

# Dopamine D<sub>2</sub>/D<sub>3</sub> receptor binding in the anterior cingulate cortex and executive functioning <sup>☆</sup>

Ville Lumme<sup>a,b</sup>, Sargo Aalto<sup>c,a</sup>, Tuula Ilonen<sup>b</sup>, Kjell Någren<sup>a</sup>, Jarmo Hietala<sup>a,b,\*</sup>

<sup>a</sup>Turku PET Centre, University of Turku, c/o Turku University Central Hospital, PO Box 52, FIN-20521 Turku, Finland

<sup>b</sup>Department of Psychiatry, University of Turku, FIN-20520, Turku, Finland

<sup>c</sup>Department of Psychology, Åbo Akademi University, Turku, Finland

Received 3 July 2006; received in revised form 22 December 2006; accepted 26 December 2006

## Abstract

The objective was to investigate the association between extrastriatal dopamine D<sub>2</sub>/D<sub>3</sub> receptor binding and performance on the Wisconsin Card Sorting Test (WCST), a measure of executive functioning. Thirty-two healthy volunteers performed the WCST and underwent positron emission tomography and a high-affinity D<sub>2</sub>/D<sub>3</sub> receptor tracer, [<sup>11</sup>C]FLB 457. All WCST error parameters, in particular nonperseverative errors, correlated positively with [<sup>11</sup>C]FLB 457 binding in the cognitive division of the right anterior cingulate cortex. An independent voxel-based receptor parametric mapping analysis confirmed these findings. The results indicate that executive functioning in healthy volunteers is modulated by D<sub>2</sub>/D<sub>3</sub> receptors in the anterior cingulate cortex.

© 2007 Elsevier Ireland Ltd. All rights reserved.

**Keywords:** Dopamine; D<sub>2</sub> receptor; PET; Anterior cingulate; Executive function; WCST

## 1. Introduction

The prefrontal cortex is essential for cognitive activity, and its dysfunction may lead to disorders in planning and execution, as well as perseverative and rigid behavior (Goldman-Rakic, 1996; Everett et al., 2001). Dopaminergic regulation contributes markedly to frontally mediated cognitive functions (Nieoullon, 2002). In particular, the role of prefrontal dopamine D<sub>1</sub> receptors in working memory functions is well established (Gold-

man-Rakic et al., 2000). The involvement of striatal D<sub>2</sub> receptors in working memory and executive functioning has been suggested (Volkow et al., 1998; Reeves et al., 2005; Kellendonk et al., 2006), but the role of cortical D<sub>2</sub> receptors has remained elusive (Glickstein et al., 2002; Seamans and Yang, 2004; Wang et al., 2004). In addition to the dorsolateral prefrontal cortex, the anterior cingulate cortex plays a key role in evaluative processes that necessitate stronger engagement of cognitive control (MacDonald et al., 2000; Buchsbaum et al., 2005).

The aim of the study was to evaluate the role of D<sub>2</sub>/D<sub>3</sub> receptors in executive functioning in humans. We investigated whether D<sub>2</sub>/D<sub>3</sub> receptor binding in the dorsolateral prefrontal cortex and anterior cingulate cortex correlates with cognitive performance involving executive control and working memory. Cortical D<sub>2</sub>/D<sub>3</sub> binding was quantified with 3D positron emission

<sup>☆</sup> This work was done in the Department of Psychiatry and Turku PET Centre, University of Turku, Turku, Finland.

\* Corresponding author. Department of Psychiatry, University of Turku, Kunnallissairaallantie 20, Building 9, FIN-20700 Turku, Finland. Tel.: +358 2 269 2520; fax: +358 2 269 2528.

E-mail address: [jahi@utu.fi](mailto:jahi@utu.fi) (J. Hietala).

Table 1  
Correlation between selected WCST parameters and regional D<sub>2</sub>/D<sub>3</sub> binding potential

			Number of trials	Errors	Perseverative errors	Nonperseverative errors
Anterior cingulate cortex	Left	<i>r</i>	0.2287	0.2525	0.1971	0.2857
		<i>P</i>	0.233	0.186	0.306	0.133
	Right	<i>r</i>	0.3341	0.4159	0.3683	0.4320
		<i>P</i>	0.077	0.025*	0.049*	0.019**
Amygdala	Left	<i>r</i>	0.1819	0.1948	0.2175	0.1628
		<i>P</i>	0.345	0.311	0.257	0.399
	Right	<i>r</i>	0.2122	0.2395	0.1680	0.2877
		<i>P</i>	0.269	0.211	0.384	0.130
Angular gyrus	Left	<i>r</i>	0.1028	0.0939	0.1055	0.0778
		<i>P</i>	0.596	0.628	0.586	0.688
	Right	<i>r</i>	0.0232	0.0299	0.0291	0.0288
		<i>P</i>	0.905	0.878	0.881	0.882
Dorsolateral prefrontal cortex	Left	<i>r</i>	0.0559	0.0638	0.0346	0.0856
		<i>P</i>	0.773	0.742	0.859	0.659
	Right	<i>r</i>	0.0095	0.0153	−0.0077	0.0345
		<i>P</i>	0.961	0.937	0.969	0.859
Inferior temporal gyrus	Left	<i>r</i>	0.1908	0.1712	0.1143	0.2108
		<i>P</i>	0.321	0.374	0.555	0.272
	Right	<i>r</i>	0.1331	0.1350	0.1209	0.1391
		<i>P</i>	0.491	0.485	0.532	0.472
Middle temporal gyrus	Left	<i>r</i>	0.1239	0.1296	0.1215	0.1288
		<i>P</i>	0.522	0.503	0.530	0.506
	Right	<i>r</i>	0.1187	0.0722	0.0229	0.1112
		<i>P</i>	0.540	0.710	0.906	0.566
Superior temporal gyrus	Left	<i>r</i>	0.2723	0.2209	0.1753	0.2473
		<i>P</i>	0.153	0.250	0.363	0.196
	Right	<i>r</i>	0.2227	0.2069	0.2129	0.1889
		<i>P</i>	0.245	0.281	0.268	0.326
Medial prefrontal cortex	Left	<i>r</i>	0.2030	0.2552	0.2148	0.2749
		<i>P</i>	0.291	0.182	0.263	0.149
	Right	<i>r</i>	0.0751	0.1241	0.1369	0.1053
		<i>P</i>	0.699	0.521	0.479	0.587
Supramarginal gyrus	Left	<i>r</i>	0.1142	0.0897	0.0843	0.0890
		<i>P</i>	0.555	0.644	0.664	0.646
	Right	<i>r</i>	0.0669	0.0475	0.0507	0.0418
		<i>P</i>	0.730	0.807	0.794	0.830
Thalamus	Left	<i>r</i>	0.0215	−0.0413	−0.0860	0.0005
		<i>P</i>	0.912	0.832	0.658	0.998
	Right	<i>r</i>	−0.0685	−0.0417	−0.0646	−0.0189
		<i>P</i>	0.724	0.830	0.739	0.922

*r*, correlation coefficient (partial correlation analysis); *P*, level of significance; \*\**P*<0.025; \**P*<0.050.

tomography (PET) using a high-affinity dopamine D<sub>2</sub>-like receptor tracer [<sup>11</sup>C]FLB 457 (Farde et al., 1997). Executive functioning was evaluated using the Wisconsin Card Sorting Test (WCST), a task widely used to evaluate frontal lobe function in humans.

## 2. Methods

### 2.1. Subjects

Thirty-two healthy non-smoking volunteers with no history of somatic illness, psychiatric disorder or substance abuse were recruited for the study. Three

subjects were female and four left-handed. All subjects underwent a 1.5-Tesla magnetic resonance imaging (MRI) scan (Siemens Magnetom) to exclude any structural brain abnormalities and for anatomical reference. The age, weight and height of the subjects were 26.8±4.0 years, 79.2±8.6 kg and 179.7±8.2 cm (mean±S.D.), respectively. The body mass index was 24.5±1.7 kg/m<sup>2</sup>.

Written informed consent was obtained in all cases. The study protocols were approved by the Ethical Committee of Turku University/University Hospital, Turku, Finland, and the study was performed in accordance with the Declaration of Helsinki.

Download English Version:

<https://daneshyari.com/en/article/335888>

Download Persian Version:

<https://daneshyari.com/article/335888>

[Daneshyari.com](https://daneshyari.com)