we found evidence of validity for the VS task which, although computerized, had no remote administration studies.

However, this study was not free of limitations. First, the generalizability of these results is limited, mainly due to the age range of the sample (30-35 years). The remote administration of the task may be more challenging in children and older adults, due to the technical handling of the test. It is expected that the sample age range will be extended in the future. Furthermore, due to the characteristics of non-probability sampling, the results are only partially generalizable.

Second, this study is solely limited to internal validity. We did not consider analyzing other types of validity or reliability because this test does not present changes in its conformation, but just in the way it is administered.

In conclusion, we consider that the VS task satisfies the validity criteria to be administered remotely. There is still a need to expand the sample groups in which it can be applied, given the particularities of the lifespan that especially affect the EFs.

References

American Psychological Association. (2017, 1st January). *Ethical principles of psychologists and code of conduct*. Retrieved from https://www.apa.org/ethics/code

Aydmune, Y., & Introzzi, I. (2018). Inhibición: Una función ejecutiva difícil de medir. Algunas problemáticas en relación con las pruebas de inhibición informatizadas. *Psicodebate, 18*(2), 7-25. doi: 10.18682/pd.v18i2.741

Aydmune, Y. S., Introzzi, I. M., Olaechea, M. C., & López-Ramón, M. F. (2022). Inhibitory processing training during childhood: A review – Processes-based inhibitory training. In F. Alcantud-Marín, M. López-Ramón, E. Navarro-Pardo, V. Moreno-Campos & Y. Alonso-Esteban (Ed.), *Handbook of Research on Neurocognitive Development of Executive Functions and Implications for Intervention* (pp. 50-77). doi: 10.4018/978-1-7998-9075-1.ch003

Aydmune, Y., Introzzi, I., & Zamora, E. V. (2020). Tarea de interferencia proactiva (IP) para la medición de la inhibición cognitiva en niños de 6 a 8 años. *Revista Evaluar, 20*(3), 34-50. doi: 10.35670/1667-4545.v20.n3.31710

Borella, E., Carretti, B., & Pelegrina, S. (2010). The specific role of inhibition in reading comprehension in good and poor comprehenders. *Journal of Learning Disabilities, 43*(6), 541-552. doi: 10.1177/0022219410371676

Borella, E., & de Ribaupierre, A. (2014). The role of working memory, inhibition, and processing speed in text comprehension in children. *Learning and Individual Differences, 34*, 86-92. doi: 10.1016/j.lindif.2014.05.001

Brearly, T. W., Shura, R. D., Martindale, S. L., Lazowski, R. A., Luxton, D. D., Shenal, B. V., & Rowland, J.

A. (2017). Neuropsychological test administration by videoconference: A systematic review and meta-analysis. *Neuropsychology Review, 27*(2), 174-186. doi: 10.1007/s11065-017-9349-1

Christ, S. E., Kester, L. E., Bodner, K. E., & Miles, J. H. (2011). Evidence for selective inhibitory impairment in individuals with autism spectrum disorder. *Neuropsychology, 25*(6), 690-701. doi: 10.1037/a0024256

Christie, J., & Klein, R. (1995). Familiarity and attention: does what we know affect what we notice? *Memory & Cognition, 23*, 547-550. doi:10.3758/BF03197256

Cicchetti, D. V., & Sparrow, S. A. (1981). Developing criteria for establishing interrater reliability of specific items: Applications to assessment of adaptive behavior. *American Journal of Mental Deficiency, 86*(2), 127-137.

Cohen, R. J., & Swerdlik, M. E. (2009). *Psychological Testing and Assessment: An Introduction to Tests and Measurement* (7th ed.). New York, NY: McGraw-Hill.

Comesaña, A., Richard's, M. M., & Vido, V. (2019). Comparative analysis of the perceptual inhibition between children and older adults. *Psychology & Neuroscience, 12*(1), 65-77. doi: 10.1037/pne0000167

Darowski, E. S., Helder, E., Zacks, R. T., Hasher, L., & Hambrick, D. Z. (2008). Age-related differences in cognition: The role of distraction control. *Neuropsychology, 22*(5), 638-644. doi: 10.1037/0894-4105.22.5.638

Davidson, M. C., Amso, D., Anderson, L. C., & Diamond, A. (2006). Development of cognitive control and executive function from 4 to 13 years: Evidence from manipulations of memory, inhibitions and tasks switching. *Neuropsychologia, 44*(11), 2037-2078. doi: 10.1016/j.neuropsychologia.2006.02.006

Delalande, L., Moyon, M., Tissier, C., Dorriere, V., Guillois, B., Mevell, K., ... & Borst, G. (2020). Complex and subtle structural changes in prefrontal cortex induced by inhibitory control training from childhood to adolescence. *Developmental Science, 23*(4), e12898. doi: 10.1111/desc.12898

Diamond, A. (2013). Executive Functions. *Annual Review of Psychology, 64*(1), 135-168. doi: 10.1146/annurev-psych-113011-143750

Diamond, A. (2016). Why improving and assessing executive functions early in life is critical. In J. A. Griffin, P. McCardle & L. S. Freund (Eds.), *Executive function in preschool-age children: Integrating measurement, neurodevelopment, and translational research* (pp. 11-43). Washington, DC: American Psychological Association. doi: 10.13140/RG.2.1.2644.6483

Diamond, A., & Ling, D. S. (2020). Review of the evidence on, and fundamental questions about, efforts to improve executive functions, including working memory. In J. M. Novick, M. F. Bunting, M. R. Dougherty & R. W. Engle (Eds.), *Cognitive and working memory training: Perspectives from psychology, neuroscience, and human development* (pp. 143-431). doi: 10.1093/oso/9780199974467.003.0008

Drasgow, F., & Mattern, K. (2006). New tests and new items: Opportunities and issues. In D. Bartram & R. Hambleton (Eds.), *Computer-based testing and the Internet: Issues and advances* (pp. 59-75). New Jersey, NJ: John Wiley & Sons. doi: 10.1002/9780470712993.ch3

Duckworth, A. L., Taxer, J. L., Eskreis-Winkler, L., Galla, B. M., & Gross, J. J. (2019). Self-control and academic achievement. *Annual Review of Psychology, 70*(1), 373-399. doi: 10.1146/annurev-psych-010418-103230

Fleiss, J. L. (1981). *Statistical methods for rates and proportions* (2nd ed.). New York, NY: John Wiley.

Friedman, N. P., & Miyake, A. (2004). The relations among inhibition and interference control functions: A latent-variable analysis. *Journal of Experimental Psychology: General, 133*(1), 101-135. doi: 10.1037/0096-3445.133.1.101

Gandolfi, E., Viterbori, P., Traverso, L., & Usai, M. C. (2014). Inhibitory processes in toddlers: A latent-variable approach. *Frontiers in Psychology, 5*. doi: 10.3389/fpsyg.2014.00381

Hasher, L., Zacks, R. T., & May, C. P. (1999). Inhibitory control, circadian arousal, and age. In D. Gopher &

A. Koriat (Eds.), *Attention and Performance XVII: Cognitive regulation of performance: Interaction of theory and application* (pp. 653-675). Cambridge, MA: MIT Press.

Hazlett, K. E., Figueroa, C. M., & Nielson, K. A. (2015). Executive functioning and risk for Alzheimer's disease in the cognitively intact: Family history predicts Wisconsin Card Sorting Test performance. *Neuropsychology, 29*(4), 582-591. doi: 10.1037/neu0000181

Heckathorn, D. D. (1997). Respondent-driven sampling: A new approach to the study of hidden populations. *Social Problems, 44*(2), 174-199. doi: 10.2307/3096941

Introzzi, I., & Canet-Juric, L. (2019). Tareas de Autorregulación Cognitiva [Software y manual de usuario]. Retrieved from https://tac.com.ar/evaluacion

Introzzi, I. M., Canet-Juric, L., Aydmune, Y., & Stelzer, F. (2016). Perspectivas teóricas y evidencia empírica sobre la inhibición. *Revista Colombiana de Psicología, 25*(2), 351-368. doi: 10.15446/rcp.v25n2.52011

Introzzi, I. M., Richard's, M. M., Aydmune,Y., Zamora, E. V., Stelzer, F., García-Coni, A., ..., & Navarro-Pardo, E. (2021). Development of perceptual inhibition in adolescents, a critical period? *Symmetry, 13*(3), 457. doi: 10.3390/sym13030457

Introzzi, I., Zamora, E., Aydmune, Y., Canet Juric, L., & López, S. (2017). El rol de la inhibición en la Teoría de Integración de las Características. *Cuadernos de Neuropsicología, 11*(3), 135-150. doi: 10.7714/CNPS/11.3.208

Introzzi, I., Zamora, E., Aydmune, Y., Richard's, M., Comesaña, A., & Canet-Juric, L. (2020). The change processes in selective attention during adulthood. Inhibition or processing speed? *The Spanish Journal of Psychology, 23*, e37. doi: 10.1017/SJP.2020.41

Jacob, R., & Parkinson, J. (2015). The potential for school-based interventions that target executive function to improve academic achievement: A review. *Review of Educational Research, 85*(4), 512-552. doi: 10.3102/0034654314561338

Logan, G. D. (1994). On the ability to inhibit thought and action: A users' guide to the stop signal paradigm. In D. Dagenbach & T. H. Carr (Eds.), *Inhibitory processes in attention, memory, and language* (pp. 189-239). San Diego, CA: Academic Press.

Mammarella, I. C., Caviola, S., Giofrè, D., & Borella, E. (2017). Separating math from anxiety: The role of inhibitory mechanisms. *Applied Neuropsychology: Child, 7*(4), 342-353. doi: 10.1080/21622965.2017.134 1836

Marra, D. E., Hoelzle, J. B., Davis, J. J., & Schwartz, E. S. (2020). Initial changes in neuropsychologists clinical practice during the COVID-19 pandemic: A survey study. *The Clinical Neuropsychologist, 34*(7-8), 1251-1266. doi: 10.1080/13854046.2020.1800098

Medrano, L., & Pérez, E. (2018). *Manual de psicometría y evaluación psicológica*. Córdoba, Argentina: Brujas.

Miyake, A., & Friedman, N. P. (2012). The nature and organization of individual differences in executive functions: Four general conclusions. *Current Directions in Psychological Science, 21*(1), 8-14. doi: 10.1177/0963721411429458

Miyake, A., Friedman, N. P., Emerson, M. J., Witzki, A. H., Howerter, A., & Wager, T. D. (2000). The unity and diversity of executive functions and their contributions to complex "frontal lobe" tasks: A latent variable analysis. *Cognitive Psychology, 41*(1), 49-100. doi: 10.1006/cogp.1999.0734

Montero, I., & León, O. G. (2002). Clasificación y descripción de las metodologías de investigación en Psicología. *International Journal of Clinical and Health Psychology, 2*(3), 503-508. Retrieved from https://www.redalyc.org/articulo.oa?id=33720308

Mullane, J. C., Corkum, P. V., Klein, R. M., & McLaughlin, E. (2009). Interference control in children with and without ADHD: a systematic review of Flanker and Simon task performance. *Child Neuropsychology, 15*(4), 321-342. doi: 10.1080/09297040802348028

Oberauer, K. (2001). Removing irrelevant information from working memory: A cognitive aging study with the modified Sternberg task. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 27*(4), 948-957. doi: 10.1037/0278-7393.27.4.948

Pallant, J. (2007). *SPSS Survival Manual. A Step by Step Guide to Data Analysis Using SPSS for Windows* (3rd ed.). Maidenhead: Open University Press.

Richard's, M. M., Introzzi, I., Zamora, E., & Vernucci, S. (2017a). Analysis of internal and external validity criteria for a computerized visual search task: A pilot study. *Applied Neuropsychology: Child, 6*(2), 110-119. doi: 10.1080/21622965.2015.1083433

Richard's, M. M., López -Ramón, M. F., Zamora, E., V., & Introzzi, I. M. (2022). Development of perceptual inhibition throughout the lifespan: Theoretical models and studies. In F. Alcantud-Marín, M. F. López-Ramón, E. Navarro-Pardo, V. Moreno-Campos & Y. Alonso-Esteban (Eds.), *Handbook of research on neurocognitive development of executive functions and implications for intervention*. doi: 10.4018/978-1-7998-9075-1

Richard's, M., Vernucci, S., Zamora, E., Canet-Juric, L., Introzzi, I., & Guardia, J. (2017b). Contribuciones empíricas para la validez de grupos contrastados de la Batería de Tareas de Autorregulación Cognitiva (TAC). *Interdisciplinaria, 34*(1), 173-192. Retrieved from http://www.ciipme-conicet.gov.ar/ojs/index.php?journal=interdisciplinaria

Stelzer, F. (2014). *Inteligencia, funciones ejecutivas y temperamento. Sus relaciones al inicio de la escolaridad básica*. (Tesis doctoral). Universidad Nacional de Mar del Plata. Retrieved from http://m.rpsico.mdp.edu.ar/handle/123456789/2

Stevens, C., & Bavelier, D. (2012). The role of selective attention on academic foundations: A cognitive neuroscience perspective. *Developmental Cognitive Neuroscience, 2*, 30-48. doi: 10.1016/j.dcn.2011.11.001

Stolte, M., Kroesbergen, E. H., & Van Luit, J. E. (2019). Inhibition, friend or foe? Cognitive inhibition as a moderator between mathematical ability and mathematical creativity in primary school students. *Personality and Individual Differences, 142*, 196-201. doi: 10.1016/j.paid.2018.08.024

Treisman, A. (1988). Features and objects: The fourteenth Bartlett memorial lecture. *The Quarterly Journal of Experimental Psychology, 40*(2), 201-237. doi: 10.1080/02724988843000104

Treisman, A. M., & Gelade, G. (1980). A feature integration theory of attention. *Cognitive Psychology, 12*(1), 97-136. doi: 10.1016/0010-0285(80)90005-5

Treisman, A., & Sato, S. (1990). Conjunction search revisited. *Journal of Experimental Psychology: Human Perception and Performance, 16*(3), 459-478. doi: 10.1037/0096-1523.16.3.459

Vadaga, K. K., Blair, M., & Li, K. Z. H. (2016). Are age-related differences uniform across different inhibitory functions? *Journals of Gerontology, Series B: Psychological Sciences and Social Sciences, 71*(4), 641-649. doi: 10.1093/geronb/gbv002

Zamora, E. V., Richard's, M. M., Canet-Juric, L., Aydmune, Y., & Introzzi, I. (2020). Perceptual, cognitive and response inhibition in emotional contexts in children. *Psychology & Neuroscience, 13*(3), 257-272. doi: 10.1037/pne0000202

Watters, J. K., & Biernacki, P. (1989). Targeted sampling: Options for the study of hidden populations. *Social Problems, 36*(4), 416-430. doi: 10.2307/800824

Wolfe, J. M., Cave, K. R., & Franzel, S. L. (1989). Guided search: An alternative to the modified feature integration model for visual search. *Journal of Experimental Psychology: Human Perception and Performance, 15*, 419-433. doi: 10.1037/0096-1523.15.3.419