Dissociable temporal components of neural similarity in face perception: An ERP study

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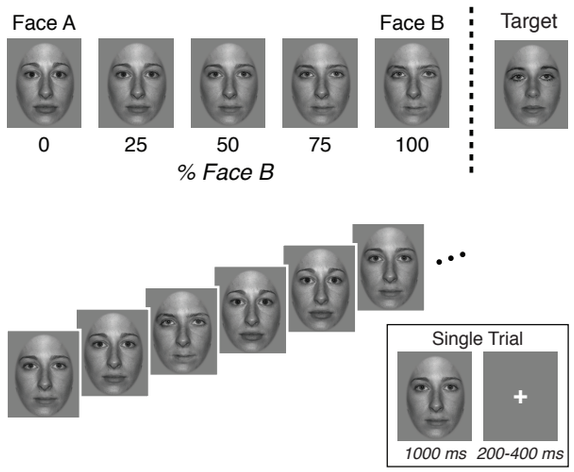
Introduction

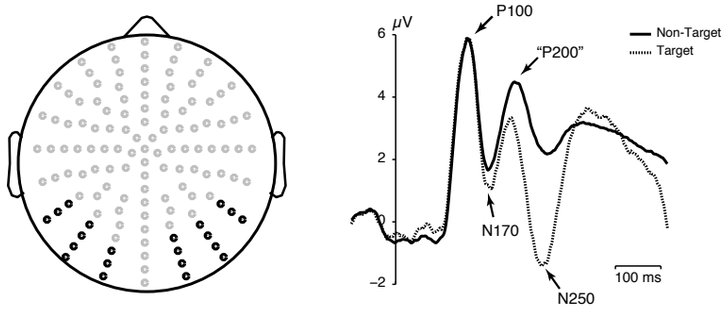
Psychological models suggest that perceptual similarity can be divided into geometric effects, such as metric distance in stimulus space, and non-geometric effects, such as stimulus-specific biases. We investigated the neural and temporal separability of these effects in a carry-over, event-related potential (ERP) study of facial similarity. By testing this dual effects model against a temporal framework of visual evoked components, we demonstrate that the behavioral distinction between geometric and non-geometric similarity effects is consistent with dissociable neural responses across the time course of face perception.

Experiment: Carry-over ERP design



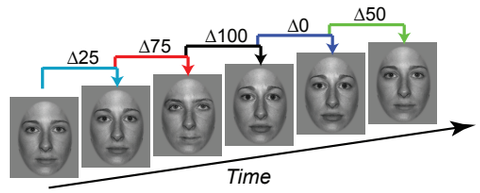
- 5 facial morphs (plus target face) in a continuos counter-balanced order
- 648 trials (plus five breaks) per run, 3 runs per subject
- 1000 ms stimulus, jittered ISI (200, 300 or 400 ms fixation cross)
- Subjects responded via button-press to target

Sensor Selection & Component Identification

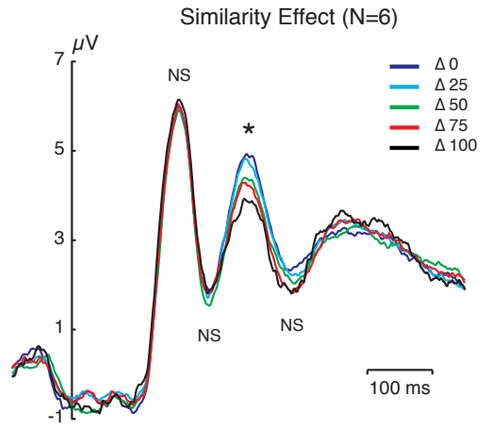


- Orthogonal localizer (faces versus houses) used to identify sensors-of-interest across subjects
- ERP components identified by timing and comparison of target and non-target trials

Geometric Effects of Similarity

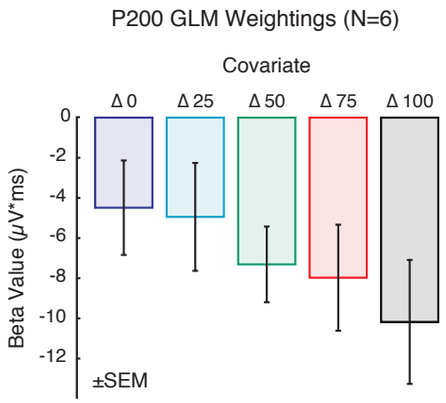


- Metric stimulus similarity was modeled as the absolute distance along the morph continuum of the preceding to current stimulus



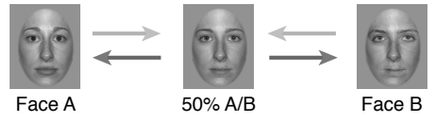
- Grand average waveform for each distance condition
- Used to visualize the location of geometric effects of similarity.

Grand average waveforms can be confounded by direct effects of each stimulus and adaptive effects of metric stimulus distance or asymmetric bias. We used a general linear model to dissociate each of these effects across four components (P100, N170, P200 and N250) for each subject.

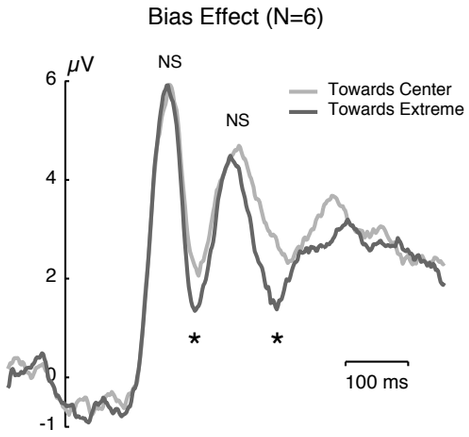


- Significant component x distance interaction [F(12, 60) = 5.05, p = 0.00001]
- Beta values for each of 5 metric distance covariates are shown for the P200 component.
- Main effect of distance within P200 is significant [F(4, 20) = 6.01, p = 0.002], and well modeled with a linear contrast [F(1, 5) = 12.9, p = 0.016].

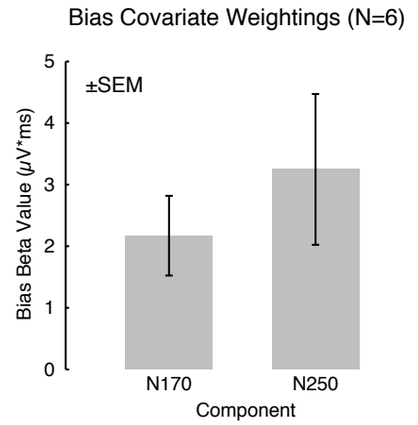
Non-Geometric Effects: Asymmetric Bias



- Non-geometric neural similarity, a "prototype" or central tendency effect, was modeled as an asymmetric modulation of the ERP response dependent upon the direction of transition.



- Grand average waveform for each direction condition
- Used to visualize the location of non-geometric "prototype" effects.



- The bias covariate had a positive value for "towards center" trials and negative value for "towards extreme" trials
- Significant non-zero weighting on this covariate indicates the presence of non-geometric effects in the modeled component.
- This asymmetric bias is significant in the N170 [t(5) = 3.36, p = 0.02] and N250 [t(5) = 2.65, p = 0.045].

Conclusions

ERP correlates of geometric and non-geometric similarity effects are dissociable in time. Parametric modulation of the P200 component corresponds to metric stimulus similarity, whereas asymmetric "prototype" bias effects arise in the N170 and N250 components. These findings support psychological models of the two elements as separate factors in the perception of proximity, and underscore the importance of concurrent modeling of both effects in studies of neural similarity.

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