Abstract 44973

Intra and cross-modal negative BOLD response to contrast-varying visual stimuli

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Purpose / Introduction

The BOLD contrast is widely used to study brain function. Under externally-applied stimuli, positive BOLD responses (PBR) are generally attributed to local increases in brain activity. Negative BOLD responses (NBR) are also frequently observed, but their underlying neurovascular-coupling mechanisms are less well-understood. Here, we study the NBR to contrast-varying visual stimuli. Both intra-modal (located in regions directly associated with the stimulus [1]) and cross-modal responses (located in functionally-distinct regions [2]) are analyzed.

Subjects and Methods

Four healthy subjects were scanned using a 7T Siemens scanner (BOLD, TR/TE=2000/25ms, 1.5×1.5×1.5mm^3). Visual stimuli consisted of 15s flashing checkerboard blocks alternated with 15s fixation; auditory stimuli consisted of white noise applied with identical timing. Subjects underwent three runs: a visual localizer, an auditory localizer, and a visual sequence with checkerboards of different contrast levels (1%,3%,5%,20%,80%, counter-balanced, 3 repetitions/level). Data were motion-corrected, brain-extracted, spatially-smoothed and de-trended. Three ROIs were defined (Fig.1): a positive visual region VP (500 voxels showing the strongest PBR for the visual localizer), a negative visual region VN (500 voxels with the strongest occipital NBR for the visual localizer), and a negative auditory region AN (500 voxels with the strongest NBR for the visual localizer, located in auditory areas defined by the auditory localizer). Responses were averaged across ROIs and across subjects.

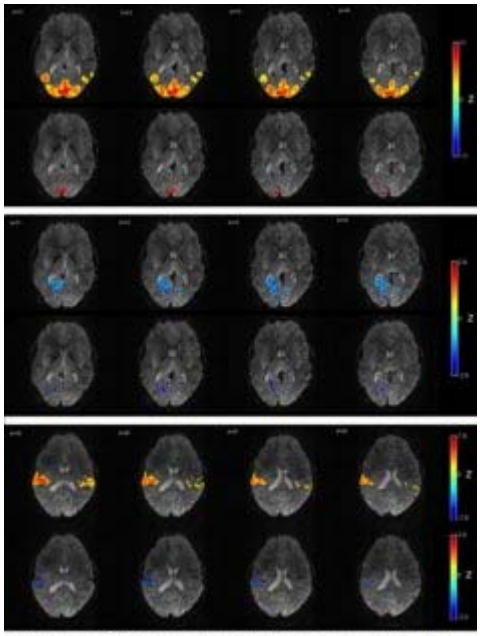

Fig.1 *Z*-score activation maps and resulting ROIs for a representative subject: (upper) PBR to the visual localizer, and resulting region VP, (middle) occipital NBR to the visual localizer, and resulting region VN, and (lower) temporal PBR to the auditory localizer, and resulting region AN.

Results

The visual localizer induced occipital PBR surrounded by NBR (intra-modal), and also NBR in typical auditory regions (cross-modal) (Fig.1). As shown in Fig.2, VP regions displayed strong PBR, increasing non-linearly with contrast level, as expected. VN regions expressed weaker NBR, with an earlier peak and a more pronounced overshoot than the PBR. AN regions expressed still weaker NBR with less-defined shapes.

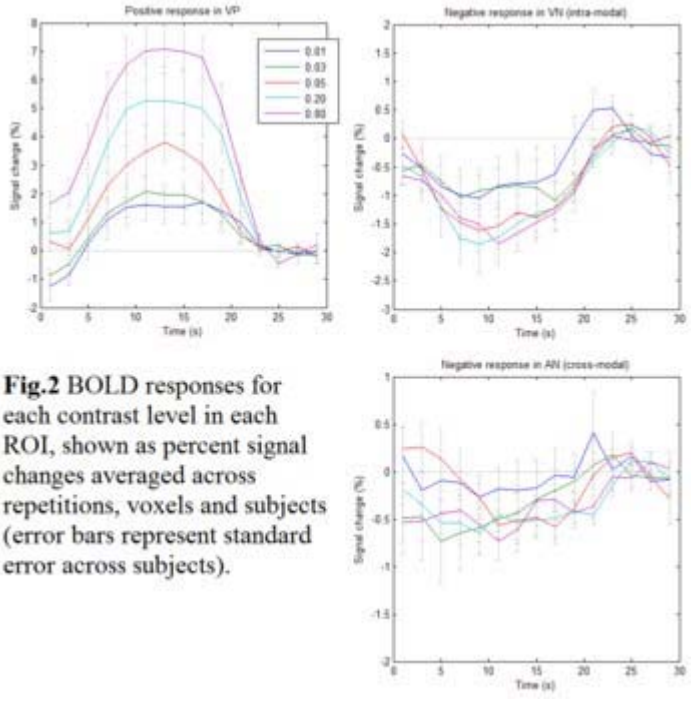

Fig.2 BOLD responses for each contrast level in each ROI, shown as percent signal changes averaged across repetitions, voxels and subjects (error bars represent standard error across subjects).

Average response peak values (Fig.3) confirm that PBR increases non-linearly with contrast level. NBR peaks in VN and AN both exhibit a smaller effect of contrast, although following distinct trend lines.

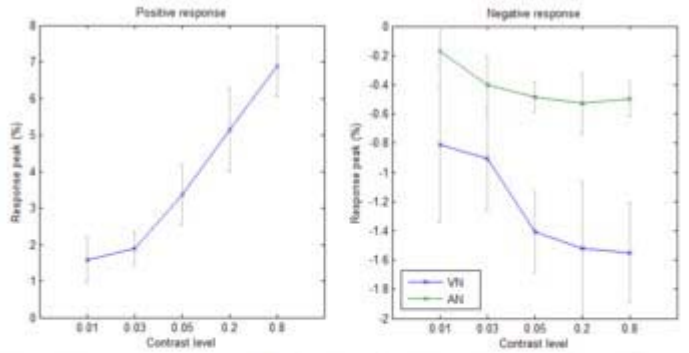

Fig.3 BOLD response peak heights as a function of contrast level in each ROI, shown as maximum percent signal changes averaged across repetitions, voxels and subjects (error bars represent standard error across subjects).

Discussion/Conclusion

These results highlight important aspects of intra-modal and cross-modal NBR. As expected [1], both PBR and intra-modal NBR increase non-linearly with contrast level. However, NBR show important differences in shape, in contrast with the idea that they behave as a mirrored version of PBR. The differences observed between intra-modal (VN) and cross-modal (AN) NBR suggest either that they are mediated by different neurovascular-coupling mechanisms or that more directed work must be performed to clarify these differences. Either way, further in-depth studies are required to better understand the NBR, and to avoid misinterpretation of fMRI results.

References

[1]Shmuel,A.(2002),Neuron,pp.1195-1210.
[2]Laurienti,P.(2002),JCognNeurosci,pp.420-9.

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