

The role of breakfast on cognitive function in adolescents-an fMRI study

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Introduction

The impact of diet on performance in children and its role within the school environment is an area that has received increasing attention over the last decade¹. Specifically, a number of studies have assessed the role breakfast has to play in dictating cognitive performance in school^{2,3} and have generally revealed a detrimental effect on attention, concentration and memory as a result of missing breakfast. Therefore, the aim of the current study was to investigate the feasibility of utilizing functional magnetic resonance (fMRI) techniques with children and to examine differences in brain activity between a breakfast fasted and satiated state when undertaking cognitive tasks.

Methods

Twenty adolescent male (n=10) and female (n=10) volunteers (age 12-14 y) were recruited for the study. One female although initially recruited and familiarised to the test protocol decided to withdraw from the study. Participants arrived at the centre following an overnight fast. The study design was a randomized crossover and was counter balanced with an equal number of participants having a controlled breakfast before testing on either their first or second visit. One hour after arrival at the centre, participants underwent the fMRI protocol while undertaking two cognitive tests: a) a choice reaction task where participants responded as quickly as possible when presented with a visual cue, with their response dependent upon the form of the cue⁴ b) N-back tasks where participants were presented with a series of letters and were asked to identify occurrences of letters being the same as the previous one (1-back), or two previous (2-back)⁵. Scanning consisted of a single shot echo-planar imaging (EPI) sequence, TR=3s, TE=45ms, resolution 2.5x2.5x3.5 mm, 39 slices, 400 dynamic scans. Functional images were analyzed using SPM8 software. Pre-processing included slice time correction, motion correction, smoothing, and warping to the Montreal Neurological Institute template (MNI305). Group analysis was subsequently undertaken combining the individual responses, with significant brain activation defined as arising within a region when the differences in signal intensity between visits gave rise to a p-value < 0.001 after no corrections had been made for multiple comparisons and the cluster size of the activated region was ≥ 10 voxels.

Results

No significant positive activation areas were found when the fasted state was compared to the satiated state. However, significant positive activation was found in Brodmann area 6 for the choice reaction task and in Brodmann areas 17 and 45 for the N-back tasks (see Figure) when comparing the satiated state to the fasted.

Discussion

The activation areas observed within the study, associated with increased activity following breakfast, appear well matched to the demands of the cognitive tasks selected. For the reaction task this is the frontal/pre-motor area associated with planned motor actions. For the N-back tasks these are the cuneus, which is the site of basic visual processing, and an area in the frontal cortex which is associated with semantic decision tasks (examining the composition of words/letters).

Conclusion

In conclusion, the findings of this study suggest that the impact of breakfast consumption can be observed through fMRI activated areas of the brain when completing cognitive tasks, compared to a fasted state in children.

References

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