Habituation and Novelty Detection fNIRS brain responses from 5 to 12 months of age: The Gambia and UK

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Aims

1.To Investigate development of cortical mechanisms for:

- habituation to repeated auditory social stimuli
- novelty detection to a change in stimuli

2. Measure cortical responses from 5-12 months in two settings, one with high-risk (The Gambia) and another with low-risk of environmental adversity (UK).

Background

- Exposure to environmental insults has a strong impact on infant development; a high proportion of infants around the world are affected, especially in low- and middle-income countries (LMIC's, Figure 1).
- fNIRS is being increasingly used to investigate atypical development [2].
- This work forms part of The Brain Imaging for Global Health (BRIGHT) project, which aims to use fNIRS to chart brain development from 0-24mo in the UK and The Gambia (GM) [3].

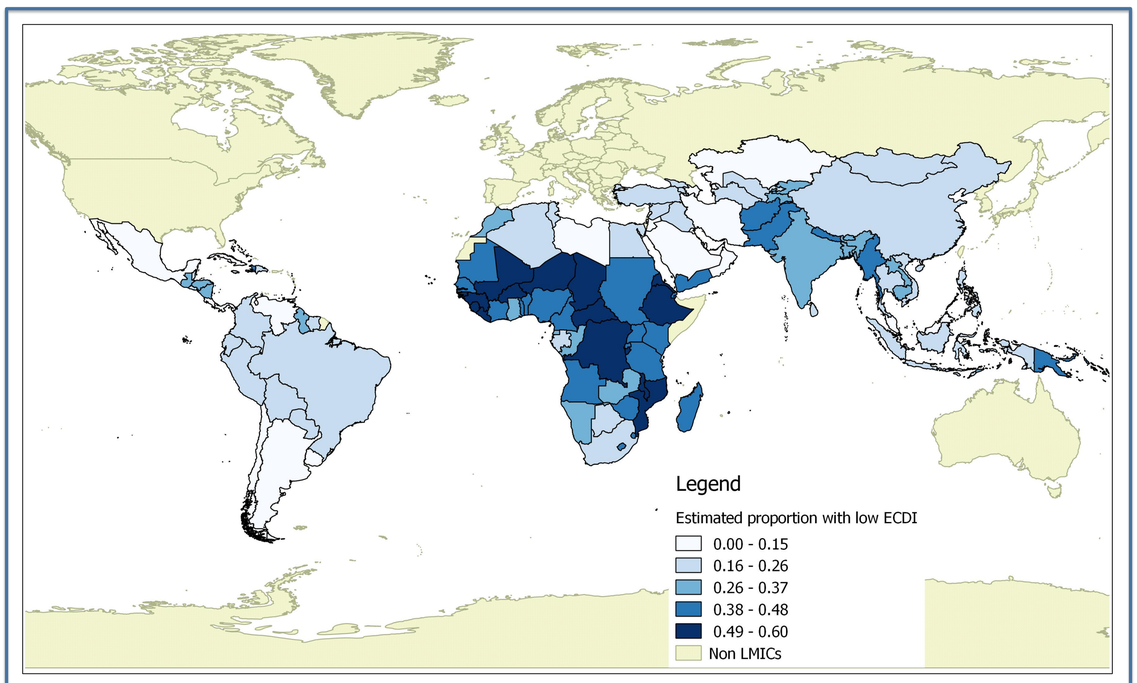

Figure 1: Estimated proportion of infants with low development per the Early Childhood Development Index; data from 2005-2015, by country (from [1]).

Results

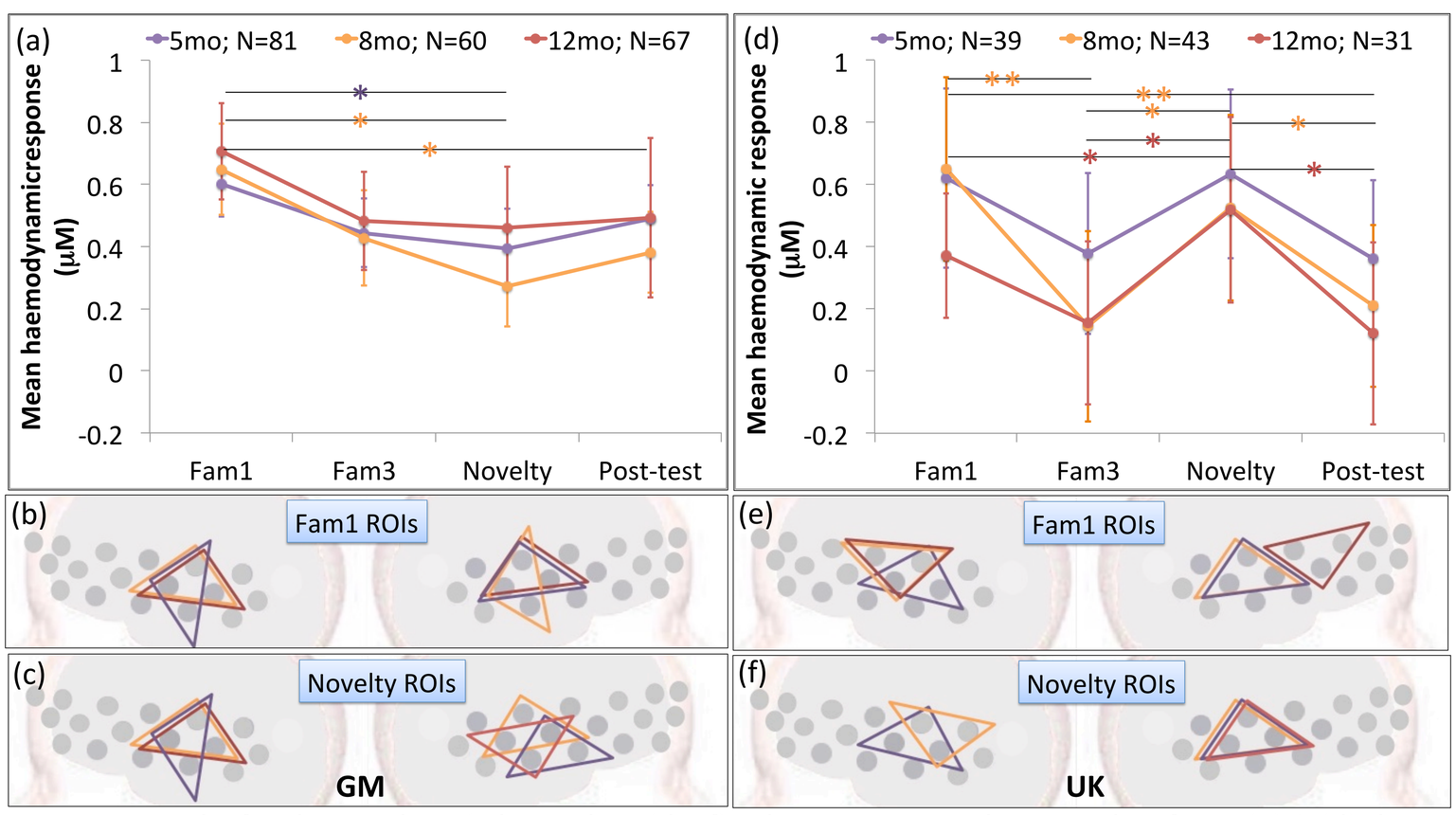

Figure 4. Results for the Gambian (a,b,c and UK (d,e,f) cohorts, at 5,8, and 12 months of age. (a) & (d) show the mean HbO_2 response for Fam1, Fam3, Novelty and Post-test epochs (error bars represent ±2*SEM); dotted lines link epochs with significant differential activation (* indicates p<0.05; ** indicates p<0.001). ROIS for the Fam1 and Novelty epochs at each time point are represented in panels (b) & (e) and (c) & (f).

Conclusions

- fNIRS offers new ways for assessing children's development in LMIC's.
- Age-related typical patterns of habituation and novelty detection were observed in the UK infants.
- Infants in the Gambian cohort did not demonstrate habituation at 5, 8 or 12months.

Future work

Data collection and analysis is for our longitudinal study is ongoing at both sites. We will generate data to investigate:

i. whether these responses are developmentally delayed and become more typical by 18 or 24 mo;

ii. whether individual responses are related to different growth trajectories or to poverty associated risk factors;

iii. if these factors are driving the different patterns of longitudinal responses observed here.

Methods

Data acquisition: fNIRS Data was collected with the NTS optical topography system (Gowerlabs Ltd., London; 780 and 850 nm wavelengths).
The fNIRS headgear had 34 channels with source-detector separation of 2cm; it covered inferior frontal and temporal regions (Figure 2).
The data presented here is from a subset of N = 176 participants from the BRIGHT cohorts, studied at 5, 8 and 12 months.
The experimental protocol had three sections: familiarisation trials, novelty trials and a repeat of the familiarisation trials (Figure 3).

Figure 2: fNIRS headgear was positioned over the inferior frontal and temporal regions bilaterally.

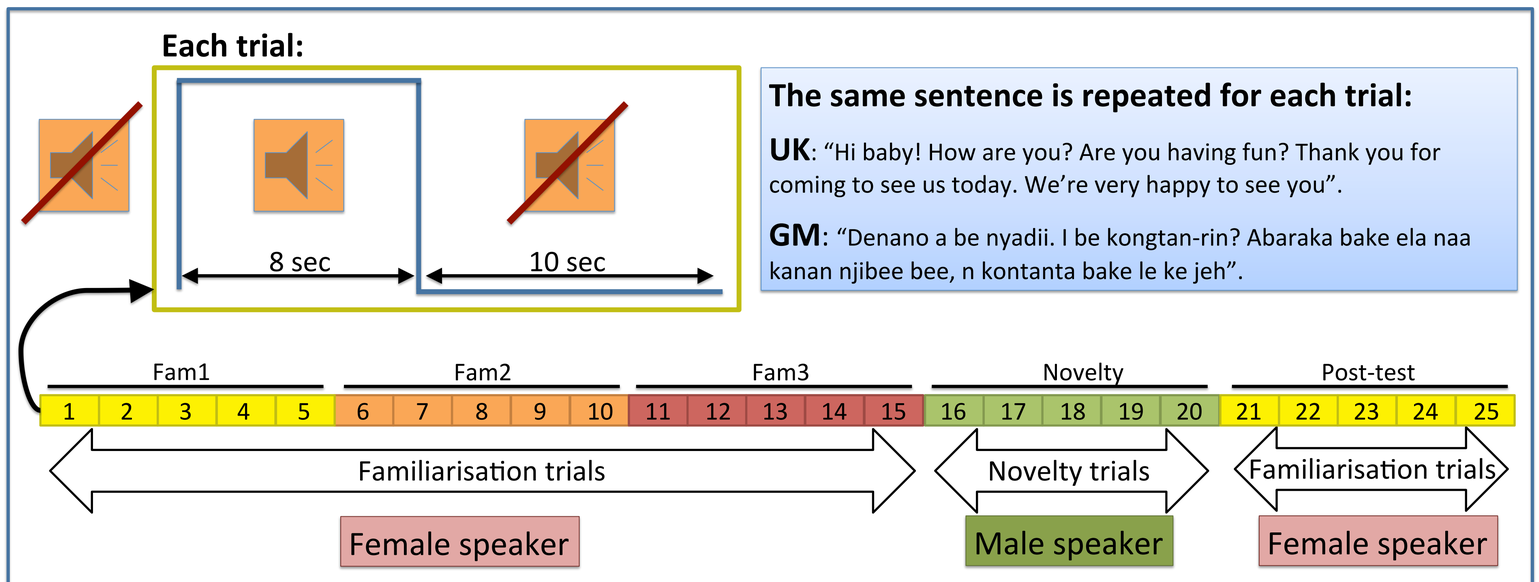

Figure 3: Experimental protocol. The same sentence of infant-directed speech (8sec) was repeated at each trial, followed by 10 sec of silence. A female voice speaks during the familiarisation trials; a male voice spoke during novelty trials.

Data analysis:
Data was analysed with in-house Matlab scripts [4,5].
Average HbO_2 change from 8 to 12 seconds post-stimulus onset was used as measure of activation.
Cluster permutation analysis - based on the responses to Fam1 and Novelty epochs - determined the Regions of Interest (ROI) [6].

We thank all the participating families in this study.

References:

[1] *McCoy et al. (2016). PLoS Medicine. https://doi.org/10.1371/journal.pmed.1002034.*
[2] *VanderWert & Nelson. (2014). NI. http://dx.doi.org/10.1016/j.neuroimage.2013.10.009*
[3] *The BRIGHT Project. (2017). Retrieved from www.globalfnirs.org/the-bright-project*
[4] *Lloyd-Fox et al. (2010). https://doi.org/10.1016/j.neubiorev.2009.07.008*
[5] *Gervain et al. (2011). Dev. Cogn. Neurosc. https://doi.org/10.1016/j. dcn.2010.07.004*
[6] *Lloyd-Fox et al. (2019). Developmental Science. https://doi.org/10.1111/desc.12817*