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T-12. Preserved Artificial Grammar Learning in Parkinson's Disease

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Abstract

Parkinson's disease (PD) patients and matched control subjects were compared in an artificial grammar learning task. The test strings were constructed in such a way that grammaticality judgments could not be based on some superficial features of the learning strings: the grammatical and nongrammatical test strings did not differ according to different measures of chunk strength (based on the frequency with which their bigrams and trigrams appear in the learning strings). Results show that PD patients and controls performed at the same level during the first presentation of the test strings series, which suggests that the striatum is not (crucially) implicated in the ability to abstract rules implicitly from exemplars generated by a finite-state grammar. However, and contrary to control subjects, the classification performance of PD patients was at chance during the second presentation of the test strings. We argue that this latter result could be the consequence of the attentional deficit of PD patients.

Introduction

Several studies have provided evidence for impairment of procedural learning in Parkinson's Disease (PD) patients, suggesting the implication of the striatum in skill acquisition. For example, implicit learning abilities have been investigated in PD patients using the serial reaction time (SRT) paradigm (e.g., Jackson et al., 1995), and results of these studies showed abnormal performances in PD patients. However, these results can be questioned because of the implication of an overt motor component in the SRT performance. The present experiment was designed to examine the basal ganglia hypothesis of procedural learning in PD patients with the artificial grammar learning paradigm, an implicit learning task in which no motor component is implied.

Method

Subjects. Seventeen patients (6 women and 11 men) with PD were studied and individually matched for age, sex and level of education with 17 neuro-logically intact control subjects. All PD patients and control subjects were right-handed and did not evidence any psychiatric symptom. PD patients were diagnosed on the basis of current criteria for probable Idiopathic Parkinson's Disease. All PD patients but one were treated with dopaminergic drugs at levodopa posology under 1000 mg, and none of them received anticholinergic or antidepressive drugs. Vocabulary scores (Mill Hill; Deltour, 1993), Digit Span and Mattis Dementia Rating Scale (1976) results did not differ significantly across the two groups. All subjects were also administered a 15 word learning test in order to assess their explicit verbal long-term memory. On this test, control subjects performed significantly better than PD patients.

Material and procedure.

The finite-state grammar used to generate the items is illustrated in Fig. 11. Out of the 63 letter strings of 4 to 7 letters that the grammar could generate, 51 were selected for the learning phase, and 12 for the test phase. Twelve nongrammatical test strings were also constructed for the test phase. Grammatical and nongrammatical test items were the same according to different chunk strength measures, ensuring that classification judgments could only be based on the adherence of the test items to the rules of the grammar (Knowlton & Squire, 1994; Meulemans & Van der Linden, in press): [a] the global chunk strength (calculated, for each item, by averaging the different frequencies of its chunks in the learning items), [b] chunk strength for the initial positions and [c] for the final positions, [d] chunk strength for anchor positions (calculated by averaging [b] and [c]), and [e] the chunk-novelty variable (a novel chunk being a chunk which never appeared in the learning items).

The experimental procedure comprised the study phase followed by the classification phase. In the study phase, the task was presented as an immediate-memory test, and subjects had to memorize 51 letter strings, one at a time.
At the classification phase, subjects were instructed that the letter strings they had just memorized a few minutes ago were constructed according to a complex system of rules. They were asked to classify 24 new items as

grammatical or not. The whole string series was presented twice.

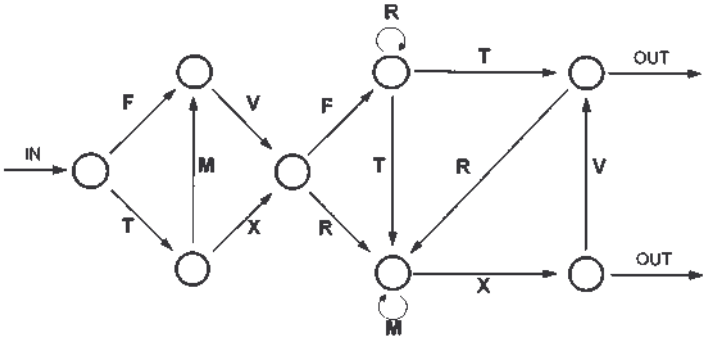

FIGURE 11

Results

For the first presentation, PD patients classified as grammatical 73.0% (*SEM* = 3.9%) of the grammatical strings and 60.3% (*SEM* = 4.4%) of the nongrammatical strings; control subjects classified as grammatical 69.1% (*SEM* = 3.4%) of the grammatical strings and 56.9% (*SEM* = 2.4%) of the nongrammatical strings. For the second presentation, PD patients classified as grammatical 64.2% (*SEM* = 4.2%) of the grammatical strings and 62.8% (*SEM* = 4.3%) of the nongrammatical strings; control subjects classified as grammatical 67.2% (*SEM* = 4.1%) of the grammatical strings and 54.4% (*SEM* = 3.2%) of the nongrammatical strings. A three-way ANOVA revealed a significant effect of the Grammaticality variable, $F(1, 16) = 10.43$, $MSE = 313.33$, $p < .01$, indicating that, on the whole, subjects classified more often the grammatical strings as grammatical than the nongrammatical strings, but no significant Group ($p > .35$) and Presentation ($p > .20$) effect. The analysis also showed a significant Group Grammaticality Presentation interaction, $F(1, 16) = 5.21$, $MSE = 56.49$, $p < .05$. No other interaction
was significant. A Newman-Keuls post hoc test showed that, for the first presentation, the Grammaticality effect was significant for both groups ($ps < .0005$) and that, for the second presentation, the Grammaticality effect was only significant for the control subjects ($p < .0005$), the performance of the PD patients being at chance ($p > .50$).

Discussion

PD patients showed normal performance in the first phase of the classification task. However, whereas control subjects maintained their performance in the second phase of the classification task, the performance of PD patients fell to chance, a result which can be attributed to a diminution of attentional ressources (which could be due to a tiredness effect) in PD patients during the task. This normal ability to classify grammatical and nongrammatical items during the first presentation of the test items cannot be attributed to some superficial features of the items, because of the rigorous control of different chunk strength measures in both item types. On the other hand, PD patients were impaired in an explicit verbal memory task.
On the whole, the results suggest that the basal ganglia are not crucially involved in the rule-abstraction mechanisms engaged in artificial grammar learning.

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