INTRODUCTION

Use of images in multiple-choice tasks is common in linguistic comprehension assessment for adults with neurogenic communication disorders. Ideally, when an auditory or written verbal stimulus is presented along with a set of images, the listener indicates the image that best corresponds to the verbal stimulus. If the correct (target) image is selected, the examiner generally assumes that the verbal stimulus was understood; when the incorrect image (nontarget foil) is selected, the examiner generally assumes that the verbal stimulus was not understood. There are ample reasons to challenge such assumptions within a given testing situation, especially given: 1) the robust body of literature demonstrating that there are numerous influences on what attracts a viewer to differentially attend to elements within a visual array (c.f., Hallowell, Wertz, & Kruse, 2002; Rayner, Sereno, Morris, Schmauder, & Clifton, 1989), and 2) the substantial body of literature demonstrating that individuals with neurogenic communication disorders (especially those associated with stroke, traumatic brain injury and dementia) are susceptible to attention-demanding factors that may confound appropriate assessment responses (Denes, Semenza, Stoppa, & Lis, 1982; Kinsella & Ford, 1985; Myers, 1998; Tompkins, 1995; Ylvisaker, 1992).

Influences on where people look within a display, and thus potential influences on patients' preferential selection of images during a multiple-choice task, include 1) physical stimulus properties such as size, color, clarity, or complexity and 2) factors affecting the semantic content conveyed (e.g. concept familiarity, cultural congruence, and imageability). Items that do not share the same basic visual characteristics as all other items in the perceptive field are especially likely to lead to disproportionate visual attention (Wolfe, 2000). For instance, a single red item shown with three blue items would attract greater visual attention when a viewer is shown the items simultaneously. This phenomenon is referred to as the "pop-out" effect. Features of multiple-choice images in a display evoke the pop-out effect when the viewer's visual attention to specific images becomes disproportionately allocated among presented images.

It is impossible to predict 1) the degree of influence of physical stimulus features and semantic content conveyance factors and 2) whether this influence may override the influence of accurate linguistic comprehension on the selection of an image by a particular individual in a specific testing situation. The only way to reduce the influence of these factors is to control for them in the design of image displays. Efforts to minimize the possibility of confounding the selection of target images as opposed to non-target foils in multiple-choice tasks are essential to ensuring validity of assessment when linguistic stimuli are presented with those visual stimuli.

A means of evaluating possible confounds associated with images that evoke disproportionate visual attention is to compare eye movement patterns as viewers examine uncontrolled test stimuli with their eye movements as they view test stimuli carefully designed to account for the balance of image features within a multiple-choice set. Given the increased availability of inexpensive or free clipart images through the Internet and published software packages, and given that these images vary widely (for example, in terms of quality, design style, degree of realistic representation, viewer perspective, number of contextual cues surrounding an image, and complexity), assessment of clipart use in multiple-choice contexts is especially timely.

PURPOSE OF STUDY

In this study we compared viewers' distribution of visual attention, as indexed through eye movements, as they viewed controlled versus uncontrolled image sets. We hypothesized that the pop-out scores obtained during viewing of uncontrolled image sets would be greater than the pop-out scores obtained during viewing of controlled image sets with conveying identical semantic content. More disproportionate fixation distributions, as captured through pop-out statistics, would indicate greater risk of distraction by physical stimulus properties rather than the content conveyed by multiple-choice images.

METHOD

Eye Movement Assessment

Participants. Twenty adults, age 18 to 25, participated in the experiment. All were native speakers of English. They had no knowledge of the study, and no history of neurological disorder. All participants passed vision and hearing screenings.

Stimuli. 46 image sets were used, each containing of four images. Twnety-three image sets contained clipart images. Twenty-three matched sets contained carefully controlled images picturing the same objects or activities as depicted in the clipart sets. The controlled images were designed by a professional graphic artist who was familiar with the purpose of the study. The graphic artist created images while controlling for the following physical stimulus features, as described in detail by Heuer and Hallowell (2004):

- Color
- Orientation
- Size
- Depth cues and shading
- Luminance
- Complexity
- Symmetry and asymmetry
- Clarity

Repeated image edits were made following three phases of review by two additional professional graphic artists and three individuals with eye tracking experience and knowledge of the purpose of the study.

Procedure. Each participant viewed the 46 images sets presented via computer in random order for six seconds each while sitting in a soft high-back chair. Participants were asked to relax and look naturally at the images to be displayed. The purpose of the experiment was not explained to the participants until after the experiment in order to prevent “purposeful looking” at certain images. Each participant’s eye movements were monitored and reported with an ISCAN RK 426 pupil center/corneal reflection system at 60 samples per second (Hallowell, Kruse, & Wertz, 2002). Eye movement data were analyzed for the first three seconds of presentation of each image set.

RESULTS

Disproportionate visual attention allocated across images within a set were indexed using the pop-out statistic. The pop-out statistic ranges from 0 to 1. A value close to 0 indicates an even distribution of eye fixations across the images presented together in a display. A value close to 1 indicates a high degree of disproportionate looking. The pop-out equation follows.

$$\text{Pop-out eye movement score} = \frac{\text{highest} - (1/\ \#\text{images})}{1 - (1/\ \#\text{images})}$$

, where "highest" refers to the highest proportion of fixation duration within the display (between 0 and 1) and "# images" refers to the number of images within the display. For this study four images were displayed in each set. Mean pop-out scores of controlled image sets were significantly lower than uncontrolled images ($t(18) = -2.218$, $p = .04$).

DISCUSSION

More disproportionate distributions of fixations across multiple-image sets, as indexed by pop-out statistics, indicates a greater risk of distraction for clipart compared to carefully designed image sets. This finding highlights the importance of strategic control in the design of images to be used for language comprehension assessment with multiple-choice image sets. Lack of careful control in multiple-choice image design may negatively impact validity of experimental task performance and of clinical assessment results.

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