Multisensory Research

Dynamic Weighting of Time-Varying Visual and Auditory Evidence during Multisensory Decision Making

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Supplementary Material

Experiment 2

Methods

Participants

Twenty-six female and 10 male participants (mean age = 20.81, standard deviation = 4.70, age range = 18–47) who took part in this experiment were recruited via the website of the Behavioural Science Lab. All participants had normal or corrected-to-normal vision and hearing and were students at the University of Amsterdam who participated for course credits. They provided written consent and were naive regarding the experimental design and goal of the study. The study was approved by The Faculty Ethics Review Board of the Faculty of Social and Behavioural Sciences (ERB) of the University of Amsterdam.

Behavioural Task

The experimental design differs from the design of Experiment 1 in some aspects. During Experiment 2, participants were presented with 468 audiovisual trials with a 1:1 ratio of ‘synchronous’ and ‘asynchronous’ trials (Supplementary Fig. S1A, B) where visual and

auditory fluctuation changes were similar or were determined in a random fashion respectively. Easy, intermediate and hard trials were randomly included in equal amounts. Baseline intensities for the difficulties and trial length were calculated using the same methods as in Experiment 1. Stimuli were presented on a 23 inch ASUS VG236H monitor with a screen refresh rate of 60 Hz which was gamma-corrected. Participants were at a viewing distance of roughly 60 cm from the centre of the screen. Auditory stimuli were presented in the same manner as during Experiment 1.

Data Analysis

Data of participants who experienced technical issues during the task or performed with an overall accuracy below 60% were removed from further analyses. This resulted in discarding data of four participants due to technical issues and of six participants who performed around chance level. The analyses were thus performed on the data of 26 participants.

We hypothesized that synchrony did not affect audiovisual decision making. To prove this null hypothesis we performed Bayesian statistics. First, we calculated the accuracies of each participant on synchronous and asynchronous trials separately and per difficulty level. These values were included in a 2 (Synchronous vs Asynchronous) × 3 (Difficulty: Easy, Intermediate, Hard) Bayesian repeated-measures analysis of variance (rmANOVA). A similar Bayesian rmANOVA was performed on the average reaction times (RTs).

Results

To reveal the influence of modulation synchrony, or lack thereof, during audiovisual discrimination we performed a 2 × 3 Bayesian rmANOVA on the accuracies. This showed that the data are most likely under a model with only the main effect of difficulty, BF_{10} = 1.32e+19. Both the model with the two main effects (i.e., difficulty and synchrony) and the model with the main effects and interaction effect were less likely, BF_{10} = 4.17e+18 and BF_{10} = 1.51e+18, respectively. Importantly, this analysis provided substantial evidence against a role for modulation synchrony: compared to the null model, the data were 4.13 times less likely under a model with only the main effect of synchrony (BF_{01} = 4.13). The average accuracies of the different conditions are presented in Supplementary Fig. S1C.

A similar analysis on the average RTs showed very similar results (Supplementary Fig. S1D). The data were found to be most likely under a model with only a main effect of

difficulty, BF_{10} = 344.87. A model with the two main effects and a model that included the interaction term were both less likely, BF_{10} = 59.85 and BF_{10} = 35.57 respectively. This analysis also revealed substantial evidence for the absence of a main effect of synchrony, BF_{01} = 5.88.

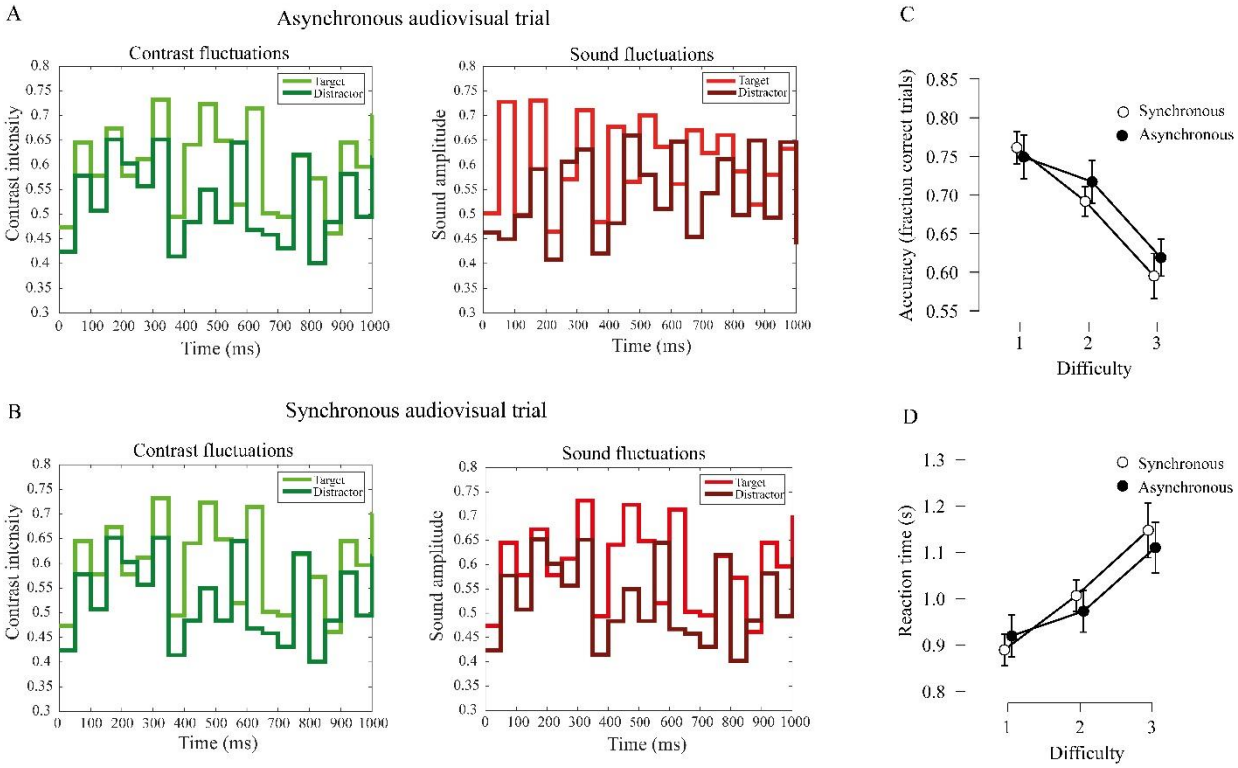

Figure S1. Performance on audiovisual trials is not affected by fluctuation synchrony. (A) Example of the contrast fluctuations of the visual target (bright green) and the visual distractor (dark green) on an asynchronous intermediate trial (left) and an example of the volume fluctuation of the auditory target (bright red) and the auditory distractor (dark red) on an asynchronous intermediate audiovisual trial. (B) Example of the contrast fluctuations of the visual target (bright green) and the visual distractor (dark green) on a synchronous intermediate trial (left) and an example of the volume fluctuation of the auditory target (bright red) and the auditory distractor (dark red) on a synchronous intermediate audiovisual trial. (C) The average accuracies and (D) the average RTs for synchronous audiovisual trials and asynchronous audiovisual trials consisting of trials of three difficulty levels. Error bars denote the 95% credible interval.

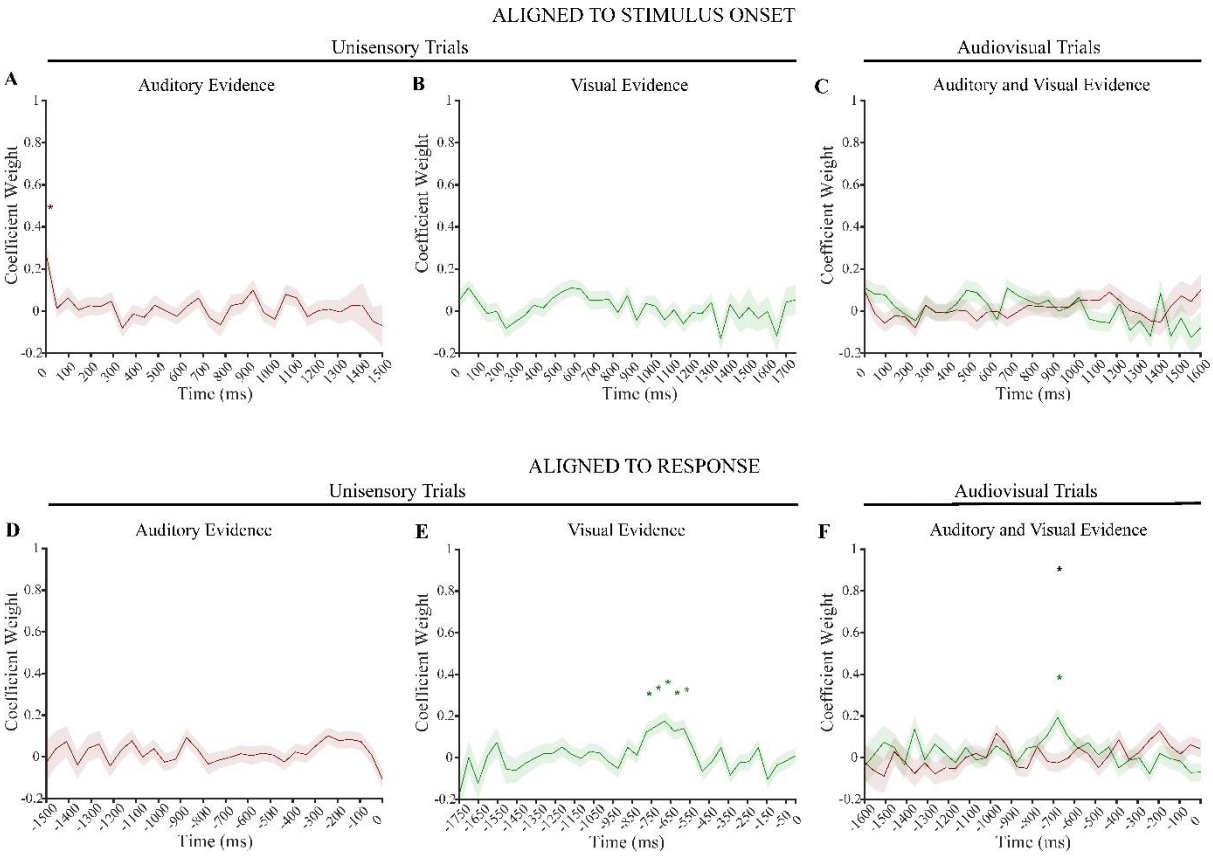

Figure S2. Visual and Auditory evidence accumulation on slow trials over all difficulty levels. Weighting profiles A–sions (*n* = 2949 trials) (red asterisks). (B) There is no significant visual evidence that contributes to visual decisions relative to the stimulus (*n* = 3048 trials). (C) On audiovisual trials, visual and auditory evidence do not contribute significantly to the decision (*n* = 3035 trials). (D) There is no significant auditory evidence that contributes to auditory decisions relative to the response. (E) Visual evidence contributes to visual decisions until 500 ms before the response (green asterisks). (F) On audiovisual trials, visual evidence is weighted significantly higher than auditory evidence at 750 ms (black asterisk).

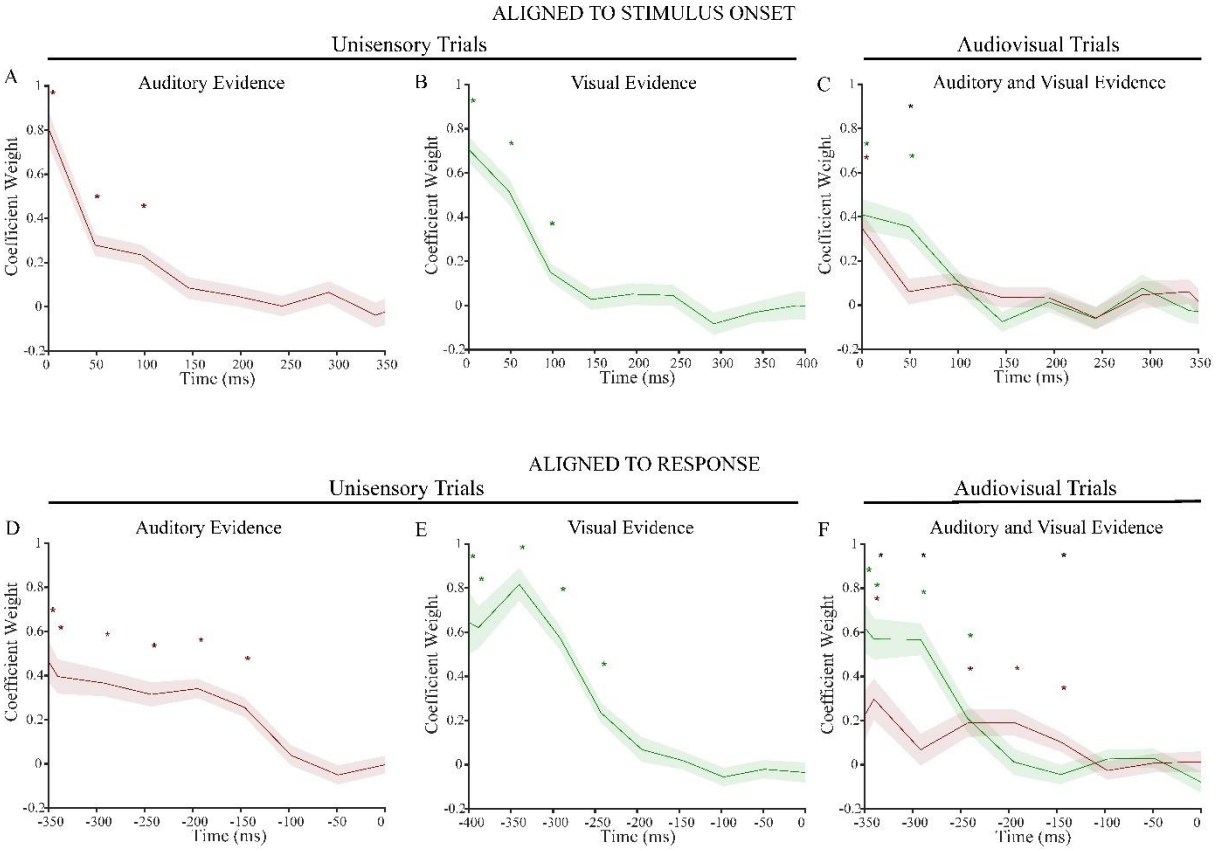

Figure S3. Visual and Auditory evidence accumulation on fast trials over all difficulty levels. Weighting profiles A–C are aligned to the stimulus onset, D–F to the response. (A) Auditory evidence early in time contributes to auditory decisions (*n* = 2978 trials) (red asterisks). (B) Visual evidence early in time contributes to visual decisions (*n* = 3079 trials) (green asterisks). (C) The first auditory and visual sample contribute equally to audiovisual decisions (*n* 3013 trials) indicated (red and green asterisks respectively). During a subsequent short period of 50 ms, visual evidence is weighted significantly higher than auditory evidence (black asterisk). (D) Auditory evidence contributes to auditory decisions until 100 ms before the response (red asterisks). (E) Visual evidence contributes to visual decisions until 200 ms before the response (green asterisks). (F) On audiovisual trials, visual integration is dominant over auditory integration after which auditory integration is dominant until the coefficient weights reach 0 around 100 ms before the response (black asterisks).