

Exploring the Role of High and Low Spatial Frequencies in the Development of Infant Selective Attention to Faces

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Introduction

- The Encoding Switch Hypothesis suggests that holistic face perception does not develop in children until age 10, proposing that before holistic face processing develops, infants and children engage in a more piecemeal or parts-based perception of faces (Diamond & Carrey, 1977).
- There is an increasing amount of research suggesting holistic processing is present earlier in development than previously thought and could potentially even precede parts-based processing (Nakabayashi & Liu, 2013).
- Adult behavioral data suggests that low spatial frequencies (LSF) facilitate holistic face processing whereas featural face processing relies on high spatial frequencies (HSF) (Goffaux & Roisson, 2006; Goffaux et al., 2005).
- Infant research indicates that newborn infants use very low spatial frequency information in face perception (de Heering et al., 2008).
- Infant sensitivity to LSF peaks at 10 weeks of age but the period between 9-32 weeks is a rapid period of increased HSF perception and a pure change in resolution where infants can perceive finer detail in visual stimuli (Norcia et al., 1990).
- The current study utilizes eye-tracking techniques to explore infant perception and recognition of LSF and HSF filtered face stimuli at 4-, 9-, and 13-months of age.

Results

Main Effect of Age

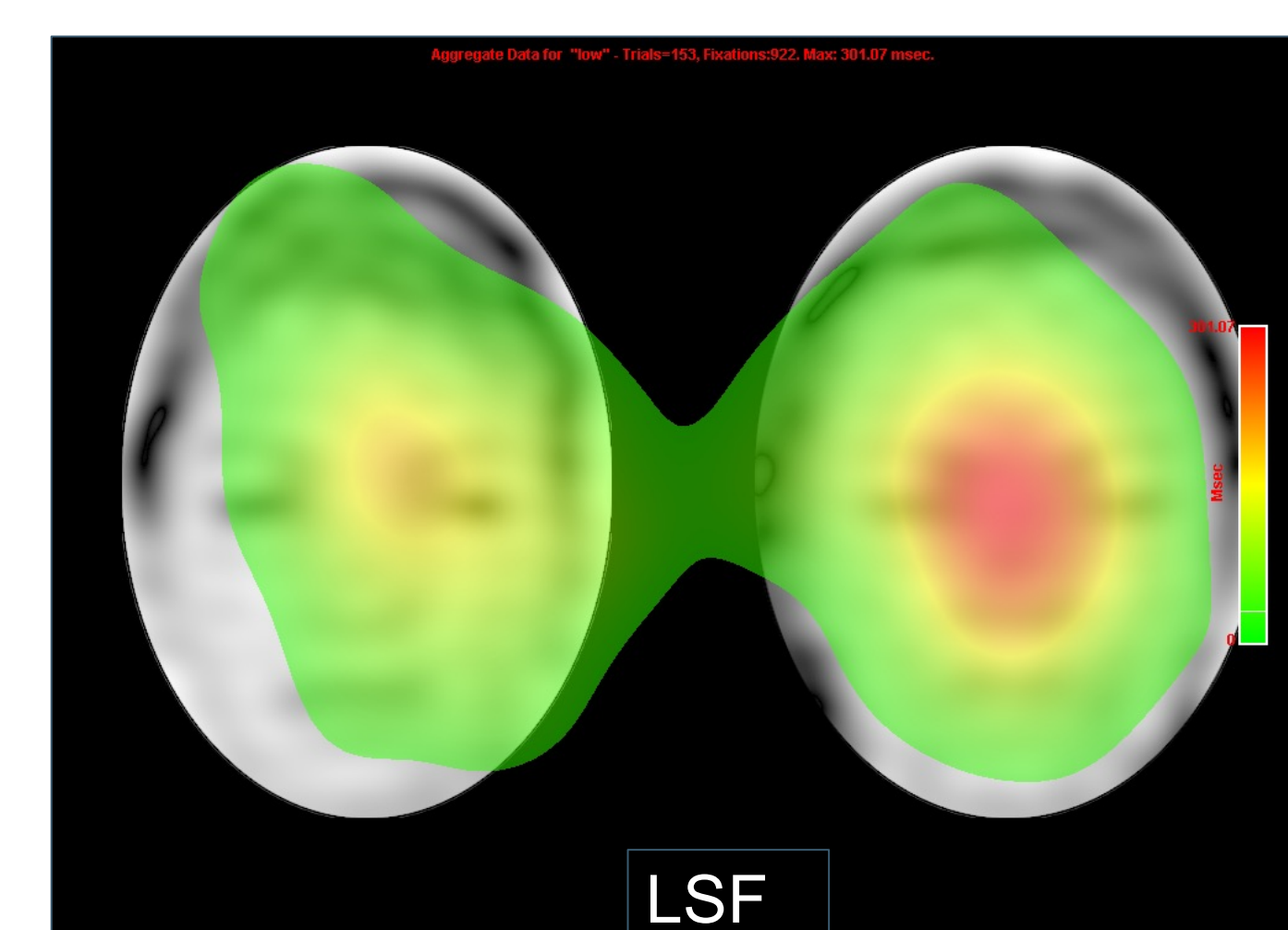
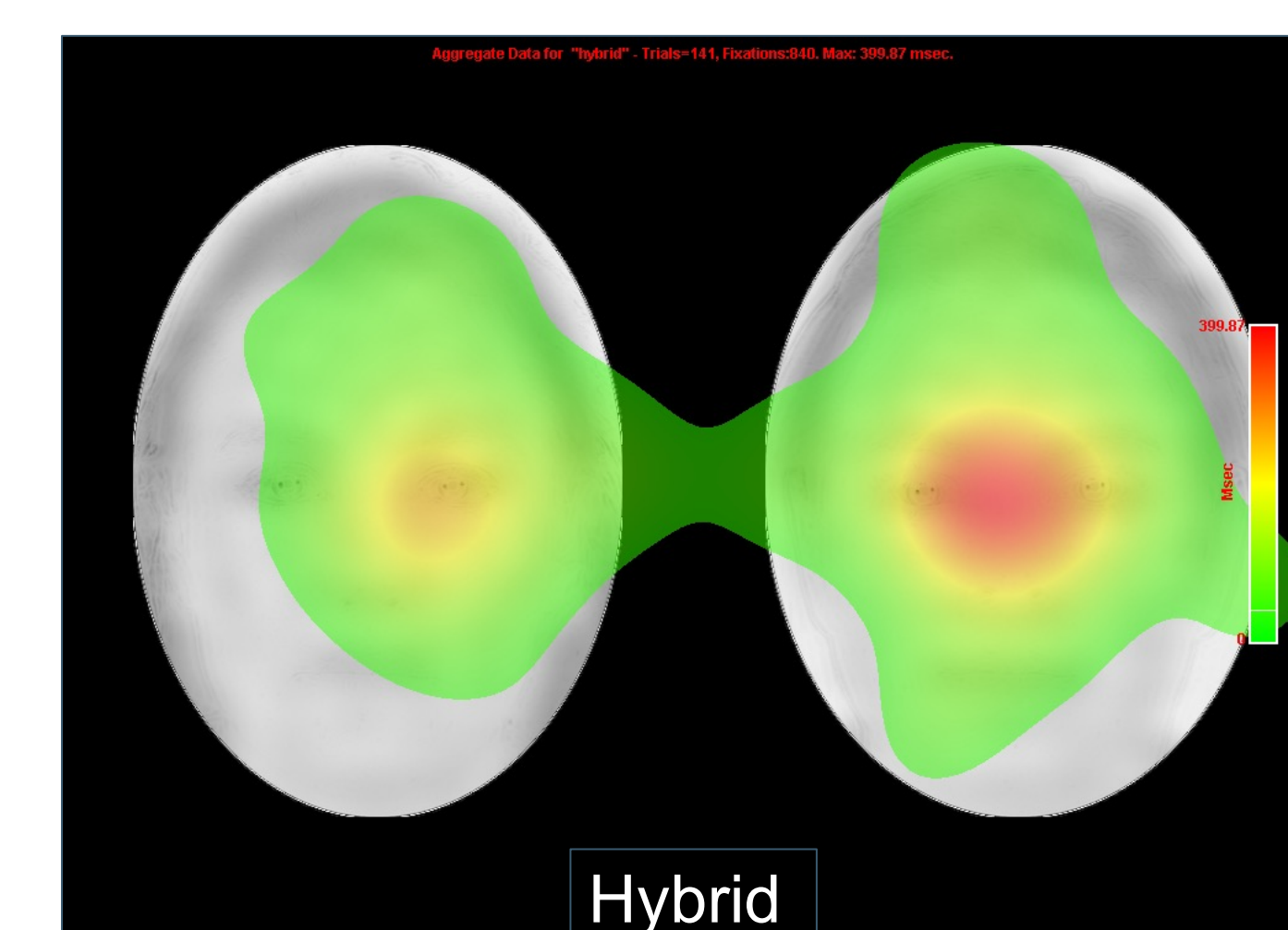
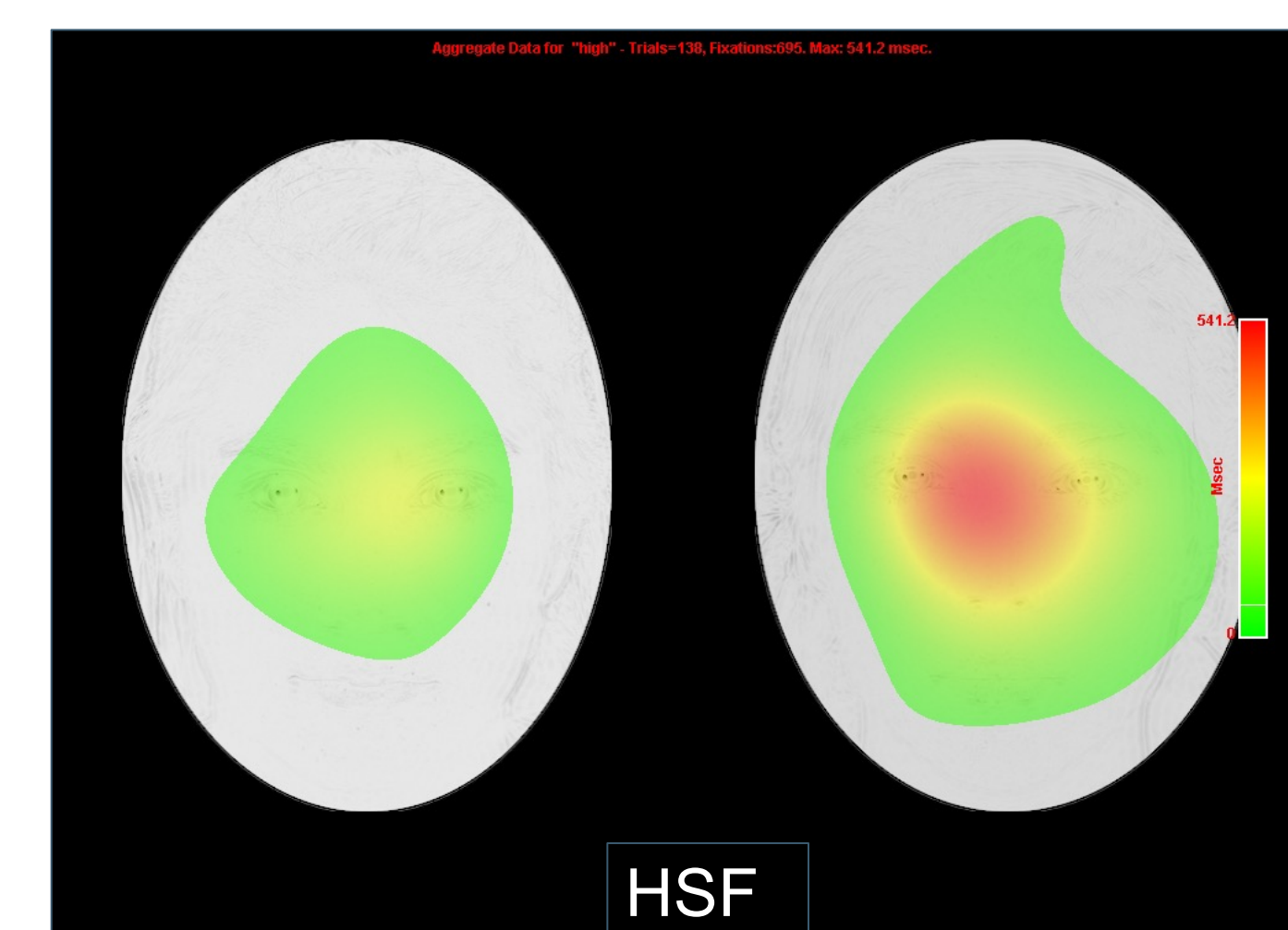
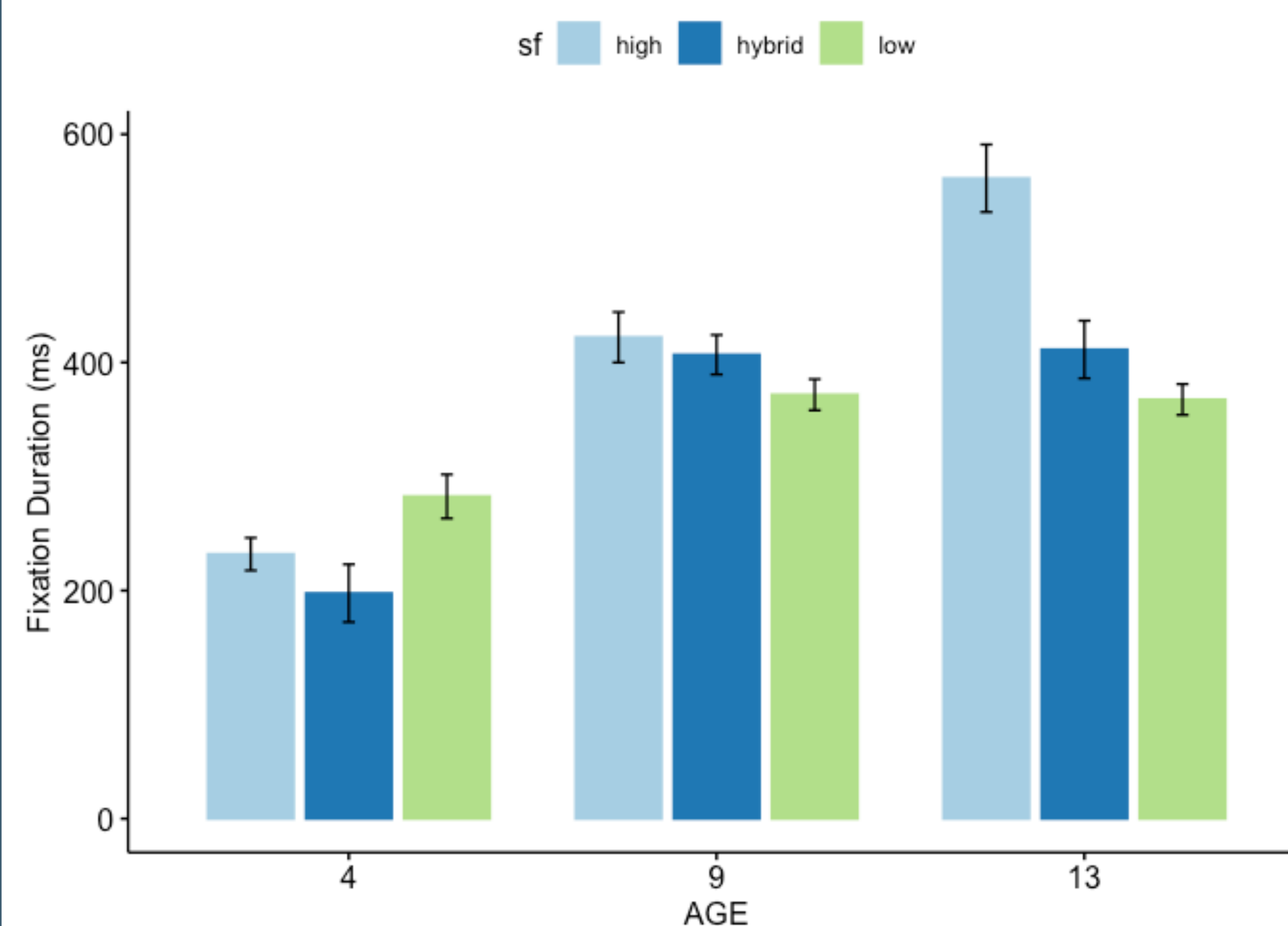
- $F(2, 42.1) = 16.337, p < .001$
- 4mo: $M = 220\text{ms}, SE = 30.6$
- 9mo: $M = 388\text{ms}, SE = 30.0$
- 13mo: $M = 441\text{ms}, SE = 28.1$

Main Effect of Spatial Frequency

- $F(2, 2287.3) = 8.651, p < .001$
- HSF: $M = 393\text{ms}, SE = 20.5$
- LSF: $M = 319\text{ms}, SE = 20.3$
- Hybrid: $M = 336\text{ms}, SE = 20.2$

Interaction of Age*Spatial Frequency

- $F(4, 2275.6) = 7.256, p < .001$
 - HSF: 9mo > 4mo, $t(100.6) = 3.865, p = .01$
 - 13mo > 4mo, $t(96.3) = 6.763, p < .001$
- LSF: NS
- Hybrid: 9mo > 4mo, $t(95.2) = 3.893, p < .001$
- 13mo > 4mo, $t(98.7) = 4.531, p < .001$
- 13mo: HSF > Hybrid, $t(2310.5) = 4.599, p < .001$
- HSF > LSF, $t(2295) = 7.799, p < .001$



Method

Participants

- 44 infants tested at 4 ($n = 16$), 9 ($n = 14$) or 13 ($n = 14$) months of age

Apparatus

- EyeLink 1000 Plus infrared eye tracker

Conditions

- LSF (<2cpd)
- HSF (>6pcd)
- Hybrid (LSF novel/HSF familiar, HSF familiar/LSF novel)

Procedure

- Each trial consists of a familiarization phase (20s cumulative looking) followed by a visual paired comparison (VPC) phase (minimum 5s cumulative looking) of a novel and familiar face in one SF condition

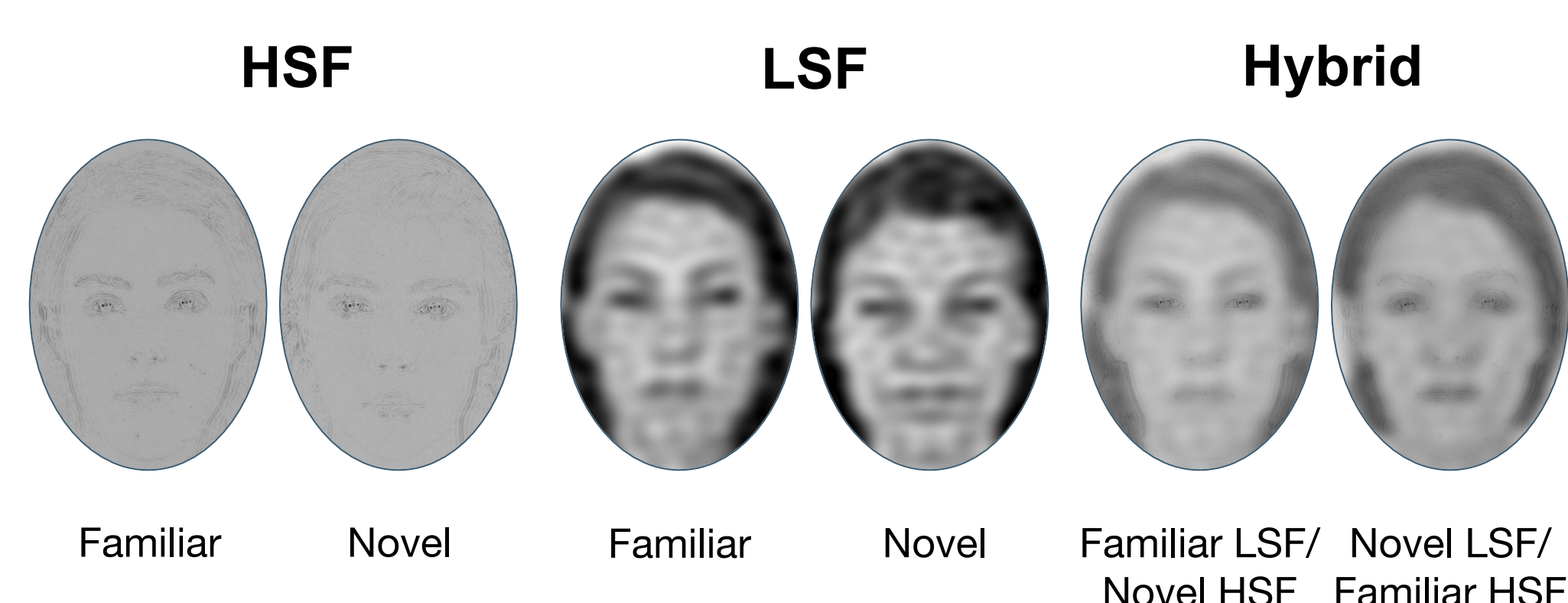
Statistical Analyses

- Mixed effects model with fixed effects of age (4mo, 9mo, 13mo), condition (HSF, LSF, hybrid), novelty (familiar, novel), and position (right, left) and a random effect of participant
- Post-hoc pairwise comparisons of significant effects with Bonferroni correction

Phase 1: Familiarization



Phase 2: Visual Paired Comparison



Discussion

- Our analysis of the infant looking data indicates a main effect of age with older infants (9-month-olds and 13-month-olds) spending more time fixated on face stimuli than 4-month-old infants. These findings are in line with developmental trends in attention with older infants having greater attentional control and engagement.
- Exploring the interaction of age and spatial frequency, we found that age group differences in visual attention to face stimuli between older and younger infants were only significant in HSF and hybrid conditions. This could be indicative of the limited spatial frequency perception of 4-month-old infants, demonstrating attention to face stimuli equivalent to 9- and 13-month-olds in the condition in which they can perceive the stimuli.
- Interestingly, 13-month-old infants were the only group to exhibit a preference for spatial frequency condition, with greater visual attention toward HSF face images over LSF and hybrid images. This could suggest a shift of attention in later infancy towards more parts-based facial perception with HSF information being most informative of internal face features (Goffaux et al., 2005).
- The lack of novelty preference in this data may be a result of insufficient encoding due to the unfamiliarity of such filtered stimuli. Future steps for this research could explore the effect of increased time for familiarization and visual paired comparison.

