Preliminary Investigation of Eye Gaze on Visual Scene Displays With a Navigation Menu

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Funded by The Rehabilitation Engineering Research Center on AAC grant from the U.S. Department of Health and Human Services, National Institute on Disability, Independent Living, and Rehabilitation Research (NIDILRR) [grant number #90RE5017].

Augmentative and alternative communication (AAC) is a compilation of methods and technology designed to supplement spoken communication for people with limited speech or language skills. Visual scene displays (VSDs) are a form of AAC display in which language concepts are embedded into an image of a naturalistic event. They provide a high level of context by portraying events, people, actions, and objects within the context that they occur. Because VSDs are accessed via the visual modality, it is critical to consider how individuals who use AAC attend to and process the visual information of the display. (Wilkinson, Light & Drager, 2012)

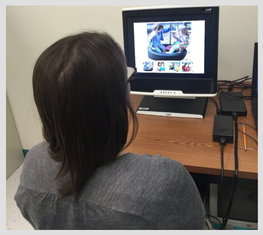
The current study examined attention to a main VSD as well as to a navigation bar on a simulated AAC display, first when the participants were free to view the stimulus without any prompt, and then following a cue to find one of the items within the navigation bar. The goal was to (a) determine how participants allocated their attention during free and cued viewing, and (b) determine how gaze patterns were influenced by the presentation of a cue.

Participants

	Number	CA Mean(range)	PPVT SS Mean (range)
TD CA matches (teens/ adults)	14	21 (13-33)	WNL
TD ~RLA matches (preschoolers)	7	4 (3;2-4;9)	116 (100-133)
Autism spectrum disorder (ASD)	15	14;6 (7;4-19;5)	37 (20-90)
Down syndrome (DS)	13	17;8 (10;1-34;11)	52 (22-73)
Intellectual/Developental Disability (IDD)	12	16;6 (10;7-28;1)	46 (20-81)

Note: CA matches = individuals with TD who were chronological age matches to participants with ASD, DS, or IDD; ~RLA matches = preschoolers with TD who were rough matches to participants with ASD, DS, or IDD on receptive vocabulary (enrollment is ongoing for the younger TD participants and numbers/matching will become more precise matches)

Method



A research eye tracker recorded point of gaze at 60 samples per second, while participants watched a series of pictures appear on a monitor.

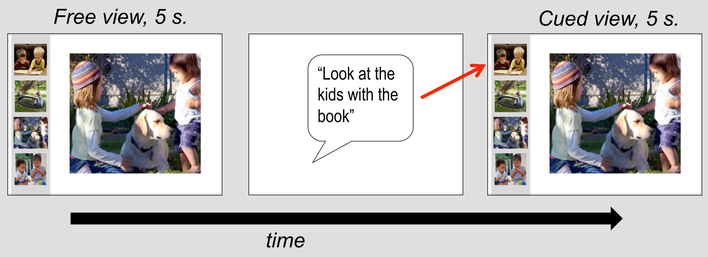
The monitor is equipped with infrared light projection and detection strips. The light that is reflected from the participant's eyes allows the system to calculate the location of gaze fixation using information about the location of the participant's pupil, the orientation of the cornea, and distance from the monitor.

Stimuli, Prescreening, & Presentation Procedures

Stimuli consisted of a main VSD and a navigation bar. The main VSDs presented two children interacting with one of four shared interests; a dog, a book, a snack, and a tire swing. An example is:

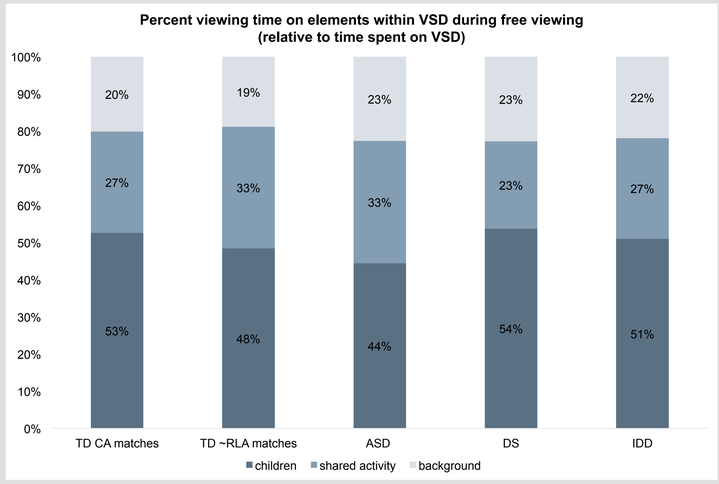
Prior to the eyetracking session, participants underwent a pre-screening for all images of the four concepts. Comprehension was demonstrated by the participant selecting targets from arrays of four upon hearing the spoken word.

•**Free viewing**: An initial period of free viewing was presented first, in which the participant was given 5 seconds to observe the display containing a main VSD and the navigation bar, with no instruction.
•**Cue**: After the free viewing period, a white screen appeared along with an auditory cue, which cued the participant to look for one of the smaller icons in the navigation bar (not the current VSD).
•**Cued viewing:** The same display then re-appeared, for 5 seconds.



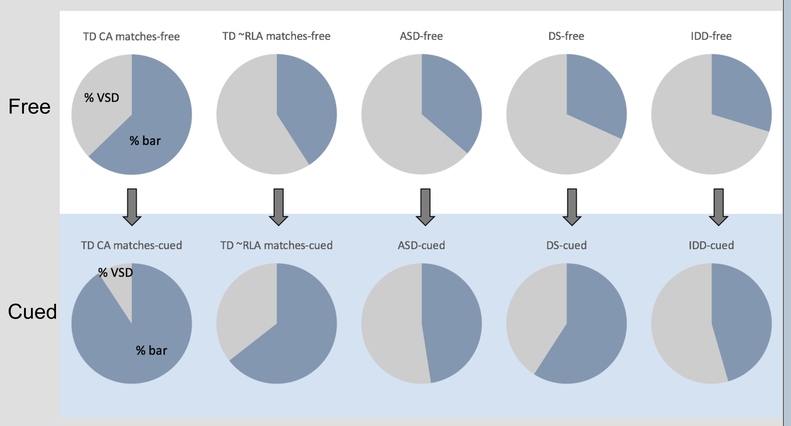
Analysis #1: How do participants allocate their attention, during free and cued viewing?

1a. What elements attract attention in the main VSD during free viewing?



Participants in all groups showed similar attention allocation within the main VSD. They spent the most time viewing the children followed by the shared activity; minimal time was spent viewing the background.

1b. How is visual attention divided between the VSD and the navigation bar in free viewing vs cued viewing?



On average, participants in all groups allocated greater time to the navigation bar after the cue was presented, relative to their allocation during free viewing. Participants with DS increased their attention to the navigation bar substantially in the cued condition. Participants with ASD and IDD also increased their attention to the bar in the cued condition but the increase was not as great.

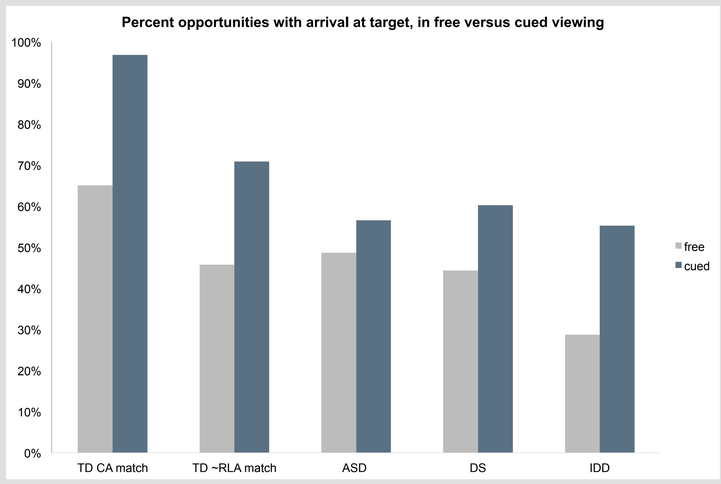
Implications of Analysis #1

1a. During free viewing, individuals in all groups spent the most fixation time on the children, followed by the shared point of interest (the dog, book, swing, or snack). There was not substantial attention allocated to non-relevant background elements, although all participants did spend some time there. Integrated visual scenes that include people engaged in social activities do not cause selective disadvantages in visual attention in individuals with disabilities; the complexity of the stimulus is not overwhelming to visual processing, nor do the social interactions depicted result in gaze aversion.

1b. Participants in all groups showed greater proportion of fixation time spent on the navigation bar after hearing the cue, indicating that the cue prompted looks to the bar. There was some variability in the level of attention shift shown by individual participants with ASD, DS, or IDD; a better understanding of what contributes to this shift is needed. Analyses are underway to evaluate what participant characteristics are associated with across- and within-group variability.

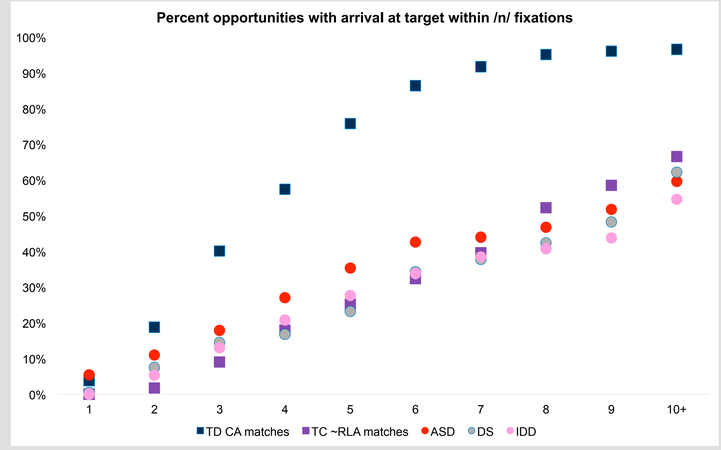
Analysis #2: When a cue is presented, how accurate and efficient is search for that target?

2a. Accuracy: In how many opportunities do participants fixate on the cued target?



Participants showed an increase in the likelihood of fixating on the target after presentation of the cue. Within-group variability was present, and analyses are underway to evaluate the causes.

2b. Efficiency: How many fixations are made prior to fixating on the cued target (cued viewing condition)?



Adults with TD (blue squares) fixated quickly on the target after the cue, as indicated by the steep slope in the percent of opportunities on which the target was reached within just a few fixations. Slopes for the participants with ASD, DS, or IDD are virtually indistinguishable from those of the children with TD with similar receptive vocabulary ages.

Implications of Analysis #2

2a. The increase in the likelihood of fixating on the target after the cue suggests that participants were attending to the cue. However, some individuals within the groups did not show this pattern, despite having demonstrated comprehension on the prescreening. This variability within participants remains to be evaluated, to determine what factors contribute to the likelihood of looking at the target after the cue.

2b. The efficiency of attention allocation to the cued target appears to be developmentally linked, where individuals at similar developmental levels show similar efficiency in their visual search for a cued target.

Analyses of whether there is an optimal location for the navigation bar are currently underway.

In summary, eye tracking technologies are viable means of obtaining information about patterns of visual attention that could not be obtained by any other method. These technologies can be used with individuals who are difficult to test via any other means, and to investigate ways to improve the design of AAC displays.