Effects of size, fixation location, and inversion in a face identification task

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Face inversion effects

Information in upright and inverted faces is identical, but processing efficiency is lower for inverted.[1]

The face inversion effect (FIE) can be accounted for by decreased sensitivity to horizontal structure in faces,[2] but what factors mediate these effects?

Here, we explored the effects and interactions of two recently hypothesized mediators of processing for identification of upright and inverted faces.

The fixation hypothesis

Observers rely on the eyes to identify faces.[3,4,5,6]

The information required for face identification is collected very rapidly, within one or two fixations.[7]

Hills[8,9] and others[10,11] argued that fixations to the upper half of inverted faces may exacerbate the FIE.

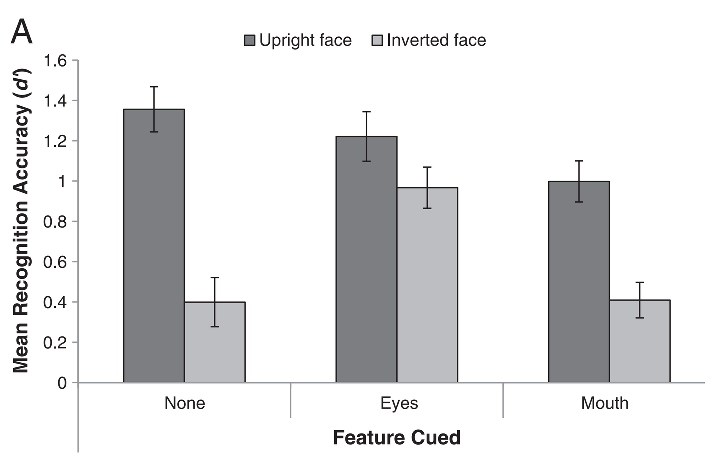


Figure 2A, adapted from Hills, Ross & Lewis (2011), demonstrating the fixation hypothesis.

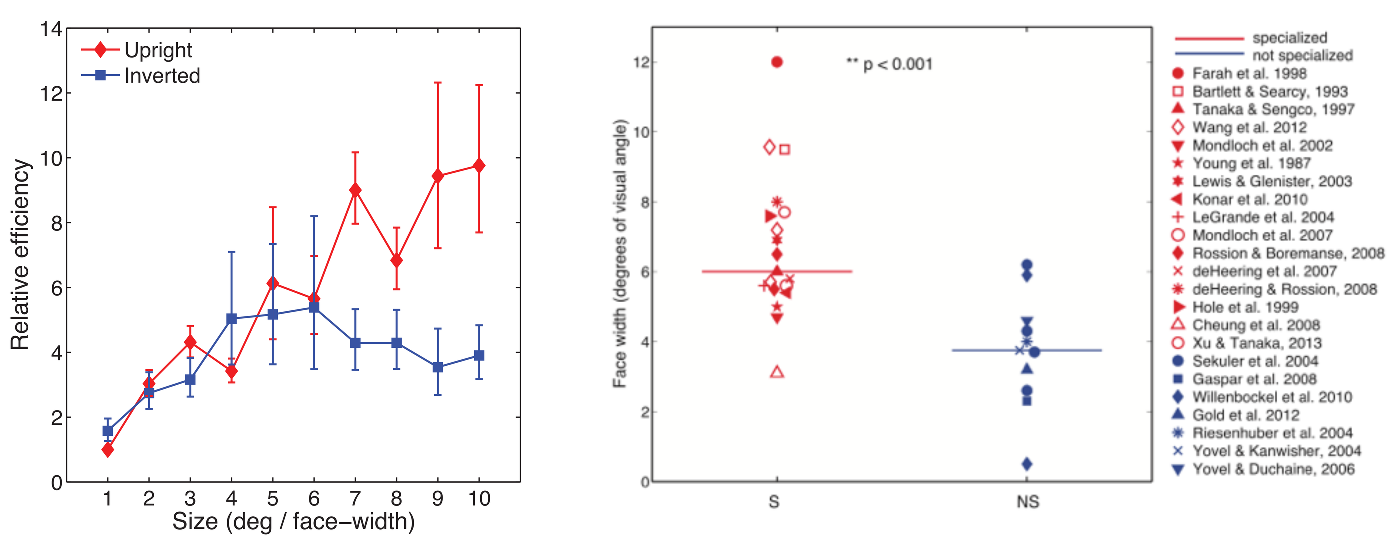
These observers completed an old-new recognition task. During the initial learning phase, the eyes or mouth were cued using a fixation cross prior to stimulus presentation.

Subsequent recognition accuracy was higher and the magnitude of the FIE lower when the eyes were cued, relative to the mouth.

The size hypothesis

Face size in visual angle varies across studies.

Yang et al.[12] recently suggested that the expert processes associated with upright face identification may be engaged only by large faces.

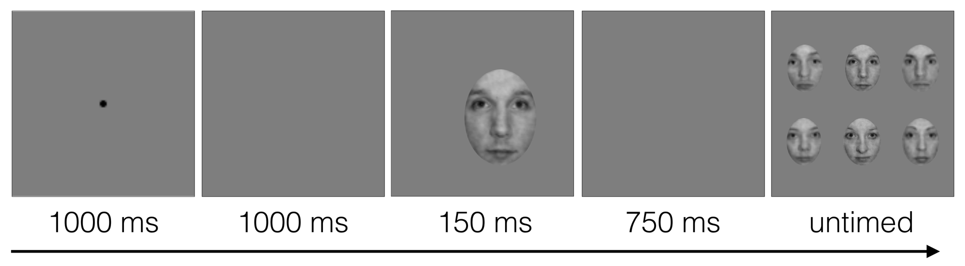


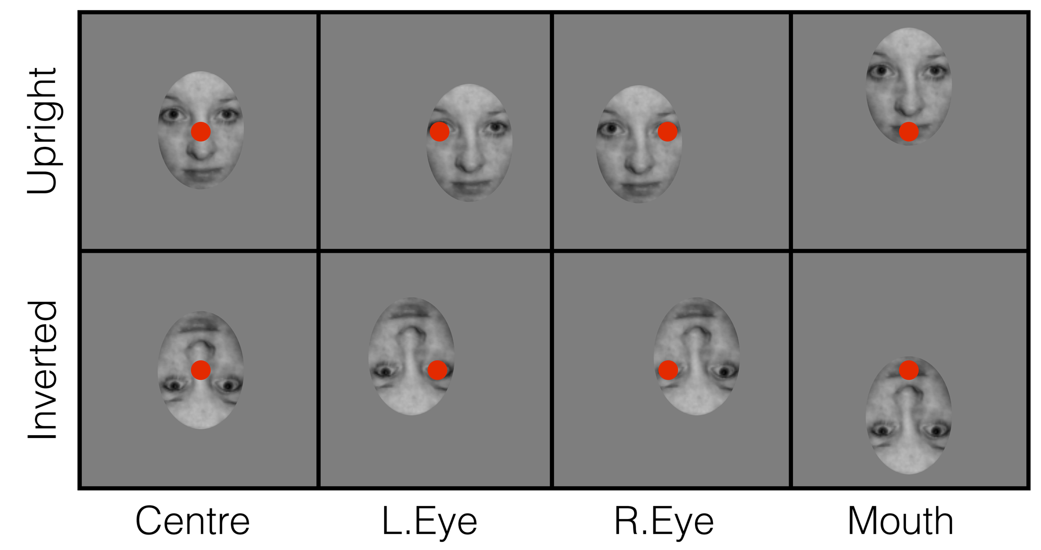
Key figures, adapted from Yang, Shafai & Oruc (2014), demonstrating the size hypothesis.

Left: Relative to a CSF-limited ideal observer, upright faces were processed more efficiently than inverted faces if face width was larger than approximately 6° visual angle (ref. 10, figure 4).

Right: Results of a literature review plotting the face width used in studies that did (left) or did not (right) find evidence of 'qualitatively distinct specialized processing' for upright faces (ref. 10, figure 6).

Methods





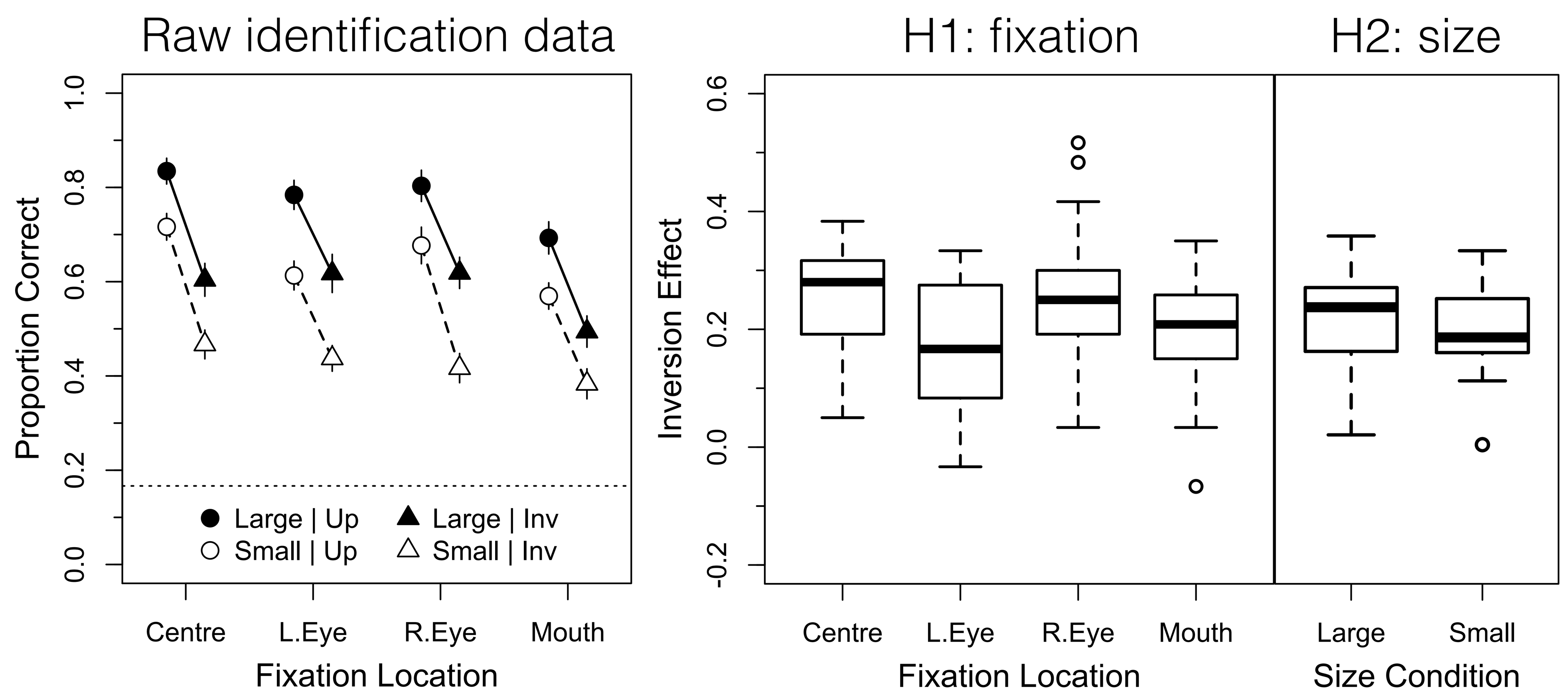
Top: Time course of a single trial. Stimulus contrast has been increased for visibility. Representative fixation condition shown.

Right: Demonstration of the fixation and orientation manipulations. Red fixation is included for representative purposes only. All fixation and orientation conditions were randomly intermixed and stimulus presentation limited to 150 ms to minimize saccades. Observers were instructed to fixate the centre of the display at all times.

Stimulus conditions: upright or inverted, $c_{RMS} = 0.03$
Stimulus size: 3.2° or 8.1° (viewing distance 60 cm)
Fixation locations: centre, left eye, right eye, mouth

Measure: 6-AFC identification accuracy + ERPs
Design: All factors varied within-subjects (n = 16)
Duration: 60 trials/condition (960 total)

Behavioural results

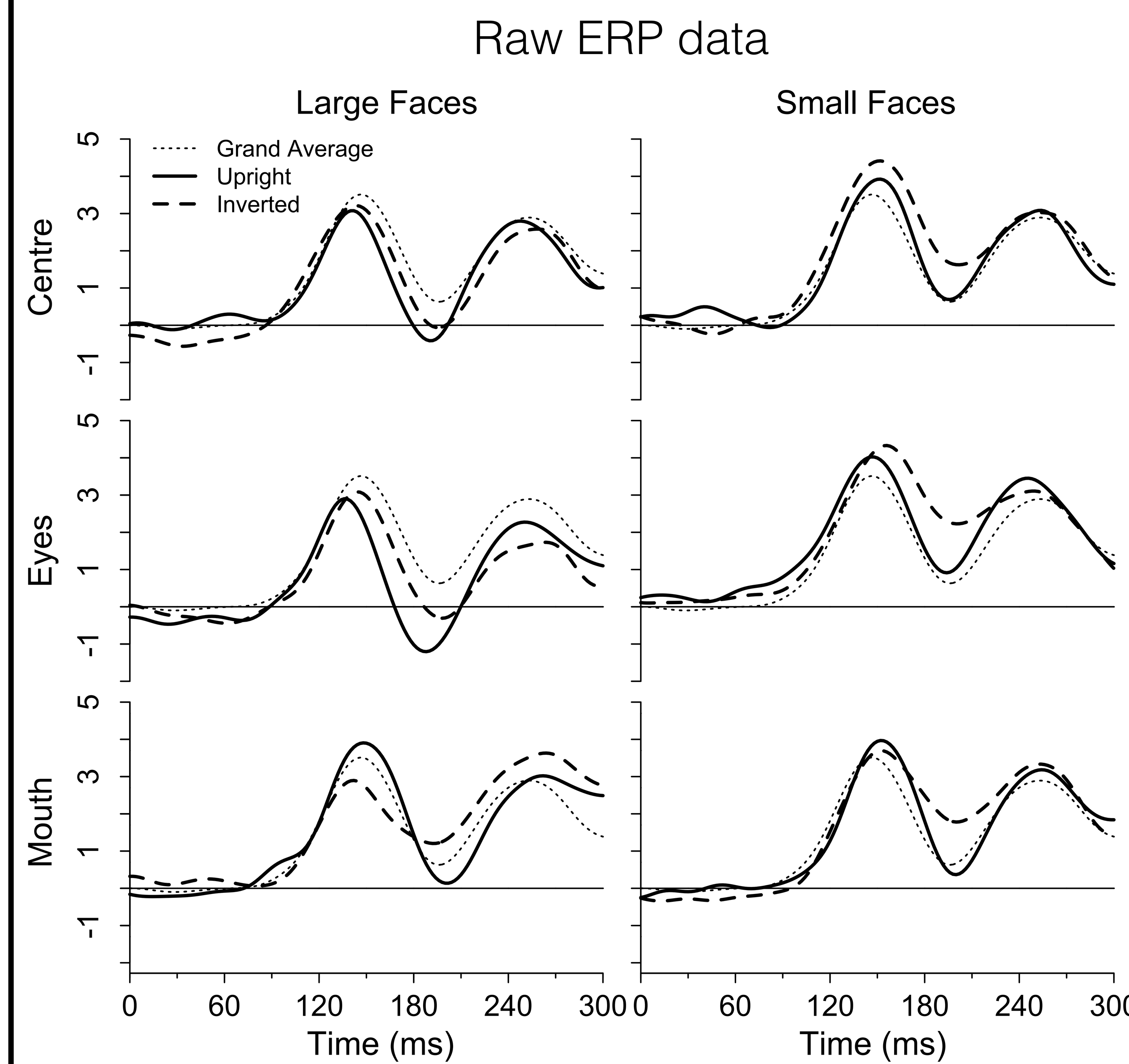


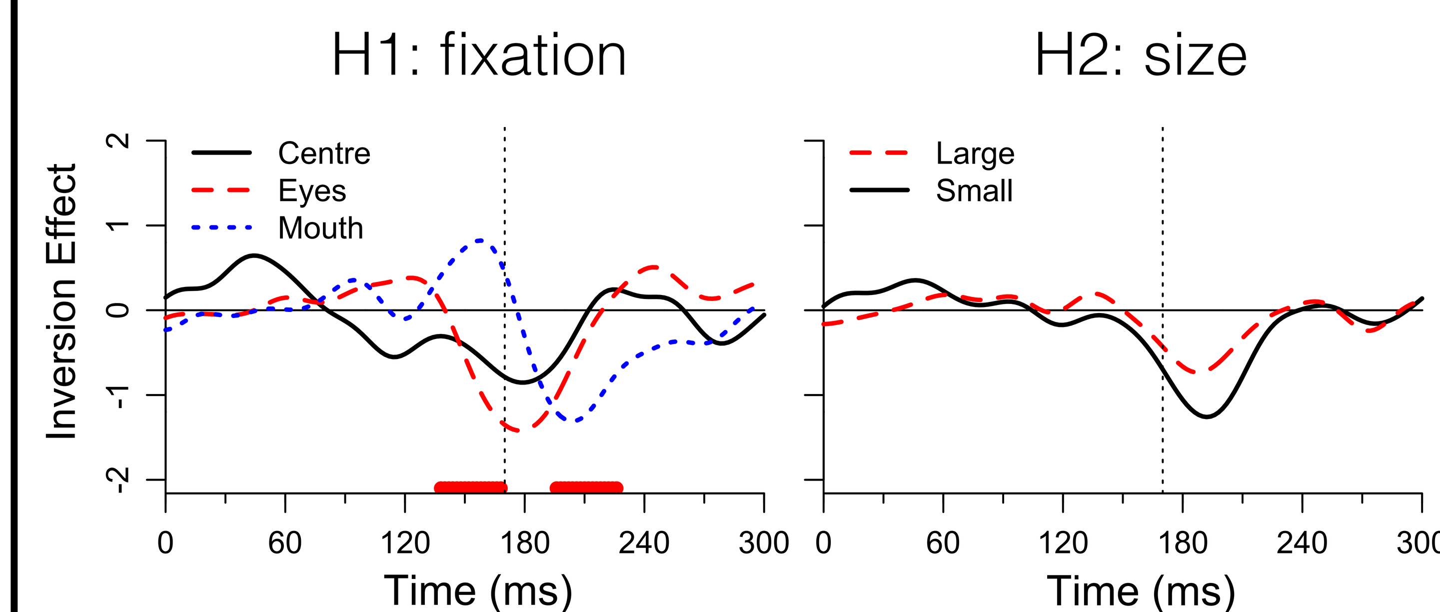
Left: Mean proportion correct +/- SEM. We submitted these data to a 2 (size) x 2 (orientation) x 4 (fixation) repeated measures ANOVA, which revealed significant main effects of size ($p<0.0001$, higher P_C for large), orientation ($p<0.0001$, higher P_C for upright), and fixation ($p<0.0001$, lower P_C for mouth). Further, the size x fixation interaction approached significance ($p=0.051$) and the orientation x fixation interaction was significant ($p=0.005$). The size x orientation ($p=0.17$) and size x orientation x fixation ($p=0.15$) interactions did not approach significance.

Middle: A direct examination of the fixation hypothesis, which predicts a modulation of the inversion effect by fixation location (mouth < eyes). Although the orientation x fixation interaction was significant in the ANOVA, these results do not support the prediction of the fixation hypothesis.

Right: A direct examination of the size hypothesis, which predicts a modulation of the inversion effect by face width (large > small). The relevant interaction in the omnibus ANOVA (size x orientation) was not significant, so these results do not support the prediction of the size hypothesis.

Electrophysiology





Top: Raw ERPs calculated using all trials, plotted with the grand average ERP for all conditions.
Bottom left: A direct examination of the effect of fixation on the N170 inversion effect. Red shading along the X-axis indicates time windows in which there was a significant difference ($p<0.05$, within-subjects).
Bottom right: A direct examination of the effect of size on the N170 inversion effect. The difference between small and large faces was not significant in any time window ($p>0.05$, within-subjects).

Conclusions

Behavioural results did not clearly support either hypothesis: the face inversion effect was similar across all fixation locations and face sizes.

The N170 face inversion effect was significantly modulated by fixation location, both in latency and amplitude, but not by face size.

Together, these results are not consistent with the strong predictions of the fixation and size hypotheses. Further research should explore the extent to which methodological differences may mediate these effects.

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The authors would like to thank Donna Waxman for her assistance throughout the completion of this research.
Support for this research was generously provided by NSERC and the Canada Research Chairs program.
Poster presented at the 15th Annual Meeting of the Vision Sciences Society, May 17, 2015.
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