Contextual Plasticity in Sound Localization vs. Source Separation in Real and Virtual Environments

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Background: Contextual plasticity (CP) is a localization aftereffect occurring on the time scale of seconds to minutes. It has been observed as a bias in horizontal sound localization of click target stimuli presented alone, when interleaved with contextual adaptor-target trials in which the adaptor was at a fixed location while the target location varied. The observed bias is always away from the contextual adaptor location, even though the adaptor is not present on the experimental trials. Here we present the results of two experiments whether examined whether this phenomenon is dependent on engagement of the subject in an active localization task on the contextual trials and whether CP is also observed in virtual environments, both reverberant and anechoic. In previous studies, two candidate mechanisms have been proposed to explain adaptation phenomena similar to CP: 1) fatigue due to extended activation reduces responses in spatial channels near adaptor location (Carlile et al., 2001) and 2) spatial representation adapts to improve source separation at the cost of introducing localization biases (Lingner et al., 2018). The Carlile et al. (2001) mechanism predicts that location discrimination performance after adaptation would be worse for targets near adaptor (vs. far from adaptor), while the Lingner et al. (2018) mechanism suggests it would be better for targets near adaptor. Here, we evaluate these opposing predictions for three bias-independent localization measures: stimulus-response correlation, response standard deviation and information transfer rate (ITR).

Methods: In the two experiments, the target stimulus was a 2-ms noise burst (click), while the adaptor was a click train consisting of 12 such clicks. Six target locations were used, ±33, ±22, ±11° in Exp 1 and ±30, ±20, ±10° in Exp. 2. Adaptor locations were fixed across block at 0, ±45, or ±90° in Exp. 1 and 0 or ±50° in Exp. 2. In addition, baseline blocks contained no adaptors. Subjects responded by using a numerical keypad while seated with their heads supported by a headrest. Exp 1 was performed in a real reverberant environment, Exp. 2 in virtual anechoic and reverberant environments, simulated by using non-individualized HRTFs and BRIRs.

Results: Variances tended to increase near the adaptor location in Exp. 1. Pearson's correlation coefficient and ITR was better for targets far from adaptor than near. Thus, all three of the measures are more consistent with Carlile et al. model.

Conclusions: These results suggest that CP is likely caused at least partially by suppression in spatial representation as opposed to shifts in the distribution of the neural spatial representation.

[Work supported by VEGA 1/0350/22 and APVV DS-FR-19-0025].