Demands on visuospatial working memory are a ubiquitous part of everyday life. As such, significant effort has been made to understand how the brain responds to these demands in real-world environments. Multiple brain imaging studies have highlighted a fronto-parietal cortical network that underlies visuospatial working memory in humans, and that appears to respond uniquely to encoding versus retrieval components. Furthermore, multiple studies have identified functional connectivity in regions of the fronto-parietal network during working memory tasks. Together, these findings have helped outline important aspects of the neural architecture that underlies visuospatial working memory. Here, we provide results from the first fNIRS-based investigation of fronto-parietal signatures of cortical activation and functional connectivity during a computer-based visuospatial working memory task. Cortical activation was greatest in prefrontal compared to parietal cortices, and was highest during retrieval. Cortical activation was also shown to vary across task difficulty (subtle vs. obvious different trials) and dot number (3 vs 5). Conversely, functional connectivity was highest within parietal compared to prefrontal regions, but did not differ significantly across task components. These results highlight important and novel information regarding neurotypical signatures of cortical activation and functional connectivity during visuospatial working memory. Our findings also demonstrate the utility of fNIRS for interrogating these cognitive processes in natural environments.

**Task Structure(s)**

- Pre-fNIRS task:
  - Used to standardize perceived task difficulty.
  - Conducted immediately prior to fNIRS task.
- **200 trials**
  - 3 or 5 dots
  - Distance change (n = 160)
  - No change (n = 20)
  - Obvious change (n = 20)
- **Stair step adjustment**
  - +/- 33% distance change depending on trial accuracy.
  - Only applied to ‘Distance change’ trials.
  - Reset every 10 trials.
- **JND calculation**
  - Non-linear trend lines fit to performance for 3 and 5 dot trials.
  - JND was point on trendline corresponding to 50% trial accuracy.

**fNIRS Channel Localization**

- **Functional Regions of Interest**
  - Bilateral prefrontal cortex
  - Bilateral parietal cortex
- **Functional localization from 3 fNIRS source optodes per region**
  - Single channel with largest contrast outcome selected for statistical analysis
  - Reduced the overall spatial coverage included in our analysis of cortical activation

**JND Estimation Task**

- **Total N = 15**
  - $N_{\text{Female}} = 8$
  - $N_{\text{Male}} = 7.75$
- **Session procedure:**
  1. Just noticeable difference (JND) estimation task (10min)
  2. fNIRS cap preparation & fitting (15min)
  3. Visuospatial working memory task (15min)

**fNIRS task structure**

- No change (n = 40)
- Subtle change (n = 28): JND + (JND x 0.1)
- Obvious change (n = 28): JND + (JND x 0.8)
- Control (n = 28): Shape change

**Cortical activation results**

- Retrieval > encoding/maintenance
- Prefrontal > parietal regions
- Easy > hard change trials
- Three > five dot trials during encoding/maintenance

**Functional coherence results**

- Parietal > prefrontal regions
- Within- > between-region channel pairs
- Significant interactions between:
  - Region x pairing: Greater coherence in left compared to right parietal regions

**Conclusions**

- Signatures of cortical activation and functional coherence are present in the fronto-parietal network during visuospatial working memory, although the local maxima of both signatures do not overlap.
- A combined focus on both signatures of brain function affords a richer and more in depth interpretation of functional brain data.
- Our novel method of functional localization may be used by future fNIRS studies to objectively subset a large number of channels down to a single channel of interest that can then be entered into group-level statistics. This method will reduce the likelihood of Type II errors.

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