Effects of emotional valence and three-dimensionality of visual stimuli on brain activation: an fMRI study

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Introduction

Examining changes in brain activation associated with emotion-inducing stimuli is essential to the study of emotions. Due to the ecological potential of virtual reality in neurocognitive rehabilitation, inspection of whether brain activation in response to emotional stimuli can also be modulated by the three-dimensional properties of the images is now important. This study sought to test whether the activation of brain areas involved in the emotional processing of scenarios of different valences can be modulated by three-dimensionality. It focused on the interaction effect among emotion-inducing stimuli of different *emotional valences* (pleasant, unpleasant and neutral valences) and *visualization types* (2D, 3D).

Methods

The sample consisted of 12 healthy male subjects. The group's mean age was 26.58 years old (*SD* = 5.16). The stimuli were three 3D Affective Inducing Scenarios (3DAIS) (1) composed by 3D objects1. Sets of 15 stimuli-objects formed each scenario, with one set per *emotional valence* – pleasant, unpleasant and neutral. The 3D objects database had been previously developed according to the type of contents in the International Affective Picture System (IAPS) (2) and validated with the Self-Assessment Maniquin (SAM)(3). *Visualization type* (2D, 3D types) and *emotional valence* (pleasant, unpleasant and neutral scenarios) were used as factors in a simple

within-subjects 3x2 experimental design. The experiment consisted of a single session of fMRI scanning. Data were analyzed through a GLM-based random effects procedure. Resulting whole brain activation maps for all contrasts were thresholded at p-value < 0.001 (uncorrected).

Results

The results show increased brain activation for the 3D affective-inducing stimuli in comparison with the same stimuli in 2D scenarios, mostly in cortical and subcortical regions that are related to emotional processing. In addition, we found the activation of portions of the limbic lobe, traditionally recognized as especially significant for emotion (Table 1). Considering that current neurobiological models of emotion and several studies recognize the mediation of cortical and subcortical areas in emotional processing these results are consistent with the literature (4-6).

Table 1: *Anatomic location, brain hemisphere, brain areas and their Talairach coordinates, in which seven or more voxels were activated, detected through 3x2 ANOVA analysis*: *Interaction effect of* visualization effects *and* valence*.*

Anatomic Location	**BH**	**BA**	**Coordinates**			***F***	***P***	**Size**
			x	**y**	**Z**			
Uncus	L	36	-19.0	-8.0	-27.0	18.506	0.000019	31
Postcentral Gyrus	R	3	41.0	-20.0	51.0	13.294	0.000164	20
Middle Frontal Gyrus	R	46	53.0	28.0	24.0	16.225	0.000047	15
Declive	R		35.0	-62.0	-15.0	16.723	0.000038	15
Cerebellar Tonsil	L		-37.0	-38.0	-36.0	15.234	0.000070	14
	L		-25.0	-41.0	-42.0	15.584	0.000061	13
	L		-13.0	-56.0	-36.0	14.638	0.000091	8
Cingulate Gyrus	R	24	20.0	-8.0	39.0	15.697	0.000058	10
Lentiform Nucleus	L		-31.0	-14.0	6.0	15.336	0.000067	9

Note: BH = Brain Hemisphere; BA = Brodmann's area; L = left; R = right; *number of voxels.

Conclusions

This study might enable us to clarify brain mechanisms involved in the processing of emotional stimuli (scenarios' valence) and their interaction with three-dimensionality.

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