GARDEN PATH AND OBJECT-EXTRACTED RELATIVE CLAUSE PROCESSING IN CONGENITALLY BLIND ADULTS: EVIDENCE FROM SELF-PACED LISTENING.

INTRODUCTION: Congenital blindness interacts with language processing and its neural basis [1,2,3]. Blind individuals are better and faster at answering comprehension questions about grammatically complex spoken sentences, especially garden-paths (GP) [4]. Are blindness advantages due to enhanced sensitivity to prosodic cues? Do blind people show online GP costs? Online grammatical complexity effects were measured the absence of any prosodic information using self-paced listening.

METHODS: 23 congenital blind (12F/13M) and 22 (17F/5M) age and education matched sighted participants listened to spoken English sentences one segment at a time, using a button box to advance to the next segment. Segments were on average 1.84 words-long (SD=0.44, range=1 to 5) and were recorded in a random order to remove prosody. **Stimuli**: 42 sentences contained a garden-path (GP) transitive/intransitive syntactic ambiguity and 42 contained a long-distance movement dependency with an object-extracted relative clause (+Move) [5,6]. Each critical sentence had a matched control (-Move and non-garden path NGP). 84 fillers were included to reduce syntactic priming. After each sentence, participants answered a yes/no who-did-what-to-who question. Logistic regression was used to model accuracy (stats, www.R-project.org/) and linear regression for RT (lme4, www.R-project.org/), with subject and item as random factors. RTs were first natural log transformed. **RESULTS: GP Sentence Accuracy & RT:** GP ambiguity was associated with lower accuracy on comprehension questions for blind and sighted groups (logit regression, main effect of GP: B=2.87 SE=0.33, p<0.001). There was no main effect of group (B=-0.05, SE=0.55, p=0.92). We found a group by GP interaction (B=-1.11, SE=0.44, p=0.01). Unlike in the previous study, blind participants showed a *larger* GP cost, suggesting a heavier reliance on prosody in the blind group. In post-hoc comparisons blind participants performed slightly better only on NGP sentences (GP t(933)=9.32, p<0.001; NGP p=0.57) (Fig.1A.). In reaction time data, we likewise observed a main effect of GP complexity as well as a group-by-complexity interaction, again with a larger GP cost for blind participants (linear regression: main effect of GP: B=-0.12 SE=0.02, p<0.001; group by GP: B=0.08, SE=0.03, p=0.02). There was no main effect of group (B=-0.05, SE=0.06, p=0.3) (Fig.1B.). **Movement Accuracy & RT:** Blind and sighted participants were less accurate on +Move comprehension questions (logit regression, main effect of +Move: B=1.10, SE=0.3, p<0.001). Blind participants performed marginally better overall (main effect of group B=-0.59, SE=0.33, p=0.07) and there was no interaction (group by +Move interaction B=-0.04, SE=0.43, p=0.9) (Fig. 1A.). In RT, both groups were slower on +Move (linear regression main effect of +Move: B=-0.08 SE=0.04, p<0.001) and there was no group or interaction effects (main effect of group: B=0.03, SE=0.06, p=0.6; group by +Move interaction B<0.001, SE=0.05, p=0.9) (Fig.1B.). **Self-paced listening times:** Blind and sighted participants alike showed an effect of GP complexity on online listening times at the critical segment (i.e., matrix verb) (linear regression, main effect GP: B=-0.01; SE=0.008, p=0.04). There was no group by GP interaction (B=-0.007, SE=0.01, p=0.4). However, overall blind participants showed much shorter listening times (main effect of group: B=0.1, SE=0.02, p<0.001) (Fig.2A). Blind and sighted participants also showed an online effect of movement at critical verb regions (both at V1 and V2) (Fig.2B) (main effect of +Move P's<.05). The effect was larger in the blind group at V1 but not at V2 (group by +Move interaction V1 P<.006; V2 P=.3). Blind participants showed overall faster listening times for +Move and -Move sentences (main effect of group V1 P=.2; V2 P<.001) (Fig.2B).

CONCLUSION: To summarize, people born blind performed self-paced listening nearly twice as fast as sighted participants, while showing similar or slightly better accuracy. However, we observed the same effects of GP and +Move cost across blind and sighted people, both in the online and offline measures of processing. When prosodic cues are eliminated, people born blind show a *larger* garden path cost, suggesting a greater reliance on prosody [4]. We hypothesize that habitual lack of visual access to referential context cues leads to greater reliance and sensitivity to prosodic information in blindness [7].

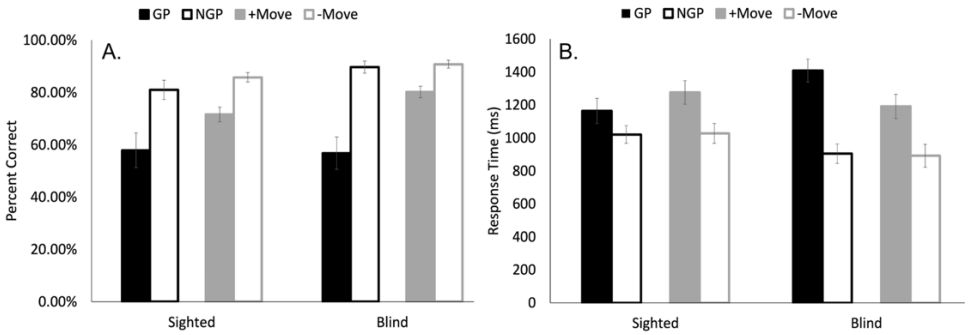

Fig.1: A. Offline Measure: Yes/No Question Accuracy. B. Offline Measure: Yes/No Question Reaction Time. Garden-path (GP) and non garden-path (NGP) in black, syntactic movement sentences (+Move) and matched non-move (-Move) sentences in gray. Error bars show SEM.

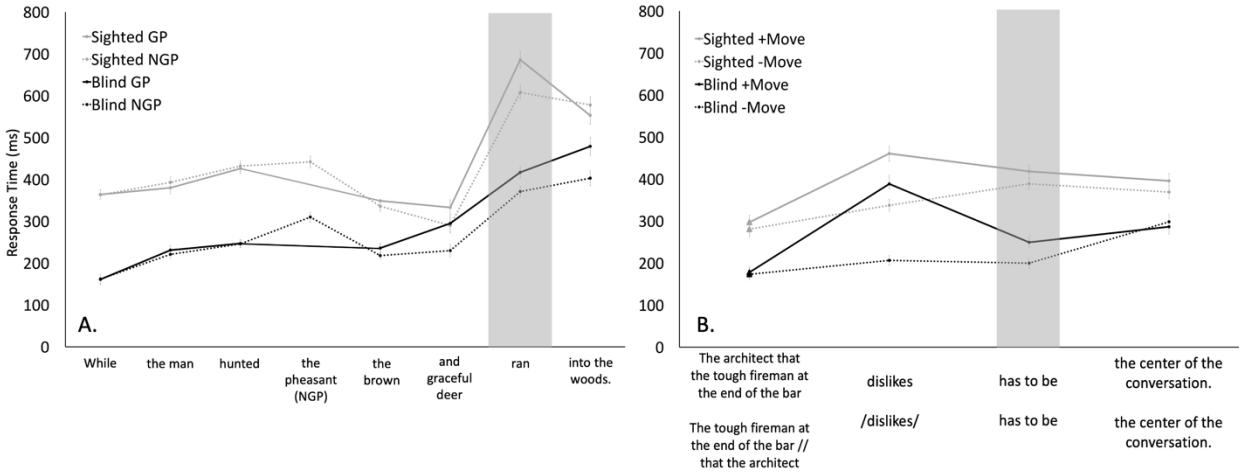

Fig.2: Online measure: Mean listening times per segment for sighted control participants (gray) and congenitally blind participants (black). A. Garden-path (GP) and no garden-path (NGP) sentences. **B.** Movement (+Move) and non-movement sentences (-Move). Error bars show SEM.

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