# Neuroscience in the Everyday World: Cortical Activation during Computer-Based Conversation Tasks Using Integrated fNIRS-EEG

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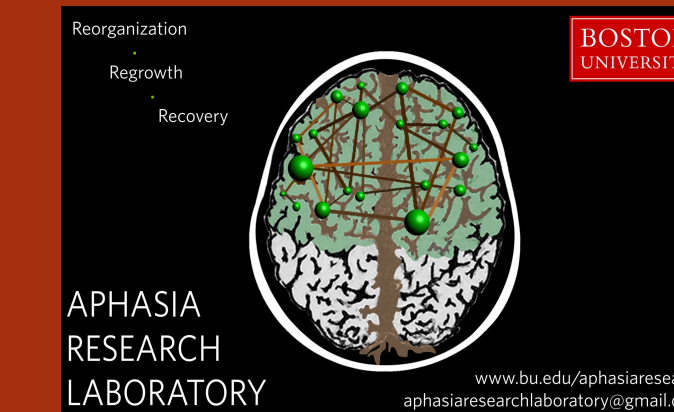
INTRODUCTION

- Response planning during conversational turn-taking has previously been investigated using EEG[1,2]
  - The authors investigated frequency band power 500 ms before question onset to 100 ms before speech onset
  - Results revealed reductions in alpha band power which were greater when critical information appeared earlier in the question
  - They interpreted this as reflecting a shift in attention from listening to the question to planning a response
- Few studies have looked at naturalistic conversation using multimodal fNIRS-EEG

Figure 3. Time-frequency results for a representative electrode (left posterior, see middle). Colors in all plots indicate the relative difference between raw power in the relevant conditions. In the time-frequency plots, the relative difference is given in transparent colors with the statistically significant cluster overlaid in opaque colors. Topographical plots are given for appropriate time windows and for the 10-12Hz range. Electrodes that are significant in the time window are highlighted in white.

(Bögels et al., 2015)

MATERIALS

EEG Device
- LiveAmp32 system[3] which uses wet and active electrodes
- 32 EEG electrodes and 1 ground and 1 reference electrode
- Standard 32Ch antiCap EEG locations were modified slightly to accommodate both the fNIRS and EEG probe locations*

fNIRS Device
- NIRx NIRSport2 continuous-wave NIRS device[4]
- 16 sources and 23 detectors, the detectors include 15 long separation and 8 short separation detectors, and 2 accelerometers (32 channels)
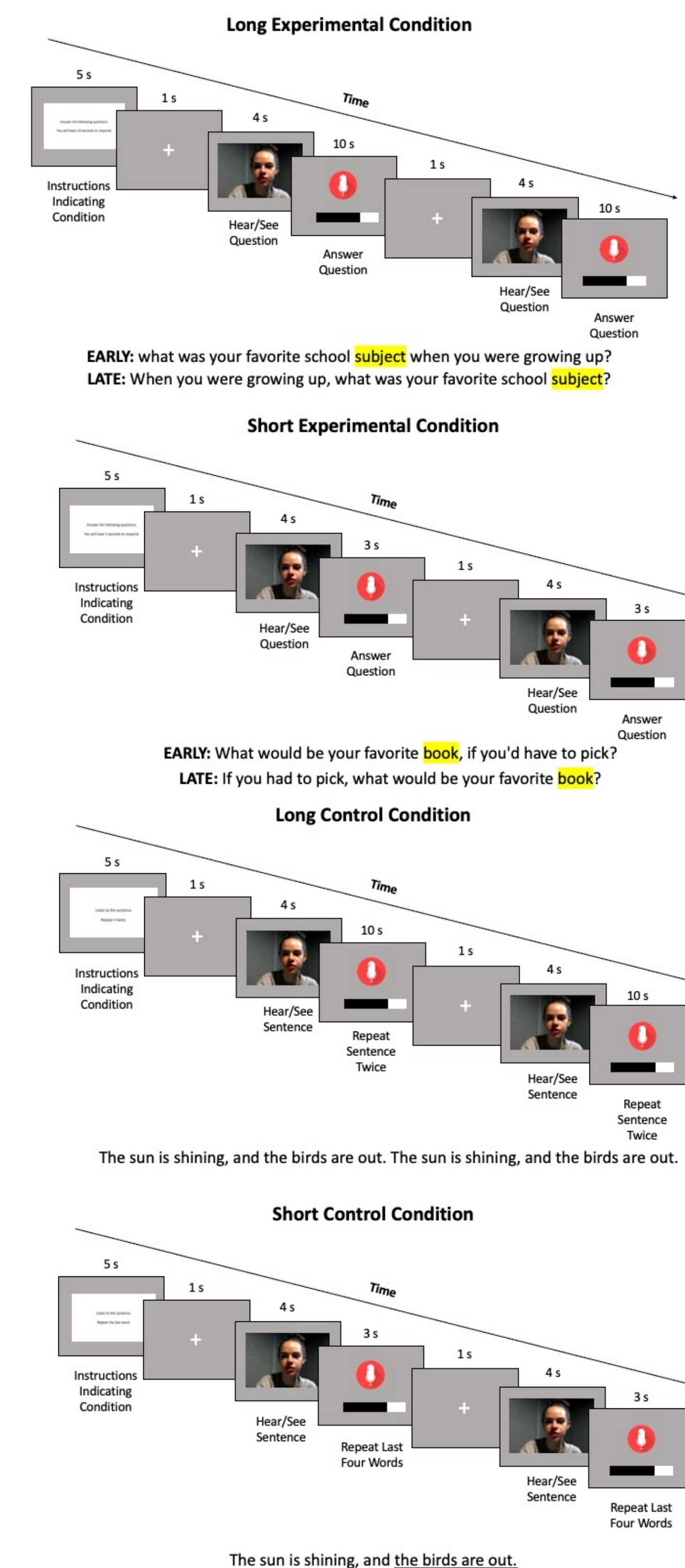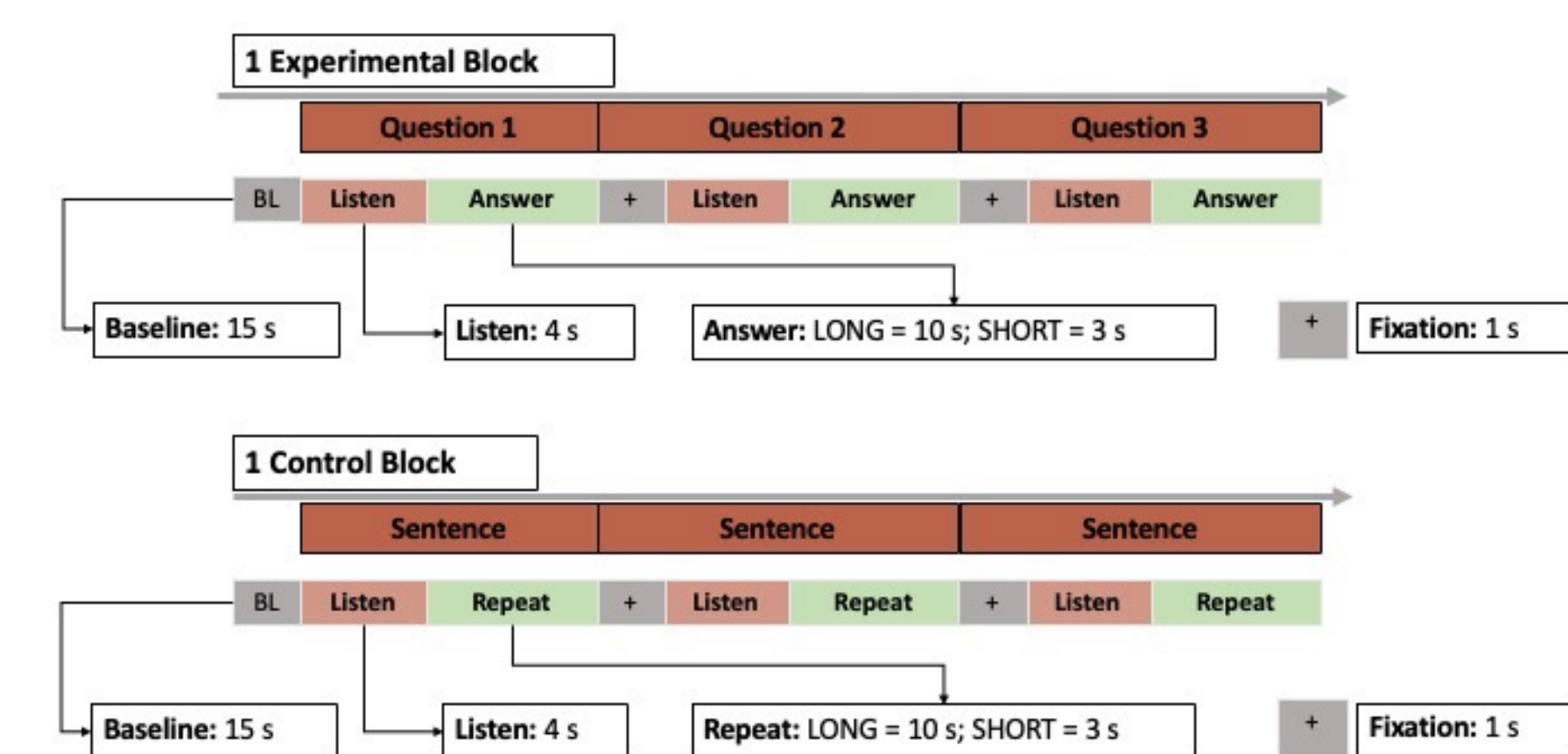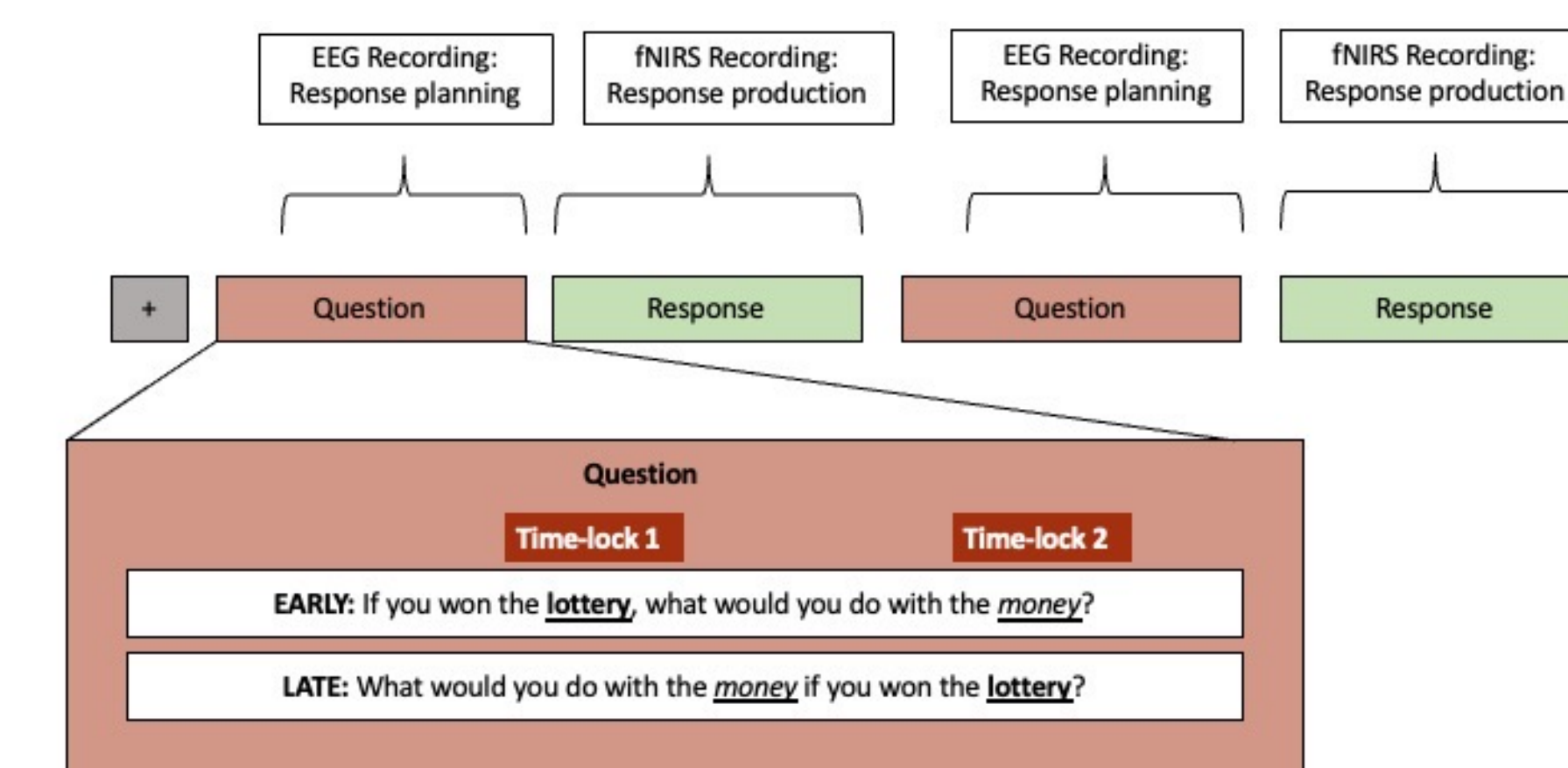- Sources emit infrared light to the detectors at 690 and 830 nm wavelengths

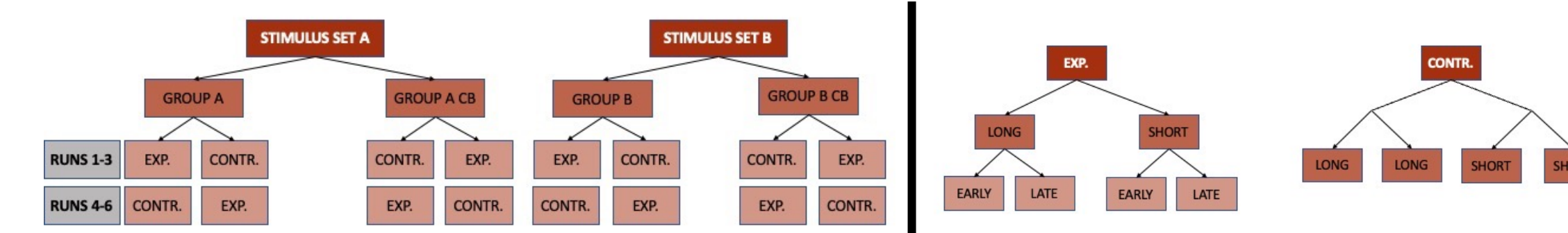### Probe Design
- Designed in Atlas Viewer[5]
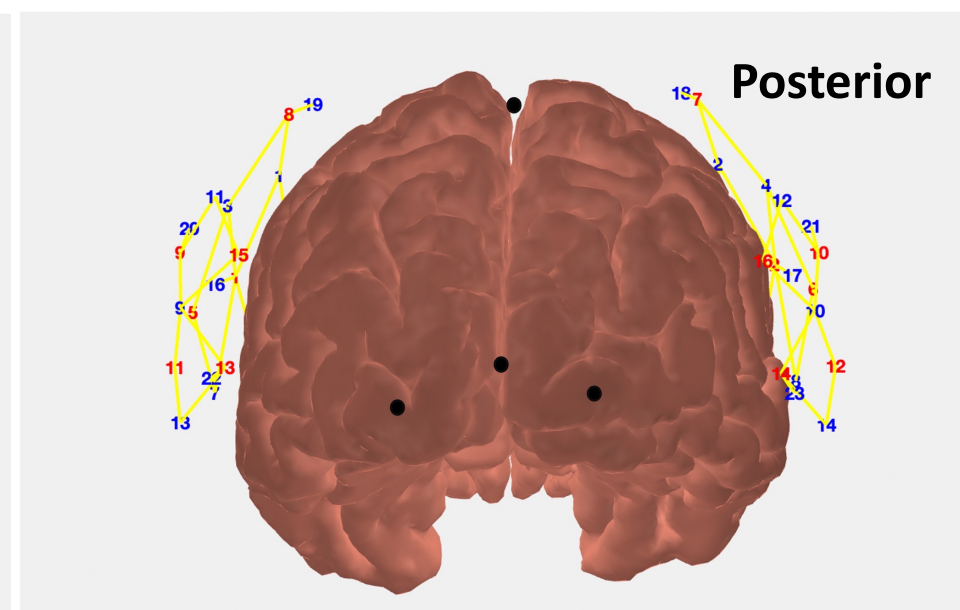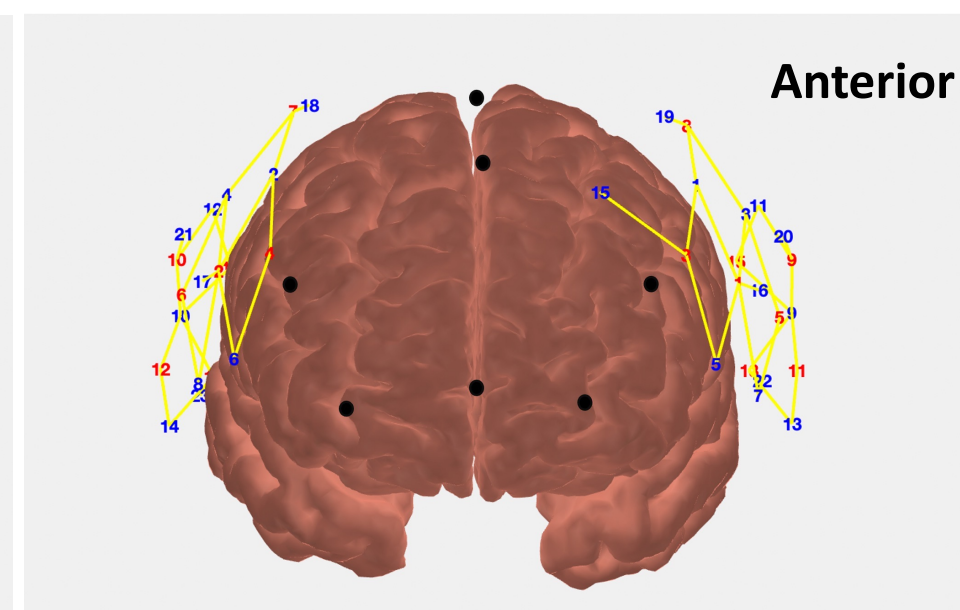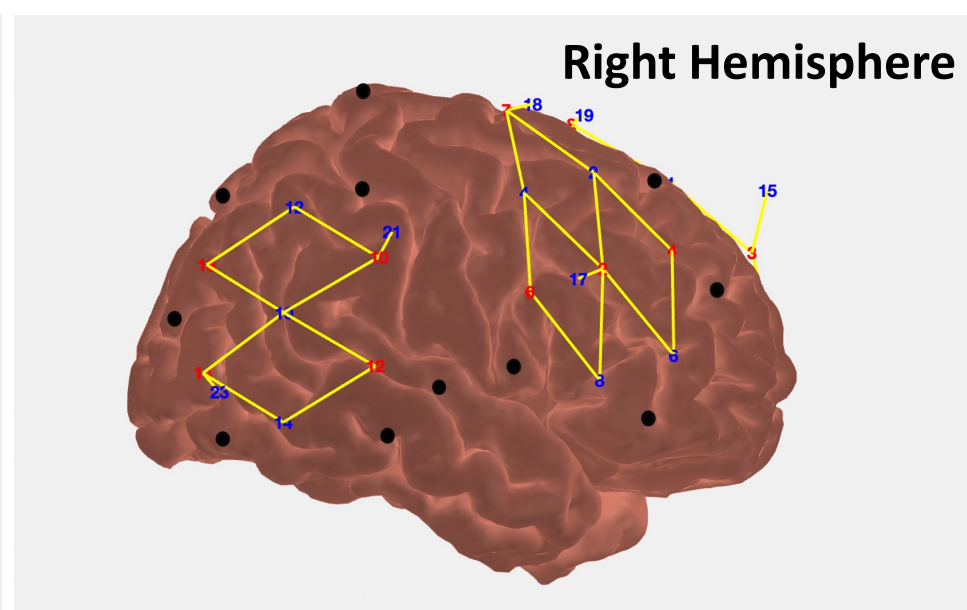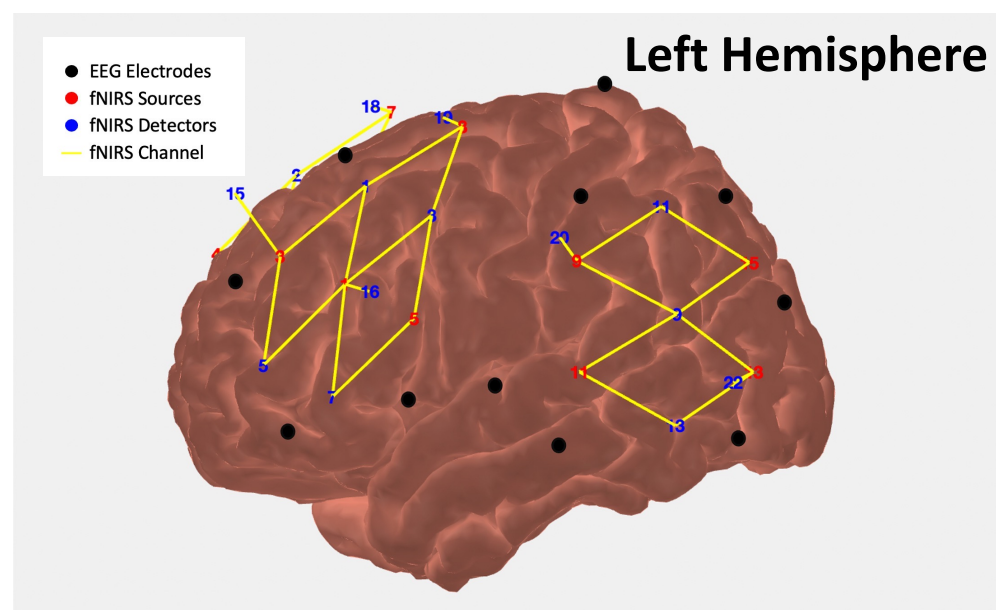
METHODS

- Recruitment goal: n = 15 young neurotypical adults
- Block design: 8 blocks per run, 6 runs
  - Presented in PsychoPy[6]
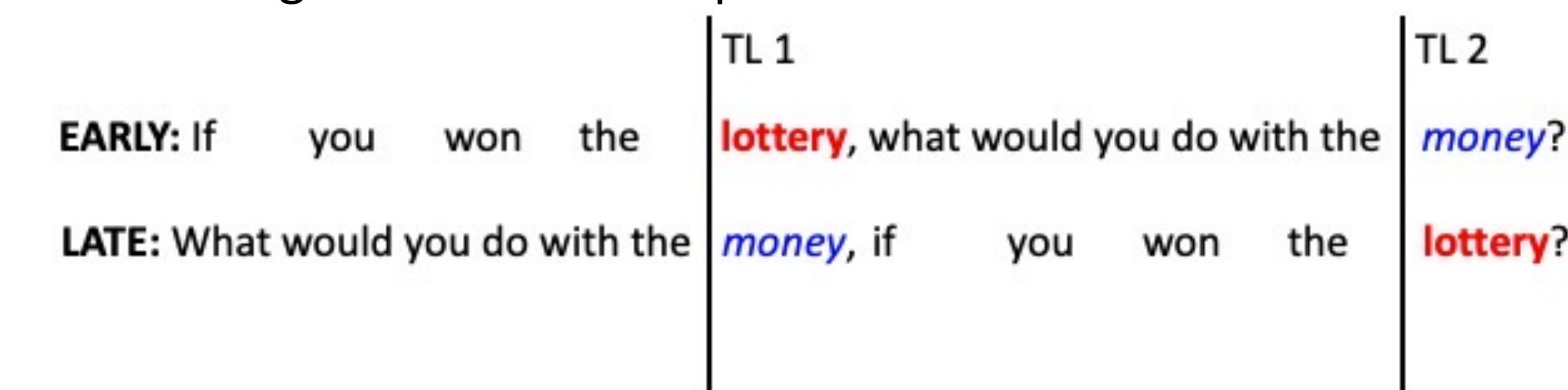- Each block contains 3 experimental questions or 3 control sentences

EEG Recording: Response planning | fNIRS Recording: Response production | EEG Recording: Response planning | fNIRS Recording: Response production

Question | Response | Question | Response

Question
Time-lock 1 | Time-lock 2

EARLY: If you won the _lottery_, what would you do with the _money_?
LATE: What would you do with the _money_ if you won the _lottery_?

1 Experimental Block
Question 1 | Question 2 | Question 3
BL | Listen | Answer | + | Listen | Answer | + | Listen | Answer
Baseline: 15 s | Listen: 4 s | Answer: LONG = 10 s; SHORT = 3 s | Fixation: 1 s

1 Control Block
Sentence | Sentence | Sentence
BL | Listen | Repeat | + | Listen | Repeat | + | Listen | Repeat
Baseline: 15 s | Listen: 4 s | Repeat: LONG = 10 s; SHORT = 3 s | Fixation: 1 s

Long Experimental Condition

EARLY: what was your favorite school _subject_ when you were growing up?
LATE: When you were growing up, what was your favorite school _subject_?

Short Experimental Condition

EARLY: What would be your favorite _book_, if you'd have to pick?
LATE: If you had to pick, what would be your favorite _book_?

Long Control Condition

The sun is shining, and the birds are out. The sun is shining, and the birds are out.

Short Control Condition

The sun is shining, and _the birds are out._

Counterbalancing

HYPOTHESES

Response Planning
- Greater change in alpha band power (via EEG) in EARLY vs. LATE condition at TL1 in parietal regions
- Greater change in alpha band power in LATE vs. EARLY condition at TL2 in parietal regions
- The difference in alpha band power between the two conditions will be greater at TL1 compared to TL2

	TL 1					TL 2
EARLY: If	you	won	the	_lottery_,	what would you do with the	_money_?
LATE:	What would you do with the	_money_,	if	you	won	the _lottery_?

Response Production
- Greater increases in HbO (via fNIRS) from baseline during the experimental vs. control conditions in left temporal and frontal regions

NEXT STEPS & FUTURE DIRECTIONS
- Collect data from 15 young neurotypical adults
- Apply this paradigm to patients with aphasia (PWA)

CONTACT

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ABSTRACT

1. Bögels, S., Magyari, L., & Levinson, S. C. (2015). Neural signatures of response planning occur midway through an incoming question in conversation. *Scientific reports*, 5(1), 1-11. https://doi.org/10.1038/srep12881; **2.** Bögels, S. (2020). Neural correlates of turn-taking in the wild: Response planning starts early in free interviews. *Cognition*, 203, 104347. https://doi.org/10.1016/j.cognition.2020.104347; **3.** https://brainvision.com/products/liveamp-8-16-32/; **4.** https://nirx.net/nirsport; **5.** Aasted, C. M., Yücel, M. A., Cooper, R. J., Dubb, J., Tsuzuki, D., Becerra, L., ... & Boas, D. A. (2015). Anatomical guidance for functional near-infrared spectroscopy: AtlasViewer tutorial. Neurophotonics, 2(2), 020801. https://doi.org/10.1117/1.NPh.2.2.020801; 6. https://www.psychopy.org