

Research paper

Neural responses to a working memory task in the human striatum

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Abstract

Previous studies have shown that the human striatum is involved in working memory tasks. However, the specific neural responses of the striatum to different working memory tasks are not clear. In this study, we used functional magnetic resonance imaging (fMRI) to investigate the neural responses of the human striatum to a working memory task. The task was a 2-back working memory task. The results showed that the human striatum, including the caudate nucleus (SI, SII), putamen (ACC), and globus pallidus (SI, SII), was activated during the task. The activation was more pronounced in the SI and SII regions. The results suggest that the human striatum is involved in working memory tasks, and that the SI and SII regions are more involved in the task. © 2007 Elsevier B.V. All rights reserved.

Keywords: Attention; MRI; Intelligence; Personality; Reward

1. Introduction

Intelligence is a complex cognitive ability that involves a variety of mental processes. One of the key components of intelligence is working memory, which is the ability to hold and manipulate information in the mind for a short period of time. Working memory is essential for many cognitive tasks, including problem solving, decision making, and learning. The human striatum, which is part of the basal ganglia, has been shown to be involved in working memory tasks. Previous studies have shown that the human striatum, including the caudate nucleus (SI, SII), putamen (ACC), and globus pallidus (SI, SII), is activated during working memory tasks. However, the specific neural responses of the striatum to different working memory tasks are not clear. In this study, we used functional magnetic resonance imaging (fMRI) to investigate the neural responses of the human striatum to a working memory task. The task was a 2-back working memory task. The results showed that the human striatum, including the caudate nucleus (SI, SII), putamen (ACC), and globus pallidus (SI, SII), was activated during the task. The activation was more pronounced in the SI and SII regions. The results suggest that the human striatum is involved in working memory tasks, and that the SI and SII regions are more involved in the task.

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[16]. T

A, W (MRI). B C ACC W C

2. Method

2.1. Subjects

T (3 7) 20 27 (±S.D.=21.6±2.01). A I T D P P U

2.2. Stimuli and procedure

T LCD. V 40 C H () TV-). T 27 (6.47 0.48, 9 8=, 0=, t=33.11; p<0.001). H C E 1.5° × 1.5° 90 A MRI E (1); (2) C (3) C T 1 3 2 3 E 3, C) T 20 E 500 2500 T 2000

A T

2.3. fMRI data acquisition

S 3T S T B MRI C B R T (64 × 64 × 32 3.4 × 3.4 × 4.4, TR=2000, TE=30, FOV=220 =90°). A 3D T1- (256 × 256 × 176 0.938 × 0.938 × 1.3, TR=1600, TE=3.93).

2.4. fMRI data analysis

SPM2 (W D C N ,UK) T T A 2 × 2 × 2 M N I (MNI) T [17] F (FWHM) 8 T C S R A S p<0.0001 () p 0.05 (). T SPM MNI W T ROI T ROI M B R, T BOLD (ANOVA).

3. Results

3.1. Behavioral performance

T (46.5 ± 10.42%, 53.5 ± 10.42%, t(9) = 1.062; p > 0.05) E C 1.0%.

3.2. fMRI results

R

T **1**
B

B	BA	x	y	z	Z-score	V
R		34	10	1	4.90	147
R MFG	9	46	23	25	4.39	444
L IFG	45/46	-38	33	8	4.27	151
L STG	22/42	-42	-32	20	5.13	1123
L SII	4/3	-57	-12	26	4.57	363
L MOG	18	-28	-74	4	3.99	139
R P		22	-7	6	3.58	146

N

R: ; BA: B ; R: ; L: ; MOG: ; MFG: ; IFG: ; STG: ; MI: ; SMA: ; SII: ; V: $p < 0.0001$, $t > 20$; $p < 0.05$.

SII, (T 1). S, SII, (T 1). W, H, T, ANOVA ($F(2, 18) = 16.94$ 34.85; $p < 0.01$). P, ($p < 0.01$; $F_{r, 1}$) ($p > 0.05$).

T **2**
B

B	BA	x	y	z	Z-score	V
R		34	10	2	4.49	177
R MFG	9	46	23	23	4.49	131
L STS	22/42	-44	-44	10	4.50	91
L SII	3	-50	-14	32	4.66	157
R SII	2	48	-16	23	5.15	143
L MOG	18	-28	-74	4	4.94	89

BA: B ; R: ; L: ; MOG: ; MFG: ; IFG: ; STG: ; MI: ; SMA: ; SII: ; V: $p < 0.0001$, $t > 20$; $p < 0.05$.

4. Discussion

T, I, B, MRI, SII, T, MRI, SII, B, MRI, O, (S, SII), T, MRI, SII, [15,18]. R, TMS, [19], [20,21]. O, T, SII, [1], [2]. H, SII, O, I,

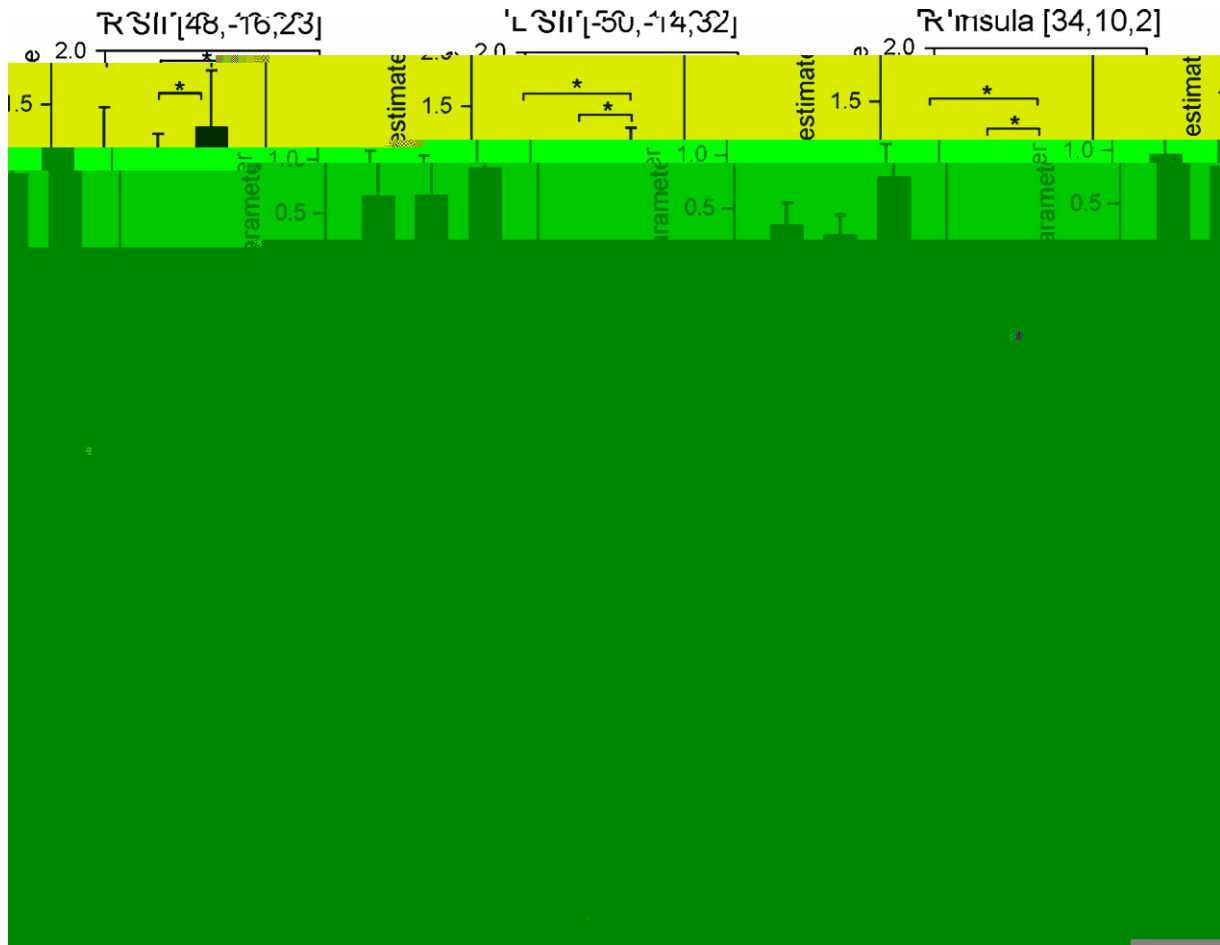


Fig. 1. **B** The color scale represents the parameter estimate of the model. The color scale ranges from 0.5 to 2.0. **T** ROI: ROI = Region of Interest. **A** Δ (*) indicates significant difference ($p < 0.05$) between conditions.

T \star ACC, ACC [8].
 I ACC, ACC [7,32].
 ACC [33].
 [12 15,34]. M ACC
 ACC [1,2]. I
 E
 ACC. O
 ACC. A
 ACC H
 I
 ACC
 S
 T \star ACC
 ACC
 F
 C
 S [35]. H
 P
 \star T
 [32,36].
 I MRI
 SII ACC.

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T \star N, N, S, F, C (30630025).

Appendix A

L C

P	N
C	T
P	W \star
S	W
S	C
S	W \star
C	M
C	E
F	W
L	L
F	L
W	W
B	L
C \star	R
B	H
S	D \star
A	W TV
H	S
C	N
P \star	P \star
T	D

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