Scalp Locations Projected to Cortical Locations for Infant NIRS

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INTRODUCTION

This study identified locations on the scalp surfaces of MRI volumes of infants in the first year and determined the closest cortical areas near those locations. The MRI volumes came from individual infants aged 3 to 12 months of age and from average MRI templates (3, 4.5, 6, 7.5, 9, and 12 months). The positions on the scalp were located in the 10-10 electrode system (81, or 358 scalp locations) and the EGI Hydrocel GSN 128 Sensor Net (128, or 470 scalp locations). The scalp locations were projected inward to the cortex and stereotaxic atlases were used to identify the lobar or macro-anatomical area of the projected location. Inter-electrode distance, scalp-cortex distance, and inter-projection distance were calculated for the MRI averages, for a set of 3T high-resolution MRI images (~N = 10 at each age), and for a set of 1.5T MRI images from the NIHPD MRI study (N = 22 to 32 at 3, 6, 9, and 12 months).

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METHOD

1—Structural MRIs of whole head
- Whole head needed for scalp locations; extracted brain for cortex
- Individual participant MRI (Lloyd-Fox et al., submitted)
- "Closest head", library approach (e.g., Emberson et al, submitted)
- Age-appropriate average MRI template (Sanchez et al., 2011, 2012)

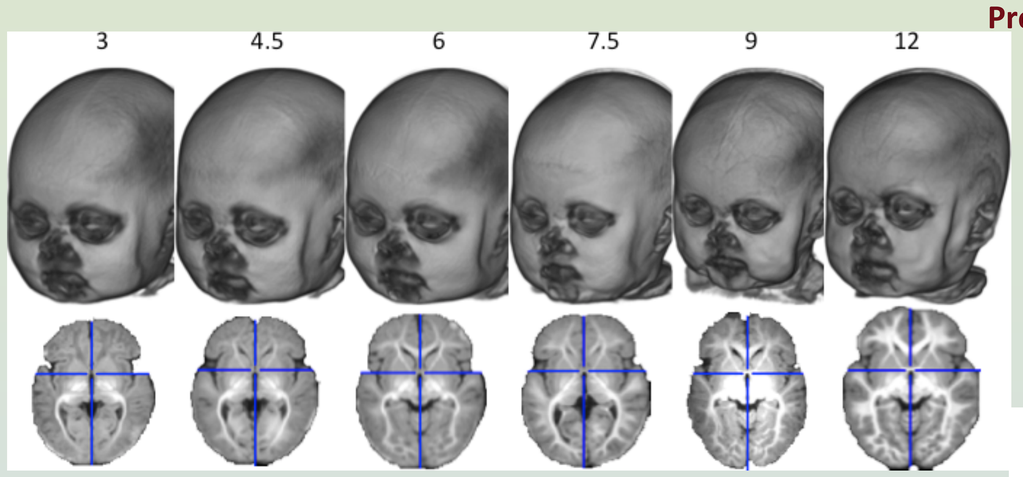
2—Scalp locations located on MRI
- Talairach origin is planes normal to AC-PC line, distance from AC
- Virtual 10-10 Electrode positions (Richards et al., in press)
- Measured electrode positions (e.g., EGI GSN128 or HGSN128) (Richards…)
- Points measured with digitized (GPS; Polhemous)
- Pictures of placements to MRI masks (Lloyd-Fox et al 2013, submitted)

3—Stereotaxic atlas categorizes the brain
- Manually delineated lobar atlas (Phillips-Meek et al, 2013; Fillmore et al…)
- Macroanatomical atlas (Gousious et al; Shattuck et al; Fillmore et al,)
- Manually drawn segments (Onishi et al)

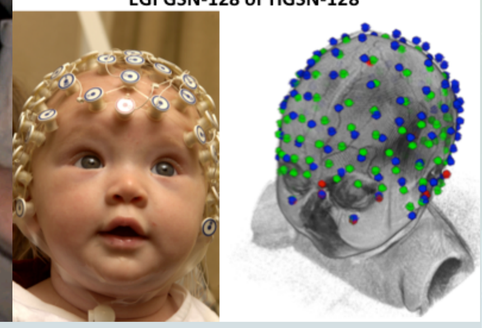
4—Projections between scalp locations and cortical locations
- Shrink the scalp until intersects the brain, find electrode position on cortex
- Expand the brain until it intersects the scalp, find electrode position
- One voxel, 1 cm sphere, NIRS banana shape
- Average MRI, individual MRIs, individual cortex projection
- Participant-defined ROI, channel projections over subjects, channel distributions

5—Final product
- Tables of scalp-location / distance / atlas location
  (age X scalp location X voxel/sphere/banana, with probability of atlas location

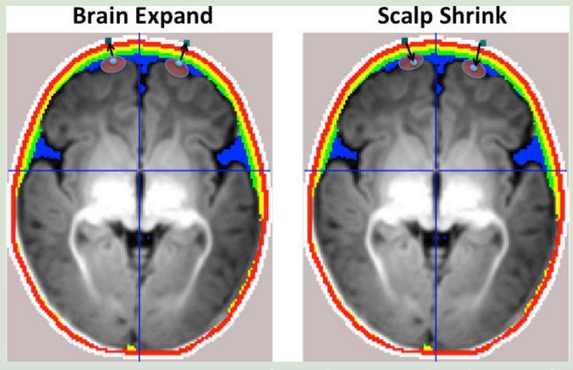
Structural MRI, Head and Extracted Brain



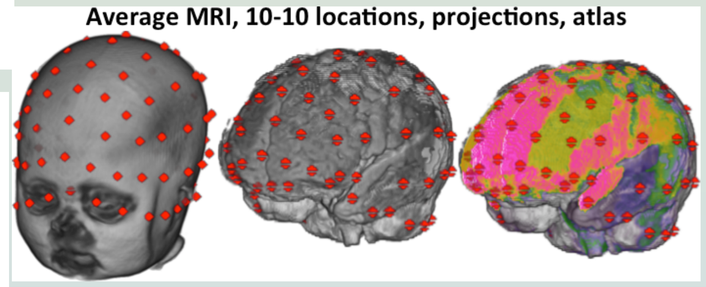
Individual Participant and Electrode Locations
EGI GSN-128 or HGSN-128



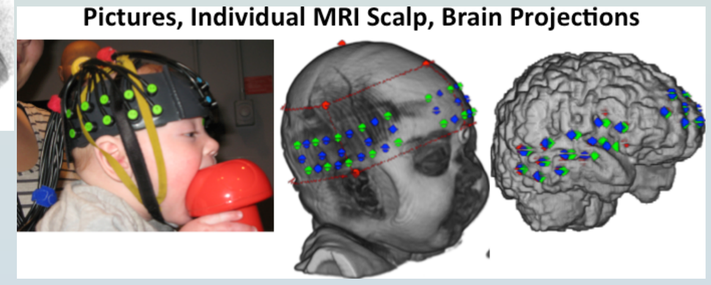
Projections from Scalp Locations to Cortex



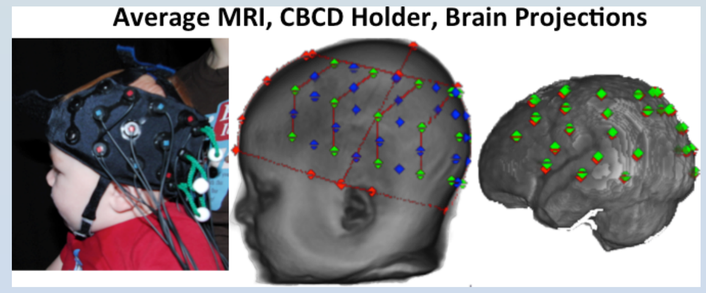
Average MRI, 10-10 locations, projections, atlas



Pictures, Individual MRI Scalp, Brain Projections



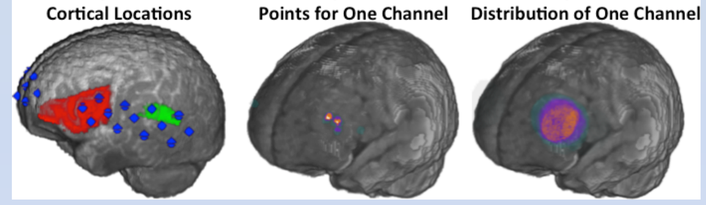
Average MRI, CBCD Holder, Brain Projections



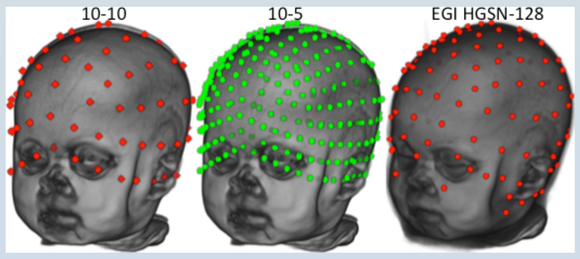
Participant MRI
Participants NIRS
Cortical Locations

Average MRI
Study-Pictures
Points for One Channel

Average MRI
Study-Pictures
Distribution of One Channel

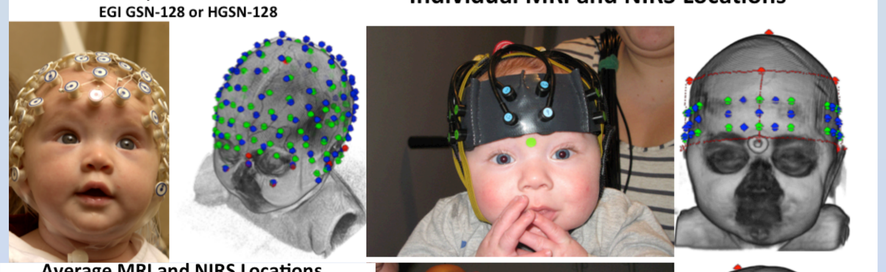


Scalp locations located on MRI

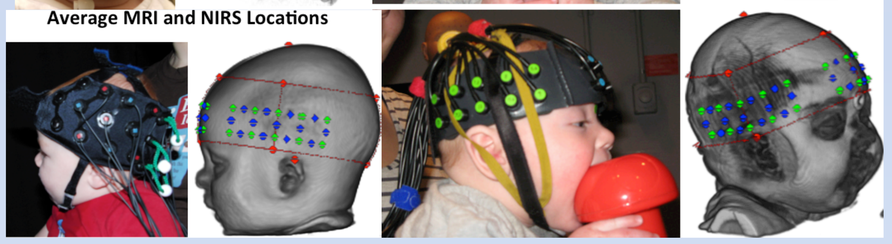


Individual Participant and Electrode Locations
EGI GSN-128 or HGSN-128

Individual MRI and NIRS Locations

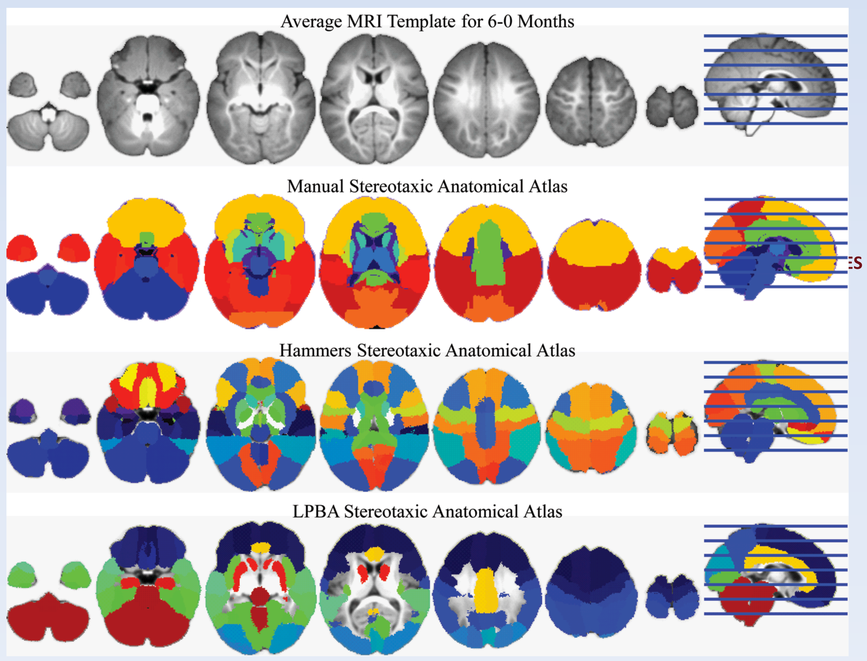


Average MRI and NIRS Locations



Tables of Locations

Stereotaxic Atlas Categorizes the Brain



Multiple Participants Projections, Table of Distribution

Table 1: Atlas locations of the NIRS channels across the group of infants. The label of the channel is followed by (%) of infants with this region. Regions are reported when the number of allocated infants a 20% of the group.

NIRS Channels	Lobar atlas	Macro-anatomical atlas (LPBA40)
Left lateral NIRS array		
1	Frontal (93)	Inferior frontal gyrus (82)
2	Frontal (100)	Inferior frontal gyrus (100)
3	Frontal (100)	Inferior frontal gyrus (95)
4	Frontal (87)	Inferior frontal gyrus (76)
5	Temporal (76) Frontal (24)	Superior temporal gyrus (66) Inferior frontal gyrus (20)
6	Frontal (84)	Inferior frontal gyrus (44) Precentral gyrus (38)
7	Temporal (65) Frontal (33)	Superior temporal gyrus (66) Precentral gyrus (20)
8	Temporal (100)	Middle temporal gyrus (73) Superior temporal gyrus (24)
9	Parietal (53) Temporal (25) Frontal (21)	Superior temporal gyrus (42) Postcentral gyrus (40)
10	Temporal (98)	Superior temporal gyrus (67) Middle temporal gyrus (31)
11	Temporal (100)	Middle temporal gyrus (86)
12	Temporal (87)	Superior temporal gyrus (71) Middle temporal gyrus (20)
13	Temporal (93)	Middle temporal gyrus (78)
Right lateral NIRS array		
14	Frontal (87)	Inferior frontal gyrus (71)
15	Frontal (100)	Inferior frontal gyrus (95)
16	Frontal (100)	Inferior frontal gyrus (76)
17	Frontal (87)	Inferior frontal gyrus (75)
18	Temporal (69) Frontal (31)	Superior temporal gyrus (51) Inferior frontal gyrus (24)
19	Frontal (84) Parietal (16)	Inferior frontal gyrus (47) Precentral gyrus (35)
20	Temporal (58) Frontal (38)	Superior temporal gyrus (49) Precentral gyrus (26)
21	Temporal (100)	Middle temporal gyrus (62) Superior temporal gyrus (36)
22	Parietal (49) Temporal (33) Frontal (18)	Superior temporal gyrus (38) Postcentral gyrus (35)
23	Temporal (98)	Superior temporal gyrus (62) Middle temporal gyrus (36)
24	Temporal (98)	Middle temporal gyrus (66) Inferior temporal gyrus (29)
25	Temporal (71) Parietal (29)	Superior temporal gyrus (56) Middle temporal gyrus (24)
26	Temporal (85)	Middle temporal gyrus (58) Superior temporal gyrus (20)
Frontal NIRS array		
27	Frontal (100)	Superior frontal gyrus (89)
28	Frontal (100)	Middle frontal gyrus (62) Superior frontal gyrus (38)
29	Frontal (100)	Middle frontal gyrus (95)
30	Frontal (100)	Superior frontal gyrus (96)
31	Frontal (100)	Middle frontal gyrus (100)
32	Frontal (100)	Superior frontal gyrus (73) Middle frontal gyrus (27)
33	Frontal (100)	Middle frontal gyrus (58) Superior frontal gyrus (42)