Effects of spatial smoothing on brain activity patterns in an auditory fMRI study

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ABSTRACT

Introduction: Functional magnetic resonance imaging (fMRI) is a neuroimaging technique commonly used to investigate brain functions by measuring the blood oxygenation level dependent (BOLD) signal. However, the BOLD signal may consist of noises, such as head motions, thermal noise, respiratory rhythms, and cardiac cycles. Therefore, these noises must be filtered out from the BOLD signal through spatial smoothing — a pre-processing procedure to reduce the amount of noise in fMRI data. The degree of spatial smoothing is determined by adjusting the value of full width at half maximum (FWHM). Noteworthy, adjusting the FWHM value unnecessarily may affect the accuracy of the fMRI analysis. To date, researchers have not reached a consensus on the optimum FWHM value to eliminate noise while preserving the quality of the BOLD signal, especially when analysing auditory functional data. This study investigated the effects of different FWHM values on fMRI data acquired during an auditory working memory (AWM) task. **Materials and Methods:** The 20 original fMRI data (voxel size of 3 x 3 x 5 mm) have gone through four pre-processing steps, which are slice timing correction, realignment, spatial normalisation, and spatial smoothing. The data was smoothed using four FWHM values: (i) 3 x 3 x 5, (ii) 6 x 6 x 10, (iii) 9 x 9 x 15, (iv) 12 x 12 x 20 mm. The pre-processed data was analysed using first-level fixed-effect (FFX) for individual analysis and then further analysed using second-level random effect (RFX) analysis for group analysis. This procedure was performed using Statistical Parametric Mapping (SPM12). **Results:** The results revealed that using the FWHM value equivalent to or twice the original voxel size produced brain activity patterns that are relevant to the AWM brain areas. Interestingly, using the FWHM values of three to four times the original voxel size results in unprecise brain activity patterns, which are mostly irrelevant to the AWM brain regions. These findings suggest that excessive spatial smoothing may result in decreased quality of the BOLD signal. **Conclusion:** The outcome of this study underscores the importance of using the recommended FWHM when analysing fMRI data.