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Reactivity of the reward system in artists during acceptance and rejection of monetary rewards

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Abstract

Humans possess an invaluable ability of self-expression that extends into visual, literary, musical and many other fields of creation. More than any other profession, artists are in close contact with this subdomain of creativity. Probably one of the most intriguing aspects of creativity is its negative correlation with the availability of monetary reward. With this study we aimed to investigate the reactivity of the dopaminergic reward system in artists and non-artist controls using the desire-reason-dilemma (DRD) paradigm, which allows separate evaluation of reactivity to the acceptance and rejection of rewards. Using fMRI, we measured blood-oxygen-level-dependent (BOLD) responses in key regions of the reward system, namely the ventral striatum (VS), the ventral tegmental area (VTA), and the anterior ventral prefrontal cortex (AVPFC). In contrast to controls, artists presented significantly weaker VS activation in reward acceptance. Additionally, they showed stronger suppression of the VS by the AVPFC in reward rejection. No other differences in demographic or behavioral data were evidenced. These results support the existence of characteristic neural traits in artists, who display reduced reactions to monetary reward acceptance and increased reactions to monetary reward rejection.

Keywords: creativity, reward, artist, fMRI

Introduction

Creativity is an extremely valuable characteristic, which enables individuals to produce novel and meaningful work (Sternberg & Lubart, 2002). This is especially true for the arts. However, certain areas of research might be inhibited by the simple fact that creativity is a very complex construct (Runco, 2004). This may apply to the field of functional neuroimaging. To advance comprehension of the neural correlates of creativity, some researchers have tried to disentangle multiple facets of creativity into subdomains according to their final outcome, namely the self-expression and problem-solving subdomains (for review, see Abraham, 2013). This framework assigns visual, literary, and musical arts to the self-expression subdomain of creativity, whereas convergent and divergent thinking are assigned to the problem-solving subdomain. It is clearly more challenging to investigate the neural correlates of first subdomain than the latter, as for the latter many standardized psychometric assessments exist, which explains at least partially its predominance in the literature. For the self-expression subdomain of creativity (Boccia, Piccardi, Palermo, Nori, & Palmiero, 2015), one straightforward approach would be to compare the performance of artists or non-artists in paradigms of interest as performed by some authors (Huang et al., 2013; Kowatari et al., 2009; Schlegel et al., 2015). However, one important limitation of the self-expression subdomain is that creativity, itself, frequently flees, the moment the artist is demanded by others to be original and creative. The existence of this phenomenon has been discussed over several decades (Amabile, Hennessey, & Grossman, 1986; Baer, Oldham, & Cummings, 2003; Eisenberger and Armeli, 1997; Eisenberger & Rhoades, 2001; Eisenberger & Selbst, 1994). An even more intriguing possibility is that the presence of extrinsic sources of reward such as monetary incentive may even inhibit creativity and self-expression (see Amabile et al. 1986;

Deci & Ryan, 1985; Lepper, Greene, & Nisbett, 1973). This is an interesting phenomenon and, following this reasoning, instead of directly requiring creative production from artist and non-artist volunteers in our research protocol (which could hinder creativity), a decision was made to study the baseline dynamics of their reward system as a fundamental starting point.

The dopaminergic reward system in humans has been extensively investigated using functional magnetic resonance imaging (fMRI) of test subjects engaging in monetary incentive tasks (Elliot et al., 2003, 2004; Haber & Knutson, 2010; Knutson, Taylor, Kaufman, Peterson, & Glover, 2005; Knutson, Westdorp, Kaiser, & Hommer, 2000; Levy & Glimcher, 2011; Pessiglione et al., 2007; Rademacher et al., 2010; Sesack & Grace, 2010; Small et al., 2005; Zink, Pagnoni, Martin- Skurski, Chappelow, & Berns, 2004). This has proven the importance of the ventral striatum (VS), which is strategically situated in between dopaminergic input from the ventral tegmental area (VTA) and modulatory suppression from the pre-frontal cortex (PFC). The desire-reason-dilemma (DRD) paradigm, an experimental reward task developed by one of the authors (Diekhof & Gruber, 2010; Diekhof et al., 2012, 2011), was developed to measure the blood-oxygen-level- dependent (BOLD) response in these subcortical and cortical key regions in two different contexts: acceptance and rejection of immediate rewards. During the DRD paradigm, activation in the VS has been shown to increase in the reward acceptance context and to decrease in the reward rejection context due to anterior prefrontal cortex suppression (AVPFC).

To the best of our knowledge, the dopaminergic reward system of artists has not yet been investigated. Here the DRD paradigm was chosen to evaluate the activation of key regions of the reward system during reward acceptance and rejection in gender and age-matched groups of artists and non-artists. Based on previous behavioral research on incentives, the

hypothesis was that in comparison to controls the reward system of artists would be less reactive to acceptance and rejection of monetary rewards.

Methods

Study Participants

Twenty-seven healthy participants aged between 18 and 60 years old actively working as artists and non-artists were recruited from arts associations. A representative group of artists from different musical, literary, and visual fields was selected. Exclusion criteria were actual or previous medical conditions, including neurological and psychiatric diagnoses, use of psychotropic substances, drugs of abuse, or existence of MRI contraindications, which were systematically investigated using structured inter-views. Participants from the 2 groups were carefully matched for gender, age, and education. The research protocol that was approved by the local ethics committee and participants provided written consent. All subjects were informed that they would be paid 30–60 euros for their participation, with the exact amount dependent on their task performance.

Desire-reason-dilemma (DRD) Paradigm

The DRD paradigm has been used to investigate (patho) physiological mechanisms of the dopaminergic reward system in moments of reward acceptance and reward rejection (Diekhof & Gruber, 2010, 2012; Diekhof et al., 2011; Goya-Maldonado et al., 2015; Trost et al., 2014; Wolf et al., 2015). In a training session 1 day prior to the MR scan, an operant conditioning task was performed in which the participants associated stimuli with either a monetary reward or a neutral outcome. In a randomized sequence, squares were presented

with eight different colors 20 times each, two of which led to immediate reward by positive feedback when selected by a button press. The DRD paradigm, itself, involved selecting target stimuli, which were signaled at the beginning of each block (Figure 1). In the desire context (DC), participants were encouraged to additionally select the conditioned reward stimuli (accept reward) when they appeared. In the reason context (RC), participants knew they had to choose targets over the conditioned reward stimuli (decline reward) to achieve the superordinate goal of correctly finishing the task. When a reward stimulus was accepted in the RC, the block terminated with the feedback goal failure and a new block started. Each trial lasted a total of 1900 ms, in which the sequence blank screen (200 ms), stimuli (900 ms), feedback (700 ms), and blank screen (100 ms) was presented (see Diekhof et al., 2012 for more details). There was a brief training session before the scanning session to reinforce task comprehension. The total duration of the DRD paradigm in the scanner was approximately 12 min.

Insert Figure 1 about here

Demographic and Behavioral Analysis

Behavioral data were acquired using Presentation software (Version 14.9, www.neurobs.com) log files. Age, gender, years of education, accuracy (number of goal failures), and reaction times for correct responses were entered into a group- by-block analysis of variance (ANOVA two-tailed $p < 0.05$) in SPSS (version 22, SPSS Inc., Chicago, Illinois, USA).

Imaging Acquisition and Preprocessing

First, structural T1-weighted scans with 1-mm isotropic resolution were acquired for each subject, then whole-brain MR images were recorded on a 3T system (Magnetom TRIO, Siemens Healthcare, Erlangen, Germany) using a 8-channel head coil (gradient-echo EPI sequence, 31 slices, AC–PC aligned, ascending orientation, 64x64 matrix, 3-mm thickness, 0.6-mm spacing, TR 1.9 s, flip angle 70°, FOV 192 mm, TE 30ms, 370 volumes).

Analysis of Imaging Data

The first four initial volumes were discarded and standard preprocessing of functional images was performed with SPM8 (www.fil.ion.ucl.ac.uk/spm8) and MATLAB (The MathWorks, Inc., Natick, MA, USA), including slice time correction, unwarping, realignment to the fifth volume using rigid body transformation, normalization to the EPI template in Montreal Neurological Institute (MNI) stereotactic space (3x3x3 mm³ voxel resolution), and spatial smoothing (9 mm FWHM Gaussian kernel). We carefully checked for motion artifacts and a cutoff of <2 mm (smaller than voxel size) was set over the entire paradigm for the three planes of translation and 2° for the three planes of rotation. Subjects moving above the cutoff were excluded from the final analysis (see Results). Estimates of neural activity were computed with the general linear model (GLM) for each subject individually. First-level contrasts were set to the correct response trials in DC and RC blocks (Figure 1). To detect potential voxelwise associations with our regions of interest (ROI), namely the VS, VTA, or AVPFC, two separate second-level matrices were built with the contrast images (T-test; Artists<Non-Artists; Artists>Non-Artists) to measure the effect of factor artistic

profession in the ROIs in DC and RC. Based on our strong a priori hypotheses concerning our ROIs, we used a threshold of small volume corrected (SVC) $p < 0.05$ for multiple testing with independent coordinates from the literature (Diekhof and Gruber, 2010) and 10mm radius as already described elsewhere (Goya-Maldonado et al., 2015). Contrast estimates and 90% confidence interval are plotted for ROIs surviving a priori statistical threshold (Figure 2). In the Supplementary Material, all differential regions are reported for illustration purposes with a more flexible threshold of clusterwise correction $p_{FWE} < 0.05$ (with $k > 88$) to avoid type II error, implemented with AlphaSim after Monte Carlo simulation (Figure 3).

Results

The final analysis was performed with 24 subjects (Table 1) after excluding 3 subjects due to excessive movement during fMRI acquisition. Of these, 5 subjects worked as actors, 2 as painters, 2 as sculptors, 2 as musicians, and 1 as a designer and photographer. When questioned, all of them considered themselves to be creative (with *yes*) in contrast to the non-artists (1 insurance salesman, 1 linguist, 1 social economist, 1 dentist, 1 environmental scientist, 1 construction engineer, 1 business administrator, 1 psychologist, and 4 university students), who answered *no* to the question. Self-reported creativity was previously used in an imaging study describing the correlates of the self-expression subdomain (Bashwiner et al., 2016). Note that no statistical differences were seen in age, gender, education, and task performance levels (Table 1).

Insert Table 1 about here

BOLD activation was strongly modulated by artistic profession in the VS (Fig. 2A and 2B) and AVPFC (Fig. 2C). Artists displayed weaker activation in the VS during reward acceptance in DC and stronger suppression by the AVPFC during reward rejection in RC.

Insert Figure 2 about here

Discussion

The goal of this study was to investigate the reward system of artists and non-artists during acceptance and rejection of monetary incentives. The DRD paradigm, an established task for evaluating BOLD responses in core regions of the dopaminergic reward system, was chosen, in particular VS, AVPFC, and VTA. Significantly reduced VS activation during reward acceptance was seen in artists, with a stronger activation in the AVPFC during reward rejection (Figure 2). The VTA did not seem to be modulated by the occupational factor tested. Collectively, our results indicate the existence of distinct neural traits in the dopaminergic reward system of artists, who are less inclined to react to the acceptance of monetary rewards.

It has been suggested that creativity can be used for either self-expression or problem solving (Abraham, 2013 for review). Previous imaging studies (Bashwiner et al., 2016; Kowatari et al., 2009; Schlegel et al., 2015) investigating the neural correlates of the self-expression subdomain in visual art and musical creativity identified prefrontal and temporal regions and white matter tracts, which probably mediated perceptual, motor, and cognitive integration. One particularly elegant study using fMRI approached the self-expression subdomain by investigating plastic neural changes during a process of visual art learning. According to the

authors, prefrontal white matter pathways were shown to be associated with the development of creative artistic skills (Schlegel et al., 2015). Another longitudinal study prospectively followed participants immersed in up to 10-hr of group training in spontaneous improvisation and figural creativity over 5 weeks (Saggar et al., 2016). In the follow up, reduced activation in a prefrontal area was interpreted as reduced engagement in conscious monitoring and control processes as a result of repeated creative exercise in a group setting. Although many aspects clearly differ from our study (e.g., aim of the study, task in the scanner, sample characteristics, longitudinal evaluation of a group intervention, etc.), this PFC region seems to be in the vicinity of the AVPFC region identified in our experiment, where artists presented stronger activity than non-artists when rejecting rewards. From the perspective of comparable behavioral outputs across groups in our study, increased prefrontal activation could be a possible compensatory mechanism for a weaker cognitive control in artists. In addition, a similar region slightly more posterior than the AVPVC was identified by an activation likelihood estimation meta-analysis of 1,007 participants from 45 studies in the visuospatial, verbal, and musical creativity domains (Boccia et al., 2015). In general, evidence suggests that this prefrontal region may represent an important intersection between the correlates of creativity and reward. Further studies should investigate the modulatory roles of these parts of the prefrontal cortex, which seem to be particularly implicated in creative self-expression and reward in artists.

In this study, the existence of differential neural activity in the dopaminergic reward system of artists and non-artists was examined. This seems to be the first and still missing step toward establishing the baseline foundations of reward and creativity for future research of the self-expression domain. Accordingly, our sample of artists represents different fields of the

musical and visual arts. They were carefully matched by gender, age, and education levels, which are demographic factors of no-interest, thereby increasing homogeneity between groups. Our hypothesis of reduced BOLD response in key regions of the reward system of artists was confirmed by the differential activations of the VS. On the other hand, activation in the AVPC was increased in artists in comparison to other professions. It must be noted that the choice of an incentive to be monetary, which might interest most but not necessarily all subjects, and perhaps artists even less. If a reward paradigm in which the reward had been other incentives more tuned to artistic interests was used, such as atelier hours or participation in artistic events, the results may have been different. In any case, the monetary reward does not invalidate but rather supports our primary working hypothesis. It reinforces the point that particularities associated with artistic creativity exist in the dopaminergic reward system, especially given that the artists were equally engaged in the task, as indicated by the similar performance of artists and non-artists (Table 1). Nevertheless, important limitations of the study should be considered. The reactivity of the reward system in artists was investigated with monetary rewards, which might not be the optimal reward for artists. Clearly, they might have responded differently with other forms of reward. Also, our results do not preclude the possibility of other factors such as social status or income playing an important role, as they were simply not investigated. Future studies with larger samples should control for such factors. It is also relevant to mention that the prior professional background of experienced decision-makers has been shown to influence their neural activity during an exploration-exploitation task (Laureiro-Martínez et al., 2014). This shed new light on possible characteristic neural traits among groups of specialized professionals. In this sense, it is possible that further studies investigating the reward system of scientists and other

creative professionals will contribute with interesting and relevant information to this field of research.

Conclusion

Our findings support the existence of characteristic neural traits in artists associated with the acceptance and rejection of monetary rewards. The VS, the main region activated by reward, was less reactive in artists than in non-artists, which confirmed our main hypothesis. On the other hand, artists in contrast to non-artists displayed a stronger AVPFC response to reward rejection. These results suggest that individuals that preferentially engage in creative activities of self-expression perceive financial decisions from a different perspective.

Conflict of Interest

The authors declare that they have no conflict of interest.

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Figure Captions

Figure 1 The desire-reason-dilemma (DRD) paradigm comprises blocks of two contexts: (A) subjects are allowed to accept bonuses (conditioned stimulus, green square) while performing the task of selecting targets (cues, blue and yellow squares) and rejecting non-targets (other colors) and (B) subjects must reject bonuses (conditioned stimulus, green square) while performing the task of selecting targets (cues, blue and yellow squares) and rejecting non-targets (other colors). If a conditioned stimulus is accepted in the reason context, the block immediately ends with the feedback “goal failure” and a new block starts.

Figure 2 BOLD signal in the regions of interest of the dopaminergic reward system elicited by the desire-reason-dilemma paradigm were modulated by artistic career (small volume corrected $p < 0.05$ for multiple testing). Contrast estimates and 90% confidence intervals are plotted for ROIs surviving a priori statistical threshold. In reward acceptance (A), artists presented weaker activation in the ventral striatum (VS). In reward rejection (B), artists presented stronger anterior ventral prefrontal cortex (AVPFC) suppression of the VS.

Supplementary Figure

Figure 3 Whole brain BOLD signal elicited by the desire-reason-dilemma paradigm. For illustration purposes a more flexible threshold of clusterwise correction $p_{FWE} < 0.05$ (with $k > 88$) displaying all regions is presented. In reward acceptance, functional overlays can be seen for (A) artists, and (B) non-artists. In reward rejection, functional overlays can be seen for (C) artists, and (D) non-artists

A) Desire context

Table 1: Behavioral and demographic parameters across Artists (A) and Non-Artists (NA)

		Mean	SD	T	p ,2-tail
GOAL FAIL (n)	A	17.00	6.59	0.90	0.353
	NA	19.58	6.46		
	Total	18.35	6.51		
RT (ms)	A	512.39	44.38	0.00	0.979
	NA	512.91	49.59		
	Total	512.65	46.02		
AGE (y)	A	38.33	11.55	0.40	0.534
	NA	35.25	12.34		
	Total	36.79	11.80		
EDUCATION (y)	A	13.00	0.00	0.00	1.000
	NA	13.00	0.00		
	Total	13.00	0.00		
		Female	Male	χ^2	p ,2-tail
GENDER (n)	A	8	4	0.00	1.000
	NA	8	4		
	Total	16	8		
		Right	Left		
HANDIDNESS (n)	A	12	0	0.00	1.000
	NA	12	0		
	Total	24	0		

Supplementary Figure

A

Statistics: *p-values adjusted for search volume*

set-level		cluster-level				peak-level					mm mm mm		
p	c	$p_{FWECorr}$	$q_{FDRcorr}$	k_E	p_{uncorr}	$p_{FWECorr}$	$q_{FDRcorr}$	T	(Z_{max})	p_{uncorr}			
0.000	5	0.000	0.000	2335	0.000	0.022	0.077	6.68	4.89	0.000	6	12	57
						0.063	0.112	6.09	4.61	0.000	6	21	54
						0.203	0.199	5.42	4.28	0.000	-36	18	-6
		0.001	0.001	401	0.000	0.091	0.112	5.89	4.52	0.000	36	24	3
						0.816	0.329	4.33	3.64	0.000	39	6	27
						1.000	0.851	3.03	2.74	0.003	51	6	15
		0.173	0.044	136	0.010	0.543	0.253	4.75	3.90	0.000	18	-102	9
						0.686	0.282	4.54	3.77	0.000	27	-96	15
						0.988	0.511	3.77	3.28	0.001	21	-84	-9
		0.066	0.027	184	0.004	0.963	0.494	3.95	3.40	0.000	-30	42	9
						0.998	0.585	3.58	3.14	0.001	-33	54	21
						0.999	0.593	3.51	3.10	0.001	-36	33	15
		0.087	0.027	170	0.005	0.966	0.494	3.93	3.39	0.000	18	-51	-24
						0.970	0.494	3.91	3.37	0.000	36	-36	-30
						0.981	0.511	3.84	3.32	0.000	39	-45	-33

table shows 3 local maxima more than 8.0mm apart

Height threshold: T = 2.82, p = 0.005 (1.000)
Extent threshold: k = 88 voxels, p = 0.032 (0.454)
Expected voxels per cluster, <k> = 18.361
Expected number of clusters, <c> = 0.61
FWEC: 6.224, FDRp: Inf, FWEC: 401, FDRc: 136

Degrees of freedom = [1.0, 22.0]
FWHM = 13.9 14.8 14.5 mm mm mm; 4.6 4.9 4.8 (voxels)
Volume: 1524636 = 56468 voxels = 456.4 resels
Voxel size: 3.0 3.0 3.0 mm mm mm; (resel = 111.01 voxels)

B

Statistics: *p-values adjusted for search volume*

set-level		cluster-level				peak-level					mm mm mm		
p	C	$p_{FW-corr}$	$q_{FDR-corr}$	k_E	p_{uncorr}	$p_{FW-corr}$	$q_{FDR-corr}$	T	(Z_{max})	p_{uncorr}			
0.003	4	0.000	0.000	11632	0.000	0.001	0.007	8.12	5.47	0.000	39	42	27
						0.002	0.007	7.92	5.39	0.000	-30	12	36
						0.003	0.007	7.65	5.29	0.000	9	12	54
		0.000	0.000	1862	0.000	0.014	0.008	6.94	5.00	0.000	36	-39	-30
						0.110	0.030	5.78	4.46	0.000	48	-60	3
						0.111	0.030	5.77	4.46	0.000	18	-54	-27
		0.000	0.000	1078	0.000	0.080	0.026	5.96	4.55	0.000	33	-45	30
						0.220	0.043	5.38	4.25	0.000	30	-51	42
						0.227	0.043	5.36	4.24	0.000	48	-39	39
		0.000	0.000	1217	0.000	0.151	0.037	5.60	4.37	0.000	-27	-87	-6
						0.279	0.052	5.23	4.17	0.000	-39	-63	-18
						0.374	0.067	5.03	4.06	0.000	-48	-51	-21

table shows 3 local maxima more than 8.0mm apart

Height threshold: $T = 2.82$, $p = 0.005$ (1.000)Extent threshold: $k = 88$ voxels, $p = 0.032$ (0.454)Expected voxels per cluster, $\langle k \rangle = 18.361$ Expected number of clusters, $\langle c \rangle = 0.61$

FWEp: 6.224, FDRp: 5.285, FWEc: 1078, FDRc: 1078

Degrees of freedom = [1.0, 22.0]

FWHM = 13.9 14.8 14.5 mm mm mm; 4.6 4.9 4.8 {voxels}

Volume: 1524636 = 56468 voxels = 456.4 resels

Voxel size: 3.0 3.0 3.0 mm mm mm; (resel = 111.01 voxels)

C

Statistics: p -values adjusted for search volume

set-level		cluster-level				peak-level					mm mm mm		
p	c	$p_{\text{FWE-corr}}$	$q_{\text{FDR-corr}}$	k_E	p_{uncorr}	$p_{\text{FWE-corr}}$	$q_{\text{FDR-corr}}$	T	(Z_{eq})	p_{uncorr}			
0.000	5	0.000	0.000	6229	0.000	0.000	0.001	9.54	5.94	0.000	30	21	3
						0.002	0.003	7.97	5.41	0.000	-12	15	42
						0.002	0.003	7.89	5.38	0.000	3	6	57
		0.000	0.000	605	0.000	0.004	0.003	7.55	5.25	0.000	15	-102	9
						0.139	0.030	5.71	4.42	0.000	30	-54	-30
						0.887	0.183	4.25	3.59	0.000	39	-57	-15
		0.208	0.025	117	0.011	0.126	0.030	5.77	4.45	0.000	-18	-102	6
		0.233	0.025	112	0.013	0.776	0.143	4.46	3.72	0.000	-36	-54	-27
		0.040	0.007	191	0.002	0.793	0.146	4.43	3.71	0.000	36	-51	42
						0.993	0.322	3.77	3.28	0.001	48	-36	36
						0.999	0.402	3.58	3.14	0.001	30	-39	36

table shows 3 local maxima more than 8.0mm apart

Height threshold: $T = 2.82$, $p = 0.005$ (1.000)

Extent threshold: $k = 88$ voxels, $p = 0.024$ (0.398)

Expected voxels per cluster, $\langle k \rangle = 16.299$

Expected number of clusters, $\langle c \rangle = 0.51$

FWEp: 6.286, FDRp: 5.322, FWEc: 191, FDRc: 112

Degrees of freedom = [1.0, 22.0]

FWHM = 13.5 14.1 13.9 mm mm mm; 4.5 4.7 4.6 (voxels)

Volume: 1524636 = 56468 voxels = 514.1 resels

Voxel size: 3.0 3.0 3.0 mm mm mm; (resel = 98.55 voxels)

D

Statistics: p -values adjusted for search volume

set-level		cluster-level				peak-level					mm mm mm		
p	c	$p_{\text{FWE-corr}}$	$q_{\text{FDR-corr}}$	k_E	p_{uncorr}	$p_{\text{FWE-corr}}$	$q_{\text{FDR-corr}}$	T	(Z_{eq})	p_{uncorr}			
0.000	6	0.000	0.000	9024	0.000	0.002	0.011	8.00	5.42	0.000	51	0	51
						0.004	0.011	7.63	5.28	0.000	30	21	3
						0.017	0.018	6.90	4.98	0.000	-3	6	54
		0.000	0.000	712	0.000	0.049	0.018	6.30	4.71	0.000	30	-60	-30
						0.171	0.034	5.58	4.36	0.000	39	-63	-27
						0.714	0.112	4.56	3.78	0.000	9	-57	-15
		0.001	0.000	385	0.000	0.103	0.025	5.88	4.51	0.000	63	-39	21
						0.379	0.060	5.08	4.09	0.000	45	-39	6
		0.166	0.017	127	0.009	0.822	0.138	4.38	3.68	0.000	48	-63	3
						0.245	0.043	5.37	4.25	0.000	18	-99	9
						1.000	0.465	3.50	3.09	0.001	12	-93	-9
		0.001	0.000	416	0.000	0.640	0.098	4.67	3.85	0.000	-33	-63	-24
						0.650	0.098	4.66	3.84	0.000	-30	-78	-12
						0.812	0.138	4.40	3.69	0.000	-24	-96	15
		0.002	0.000	346	0.000	0.651	0.098	4.65	3.84	0.000	39	-27	33
						0.864	0.151	4.30	3.62	0.000	30	-51	48
						1.000	0.465	3.50	3.09	0.001	51	-39	36

table shows 3 local maxima more than 8.0mm apart

Height threshold: $T = 2.82$, $p = 0.005$ (1.000)

Extent threshold: $k = 88$ voxels, $p = 0.024$ (0.398)

Expected voxels per cluster, $\langle k \rangle = 16.299$

Expected number of clusters, $\langle c \rangle = 0.51$

FWEp: 6.286, FDRp: 5.281, FWEc: 346, FDRc: 127

Degrees of freedom = [1.0, 22.0]

FWHM = 13.5 14.1 13.9 mm mm mm; 4.5 4.7 4.6 {voxels}

Volume: 1524636 = 56468 voxels = 514.1 resels

Voxel size: 3.0 3.0 3.0 mm mm mm; (resel = 98.55 voxels)