

Impaired category learning in patients with damage to prefrontal cortex

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INTRODUCTION

Previous research has demonstrated that patients with damage to the basal ganglia (BG) are impaired at rule-based (RB) category learning while normal on an information integration approach (Eil, et al, 2006). While BG structures play a demonstrated role in RB category learning, the effective implementation of decision rules has also been shown to be critically dependent on regions of prefrontal cortex. The current study examined the role of prefrontal cortex in 2 types of category learning (RB and II) in 8 patients with damage primarily to medial prefrontal regions.

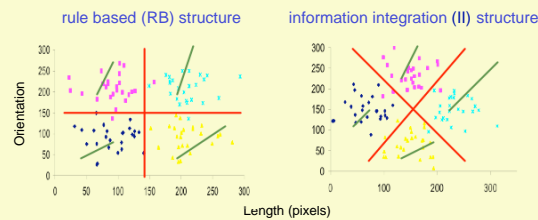
METHODS

Procedure - Eight patients with damage to frontal cortex and 7 matched controls (see Table 1) assigned lines of various orientations and lengths, presented on a computer screen, to one of 4 categories. The categorization utilized 2 different structures (see below, *example stimuli in green*) each tested separately in sessions at least 1 week apart. Subjects indicated their categorization by pressing 1 of 4 buttons.

Session 1 - 6 100-trial learning runs

- Feedback was given after each trial and at the end of each run

Session 2 - Same procedure as before but with the condition that had not previously been tested (At least 1 week later).

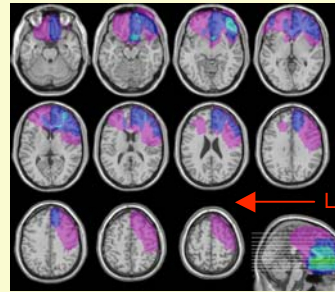


Patient	Etiology	Age	VIQ	GM	Trails B	WCST	FAS
FC_003	ACOA	49	101	107	99	7/17%	53
FC_004	ACOA	60	124	82	75	6/14%	36
FC_006	ACOA	73	88	67	-	3/-	25
FC_008	ACOA	55	117	-	67	6/11%	38
FC_011	ACOA	68	103	111	75	1/27%	37
FC_014	ACOA	60	105	86	50	6/6%	60
FC_016	ACOA	63	137	114	94	6/11%	46
FC_022	frontal hemorrhage	63	114	-	-	6/5%	25

Patient Mean 61.4 111.1
Control Mean 60.8 115.2

Table 1 - Note - Age in years, WAIS-III, Wechsler Adult Intelligence Scale, 3rd edition (Wechsler, 1997), VIQ = verbal IQ, Wechsler Memory Scale, 3rd edition (Wechsler, 1997) - GM = general memory index. Trails B in seconds, WCST categories/percent perseverative errors, FAS words named. Patients are color coded to match the graph in the top right hand panel.

Template displaying overlap of regions of damage in 6 of 8 patients. (Areas in blue include 2 patients and teal 3 or more)

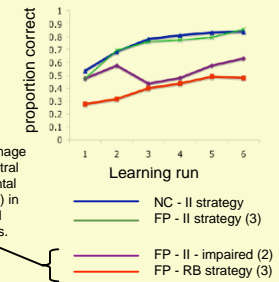


Computational modeling

was used to examine the strategy utilized by participants in the sixth run of the II task (Ashby, 1992). All control participants were using an II strategy. Of the 5 impaired frontal patients, 3 used the inefficient RB strategy.



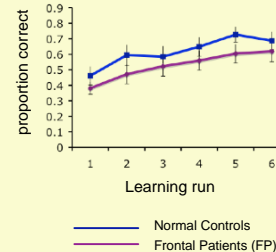
Patients listed in table 1 are color coded to correspond to the graph.



RESULTS

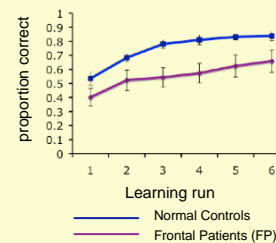
Rule Based Learning

While rule based learning in patients was numerically less than in matched controls, no reliable impairment was found



Information Integration Learning

In contrast to the results from RB learning, 5 patients were clearly impaired at information integration learning, failing to reach comparable performance by the sixth learning run.



CONCLUSIONS

1. In contrast to previous work in patients with damage to the basal ganglia, patients with damage to medial prefrontal cortex were able to achieve comparable learning, relative to matched controls, in a rule based category learning task.
2. Also in contrast to previous work (Eil, et al, 2006), frontal patients demonstrated clear impairment on category learning when the task required an information integration approach. This impairment seems primarily driven by a subset of patients who continue to use RB strategies throughout the task.
3. Frontal patients clearly impaired on the task had damage overlap in VMPC. The performance of the 3 that were unable to adopt an II strategy is consistent with an inability to disengage the most salient approach to a task even when this approach may lead to suboptimal performance (Damasio, Tranel, & Damasio, 1991). Of the impaired patients who eventually adopt an II strategy, there appears to be better performance on the II task.

Eil, S.W., Marchant, N.L., and Ivry, R.B. (2006). Focal putamen lesions impair learning in rule-based, but not information-integration categorization tasks. *Neuropsychologia*, 44,10, pp 1737-1751.

Damasio, A.R., D. Tranel & H. Damasio. 1991. Somatic markers and the guidance of behavior: theory and preliminary testing. In *Frontal Lobe Function and Dysfunction*. H.S. Levin, H.M. Eisenberg & A.L. Benton, Eds.: 217-229. Oxford University Press. New York.

Ashby, F.G. (1992). Multidimensional models of categorization. In F.G. Ashby (Ed), *Multidimensional models of perception and cognition*. Hillsdale, NJ: Erlbaum.

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