

Minutes-scale Adaptation in Horizontal of Transient Sounds

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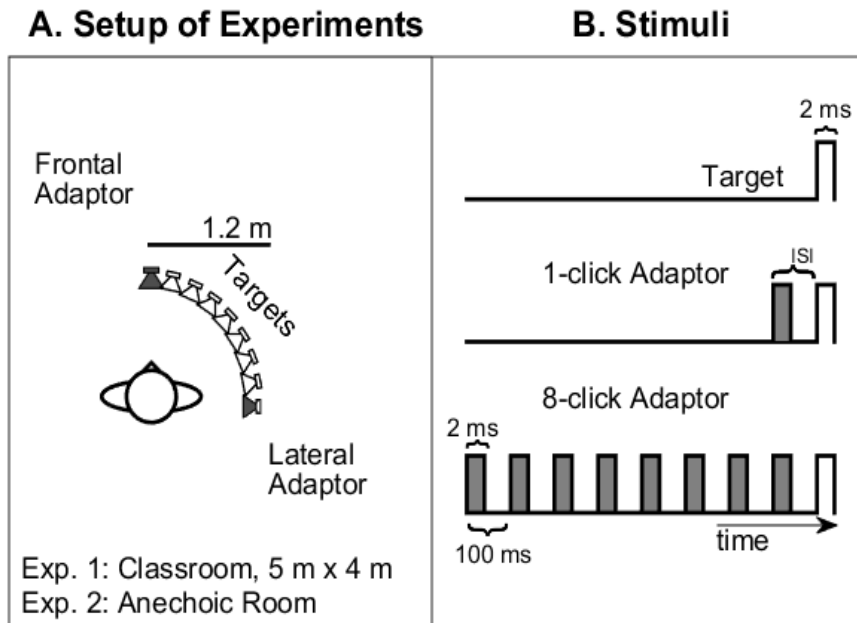
Introduction

- Auditory spatial perception is highly adaptive
- The adaptation induced by preceding stimulation – long-time scales of tens of seconds and minutes, e.g.,
 - Carlile et al., 2001; Phillips & Hall, 2005; Thurlow & Jack, 1973 - the auditory localization aftereffect induced by prolonged presentation of an adaptor
 - Djelani & Blauert, 2001; Freyman et al., 1991 - the precedence buildup by repeated presentation of ‘lead-lag’ stimulus pairs
- The current study - **adaptive processes in sound localization** induced by preceding stimuli (adaptors) on longer time scales

Behavioral Data (Kopčo et al., 2007, 2017)

Psychophysical experiments

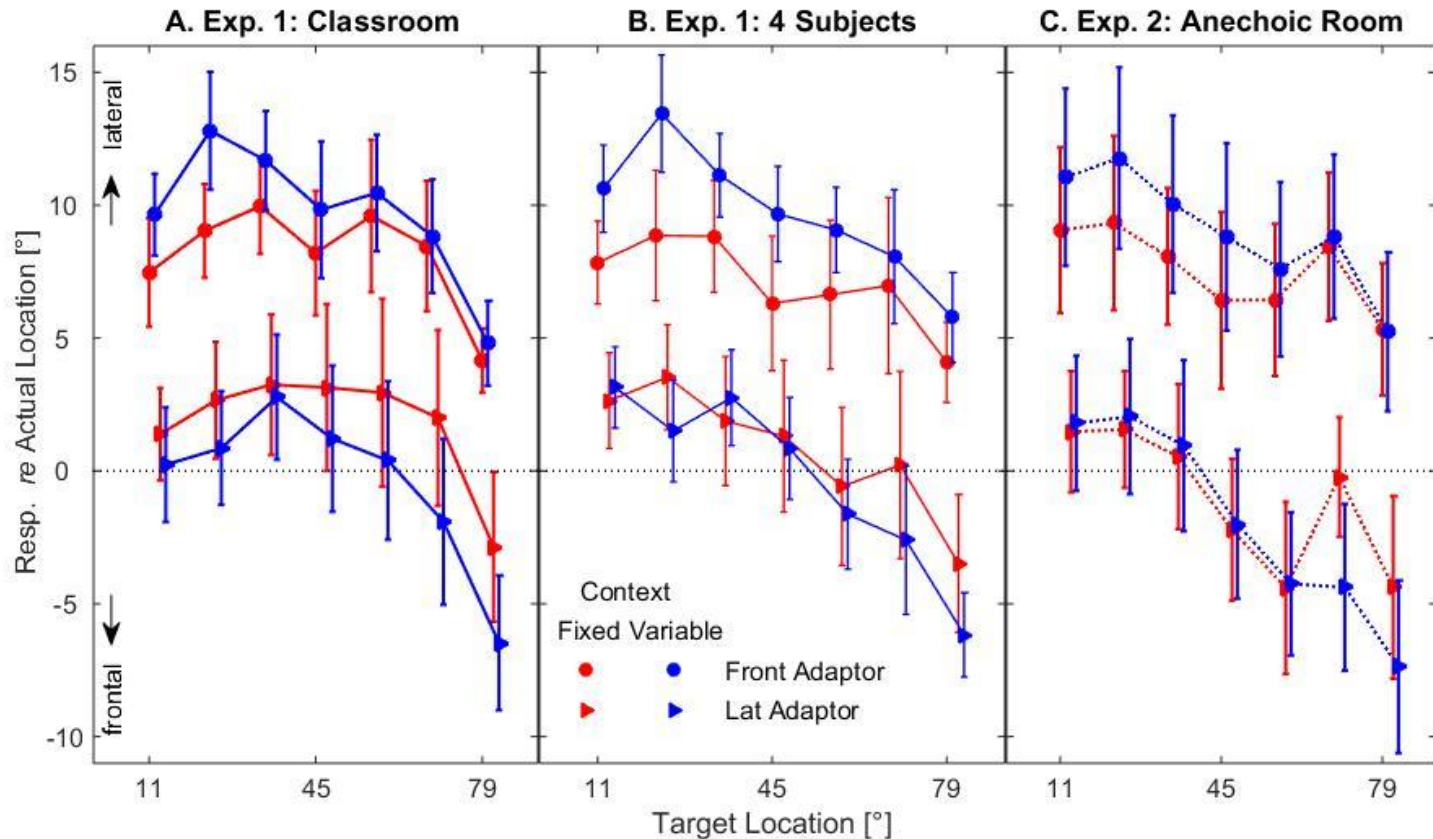
- Target click presented from a random loudspeaker (7)
- Adaptor location – frontal or lateral to a subject
- No-adaptor trials - the target presented alone
- Context trials - “adaptor” clicks preceded the target
 - **Fixed (Kopco et al., 2007)**: 1-click adaptor;
 - **Variable (Kopco et al., 2017)**: 1-click or 8-click adaptor in a run
- 4 subruns in run (5 min), 4 runs (AdLoc, ears) in session, 4 sessions (permuted runs)



Analyzed target-alone trials

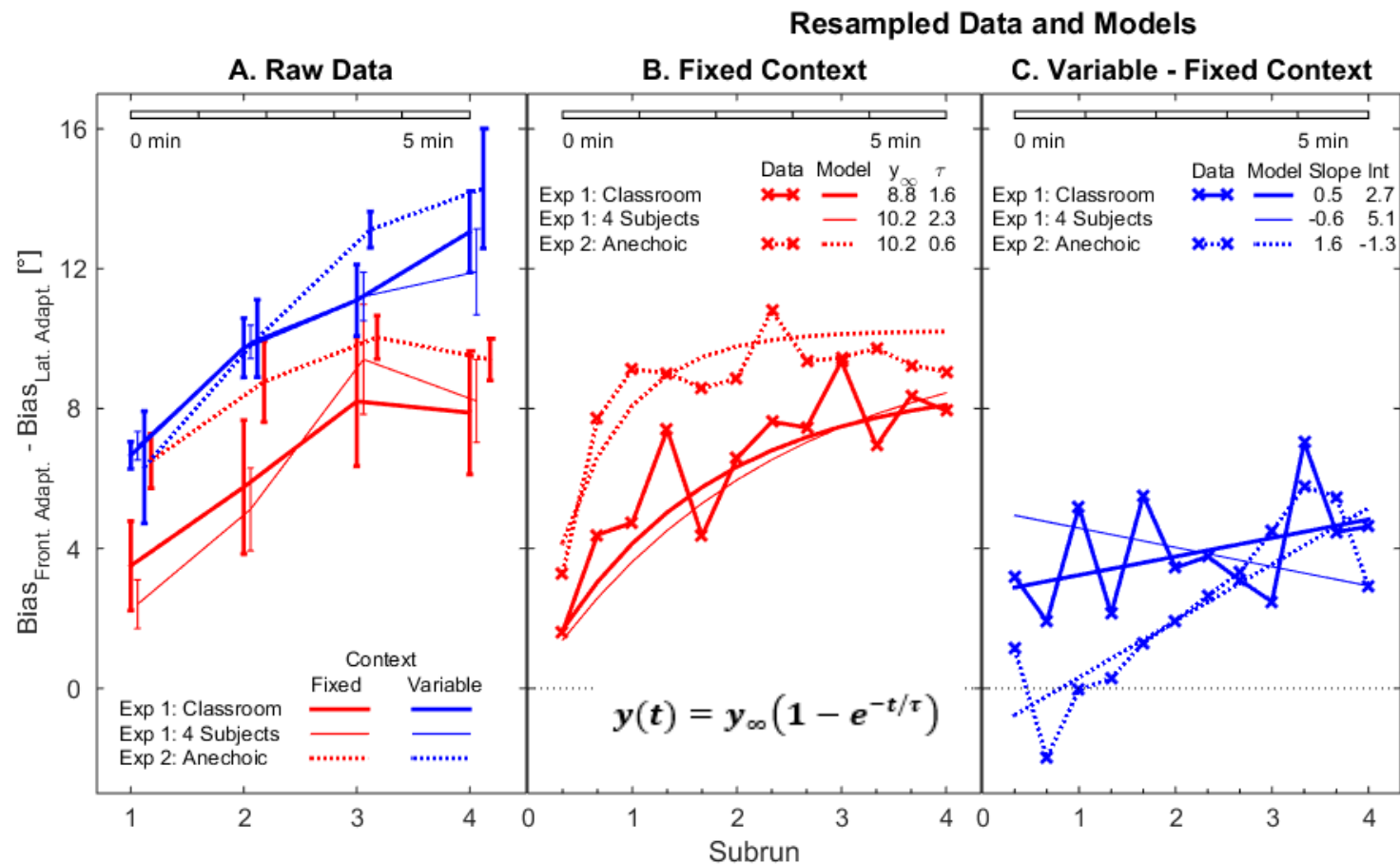
7 normal-hearing subjects in classroom
(four in anechoic room)

Mean response biases (\pm SEM) in no-adaptor trials plotted as a function of target location

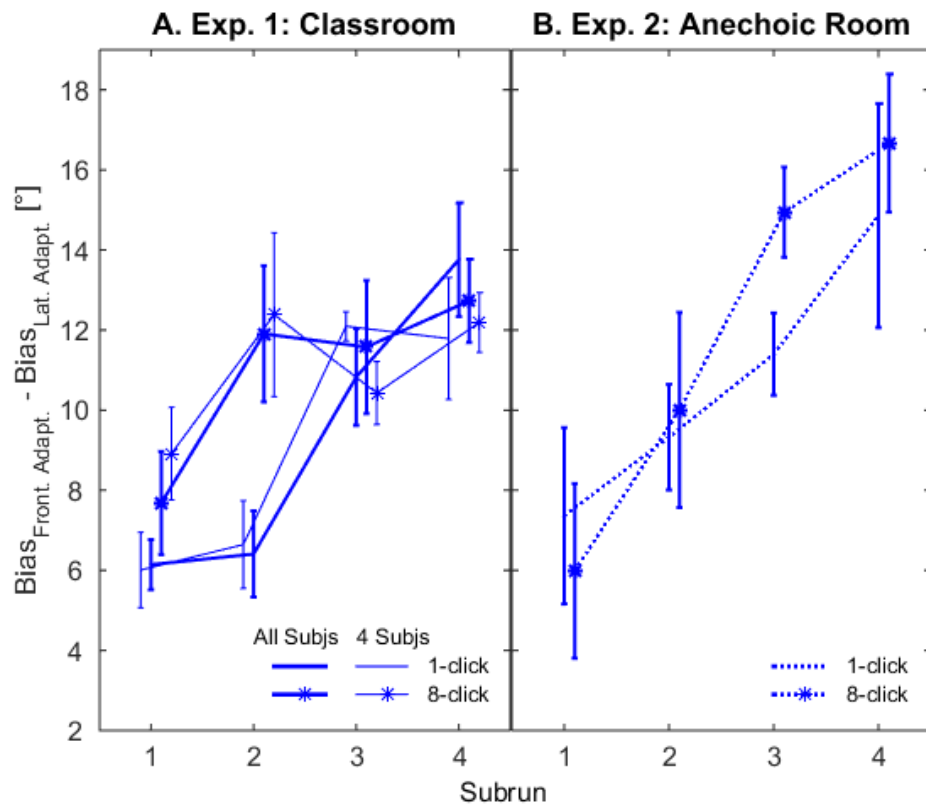


Significant interactions: *Context Type* \times *Experiment* \times *Subrun* \times *Adaptor location* ($F(3,9)=4.84$, $p=0.0285$), *Context type* \times *Target location* ($F(6,18)=6.19$, $p=0.0012$), *Context type* \times *Adaptor location* ($F(1,3)=12.54$, $p=0.0383$), and ***Subrun* \times *Adaptor location*** ($F(3,9)=35.62$, $p=0.0000$).

Temporal profile of CP collapsed across target location as a function of subrun



Effect of the context adaptor (1- vs. 8-click) in the immediately preceding trial on CP in the variable context



Classroom:
Significant main effect of *Subrun* ($F(3,18) = 14.93$, $p = 0.0003$) and a significant interaction *Context x Subrun* ($F(3,18) = 3.59$, $p = 0.034$).

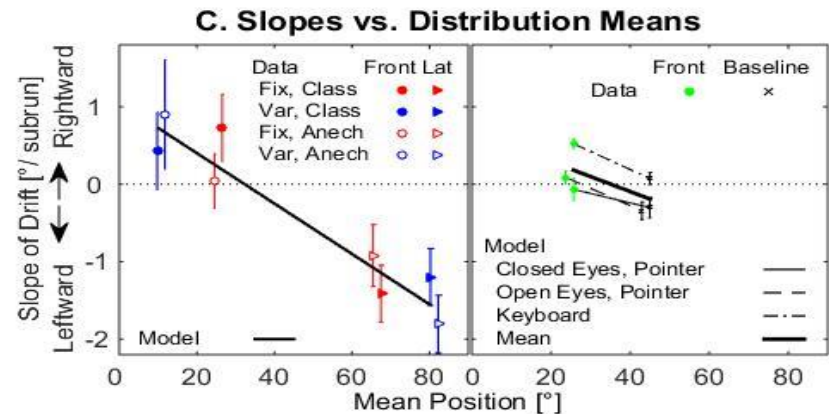
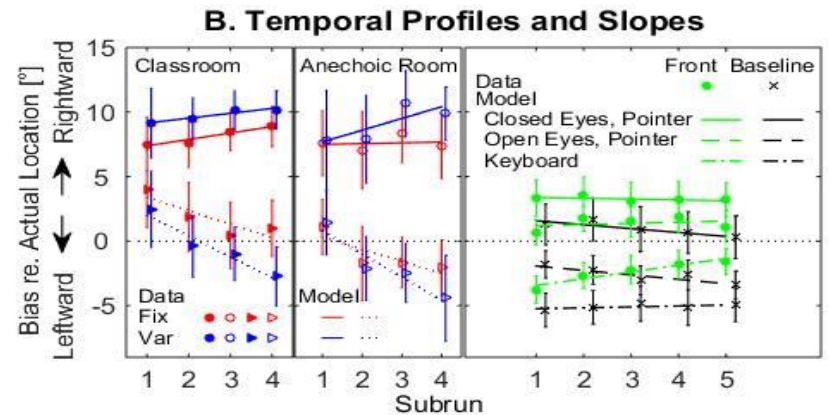
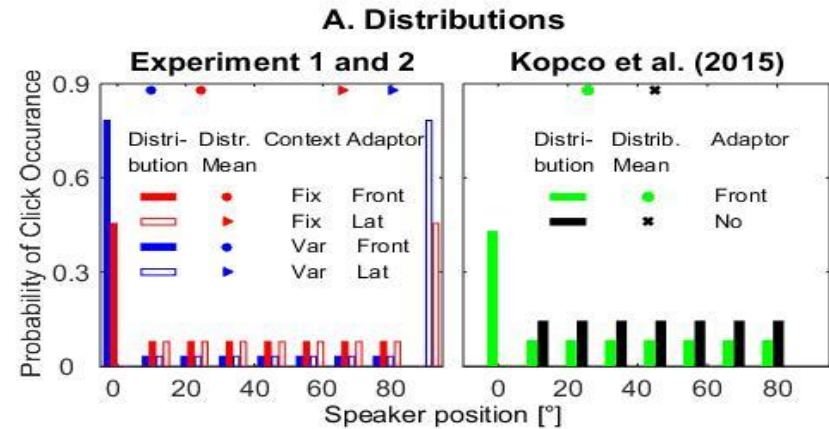
Anechoic room:
Found no effects

Relationship between stimulus distribution and drift in responses

- The mechanism underlying CP is largely unknown, it shares many properties with the localization aftereffect (**Phillips & Hall, 2005; Thurlow & Jack, 1973**).
- CP gives similar shifts in the perceived target location away from the adaptor location, although on a longer time scale of minutes
- **Models:**
 - **Carlile, 2014; Dingle et al., 2012** – model of suppression in neural representation of auditory space
 - **Dahmen et al., 2010** – observed shifts are a result of a broad dynamic range adaptation of the auditory spatial representation, occurring when the stimulus distribution becomes concentrated in a subregion of the full horizontal spatial range
 - **Lingner et al., 2018** – developed a new hierarchical decoding model in which sound source azimuth is estimated based on population vector analysis for both hemispheres independently; relative separation rather than absolute sound localization
- The hypothesis: **the auditory representation adapts to the non-uniform stimulus distribution**

Relationship between stimulus distribution and drift in responses

- the drifts in response biases over runs
- ? the slope of these drifts, averaged across target location, can be predicted by the size of the change in the stimulus distribution mean
- a 3-way ANOVA with factors of *Context type*, *Experiment*, and *Adaptor location*, on the slopes of linear fits, found a significant 3-way interaction of ***Experiment x Context type x Adaptor location*** ($F(1,3)=10.43$, $p=0.048$) and a significant main effect of ***Adaptor location*** ($F(1,3)=105.87$, $p=0.002$).



the response methods used by the subjects

Conclusion

The main finding - a repeated presentation of a context consisting of click adaptors induces a slow adaptation in localization of an identical click target that

1. results in biases of **up to 14° away from the adaptor** location,
2. can build up **over at least 5 minutes**, and
3. depends on the **spatial and temporal structure of the adaptors**, as well as on the presence of **reverberation**
4. relation between **stimuli distribution** and **drift in responses** – decreasing linear model, FA distribution → LA

Conclusion

- Increasing the average number of adaptor clicks (variable context has more clicks) - a **stronger CP**
- Both varying the number of clicks from trial to trial and an exposure to reverberation - **a slower temporal profile of the adaptation**
- Reverberation - **a slower onset of adaptation** and only with the fixed 1-click context,
- The variable context - the **adaptation continues to grow in both environments**, resulting in CP that is the strongest observed so far, even stronger than that induced by a fixed 8-click context (Hládek, et al. 2017)



Thank you for your
attention