HEARING THROUGH YOUR EYES

THE VISUALLY-EVOKED AUDITORY RESPONSE

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Introduction

Saenz & Koch (2008) first described '*hearing-motion synaesthesia*', in which visual flashes and movements induce auditory sensations. They reported that self-identified synaesthetes found it easier than non-synaesthetes to distinguish sequences of flashes, perhaps because they could hear them too.

There has been no research on this since 2008! Until now…

Our questions:

1. How *prevalent* is this? We tested a random rather than self-selected sample.
2. Are induced sounds *perceptually real* enough to affect detection of real sounds?
3. Do objective measures correlate with subjective measures?

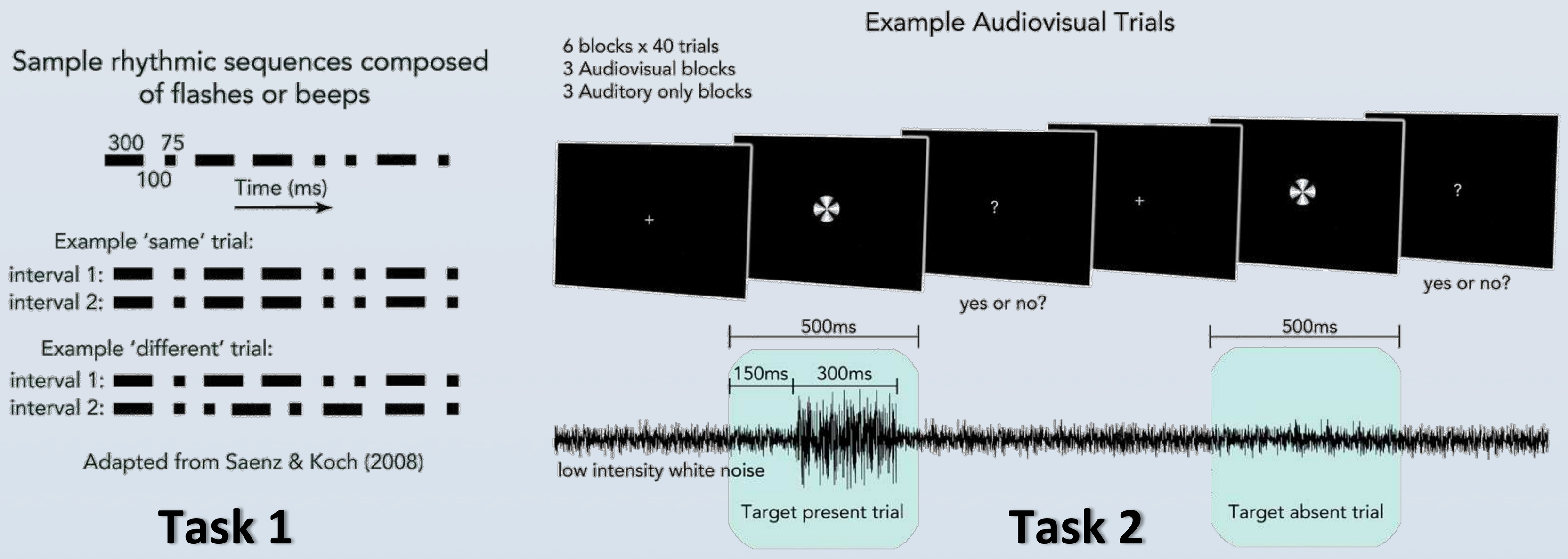
Methods

Task 1 – Same/different sequence discrimination (after Saenz & Koch, 2008).

- Either auditory or visual sequences
- Visual stimuli were a white disk (1.5 degrees visual angle) presented on a black background.
- Auditory stimuli were 360 Hz sine wave tones.

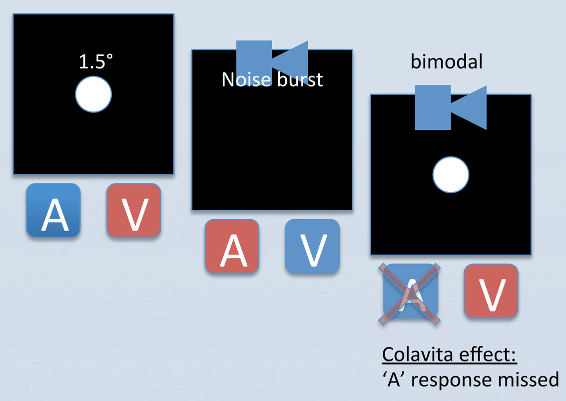
Task 2 – Auditory detection task (after Lovelace et al., 2003).

- 'Yes/No' auditory detection task.
- Either unimodal or with non-predictive visual stimulation.
- Auditory target: 300 ms white noise burst presented near threshold, 50% probability; concurrent background white noise.
- Visual stimulus (when present): rotating radial grating for 500ms.



Task 3 – Measure of visual dominance over audition (after Colavita, 1974).

- Visual (40% of trials), Auditory (40%) or bimodal stimuli (20%), randomly.
- Identify modality – Hit 'A' and/or 'V' key.
- Visual dominance ← missed auditory responses on bimodal trials.
- Visual stimuli: white disk (1.5°) on black background.
- Auditory stimuli: white noise bursts.



Task 4 – Debrief Questionnaire (performed after Task 1).

- Used to gage whether subjects perceived any sound on viewing visual flashes.
- E.g. What strategy were you using to remember the visual sequences?
- E.g. Did you actually hear faint sounds when you saw the flashes?

Participants

All participants took part in task 1, with subsets performing the remaining 3 tasks. All were naïve to the purpose of the study and had normal/corrected vision, normal hearing, and did not identify as synaesthetes.

Task 1 N = 96 (65 female, ages 18-55 (M 23, SD 6.5))
Task 2 N = 40 (25 female, ages 19-36 (M 24.5, SD 3.5))
Task 3 N = 22 (17 female, ages 19-36 (M 23.9, SD 4.5))
Task 4 N = 38 (24 female, ages 19-36 (M 24.5, SD 4.9))

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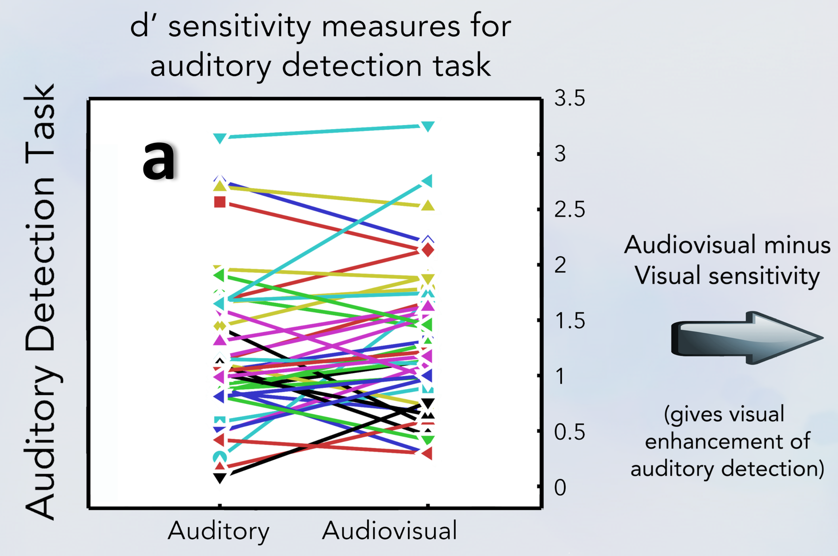
Colavita, F. B. (1974). Human sensory dominance. *Perception & Psychophysics, 16*(2), 409-412.

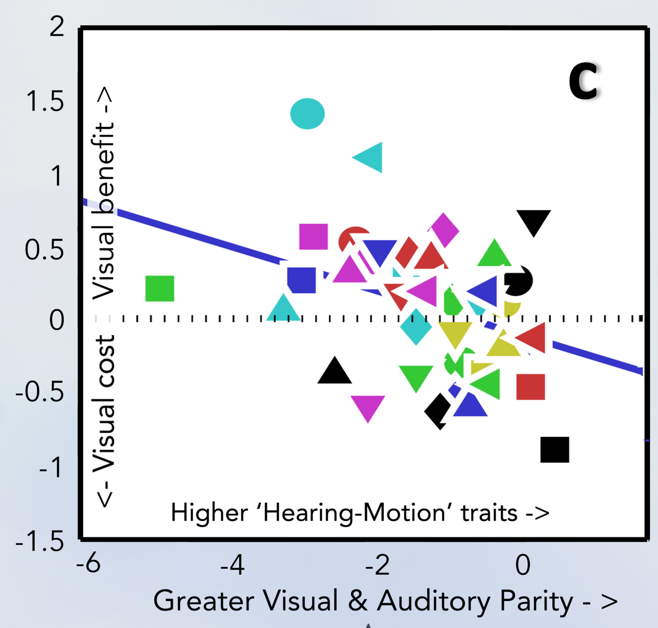
Lovelace, C. T., Stein, B. E., & Wallace, M. T. (2003). An irrelevant light enhances auditory detection in humans: a psychophysical analysis of multisensory integration in stimulus detection. *Cognitive Brain Research*, *17*(2), 447–453

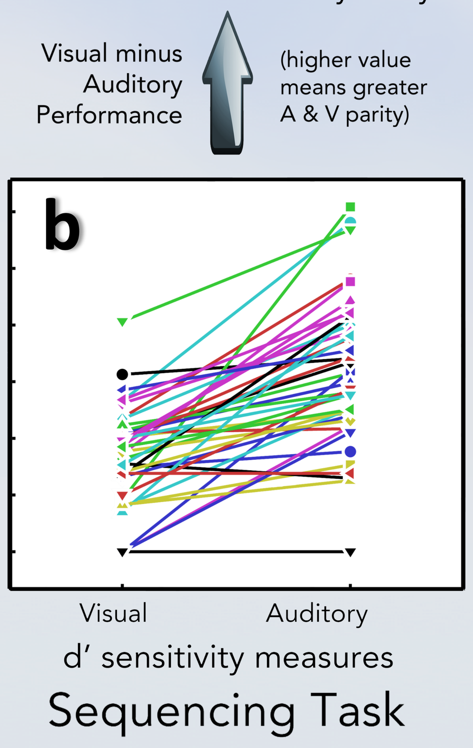
Saenz, M., & Koch, C. (2008). The sound of change: visually-induced auditory synesthesia. *Current Biology, 18*(15), 650–651.

Results

Higher visual sequence discrimination (relative to auditory) on Task 1 correlated significantly with lower auditory detection rates in the presence of visual stimuli (relative to without) on Task 2 (rho(39)=-0.36, p<0.02). This suggests that internal auditory noise evoked by the visual stimulus can actually interfere with an externally-originating auditory signal.





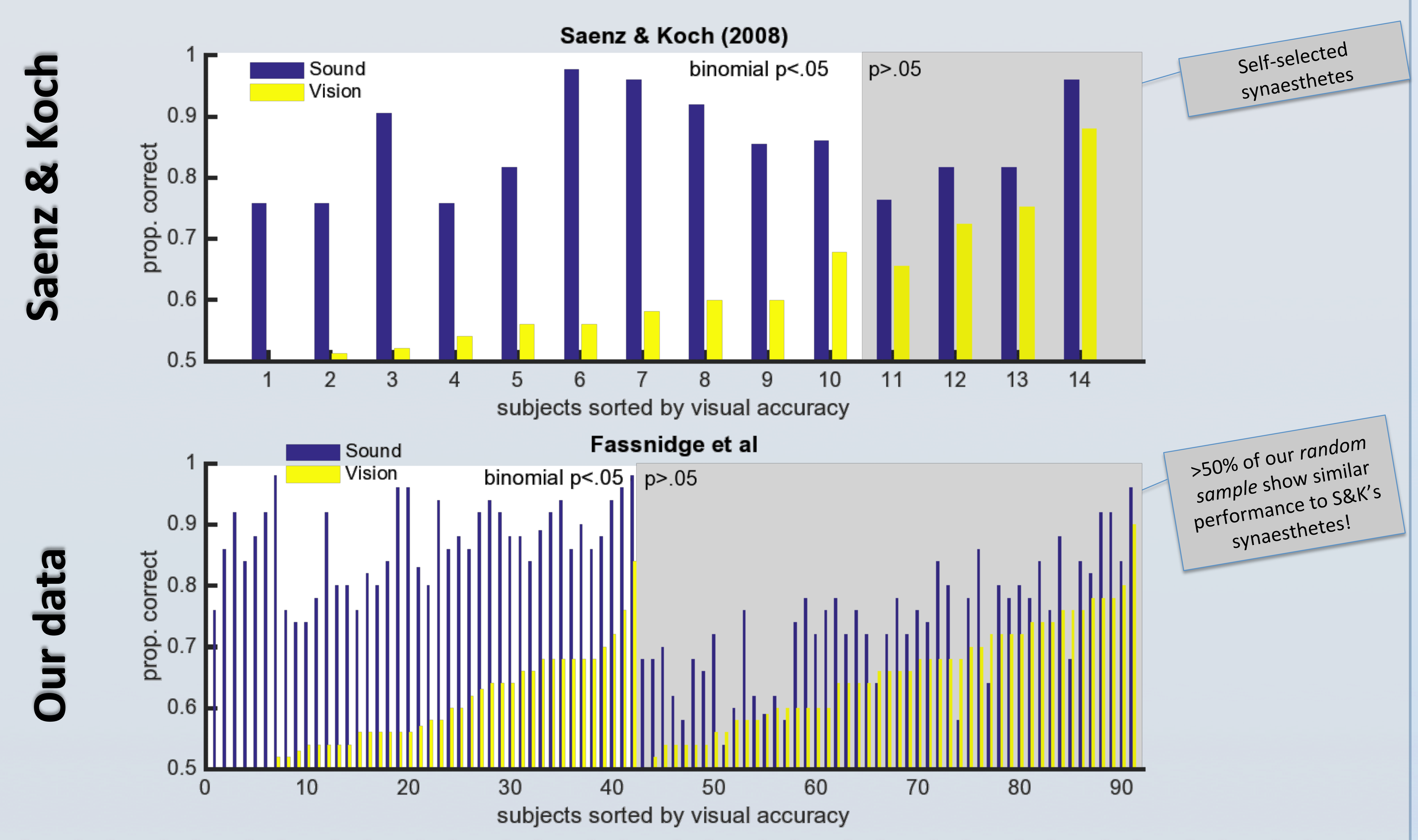


a – The presence of an irrelevant visual stimulus could either increase or decrease a participant's auditory detection performance.

b – Sequencing task performance was higher for auditory than for visual stimuli, although the extent of this auditory advantage varied.

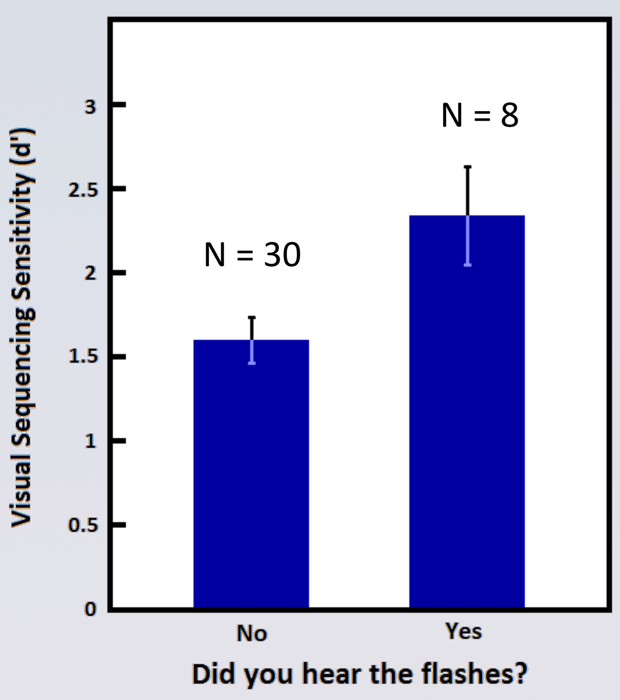
c – There was a significant negative correlation between subjects with greater visual relative to auditory sequencing and poorer auditory detection in the presence of a visual stimulus.

Prevalence: Sequencing task (Task1)



High prevalence on Task 1 objective measure: >50% of our *random sample* resembled Saenz & Koch's self-selected synaesthetes, on S&K's statistical criterion.

When asked in Task 4, 8 out of 28 subjects (21%) reported being able to hear faint sounds when viewing the flashes. These 8 subjects performed significantly better at visual sequencing [M = 2.341, SD = .841] than others [M = 1.599,SD = .788], t(36) =-2.336, p = .025 (See below, left).



Visual Attentional Bias?

A robust Colavita effect was seen in task 3, with more missed auditory stimuli [M – 25.77] than missed visual stimuli [M = 9.91] on bimodal trials, t(21) = -3.26, p = .004.

However visual dominance scores did not correlate with visual sequencing ability expressed as either d' (r = .01, p > .05) nor as percentage of correct trials (r = .036, p > .05).

Discussion

In >50% of our random sample, remarkably similar results to Saenz & Koch's self-selecting synaesthetes are observed. Their objective measure appears less reliable than a subjective measure. However in the sample as a whole visual flashes appear able to disrupt auditory detection. We suggest that this synaesthesia may exist as a continuum, even if any corollary sensation is below perceptual threshold in most individuals. We term this the visually-evoked auditory response.