Enhancing visual search abilities of people with intellectual disabilities

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Abstract

This study aimed to evaluate the effects of cueing in visual search paradigm for people with and without intellectual disabilities (ID). A total of 36 subjects (18 persons with ID and 18 persons with normal intelligence) were recruited using convenient sampling method. A series of experiments were conducted to compare guided cue strategies using either motion contrast or additional cue to basic search task. Repeated measure ANOVA and post hoc multiple comparison tests were used to compare each cue strategy. Results showed that the use of guided strategies was able to capture focal attention in an autonomic manner in the ID group (Pillai's Trace = 5.99, $p < 0.0001$). Both guided cue and guided motion search tasks demonstrated functionally similar effects that confirmed the non-specific character of salience. These findings suggested that the visual search efficiency of people with ID was greatly improved if the target was made salient using cueing effect when the complexity of the display increased (i.e. set size increased). This study could have an important implication for the design of the visual searching format of any computerized programs developed for people with ID in learning new tasks.

1. Introduction

During the past decade, significant theoretical frameworks and empirical studies have been established for the study of human visual search behaviors. One of the most important research areas is the extent to which visual attention can enhance the speed and accuracy with which the target is detected and analyzed (Baldassi & Burr, 2000). The ability to focus attention on relevant

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features in visual search while limiting attention to irrelevant elements is important in most educational tasks, especially among people with intellectual disabilities (ID), who have been known to be easily distractible (Conners, Caruso, & Detterman, 1986).

Several theories have been proposed regarding the nature of the processes involved in feature and conjunction search tasks. Treisman and Gormican (1988) have described two distinct stages of visual processing: (a) pre-attentive stage (i.e. parallel search) which involved distinctions between disparate features on a particular dimension and (b) attentive stage (i.e. serial search) which was a subsequent serial-processing stage that allowed for fine discriminations among the stimuli presented. The assumption of parallel search was that all stimuli were assumed to be processed simultaneously because highly disparate features could be identified rapidly and independently of the number of elements in the array (set size); whereas if the target was not identifiable immediately, e.g. less disparate features, a sequential shift of focal attention across a scene in serial search of the array was required. The hallmark of this theory was that the perceptual analysis of complex visual objects depended on focal attention, and could only occur for one object at a time. It is believed that when target–non-target similarity was high, increasing heterogeneity in the non-target stimuli would result in decreased search efficiency and vice versa.

1.1. Enhancing visual search for people with ID

One of the common techniques to study the effects of cueing in visual search paradigm is to ask the participants to make perceptual judgment about the target in the presence of a variable number of neutral distracters. Cueing attention may or may not have any effect on both speed and accuracy (Baldassi & Burr, 2000). A number of studies on visual search among people with normal intelligence have reported that a visually salient element in a given environmental context is an important parameter in capturing attention. Stimulus character that appears abruptly (i.e. as "popout") in a display could direct focal attention and guide the selection and identification processes of the visual system, by which the target properties are then recognized. Visual cues such as color contrast, motion contrast, and change of luminance have been found to produce efficient saliency effects that allowed targets to be identified quickly and attracted focal attention for task target analysis (Irwin, Colcombe, Kramer, & Hahn, 2000; Nothdurft, 1995, 2002; Turatto & Galfano, 2000), and can even override the intended direction of an eye movement. Therefore, in the context of the guided visual search method, it is assumed that knowledge of target feature (i.e. top–down activation) and various saliency effects (i.e. bottom–up activation) can facilitate the pre-attentive stage and guide the attention to the target in the visual array which is relevant to the search goal.

The question remaining is whether people with ID could also demonstrate the efficacy in pre-attentive and attentive-processing search manner. However, the development of the literature on visual search processes in individuals with ID has been inadequate. In the past decades, several researchers have attempted to investigate the visual search arrays for dimensions such as color, form or size among people with ID. It was found that at times, individuals with ID performed serial searching for target stimuli in which people with normal intelligence identified the target rapidly and independently of the number of objects in the array (i.e. parallel search) (Carlin, Soraci, Dennis, Strawbridge, & Chechile, 2002; Carlin, Soraci, Goldman, & McIlvane, 1995).

In this study, the variation of the paradigm used by Carlin et al. (1995, 2002) was adopted to test visual search efficacy. The goals of this study were to measure the visual attention in a guided feature search task using different saliency effects (i.e. guided motion and guided cues), and to investigate the efficiency of visual search for a predefined target by assessing the effect of cueing