
Figures and figure supplements

Sensory experience during early sensitive periods shapes cross-modal temporal biases

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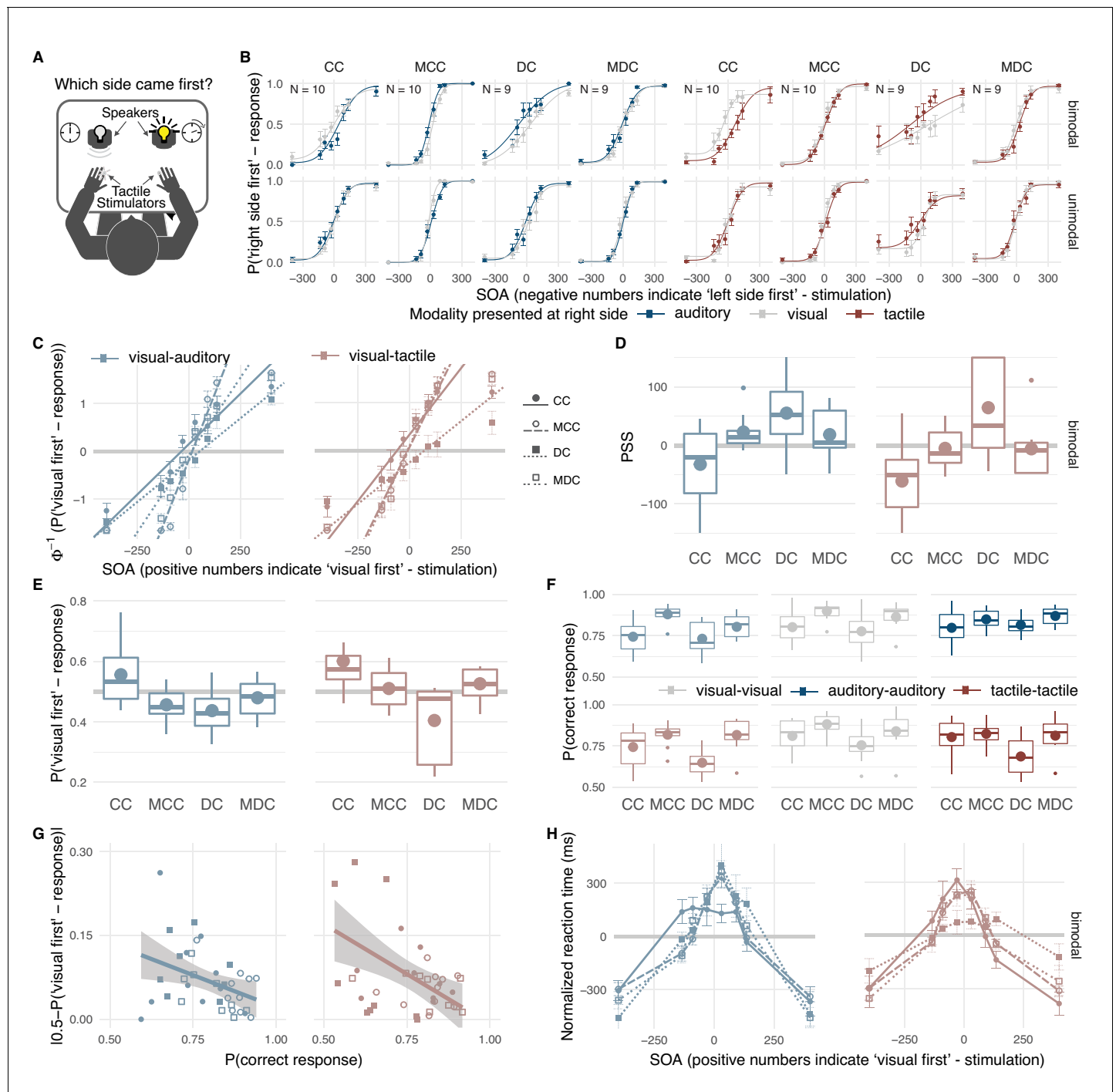


Figure 1. Effects of early visual experience on spatio-temporal order biases and resolution within and across vision, audition, and touch. Thirteen individuals with surgically removed congenital, bilateral dense cataracts (CC) and sixteen individuals whose reversed cataracts had developed later in life (DC) as well as normally sighted individuals matched for age, gender, and handedness (MCC, MDC) took part in the study (see [Table 1](#) for details about the samples). (A) Participants judged the spatio-temporal order of two successive stimuli—one presented in each hemifield—by indicating the location of the first stimulus. In Expt. 1, visual-visual, auditory-auditory, and visual-auditory stimulus pairs were presented, in Expt. 2, visual-visual, tactile-tactile, and visual-tactile stimulus pairs. (B) Psychometric curves: group average probabilities of a 'right side first'-response as a function of SOA (negative values indicate 'left side first'-stimulation). Data are split by the modality presented at the right side (visual = grey, auditory = dark blue, tactile = dark red) and the modality at the other side (rows, bimodal = different modality, unimodal = same modality). Curves display cumulative Gaussian distributions fitted to the group data for illustrative purposes. Error bars indicate standard errors of the mean in all panels. (C) Probit analysis: Group mean probits (CC = filled circle, MCC = open circle, DC = filled square, MDC = open square) of the probability for a 'visual first'-response as a function of SOA (positive numbers indicate 'visual first' stimulation). (D) Box plots showing the Probability of a 'Visual First' Response (PSS) for the four groups (CC, MCC, DC, MDC) under bimodal conditions. (E) Box plots showing the probability of a 'visual first' response for the four groups (CC, MCC, DC, MDC) under unimodal conditions. (F) Box plots showing the probability of a correct response for the four groups (CC, MCC, DC, MDC) under unimodal conditions for three pairs of modalities: visual-visual, auditory-auditory, and tactile-tactile. (G) Box plots showing the probability of a correct response for the four groups (CC, MCC, DC, MDC) under unimodal conditions for three pairs of modalities: visual-visual, auditory-auditory, and tactile-tactile. (H) Box plots showing the normalized reaction time (ms) for the four groups (CC, MCC, DC, MDC) under unimodal conditions for three pairs of modalities: visual-visual, auditory-auditory, and tactile-tactile. The x-axis represents SOA (positive numbers indicate 'visual first' stimulation).

Figure 1 continued

function of SOA (positive values indicate 'visual first'-stimulation) in bimodal trials (visual-auditory = light blue, visual-tactile = light red). Lines show group averages of linear regression lines fitted to individual participant's data. The longest SOA was excluded from the linear regression, if a participant's performance had reached an asymptote. **(D)** Point of cross-modal subjective simultaneity (PSS): Box-and-whisker plots show the distribution (median, quartiles, minimum and maximum bounded at 1.5 x interquartile range, outliers) of individual PSS values; big circles indicate group mean values. Positive PSS values indicate that stimulus pairs in which the visual stimulus was presented first were perceived as simultaneous. **(E)** 'Visual first'-bias: Box-and-whisker plots show the distribution of the proportion of 'visual first'-responses per participant; big circles indicate group mean values. All SOAs were presented equally often, thus, a PSS of zero and a proportion of 'visual first'-responses equal to 0.5 would have been correct. A positive PSS corresponds to a proportion of 'visual first'-responses below 0.5 and vice versa. **(F)** Temporal order judgment accuracy: Distribution and group average probabilities of correct responses separately for each group and modality condition for each of three different modality combinations per experiment (light blue: visual-auditory, light red: visual-tactile, grey: visual-visual, dark blue: auditory-auditory, dark red: tactile-tactile). **(G)** Bias-accuracy relation: Single participants' proportion of correct responses (x-axis) plotted against the absolute value of their 'visual first'-bias (y-axis; markers as in **(C)**). Lines show linear regressions and 95% confidence intervals. **(H)** Reaction time (RT) distributions: Individually normalized RT in bimodal trials as a function of SOA (positive values indicate 'visual first'-stimulation) per group. Markers and lines show group mean values (markers and line styles as in **(C)**).

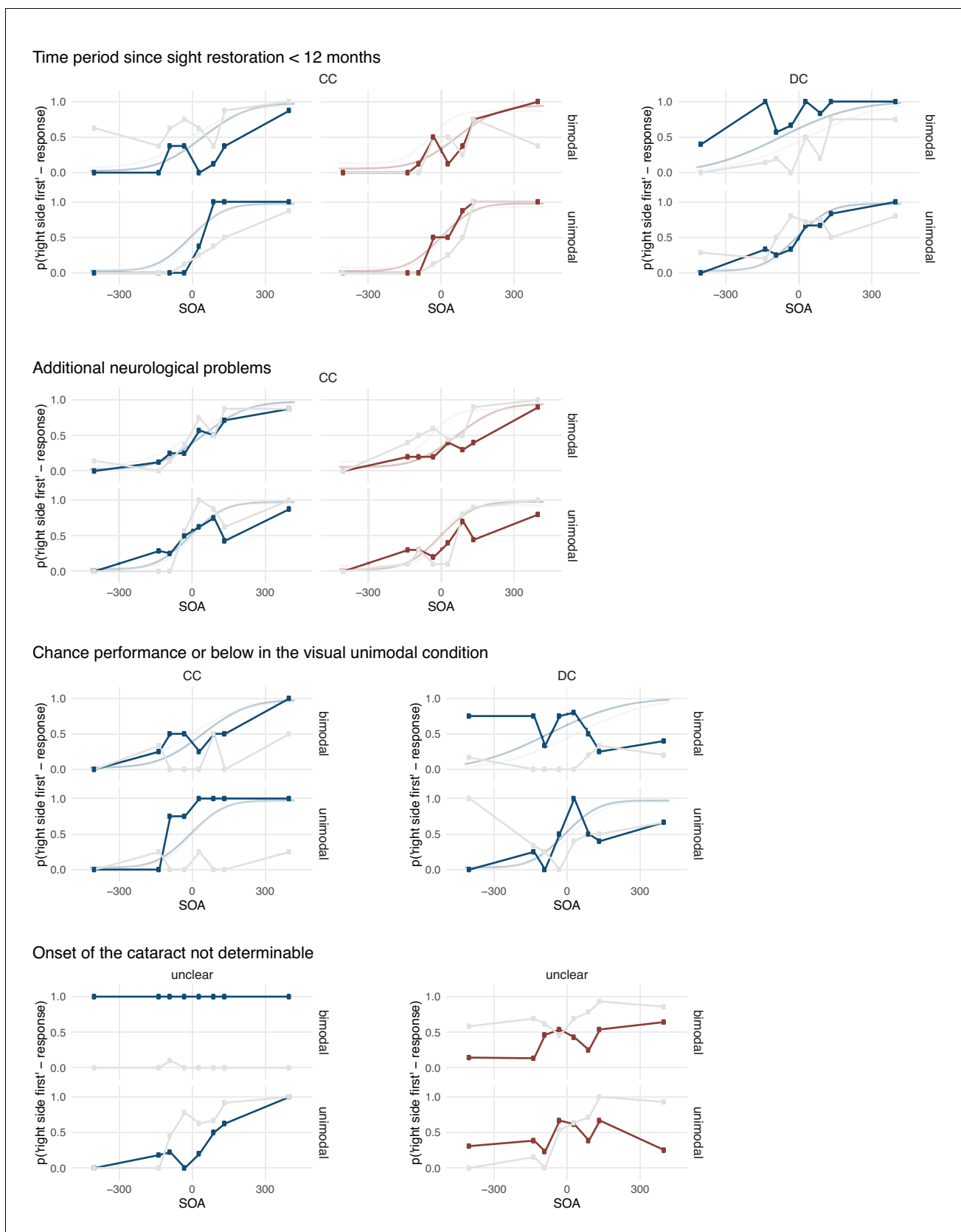


Figure 1—figure supplement 1. Excluded data. Participant-level mean proportions of 'right side first'-responses are shown as a function of the stimulus onset asynchrony (SOA) of the two stimuli, with negative values indicating 'left side first'-stimulation. The data are split into responses to Figure 1—figure supplement 1 continued on next page

Figure 1—figure supplement 1 continued

bimodal (top row) and unimodal (bottom row) stimulus pairs and according to the modality presented at the right side (visual = grey, auditory = dark blue, tactile = dark red). Sigmoid curves fitted to the group mean data reported in **Figure 1B** are shown as a reference for participants for whom the onset of the cataract could be identified.

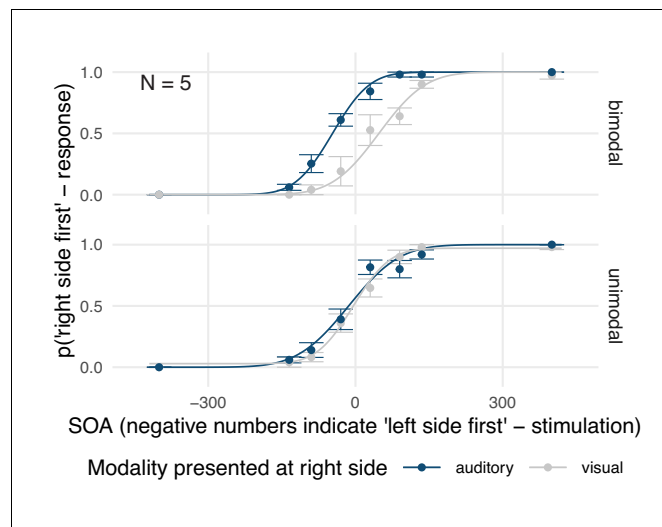


Figure 1—figure supplement 2. Visual-auditory temporal order judgments in typically sighted individuals in an additional experiment controlling for the effects of visual stimulus brightness. Five additional, typically sighted participants (all female and right-handed, 23–50 years old, mean age 34 years) completed the visual-auditory experiment. Here, a visual stimulus consisted of three activated LEDs whereas in the main experiment for typically sighted controls only one LED had been activated. Group mean proportions of 'right side first'-responses are shown as a function of the stimulus onset asynchrony (SOA) of the two stimuli, with negative values indicating 'left side first'-stimulation. The data are split into responses to bimodal (top row) and unimodal (bottom row) stimulus pairs and according to the modality presented at the right side (visual = grey, auditory = dark blue). Participants showed a typical bias of perceiving visual stimuli as delayed compared to auditory stimuli.

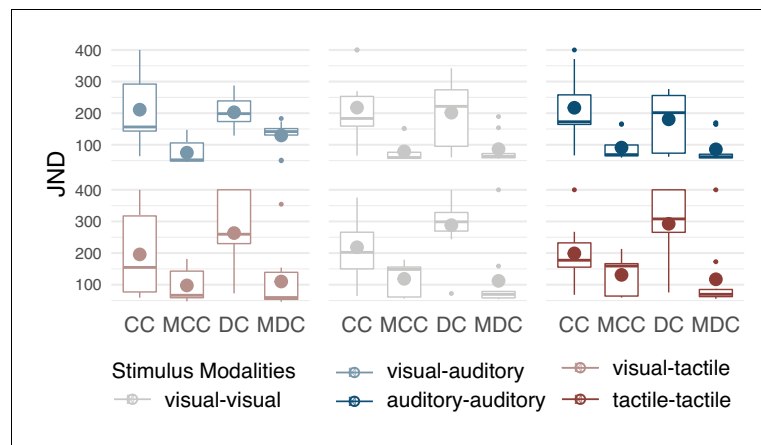


Figure 1—figure supplement 3. Just noticeable differences (JND). Box-and-whisker plots show the distribution (median, quartiles, minimum and maximum bounded at 1.5 x interquartile range, outliers) of individual JND values; big circles indicate group mean values.