The Effects of Cue Reliability on Crossmodal Recalibration in Adults and Children

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Supplementary Material

Supplementary Results

Detailed analysis of the immediate ventriloquist aftereffect (VAEi)

Auditory localization precision (pretest trials)

Immediate Ventriloquist Aftereffect (VAEi)

To assess the size of VAEi and the dependency of the VAEi on visual cue reliability, we analyzed localization errors in unimodal auditory test trials as a function of whether the immediately preceding audiovisual (AV) adaption trial comprised the same or the different sound frequency. The difference between localization errors in same-frequency trials and different-frequency trials indicates the size of the VAEi. Auditory localization in unimodal auditory test trials depended on the frequency (the direction of auditory-visual spatial discrepancy) and (visual cue) reliability of the preceding AV trial as well as on the age group as indicated by a significant three-way interaction of *Preceding Frequency*, *Reliability,* and *Age* ($F_{2,63} = 3.92$; $p = 0.25$; $BF_{incl} = 0.857$). In adults, a significant VAEi was observed (main effect of *Preceding Frequency*: $F_{1,21} = 20.42$; $p < 0.001$; $BF_{incl} = 5.099$), which was modulated by the reliability of the visual stimuli as indicated by a significant interaction of *Reliability* and *Preceding Frequency* ($F_{2,63} = 4.477$; $p = 0.26$; $BF_{incl} = 0.88$). The same-frequency trials significantly differed from the different-frequency trials in both reliability conditions (High: $p < 0.001$; $BF_{10} = 747.98$; Low: $p = 0.004$; $BF_{10} = 1.663$). However, the differences between localization errors in same-frequency trials and different-frequency trials (indicating the VAEi) were significantly larger for the high-reliability compared to the low-reliability condition ($p = 0.002$; $BF_{10} = 72.40$; see Supplementary Fig. S1), indicating a reliability effect for the VAEi. This reliability effect was larger in adults compared to 5-year-old ($p = 0.016$; $BF_{10} = 6.468$) and 6-to-7-year-old children ($p = 0.47$; $BF_{10} = 1.787$).

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In contrast, in 6–7-year-olds only a significant main effect of *Preceding Frequency* was observed ($F_{1,21} = 30.89$; $p < 0.001$; $BF_{incl} = 7.622e +7$); the VAEi was significantly larger than in the other two age groups (all $ps \leq 0.006$; all $BF_{10}s \geq 14.83$). The same-frequency trials differed significantly from the different-frequency trials for the high-reliabiliy ($p < 0.001$; $BF_{10} = 3357.496$) as well as for the low-reliability condition ($p < 0.001$; $BF_{10} = 300.427$), indicating a VAEi in both conditions. The size of VAEi was not modulated by visual cue reliability in the preceding AV trial (interaction of *Reliability* and *Preceding Frequency*: $p = 0.711$; $BF_{incl} = 0.303$).

Unlike adults and 6–7-year-olds, the 5-year-old children did not exhibit a VAEi (main effect *of Preceding Frequency*: $F_{1,21} = 0.56$; $p = 0.461$; $BF_{incl} = 0.217$). Moreover, no significant effects of reliability were found (main effect of *Reliability* and interaction of *Preceding Frequency × Reliability:* both $ps \geq 0.205$; both $BFs_{incl} \leq 0.179$; see Supplementary Fig. S1).

Auditory Localization Precision

We calculated variable errors of auditory localization responses (the higher the values, the lower the localization precision) of the pretest trials (see Fig. S2). The auditory localization precision in adults was higher (lower variable errors) than in 5-year-old ($t_{42} = 6.89$, $p < 0.001$; $d = 2.078$; $BF_{10} = 437634.160$) and 6–7-year-old children $t_{42} = 5.671$, $p < 0.001$; $d = 1.710$; $BF_{10} = 10994.804$), whereas localization precision did not differ between the two groups of children ($t_{42} = 1.12$, $p = 270$; $d = 0.337$; $BF_{10} = 0.492$).

Table S1.

Detailed statistical results for the analyses related to the ventriloquist effect (VE). Results for each age group and results of group comparisons are reported.

Size of the VE		Reliability effect	
Single age group (one-sample t-tests)	Group comparisons (independent-samples t-tests)	Single age group (paired-samples t-tests)	Group comparisons (independent-samples t-tests)
5-year-olds	5-year-olds vs 6–7-year-olds	5-year-olds	5-year-olds vs 6–7-year-olds
Overall: t_{21} = 18.844, p < 0.001; d = = 4.018; BF$_{10}$ = 9.268e +11	*Overall: t_{42} = 0.103, p = 0.918; d =* 0.031; BF$_{10}$ = 0.299	*High vs Low: t_{21} = 2.093, p =* 0.34; d = 0.446; BF$_{10}$ = 2.660	t_{42} = −1.273, p = 0.301; d = −0.384; BF$_{10}$ = 0.569
High: t_{21} = 19.066, p < 0.001; d = 4.065; BF$_{10}$ = 1.155e +12	*High: t_{42} = −0.153, p = 0.879; d =* −0.046; BF$_{10}$ = 0.240		
Low: t_{21} = 18.226, p < 0.001; d = 3.886; BF$_{10}$ = 4.954e +11	*Low: t_{42} = 0.371, p = 0.721; d =* 0.112; BF$_{10}$ = 0.314		

6–7-year-olds

Overall: $t_{21} = 19.109$, $p < 0.001$; $d = 4.074$; $BF_{10} = 1.205e+12$

High: $t_{21} = 18.043$, $p < 0.001$; $d = 3.847$; $BF_{10} = 4.098e+11$

Low: $t_{21} = 19.134$, $p < 0.001$; $d = 4.079$; $BF_{10} = 1.236e+12$

6–7-year-olds vs adults

Overall: $t_{42} = 7.846$, $p < 0.001$; $d = 7.846$; $BF_{10} = 1.584\ e+7$

High: $t_{42} = 6.467$, $p < 0.001$; $d = 1.950$; $BF_{10} = 10217.940$

Low: $t_{42} = 8.255$, $p < 0.001$; $d = 2.489$; $BF_{10} = 5.424e+7$

6–7-year-olds

High vs Low: $t_{21} = 2.708$, $p = 0.07$; $d = 0.577$; $BF_{10} = 7.842$

6–7-year-olds vs adults

$t_{42} = -1.048$, $p = 0.301$; $d = -0.316$; $BF_{10} = 0.462$

Adults

Overall: $t_{21} = 13.799$, $p < 0.001$; $d = 2.942$; $BF_{10} = 2.990e+9$

High: $t_{21} = 12.455$, $p < 0.001$; $d = 2.656$; $BF_{10} = 4.874e+8$

Low: $t_{21} = 11.195$, $p < 0.001$; $d = 2.387$; $BF_{10} = 7.739e+7$

Adults vs 5-year-olds

Overall: $t_{42} = -7.851$, $p < 0.001$; $d = -2.367$; $BF_{10} = 1.607e+7$

High: $t_{42} = -6.561$, $p < 0.001$; $d = -1.978$; $BF_{10} = 321012.332$

Low: $t_{42} = -8.269$, $p < 0.001$; $d = -2.493$; $BF_{10} = 5.648e+7$

Adults

High vs Low: $t_{21} = 2.901$, $p = 0.04$; $d = 0.618$; $BF_{10} = 11.281$

Adults vs 5-year-olds

$t_{42} = -2.014$, $p = 0.132$; $d = -0.607$; $BF_{10} = 1.260$

Table S2.

Detailed statistical results for the analyses related to the immediate ventriloquist aftereffect (VAEi). Results for each single age group and results of group comparisons are reported.

Size of the VAEi		Reliability effect	
Single age group (one-sample *t*-tests)	Group comparisons (independent-samples *t*-tests)	Single age group (paired-samples *t*-tests)	Group comparisons (independent-samples *t*-tests)
5-year-olds	5-year-olds vs 6–7-year-olds	5-year-olds	5-year-olds vs 6–7-year-olds
Overall: $t_{21} = 0.751$, $p = 0.231$; $d = 0.160$; $BF_{10} = 0.436$	*Overall*: $t_{42} = -3.395$, $p < 0.001$; $d = -1.024$; $BF_{10} = 44.364$	*High vs Low*: $t_{21} = -1.308$, $p = 0.898$; $d = -0.279$; $BF_{10} = 0.427$	$t_{42} = -1.345$, $p = 0.168$; $d = -0.406$; $BF_{10} = 0.613$
High: $t_{21} = -0.435$, $p = 0.666$; $d = -0.093$; $BF_{10} = 0.166$	*High*: $t_{42} = -3.643$, $p < 0.001$; $d = -1.098$; $BF_{10} = 80.415$		
Low: $t_{21} = 1.434$, $p = 0.166$; $d = 0.306$; $BF_{10} = 0.989$	*Low*: $t_{42} = -1.713$, $p = 0.94$; $d = -0.517$; $BF_{10} = 1.782$		
6–7-year-olds	6–7-year-olds vs adults	6–7-year-olds	6–7-Year-olds vs adults

Overall: $t_{21} = 5.558$, $p < 0.001$; $d = 1.185$; $BF_{10} = 2814.729$

High: $t_{21} = 5.642$, $p < 0.001$; $d = 1.203$; $BF_{10} = 3357.496$

Low: $t_{21} = 4.500$, $p < 0.001$; $d = 0.959$; $BF_{10} = 300.427$

Overall: $t_{42} = 3.119$, $p = 0.04$; $d = 0.940$; $BF_{10} = 23.621$

High: $t_{42} = 1.971$, $p < 0.084$; $d = 0.594$; $BF_{10} = 2.636$

Low: $t_{42} = 3.459$, $p < 0.001$; $d = 1.043$; $BF_{10} = 51.609$

High vs Low: $t_{21} = 0.375$, $p = 0.356$; $d = 0.080$; $BF_{10} = 0.303$

$t_{42} = -1.715$, $p = 0.47$; $d = -0.517$; $BF_{10} = 1.787$

Adults

Overall: $t_{21} = 4.519$, $p < 0.001$; $d = 0.963$; $BF_{10} = 312.722$

High: $t_{21} = 4.930$, $p < 0.001$; $d = 1.051$; $BF_{10} = 747.980$

Low: $t_{21} = 1.796$, $p = 0.87$; $d = 0.383$; $BF_{10} = 1.663$

Adults vs 5-year-olds

Overall: $t_{42} = -1.232$, $p = 0.112$; $d = -0.371$; $BF_{10} = 0.942$

High: $t_{42} = 2.514$, $p < 0.032$; $d = 0.758$; $BF_{10} = 6.806$

Low: $t_{42} = -0.784$, $p < 0.781$; $d = -0.236$; $BF_{10} = 0.185$

Adults

High vs Low: $t_{21} = 3.322$, $p = 0.02$; $d = 0.708$; $BF_{10} = 25.807$

Adults vs 5-year-olds

$t_{42} = -2.33$, $p = 0.12$; $d = -0.703$; $BF_{10} = 4.869$

Table S3.

Detailed statistical results for the analyses related to the cumulative ventriloquist aftereffect (VAEc). Results for each single age group and results of group comparisons are reported.

Size of the VAEc		Reliability effect	
Single age group (one-sample *t*-tests)	Group comparisons (independent-samples *t*-tests)	Single age group (paired-samples *t*-tests)	Group comparisons (independent-samples *t*-tests)
5-year-olds	5-year-olds vs 6–7-year-olds	5-year-olds	5-year-olds vs 6–7-year-olds
Overall: $t_{21} = 0.460$, $p = 0.325$; $d = 0.098$; $BF_{10} = 0.327$	*Overall:* $t_{42} = -0.484$, $p = 0.631$; $d = -0.146$; $BF_{10} = 0.327$	*High vs Low:* $t_{21} = -0.323$, $p = 0.625$; $d = -0.069$; $BF_{10} = 0.178$	$t_{42} = -0.386$, $p = 0.917$; $d = -0.116$; $BF_{10} = 0.316$
High: $t_{21} = 0.102$, $p = 0.460$; $d = 0.022$; $BF_{10} = 0.241$	*High:* $t_{42} = -0.545$, $p = 0.866$; $d = -0.164$; $BF_{10} = 0.335$		
Low: $t_{21} = 0.685$, $p = 0.250$; $d = 0.146$; $BF_{10} = 0.407$	*Low:* $t_{42} = -0.170$, $p = 0.866$; $d = -0.164$; $BF_{10} = 0.301$		

6–7-year-olds	6–7-year-olds vs adults	6–7-year-olds	6–7-year-olds vs adults
Overall: $t_{21} = 1.101$, $p = 0.142$; $d = 0.235$; $BF_{10} = 0.646$	*Overall:* $t_{42} = -3.135$, $p = 0.04$; $d = -0.945$; $BF_{10} = 24.504$	*High vs Low:* $t_{21} = 0.211$, $p = 0.417$; $d = 0.045$; $BF_{10} = 0.263$	$t_{42} = 0.105$, $p = 0.917$; $d = 0.032$; $BF_{10} = 0.299$
High: $t_{21} = 0.942$, $p = 0.178$; $d = 0.201$; $BF_{10} = 0.537$	*High:* $t_{42} = -1.993$, $p = 0.78$; $d = -0.601$; $BF_{10} = 2.733$		
Low: $t_{21} = 0.932$, $p = 0.181$; $d = 0.199$; $BF_{10} = 0.531$	*Low:* $t_{42} = -2.955$, $p = 0.15$; $d = -0.891$; $BF_{10} = 16.555$		

Adults	Adults vs 5-year-olds	Adults	5-year-olds vs adults
Overall: $t_{21} = 6.706$, $p < 0.001$; $d = 1.430$; $BF_{10} = 29620.200$	*Overall:* $t_{42} = 3.801$, $p < 0.001$; $d = 1.146$; $BF_{10} = 119.054$	*High vs Low:* $t_{21} = 0.011$, $p = 0.496$; $d = 0.002$; $BF_{10} = 0.225$	$t_{42} = -0.224$, $p = 0.917$; $d = -0.068$; $BF_{10} = 0.304$
High: $t_{21} = 3.511$, $p < 0.001$; $d = 0.749$; $BF_{10} = 37.862$	*High:* $t_{42} = 2.391$, $p = 0.44$; $d = -0.721$; $BF_{10} = 5.412$		

Low: $t_{21} = 5.388$, $p < 0.001$; $d = 1.149$; $BF_{10} = 1971.298$

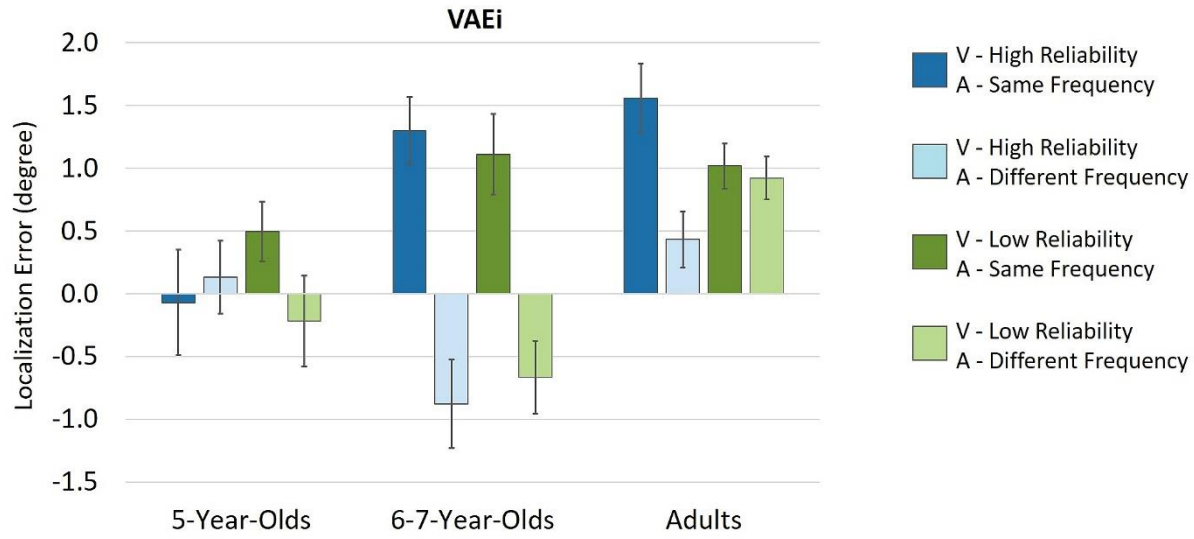*Low:* $t_{42} = 3.188$, $p = 0.12$; $d = 0.940$; $BF_{10} = 23.587$

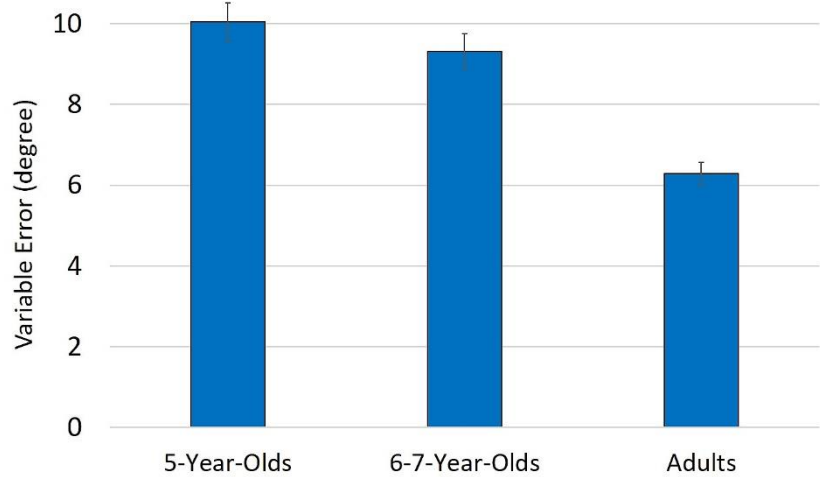**Figure S1.** The Immediate Ventriloquist Aftereffect (VAEi) in all three age groups.

Figure S2. Auditory Localization Precision in all three age groups.