VISUAL SEARCH AND ATTENTION TEST

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B. Definition

The Visual Search and Attention Test (VSAT) is a test of attention that assesses potential visual field defects, unilateral spatial neglect, and syndromes that affect perception in portions of the visual field. The VSAT employs a cancellation task paradigm, in which participants must detect a relevant target stimulus amongst other irrelevant stimuli (distractors) and cross out the target. The VSAT is comprised of four different cancellation tasks. Each task is presented on an 11" x 8.5" page, on which the relevant target stimulus (e.g., a letter or a symbol) is centrally located at the top of the page. If the relevant target stimulus is a letter, the irrelevant stimuli will all be letters, and if the target is a symbol, the irrelevant stimuli will all be symbols. Ten rows with 40 letters or symbols are presented per row, below the target. Each row contains ten relevant target stimuli randomly distributed amongst 30 irrelevant stimuli. All four cancellation tasks are timed with an allowed maximum of 60 seconds per task.

The first two tasks are conducted as practice in order to familiarize the participant with the cancellation procedure. In Task 1, participants are given the letter "F" in black ink as the target and the irrelevant stimuli are other letters also printed in black. In Task 2, participants are given the symbol "]" in black ink as the target and the irrelevant stimuli are symbols also printed in black ink. Because the target and distractors in Tasks 1 and 2 differ only in one modality (form *or* color), these tasks are known as single-feature search conditions. In Task 3, participants are instructed to cross out blue Hs from an array of blue, green, and red letters (other than Hs). In Task 4, participants are instructed to cross out blue "/"s from an array of blue, green, and red symbols (other than "/"s). Because the target and distractors in Tasks 3 and 4 differ in both form *and* color, these tasks are known as a dual-feature or conjunction search condition.

To score the VSAT, all of the correctly cancelled targets from Tasks 3 and 4 are totalled. Neither the practice trials nor incorrectly identified targets from Tasks 3 and 4 contribute to scoring. The left and right sides of a page are scored both separately and together over both Tasks 3 and 4, such that the VSAT produces three scores: a *left side score* (out of 100), a *right side score* (out of 100), and a combined *overall attention score* (out of 200).

C. Historical Background

The VSAT was developed in 1990 to specifically measure visual scanning and sustained attention in adults (Trenerry, Crosson, DeBoe, & Leber, 1990). Normative data from 272 healthy adults (67% female; aged 18–85 years) showed that VSAT scores were negatively correlated with age, while gender and level of education had no effect on the scores: while young adults'

average overall attention score was 166/200, older adults' average overall attention score was 100/200.

D. Current Knowledge

Construct Validity

O'Donnell et al. (1994) examined the construct validity of the VSAT in relation to other neuropsychological tests, including the Category Test (CAT), Wisconsin Card Sorting Test (WCST), Paced Auditory Serial Addition Task (PASAT), and Part B of the Trail Making Test (TMT-B). The study included 117 adults between the ages of 18-61 years (33% female), who were referred from a state department of rehabilitation services. The sample included adults with learning disabilities, head injuries, seizure, behavioural/personality disorders, cortical atrophy, Parkinson's Disease (PD), and dementia.

The VSAT showed only moderate discriminant validity as it correlated moderately with other measures (r = 0.2 to 0.3). A Principal Components Analysis showed that the VSAT, PASAT, and TMT-B all exhibited convergent validity with one another and loaded onto an attention factor which exemplified speeded mental processing (VSAT factor loading of 0.84). In contrast, the CAT and WCST loaded onto a divergent, second, abstract conceptual processing factor. O'Donnell et al. (1994) concluded that the aforementioned tests of attention and conceptual processing are not interchangeable and represent similar but distinct constructs.

Current Published Use of the VSAT

Parkinson's Disease (PD)

Filoteo, Williams, Rilling, and Roberts (1997) used a sample of N = 20 (25% female) non-demented participants with PD and compared their performance to N = 20 (45% female) control participants who were matched for both age and education level on a modified version of the VSAT. One modification in administering the VSAT was that Filoteo et al. (1997) eliminated the standard 60-second time limit per task, instead allowing participants to finish each task at their own pace. Also, they modified the scoring of the VSAT by including scores from all four tasks (i.e., use of no practice tasks) deeming Tasks 1 and 2 as "single-feature search tasks" and Tasks 3 and 4 as "dual-feature search tasks." They also scored participants' completion time, omission errors (e.g., relevant targets that were not cancelled), and commission errors (e.g., irrelevant stimuli that were cancelled).

The PD group compared to the control group showed significantly slower completion times on the single-feature search tasks but not on the dual-feature search tasks. This implies that participants with PD had difficulty with selective attention processes. The study provided evidence that pre-clinical dementia may be detected by measures such as the VSAT.

Schizophrenia

Maia (2010) used a sample of N = 21 males with schizophrenia (no control) to conduct an exploratory and descriptive study attempting to link participants' performance on several assessment measures (e.g., VSAT, WAIS, Clock Task) to various demographic variables (e.g.,

length of internment in a mental health care center, family contact, schooling). All participants scored below the 6th percentile on the VSAT.

F. Future Directions for Use of the VSAT

Clinical Application

Visual search is often affected in neurological disorders and therefore the implementation of assessments of visual search capacities in a clinical context has been paramount (Huang & Wang, 2008).

Alzheimer's Disease (AD)

Research supports that during standard conjunction tasks, participants with AD perform worse than control participants (Foster, Behrmann, & Stuss, 1999; Landy et al., 2015). Further investigating whether this deficit was due to the attentional load (search difficulty) or the conjunction itself, Tales et al. (2002) found that even when attentional load during conjunction tasks was low, AD patients were still significantly impaired overall compared to healthy controls. This is noteworthy, in that visual deficits were detectable among a pre-clinical population (diagnosis of "probable AD"), supporting the use of the VSAT as a clinical tool in early stages of dementia. Furthermore, there is ample evidence that orienting or shifting of attention (which is integral to the process of visual search) is more difficult among individuals with AD, and eye-tracking studies have found that fixation durations (and the inability to disengage from stimuli) were longer in AD patients than healthy controls (Tales & Porter, 2008). It is speculated that because the temporal and parietal cortex (which are known to be affected by AD) are also believed to mediate feature binding in visual search, neurophysiological deficits are associated with visual search deficits.

Healthy Aging

Cognitive aging research robustly demonstrates age-related decline in speed and accuracy of visual search tasks, which may be suggestive of change in attentional processing with age (Madden, 2007). Using Event-Related Potentials (ERPs) in combination with standardized Low-Resolution Brain Electromagnetic Tomography (sLORETA), researchers showed an increase in mean reaction times and lower hit rates on visual search tasks among older compared to young participants (Lorenzo-López, Amenedo, Pascual-Marqui, & Cadaveira, 2008). Results further suggest an age-related decline in the intensity and speed of visual processing (and underlying neural circuits) during visual search with normal aging. Using similar methodologies, it is likely that timed tests like the VSAT would be useful in further examining age-related differences in visual search ability.

Autism

Attentional abnormalities and a noted capacity for attending to irrelevant visual information is prominent among individuals with Autism Spectrum Disorder (ASD) (Remington, Swettenham, Campbell, & Coleman, 2009). There is evidence that ASD patients have more difficulty filtering out distracting stimuli compared to healthy controls (Ciesielski, Courchesne, & Elmasian, 1990). However, research also suggests that these observed discrepancies in performance may be due to underlying differences in perceptual capacity within the context of varying perceptual

load of the task. In other words, if individuals with ASD retain a higher perceptual capacity, they have the privilege of attending to distractors without suffering deficits in performance on target items. Not until the perceptual load (and cognitive demand) of the task increases past a certain threshold, will they need to fine tune attention to only relevant stimuli (Remington et al., 2009). This framework would explain the superior visual search abilities that have been demonstrated among ASD populations (Hessels, Hooge, Snijders, & Kemner, 2014). It is highly probable that the VSAT could serve as a pragmatic assessment in this population, although little research thus far has been conducted using this specific task paradigm.

Study of Neurocorrelates in Visual Search

Using functional Magnetic Resonance Imaging (fMRI), Nobre, Coull, Walsh, and Frith (2003) found that visual search tasks elicited the extensive use of parietal (bilateral superior and inferior parietal lobules), frontal (anterior cingulate cortex and dorsolateral prefrontal and premotor cortex), and (dorsolateral, medial, and ventral) occipital brain regions. Use of the VSAT as an experimental task in future fMRI studies towards understanding the neurocorrelates of visual search processes appears fruitful given its variation of single-feature and double-feature search conditions as well as its potential for varying attentional load.

G. See also

Paced Auditory Serial Attention Test

Trail Making Test

Selective Attention Models

Cingulate Gyrus

H. References and Readings

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