Working memory using n-back: self-paced paradigm and meta-analysis comparisons

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Introduction

A self-paced version of n-back was performed by four subjects and compared to meta-analysis results to confirm its utility and determine differences in activation patterns. Self-paced designs could have use in abnormal or aging populations who might need more time to complete a task as well as in healthy volunteers who may lose focus in a longer than optimal interstimulus interval (1). In the self-paced study, subjects were instructed to perform 2 variations of the n-back task in which they monitored both the identity and the location of the presented stimuli (single letters) during the 2-back and 0-back conditions. The fMRI results were then compared with the meta-analysis results of the published n-back studies (2).
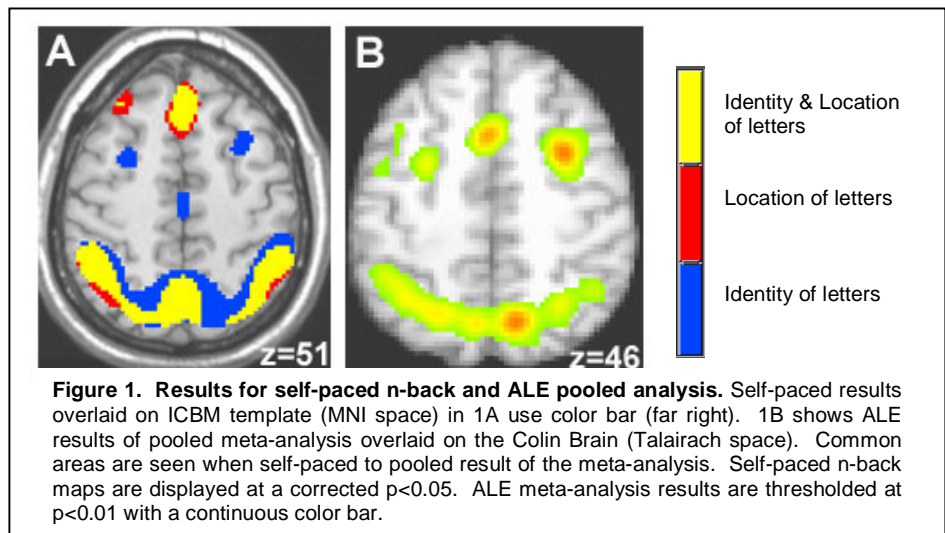
Methods

Four subjects gave informed consent and were scanned at 1.5 T using the self-paced n-back paradigm. The letters A,B,C,D were chosen as stimuli and tasks monitoring the identity as well as the location (top right, top left, bottom right, bottom left) were considered. Six minutes were allowed for completion of 5 blocks of 0-back and 2-back tasks. Stimuli were presented for a maximum of 4 seconds, but the next stimulus appeared after a button press used to determine whether the stimulus matched the one presented n-back. Scans were performed with a 2 sec TR, 80º flip angle, 5 mm slice thickness. Practice sessions were performed before each scan to ensure understanding of the paradigm.

Results

Response time and accuracy when comparing location and identity tasks in self-paced n-back were not significantly different among subjects. The patterns of activation for identity and location in the self-paced study are very similar (*Fig. 1A*). Areas common to both tasks are seen in yellow and are found in the cingulate gyrus and parietal areas. Frontal activity areas unique to identity are found bilaterally in the middle frontal gyrus for identity (blue voxels), and on the right for location (red voxels).

Figure 1B shows ALE results of an analysis of 26 n-back papers utilizing many stimulus types, task requirements and presentation methods. It shows activations in many of the same areas seen in the self-paced paradigm (*Fig 1A*). Common areas include bilateral frontal areas thought related to the active maintenance of information over a delay or manipulation of this information. The cingulate gyrus is typically activated during increased effort or task complexity. Activation in the area of the parietal lobe found here is viewed as buffer for modality-specific information

Color information has been recently added to the self-paced paradigm to

Figure 1. Results for self-paced n-back and ALE pooled analysis. Self-paced results overlaid on ICBM template (MNI space) in 1A use color bar (far right). 1B shows ALE results of pooled meta-analysis overlaid on the Colin Brain (Talairach space). Common areas are seen when self-paced to pooled result of the meta-analysis. Self-paced n-back maps are displayed at a corrected p<0.05. ALE meta-analysis results are thresholded at p<0.01 with a continuous color bar.

examine how monitoring attributes of the image activates working memory in relation to current results as well as meta-analysis areas. Meta-analysis has utility in confirming the efficacy of new designs. Combining ALE information with our results using four volunteers gives confidence that more data can be taken without altering the paradigms.

Conclusion

Self-paced versions of many paradigms can have clear benefits in both healthy and diseased populations. Comparison to established studies is simplified by meta-analyses, and extension to further variations of existing paradigms is therefore faster and more effective.

References

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