Word Skipping in Deaf and Hearing Bilinguals: Cognitive control remains with increased perceptual span.

Matthew J. Traxler (UC Davis), Pilar Pinar (Gallaudet University), David Corina (UC Davis), Kurt Winsler (UC Davis), Liv J. Hoversten (Basque Center on Cognition, Brain, & Language), & Trevor Brothers (Tufts University)

Deaf readers face a number of challenges in developing literacy skills (Allen, 1986; CB Traxler, 2000). Deaf readers must simultaneously learn a second language (e.g., English) at the same time they are learning to interpret print. Prior studies indicate that sensitivity to syntactic and semantic cues in relative clause processing look similar in deaf and hearing readers (Anible et al., 2015; Traxler et al., 2014).

Prior studies indicate that deaf participants have an advantage in detecting peripheral visual targets (Parasnis and Samar, 1985; Bosworth & Dobkins, 2002; Dye et al., 2007; Seymour et al., 2017). Enhanced performance on some visual tasks seems to be driven by an increased ability to allocate visual attention to peripheral space (e.g. Bosworth et al., 2013; Neville and Lawson, 1987; Bavelier et al., 2000). Redistribution of attention towards the periphery may offset the absence of auditory cues in target detection (Bavelier, 2006). Differences in the allocation of visual attention may affect the *perceptual span* during reading. The perceptual span is the region of visual space from which readers extract information that affects their eye-movements (Rayner & Pollatsek, 1989). Perceptual span varies with a number of factors, including reading experience, reading proficiency, and text difficulty. Because the same reader can demonstrate a larger perceptual span on a given text and a smaller span on another text, span size and shape is thought to be affected by a combination of attentional and acuity factors, rather than being a fixed characteristic of a given reader.

Recent studies have indicated that deaf readers have larger than predicted perceptual spans (Belanger & Rayner, 2015; Belanger et al. 2012, 2013). In *moving window* eye-tracking experiments, Belanger and colleagues showed that reading speed for deaf participants reached asymptote at a larger window size than comparably skilled hearing readers. In addition, less skilled deaf readers demonstrated perceptual spans that were as large as more skilled hearing readers. Belanger formulated the *word processing efficiency* hypothesis to explain larger spans in deaf readers. According to this account, deaf readers may be taking up more information more quickly from parafoveal regions than hearing counterparts. Alternatively, they may have stronger orthographic-to-semantic associations than other readers.

This study was conducted to test further predictions derived from the word processing efficiency account. We conducted two eye-tracking experiments, each with three groups of participants – deaf ASL-English bilinguals (N = 80 & 80), hearing Chinese-English bilinguals (N = 48 & 60), and native English speakers (N = 48 & 60). In both experiments, participants read sentences while having their eye-movements monitored. We analyzed skip rate, first-pass,and total time for seven scoring regions. We also analyzed accuracy on comprehension questions.

The results from both experiments showed that deaf readers skipped scoring regions more often than the other two groups, while achieving comparable (Experiment 1) or greater (Experiment 2) comprehension accuracy than the hearing bilingual comparison group (see Tables 1 and 2). Within-group comparisons showed generally negative correlations between skip rate and comprehension. Deaf readers also had shorter first pass and total fixation times than the other two groups of readers, although fixation times varied with lexical frequency for all groups. Subsidiary analyses that evaluated performance in light of non-verbal IQ (K-BIT matrices), reading experience (author recognition test), and vocabulary (Nelson-Denny) indicated that none of these accounted for differences in skipping rate and comprehension accuracy across groups (see Table 3). The results as a whole are compatible with the word processing efficiency account.

Table 1: Experiment 1 Average comprehension accuracy rate, average skip rate for interest areas 2-6, and the Pearson r correlation between skip rate and accuracy by group. *indicates $p < .05$

Group	**Accuracy**	**Skiprate**	**Within-Group Correlation**
Deaf	91.3% (5.5%)	34.3% (11.3%)	**-.24***
Chinese-English Bilingual	91.2% (5.6%)	17.6% (10.5%)	**-.34***
Native English Reader	94.1% (3.4%)	24.0% (10.6%)	**-.12**

Table 2. Experiment 2, Average comprehension accuracy rate, average skip rate for interest areas 2-6, and the Pearson r correlation between skip rate and accuracy by group for Experiment 2. *indicates $p < .05$

Group	**Accuracy**	**Skiprate**	**Correlation**
Deaf	86.6% (8.2%)	18.2% (8.9%)	**-.21**
Chinese-English Bilingual	83.5% (7.2%)	8.5% (5.3%)	**-.43***
Native English Reader	92.6% (4.3%)	9.9% (4.9%)	**.16**

Table 3: **Experiment 1**, means and standard deviations for Nelson-Denny vocabulary, author recognition, KBIT test scores, gender, and age by group.

Group	**Nelson-Denny**	**Author Recognition**	**KBIT**	**%Female**	**Age**
Deaf	**50.0 (16.47)**	**13.5 (12.64)**	**40.1 (4.18)**	**68.8**	**24.7 (5.20)**
Chinese-English Bilingual	**44.0 (12.78)**	**3.7 (4.09)**	**42.5 (2.37)**	**64.6**	**20.3 (2.77)**
Native English	**66.0 (6.98)**	**12.8 (6.85)**	**41.2 (4.90)**	**74.5**	**19.3 (1.14)**