Temporal profile of contextual adaptation in horizontal sound localization

Beáta Tomoriová, Rudolf Andoga, Michal Barto, Norbert Kopčo
Dept. of Cybernetics and Artificial Intelligence, Technical University of Košice, Slovakia

1. Introduction

Background

Localization of a sound can be affected by
- acoustics of environment (reverberation)
- temporal arrangement of targets (precedence effect)
- sensitivity to localization cues, etc.

In Kopco et al. (2007), trials with target preceded by distractor were interleaved with no-distractor trials with target alone. Localization shifts were observed not just in trials with distractor, but also in no-distractor trials.
- localization affected by context? (difficult to estimate since no baseline)

Current study

Examine the influence of context on localization performance.

Design similar to Kopco et al. (2007).

Measure
- how plasticity depends on:
  - frequency of occurence of "inducing" distractor trials
  - difficulty of the task (defined by SOA between distractor and target)
- overall temporal and spatial profile of contextual shifts

Find parameters of the context resulting in strongest effect.

Hypotheses

Context will affect localization performance.

Effect will grow with:
- increasing frequency of occurence of inducing trials
- increasing difficulty of the task (decreasing SOA)

Contextual adaptation will build-up/decay quickly (within 5 minutes).

2. Methods

Setup

Array of 8 loudspeakers (Figure 1)
- 7 used to present target sound
- 1 (frontal) to present distractor

Task

Subjects pointed to the perceived location of a target sound.

2 types of trials randomly interleaved (Figure 2):
- distractor-containing "inducing" trials (represented the context)
- no-distractor "probe" trials

Experimental procedure

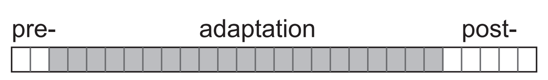
Nine normal-hearing subjects

Stimuli
- **target**: 2-ms frozen noise burst presented randomly from one of the 7 target loudspeakers
- **distractor:** identical noise burst as target, presented from (known) frontal location
- distractor-target onset asynchrony was fixed: SOA of 25, 100 or 400 ms.

Four approx. 2-hour sessions

Session consisted of 15 blocks keeping % of probe trials and SOA fixed
- 1 block of 50% at all SOAs
- 2 blocks of 25% at all SOAs
- 5 blocks of 10% only at 100 ms SOA
- 1 baseline block with only no-distractor trials
- subjects changed orientation between blocks

One block consisted of pre-adaptation (14 trials, 2 repeats), adaptation (140 trials, 20 repeats) and post-adaptation (35 trials, 5 repeats) part



Data analysis

Consider only no-distractor trials from all blocks.
Analyze difference in bias between distractor and baseline blocks.
Plot across-subject mean and within-subject standard error.

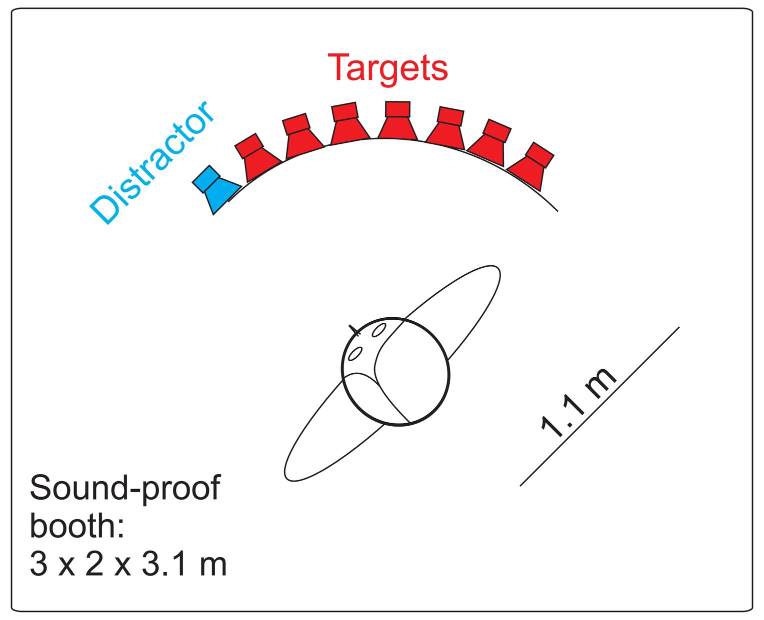


Figure 1 Experimental setup

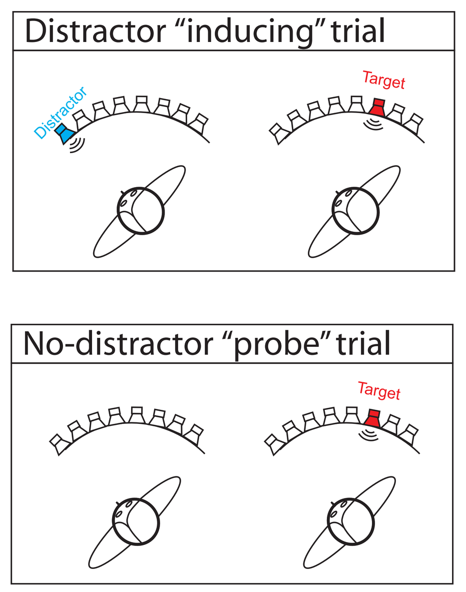


Figure 2 Types of trials. Distractor trial consisted of sequence of distractor and target, no-distractor trial consisted of target alone preceded by 400-ms silence

3. Results

Figure 3 Mean responses on no-distractor trials for different "inducing" distractor trial types and probe-trial-only baseline.

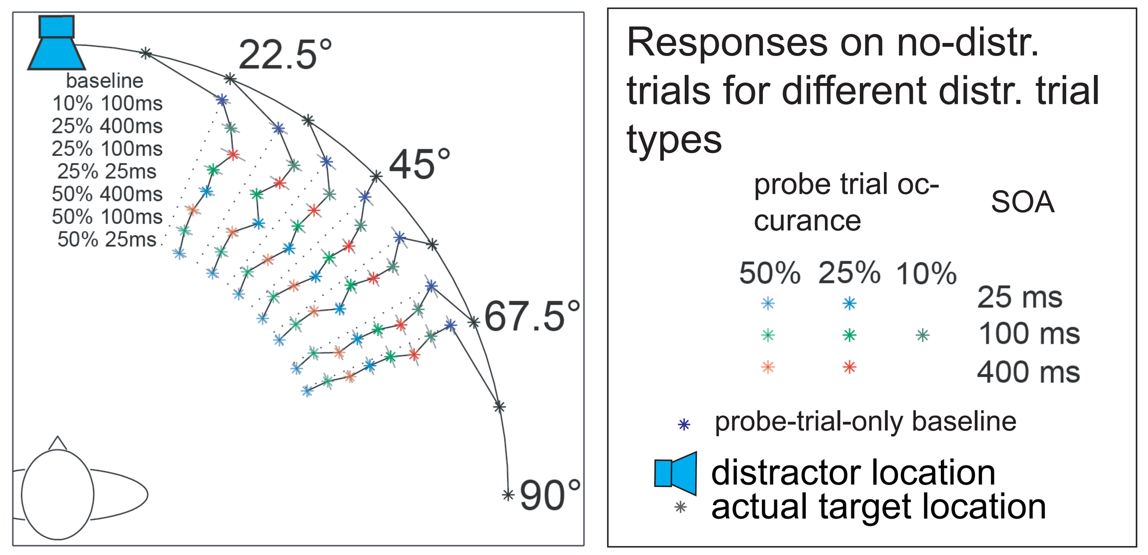


Figure 4 Bias in responses induced by context (bias re. probe-trial-only baseline).

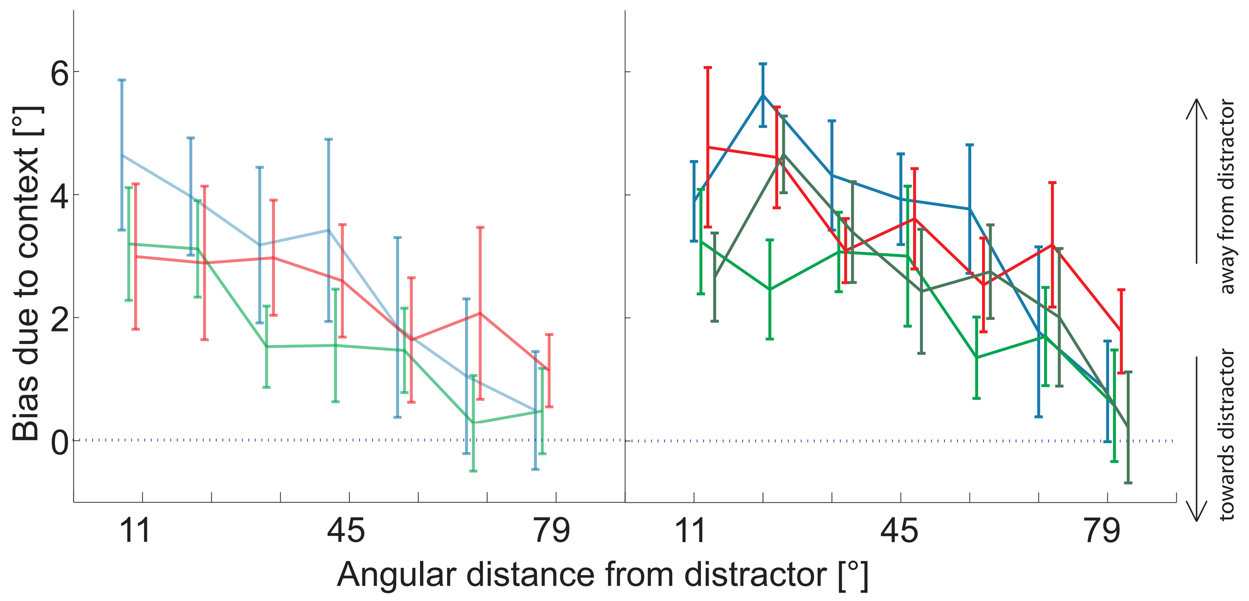


Figure 5 A) Bias in responses re. actual target location, averaged across target locations. B) Bias in responses re. probe-trial-only baseline, averaged across inducing trial types.

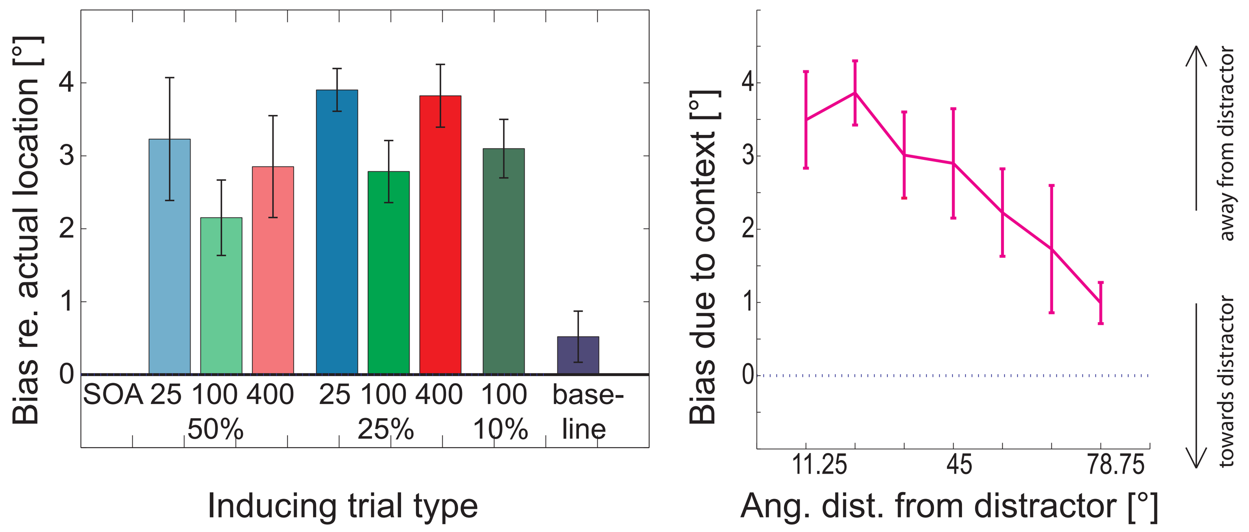
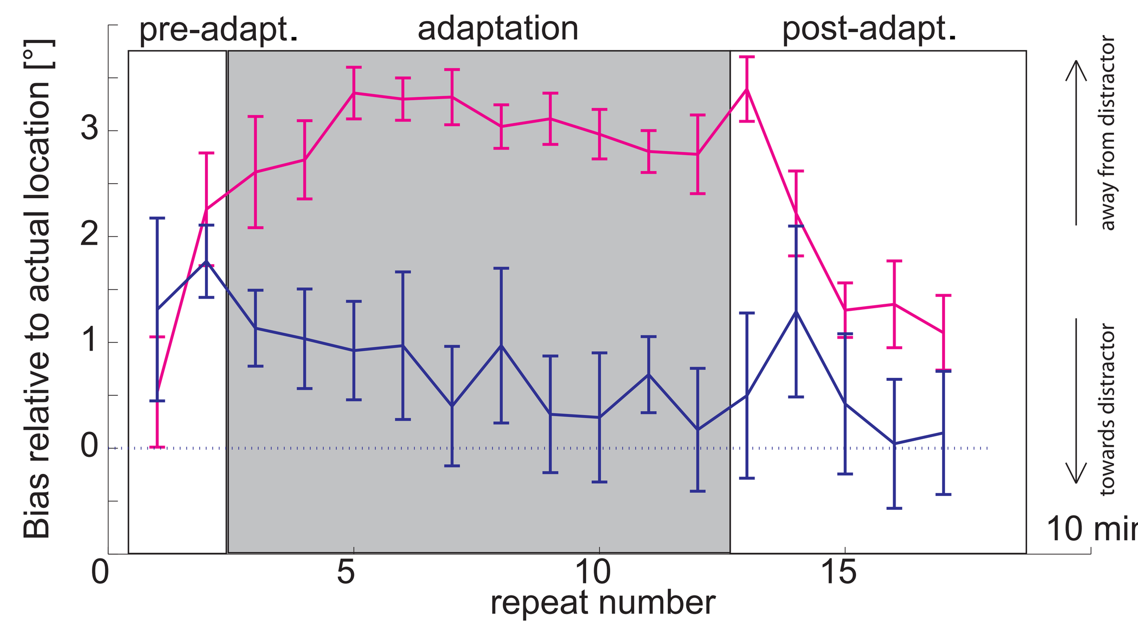


Figure 6 Build-up and decay of contextual bias as a function of the repeat number within a block, averaged across target locations and inducing trial type



Responses biased towards middle of response range (Figure 3)

Context induces plasticity in target localization. The plasticity depends on complexity and frequency of occurence of the shift-inducing trials.

Contextual shifts (Figure 4, 5B)
- size up to 5°, always away from distractor
- depends on target location
- depends on inducing trial types

Contextual shifts are largest for targets near the distractor.

Contextual effect (Figure 5A):
- grows with inducing trial frequency
- depends slightly on task difficulty

The dependence of contextual plasticity on temporal parameters of context is small.

Build-up (and decay) of contextual effect (Figure 6):
- is quick (2-3 mins)
- is sustained through adaptation phase

Contextual plasticity builds up and decays quickly (within 2-3 minutes)

3. Summary and Discussion

Summary

Responses on probe trials shifted away from the location of the (now missing) distractor

The effect size
- depends slightly on "inducing" task difficulty (SOA),
- grows slightly with frequency of "inducing" trials,
- depends on distance of probe target from the distractor,
- has fast build-up and decay

Parameters of context for future studies: 25% of probe trials, 25 or 400 ms SOA,

Discussion

Contextual plasticity
- unlikely to be related to acoustic factors like reverberation (because shifts had equal strength also for SOA 400 ms),
- could be either bottom-up or top-down effect
- is likely to affect performance in many common and laboratory situations
- relatively strong contextual bias possibly also due to absence of visual input during experiment (subjects had their eyes closed while plasticity was induced and tested)

Motivation for future studies - examine effect of:
- distractor location
- visual input
- top down vs. bottom-up, etc.

References:
N Kopčo, V Best, and BG Shinn-Cunningham (2007). Sound localization with a preceding distractor, Journal of the Acoustical Society of America, 121, 420-432.

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