

## Past tense formation and comprehension of passive sentences in Parkinson's disease: Evidence from Greek

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### Abstract

The present study investigates the production of regular and irregular verbs in the past tense and the comprehension of passive sentences by Greek-speaking PD patients, and compares their behavior to that of normal speakers. Although the two groups manifest large scale differences at all the above constructions, the behavior of PDs is not different at regular vs. irregular past tense formation neither did we obtain strong evidence that they do not comprehend passives, most importantly, they certainly do not perform at chance. On the basis of the above, we conclude that there are no indications for a clearly linguistic deficit of the PD group, hence, their difference with the control group should be attributed to other factors, such as the computational demands of the tasks.

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### 1. Introduction

Parkinson's disease (PD) is caused by degeneration of midbrain dopaminergic neurons mainly in the substantia nigra. Although motor symptoms (mainly tremor, bradykinesia, and rigidity) predominate during the initial stages, several areas receiving projections from the basal ganglia (i.e., frontal cortical areas) become affected with disease progression. PD patients are known to manifest cognitive and linguistic impairments (Berg, Bjornram, Hartelius, Laakso, & Johnels, 2003; Grossman, Carvell, Stern, Gollomp, & Hurtig, 1992; Lieberman et al., 1992) but it is not entirely clear whether the latter are the result of a defective language system or constitute side effect limitations of cognitive resources that contribute to the

processing of complex material (Grossman, 1999). A property that most of the previous studies share is that they group together a number of linguistic structures, not always associated with each other or constrained by a precise linguistic theory, with the result that it becomes difficult to identify impaired domains of grammar.

Ullman et al. (1997) under the assumption that the past tense formation of regular verbs in English involves the application of a grammatical rule (one that attaches the suffix *-ed* to the verb) focus on this particular construction in detail. They find past tense formation of regular verbs defective among PD patients and hold that this is a linguistic deficit most probably related to the general impairment of the procedural memory system that is subserved by basal ganglia circuits connected with frontal cortex. By contrast, they do not detect serious problems with the formation of the past tense of irregular verbs, a finding consistent with their assumptions, since irregular past tense is considered to involve

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retrieval of the corresponding entry from the lexicon, hence, implicates the declarative memory system instead. In the same study, the behavior of PD patients is compared to that of Broca's aphasics (agrammatics), a group that is well known for manifesting linguistic deficits in other domains of grammar as well (Friedmann, 2002; Grodzinsky, 1986, 1995, 2000 and references therein).

In this work we first considered investigating the behavior of Greek-speaking PD patients on the past tense formation of regular and irregular verbs. We thought, however, that since Greek does not manifest the clear distinction of English in the process of forming regular vs. irregular past tense forms, since there are no forms that rely exclusively on the application of grammatical rules and on retrieval from the lexicon, respectively, it would be unlikely that the English type of results are replicated. Thus, taking into account the comparable behavior of English-speaking PD patients to that of agrammatics at past tense formation, we decided to also study Greek PD patients' behavior at another syntactic domain that has been studied extensively among agrammatics crosslinguistically, the comprehension of passive sentences (Grodzinsky, 1986, 1995, 2000). The poor performance of agrammatics on passives has been attributed to a different (and purely linguistic) characteristic, namely, the deletion of traces (Grodzinsky, 1986). We thought however that, since passives are also the outcome of a syntactic rule (formation of A-chains), it is reasonable to expect them to be impaired among PD patients as well, therefore, they are worth being studied. If so, the association between grammatical rules and procedural memory would be even more complete while we would have obtained results from two clearly defined domains of grammar (verb inflection and passive sentences) in a relatively understudied language (Greek). The results would hopefully be able to further contribute to the understanding of the nature of the impairment involved in the language of PD patients.

Before laying out the details of the experiments we conducted, we present immediately below a few details concerning the properties of the structures we investigated in Greek. Greek is a highly inflected language. With respect to the verbal paradigm in particular, and since the language has no infinitives, no uninflected form is to be found. The past tense of regular verbs is formed by the stem of the verb followed by the past tense aspectual morpheme *-s-*, followed by person and number inflection. An example of this type is: *diavaz-o*, *diava-s-a* 'read-pres-1sg,' 'read-past-1sg.'

The past tense of irregular verbs is formed by the stem of the verb, followed by person and number inflection. This past stem may be radically different from the stem of the present tense or less so. An example of the first instance is: *leg-o*, *ip-a* 'say-1sg,' 'said-1sg', while an example of the second is: *plen-o*, *eplin-a* 'wash-1sg,' 'washed-1sg.'

In both regular and irregular verbs, the past form may also involve the prefix *e-*. An example of a regular verb in which *e-* precedes the stem in the past is: *trex-o*, *e-trek-s-a* 'run-1sg,' 'ran-1sg.' An example of an irregular verb in which *e-* precedes the stem is: *tro-o*, *e-fag-a* 'eat-1sg,' 'ate-1sg' (and also *pleno*, *e-plina* earlier).

It emerges from the above therefore, that there is no (irregular) past tense form which involves mere retrieval from the lexicon and thus contrasts (regular) past tense forms that involve application of the corresponding rule. Hence, since irregular past is also inflected for person and number agreement, it should engage the application of the relevant rules and the prefixation of *e-* as well.

Let us now turn to the morphology and the syntactic properties of passive sentences. Greek distinguishes two types of passives, synthetic and analytic. Synthetic (or else, verbal) passives are formed by the verb inflected for passive morphology: *diavaz-i*, *diavaz-et-e* 'read-3sg,' 'is-read-3sg.' Analytic (or else, adjectival) passives are formed by the verb *ime* 'be' followed by an adjectival form, i.e., *diavaz-men-os*. The latter form bears nominal inflection, that is, is inflected for number, gender and case. Thus, a full paradigm of Greek active and passive sentences is: *O Yiannis diavazi to vivlio*. '(the) John reads the book.', *To vivlio diavazete apo to Yianni* 'The book is-read by (the) John.', and *To vivlio ine diavazmeno apo to Yianni*. 'The book is read by (the) John.' As will be noted again later, while verbal passives have always been considered to involve movement of the sentential object to the subject position, hence, formation of an A-chain, the syntactic status of adjectival passives has not always been equally clear. In the older literature, (Lascaratou & Philippaki-Warburton, 1983/1984), adjectival passives were considered to be formed in the lexicon, thus, not to be the result of an A-chain, while recent theoretical developments (Alexiadou & Anagnostopoulou, 2004; Anagnostopoulou, 2001) provide evidence that adjectival passives are also the result of A-chain formation. It should be pointed out here that research on Greek PDs has not focused on either type of passives (but see Katsarou et al., 2003 for unaccusatives and Nat-sopoulos et al., 1991 for relative clauses), hence, the present work aims at filling this gap as well.

To conclude, the rationale behind studying the two structures we report in this article is that, even if Greek PD patients are not found to replicate the behavior of English PDs on the formation of past tense because of the particularities of the Greek verb morphology that we described, they are expected to exhibit problems at comprehending passive sentences. This should be so because at least verbal passives undoubtedly involve the application of a grammatical rule, namely, the rule that forms A-chains. Furthermore, comprehension of passives is well known to be problematic for Broca's aphasics, another group that performed similarly to PDs in the past tense formation study of Ullman et al. (1997) (because of

problems with the application of the grammatical rule that suffixes *-ed* onto the stem of regular verbs). With the above in mind, we set off to investigate Greek PD patients' behavior at the structures of interest via the experiments that we describe immediately below.

## 2. Methods

### 2.1. Materials

#### 2.1.1. The past tense task

The past tense formation task we conducted was a sentence completion production task. Participants were given 20 sentences each, and after each sentence was read to them it was repeated in the context of an event taking place in the past but with the slot for the verb empty. Participants had to fill in the slot with the verb in the past tense. Ten of the verbs used in the sentences have regular past tense and 10 irregular. An example is: *O Vassilis kapnizi 5–6 tsigara tin imera. Xtes omos itan agxomenos ke—ena paketo* 'Vassilis smokes 5–6 cigarettes a day. But yesterday he was stressed and—a pack.' The form of the verb that has to be inserted in the slot is *kapnise* 'smoked', a regular verb in Greek.

The other regular verbs were: *akouo* 'hear,' *potizo* 'water,' *magirevo* 'cook,' *aplono* 'lay,' *poulo* 'sell,' *trexo* 'run,' *lino* 'solve,' *ravo* 'saw.' The irregular verbs employed were: *lego* 'tell/say,' *trogo* 'eat,' *gderno* 'scratch,' *pleno* 'wash,' *vlepo* 'see,' *pino* 'drink,' *perno* 'take,' *mathaino* 'learn/get to know,' *erxome* 'come,' *fevgo* 'leave.'

We should note here that the irregular verbs of our study coincide with those that were considered irregular in the processing study by Tsapkini, Jarema, and Kehayia (2002), a study that appeared after our experiment was designed. Namely, we considered as irregular verbs those whose past tense undergoes stem internal change, which is in some occasions radical, such as, *lego—ipa*, 'say'—'said' or *vlepo—ida* 'see—saw,' and in others less so, as *pleno—eplina* 'wash—washed.' The regular past tenses of our study comprised those of the categories (b) and (c) of Tsapkini et al. (2002). These are verbs in which the past tense aspectual marker *s* is present, *lino—elisa* 'tie'—'tied,' as a result of which a phonological change of the final consonant of the stem may take place, as in *grafo—egrapsa* 'write'—'wrote.'

#### 2.1.2. The passive task

The passive task was a picture identification comprehension task. Participants were read 20 sentences, 10 active and 10 passive. Two types of passive sentences were tested, 5 verbal and 5 adjectival. For each passive sentence read to the participants two pictures were presented to them. Both pictures had the verb of the sentence uttered, but the persons involved in the event were

reversed. Participants were asked to point to the picture that corresponded to the sentence they heard.

Five of the active sentences were inserted in the questionnaire in order to establish that the verb was recognized and five in order to establish that the persons participating in the event denoted by the verb were recognized. Thus, there were two active sentences corresponding to each verb: one of the sentences employed the same persons as the corresponding passive sentences and the other employed only one of the two persons. More concretely, for a verb such as *sproxno* 'push,' picture A with John pushing a trunk was presented along with picture B with John kicking a trunk in order to establish comprehension of the verb 'push' and the sentence *O Yiannis sproxni to baoulo* 'John pushes the trunk' was read. Then picture C with John pushing Mary along with picture D with Mary pushing John was presented to test the comprehension of the verb 'push' in the active form in sentences like *O Yiannis sproxni ti Maria* 'John pushes Mary.' Pictures C and D were presented again for testing the comprehension of the verbal passive *I Maria sproxnete apo to Yianni* 'Mary is pushed by John' as well as of the adjectival passive *I Maria ine sprogmeni apo to Yianni* 'Mary is pushed by John.' The 20 sentences with the relevant pairs of pictures were presented to the participants in random order.

### 2.2. Participants

For a period of 12 months (9/2002–9/2003) 25 right-handed patients were recruited from the outpatient clinic of the Department of Neurology of the University Hospital of Patras, Greece. Two more patients were recruited in October 2004, after a reviewer's suggestion, with the objective to obtain clearer results and, possibly, a statistically significant difference with respect to a result of the PD population that approached significance the first time. All Parkinson's disease patients were diagnosed by the same movement disorders specialist (SP) on the basis of bradykinesia associated with one of the other two cardinal signs (tremor, rigidity) and responsiveness to levodopa therapy. All patients fulfilled the UK Parkinson's Disease Brain Bank criteria for the diagnosis of idiopathic Parkinson's disease (Hughes, Daniel, Kilford, & Lees, 1992). Cases considered as atypical parkinsonism, vascular parkinsonism, or any PD plus syndrome were excluded from the study. Patients who had a history of neurological or psychiatric disease other than PD were also excluded. Patients who had end-of-dose motor fluctuations were always tested in the on phase. Cognitive status was assessed using Mini-Mental State Examination (Folstein, Folstein, & McHugh, 1975). Patients who scored less than 25 were excluded in order to avoid inclusion of demented PD patients.

Table 1  
Demographic data of PDs and control group

	PD patients ( <i>n</i> = 27)	Matched controls ( <i>n</i> = 27)	<i>p</i>
Gender (% male)	14 (52%)	14 (52%)	1.0
Mean age in years ( <i>SD</i> )	64.7 (11.5)	65.0 (10.8)	0.9
<i>Education</i>			
No	3 (11%)	3 (11%)	
1–6 years	14 (52%)	14 (52%)	1.0
6–12 years	7 (26%)	7 (26%)	
>12 years	3 (11%)	3 (11%)	
MMSE ( <i>SD</i> )	27.7 (1.6)	28.1 (1.5)	0.437

The majority of the patients were on antiparkinsonian medication (only three patients were not receiving antiparkinsonian medication) at the time of testing, and the patients were not taking medication associated with sedation.

During an informal structured interview conducted during the patients' visit to the outpatient clinic or after a scheduled appointment, we obtained information on disease history and drug therapy. To always obtain reliable information from patients, a healthy member of the patient's family with knowledge of the patient's medical history was also interviewed to confirm the data obtained.

The Unified Parkinson's Disease Rating Scale (UPDRS) (Fahn et al., 1987) was completed during clinical examination and was used for comparisons. This includes: part I (mentation, behavior, and mood), part II (activities of daily living), part III (motor examination), part IV (complications of therapy), Hoehn and Yahr scale (Hoehn & Yahr, 1967) (measures the severity of the disease and is based on lateralization of the symptoms and balance evaluation), and Schwab and England scale (Schwab & England, 1969) (also measures activities of daily living). A study of the clinical characteristics of PD patients in relation to the severity of their linguistic impairment is currently conducted and results will be reported elsewhere. By using a case–control design, each PD patient was matched with a right-handed Greek healthy subject, for age, gender, and education. The same tests were also performed on the healthy subjects including the MMSE. Demographic data of PD patients and controls are reported in Table 1.

### 3. Results

The results of both experiments are presented in Table 2 and, as well as in Table 1, they include the two additional PD patients that we tested and their matched controls. With the exception of the result that motivated the additional testing, which we will bring up in Section 4, we do not report the earlier results as they did not differ from the present ones in some interesting manner.

Table 2  
Errors in past tense formation and sentence comprehension by PDs and normal

	PD patients ( <i>n</i> = 27)		Matched controls ( <i>n</i> = 27)	
	Mean ( <i>SD</i> )	Errors/trials	Mean ( <i>SD</i> )	Errors/trials
<i>Past tense formation</i>				
Regular	1.04 (1.13)	28/270	0.04 (0.19)	1/270
Irregular	1.48 (1.63)	40/270	0.19 (0.48)	5/270
<i>Sentence comprehension</i>				
Actives	0.70 (0.82)	19/270	0.19 (0.48)	5/270
Passives	1.81 (1.94)	49/270	0.15 (0.36)	4/270
Verbal passives	0.74 (1.06)	20/135	0.04 (0.19)	1/135
Adjectival passives	1.07 (1.24)	29/135	0.11 (0.32)	3/135

Fifteen out of the 27 tested PDs were responsible for the errors at passive sentence comprehension and 20 for the errors at past tense formation. The seven PDs who did not make errors at past tense did not make any error at passive sentences either. Consequently, there were five PDs who made errors at the comprehension of passives but did not err at past tense formation. The seven PD subjects who made errors at neither past tense formation (regular or irregular) nor at passive sentence comprehension were people with level of education from 6 to 12 years (high school). Of the five remaining individuals with errors at passive comprehension, one had no formal education, two had elementary school education, and two had university education (cf. Table 1). Thus, the overwhelming majority of errors came from people with education of elementary school or less.

The above information appears in Supplementary Tables 1 and 2.

#### 3.1. Comparisons between PD subgroups

PD patients were stratified according to gender, disease duration ( $\leq 5$  and  $> 5$  years), disease stage (Hoehn & Yahr  $\leq 2.5$  and  $> 2.5$ ), initial symptom (tremor related or bradykinesia-rigidity related), prevalent symptom (tremor, bradykinesia, and rigidity), and disease type (tremor predominant and bradykinesia-rigidity predominant). Statistical analysis was performed using the SPSS for Windows release 10.0 (SPSS, Chicago, IL, USA), run on an IBM-compatible computer.  $\chi^2$  with Yates corrected *p* value in the comparison of proportions. A statistical level of 5% was considered significant in the study. When comparing the behavior on past tense formation and sentence comprehension between PD patients' subgroups divided according to the above criteria that is, gender, disease duration, disease stage, initial symptom, prevalent symptom, disease type, no statistically significant results were recorded however ( $p > .05$  in all cases).

### 3.2. Comparisons between PDs and controls

Paired samples *t* test was used for comparing the behavior of PDs and controls in each of the syntactic structures studied. The difference was highly significant between the two groups for all syntactic structures. More precisely, for the formation of regular past tenses,  $t(26) = 4.54$ ,  $p < .0001$ ; for irregular past tense,  $t(26) = 4.45$ ,  $p < .0001$ ; for verbal passives,  $t(26) = 3.32$ ,  $p < .01$ ; for adjectival passives,  $t(26) = 4.09$ ,  $p < .0001$ ; for actives,  $t(26) = 3.58$ ,  $p < .001$ .

### 3.3. Within group comparisons of syntactic structures

Paired samples *t* test was also used for comparing regular vs. irregular past tense formation and active vs. passive sentence comprehension within each group.

### 3.4. Past tense production

No statistically significant difference was found between regular and irregular past tense formation for either group. For PD patients,  $t(26) = -1.381$ ,  $p = .179$  and for controls,  $t(26) = -1.442$ ,  $p = .161$ .

### 3.5. Comprehension of passives

With respect to the comprehension of active vs. verbal passive sentences we did not find statistically significant difference for either one of the groups. For PD patients:  $t(26) = -1.959$ ,  $p = .061$  and for controls,  $t(26) = 0.901$ ,  $p = .376$ .

Similarly, there was no significant difference for either one of the groups at the comprehension of verbal vs. adjectival passives. Thus, for PD patients,  $t(26) = -1.396$ ,  $p = .174$  and for controls,  $t(26) = -1$ ,  $p = .327$ .

The comprehension of adjectival passives differed significantly from that of actives for PD patients however:  $t(26) = -3.204$ ,  $p < .01$ , while the difference was not significant for the control group:  $t(26) = -0.254$ ,  $p = .802$ .

## 4. Discussion

The similar behavior of PD patients at past tense production of regular and irregular verbs in Greek is not a surprising finding given the properties of the Greek past tense morphology that we presented in the introduction, thus, does not seem to contradict the findings and subsequent claims of Ullman et al. (1997). Recall that the past tense of Greek regular verbs is much less different from the past tense of irregulars than their English counterpart pairs since, unlike in English, there is no past tense form in Greek which one can claim to be the result of mere retrieval from the lexicon. The past tense of irregular verbs manifests subject agreement (six different

suffixes for each one of the three singular and plural persons) and the past tense of regular verbs is similarly inflected for subject agreement (the same six different suffixes), rendering the two types of verbs by far more similar than their English counterparts.

Put in different terms, if one considers subject agreement inflection of the Greek verb a grammatical rule as well, which applies to the past form of both regular and irregular verbs, the sharp difference between the Greek and English verbal paradigms in the past becomes obvious: Greek speakers must always apply a grammatical rule to the verb in the past, while this is not the case for English. To the above we should add the prefixation of the morpheme *e-*, which does not make a distinction between regular versus irregular verbs either.

This is also the point to note that no difference was found with respect to the processing of the past tense of regular vs. irregular Greek verbs by normal subjects in the study of Tsapkini et al. (2002). As mentioned earlier, the verbs we employed coincide with those of the above study with the advantage that our study contained more of those irregular verbs whose past tense undergoes radical stem change. Thus, our study used a more pronounced regular vs. irregular contrast, yet, no different behavior was elicited from PD patients for the two types of verbs.

Therefore, it is rather safe to conclude that the past tense formation task in Greek is indeed in no position to offer decisive evidence as to whether grammatical rules, in the sense of Ullman et al. (1997), are impaired among Greek PD patients, hence it is not in a position to offer arguments for or against Ullman et al.'s claims either. This is so, as we had predicted, because there are no verbs in the language whose past is the result of retrieving a form from the lexicon, without the application of any grammatical rules.

Let us now turn to the behavior of PD patients at passives. The results we obtained in this domain are puzzling since verbal passives have been considered the result of A-chain formation while adjectival passives have been regarded, by some researchers at least, as constituting entries of the lexicon in Greek (Lascaratou & Philippaki-Warburton, 1983/1984). Therefore, if a different behavior between the two types of passives was to be found among PD patients as a result of problems with A-chain formation, this should affect negatively verbal, rather than adjectival, passives. Nevertheless, by comparing each type of passives with actives, it seems at first glance at least that we have obtained better performance at verbal passives instead. We should note here that the reason for testing additional PD subjects was precisely in order to detect whether they would affect the previous results on verbal passives, which approached significance ( $t(24) = -1.868$ ,  $p = .074$ ). As shown in Section 3, however, the difference between actives and verbal passives

did not become significant the second time either ( $t(26) = -1.959, p = .061$ ). We will consider it to be the case that although PD patients did not behave perfect at verbal passives, they seemed to comprehend them (especially since they behaved by far above chance).

Turning now to adjectival passives, recall that Alexiadou and Anagnostopoulou (2004) and Anagnostopoulou (2001) argue that they also involve object movement in the syntax, hence they result in A-chain formation as well. If this is the case, we should expect PD patients to perform similarly at the two types of passives. We believe that they actually are doing so and this is indicated by the fact that, although they do worse at adjectival passives when compared to actives, the different performance between the two types of passives is not significant:  $t(26) = -1.396, p = .174$ . Thus, we believe that the difference between adjectival passives and actives appears to be significant only because the former are less natural in contexts in which the agent is expressed overtly (in the by-phrase). As corroborating evidence for this stand we may consider the finding that normal speakers, with admittedly extremely low error rates, made more errors at adjectival than at verbal passives (3 vs. 1 errors, respectively). Based on the above, it is rather safe to conclude that, although the PD patients experienced problems with the formation of A-chains, these are preserved in their grammar (as it emerges from their performance at both verbal and adjectival passives). Notice that Katsarou et al. (2003) reach similar conclusions regarding A-chains, based on the comprehension and production of a related structure, unaccusatives, in Greek.

Consequently, what we consider most interesting in the above findings is that the overall performance of PD patients on passives is by far better than the chance performance that crucially characterizes the performance of agrammatics at the same structure (Grodzinsky, 1986, 1995, 2000). This is, we believe, telling with respect to the nature of the impairment of PDs and suggests that, unlike agrammatics, PD patients' language is not impaired, or at least, no such indication emerges from the structures we have studied.

Let us finally turn to comparing the behavior of PDs and normal subjects. Although there were no significant differences in performance for the various structures within each group (with the exception of the adjectival passives vs. actives of PDs), the performance between the two groups was very different and this was true for all the structures studied. It is difficult to pinpoint at the present time the factor that is responsible for this large scale difference. Tentatively, we will attribute it to the computational demands of the task for the PD patients, a conclusion which Katsarou et al. (2003) have also reached, or to limitations in cognitive resources for comprehending complex material (Grossman, 1999). If on the right track, the above reasoning suggests again that

PD patients, unlike agrammatics, are not characterized by a defective language system.

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### Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at [doi:10.1016/j.bandl.2005.01.005](https://doi.org/10.1016/j.bandl.2005.01.005).

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