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Compound naming in Greek-speaking individuals with the agrammatic variant of Primary Progressive Aphasia

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Abstract

The paper reports findings obtained from a *naming by definition* task in two Greek-speaking individuals with the agrammatic variant of Primary Progressive Aphasia (PPA-G). One of the patients was at an early stage of the disease while the other was at a more advanced stage. The patient who was at a later stage produced a greater number of errors that differed significantly from healthy controls. This suggests that PPA-G affects compound naming albeit at a later stage. Qualitative error analysis highlights morphological impairment behind these difficulties in contrast to stroke induced aphasia.

Keywords: Primary Progressive Aphasia, agrammatism, compounding, morphology, naming, definition task, Stroke Aphasia

1. Introduction

The aim of the present study is to investigate whether Greek-speaking individuals with the agrammatic variant of Primary Progressive Aphasia (PPA-G) have difficulties with morphology and more specifically with the production of compound words (e.g., *ku'klospito*/'doll-house'), conducting a naming by definition task on two individuals with PPA-G.

Primary Progressive Aphasia is a neurodegenerative disease which slowly and progressively disrupts the language regions of the brain, resulting in a gradual, and initially isolated, decline in language function (Mesulam 1982, 2013). Other mental functions such as memory remain intact. According to recent guidelines, PPA can be

subdivided into three main variants on the basis of clinical and imaging criteria (Gorno-Tempini et al. 2011). The first variant is the *PPA agrammatic* (PPA-G) which is characterized by impairments of grammar (syntax and morphology) but not of word comprehension; the *semantic variant* (PPA-S) is characterized by impairments of word comprehension while the main characteristics of the *logopenic variant* (PPA-L) is intermittent word-finding hesitations and problems with repetition.

In this study we focused on PPA-G, in which agrammatism and effortful speech are the core characteristics (Thompson et al. 2012a). *Agrammatism* typically consists of short, simple phrases and omissions of grammatical morphemes (e.g., function words, inflections). *Effortful speech* refers to slow and labored speech production. Several factors can contribute to effortful, non-fluent speech in PPA-G. The most prominent factor is difficulty processing grammatical aspects of speech (Grossman 2012). Naming difficulties have been reported (Thompson & Mack 2014), as well as verb production deficits and difficulties with comprehension and production of complex sentences, i.e., passives and object relative clauses (Grossmann & Moore 2005; Thompson et al. 2012a). In contrast, single-word comprehension and object knowledge are usually relatively spared (Gorno-Tempini et al. 2011; Mesulam 2013). Regarding neuroanatomic damage, this variant affects the left posterior frontal lobe, insular regions and supplementary motor areas (Gorno-Tempini et al. 2011). Although PPA and specifically PPA-G have not been described in detail, several studies highlighted similarities between PPA-G and agrammatic aphasia caused by stroke (StrAgr). More specifically, Thompson et al. (2012b) noticed that PPA-G and StrAgr patients had common difficulties in morphosyntactic language tasks. For instance, they had difficulties in naming verbs compared to nouns (e.g., ‘swim’ vs. ‘apple’); verbs in finite form compared to infinitives (e.g., ‘swims’ vs. ‘(to) swim’); and verbs with complex argument structure (e.g., ‘write’ vs. ‘run’). The above facts suggest that there is a symmetry between PPA-G and StrAgr concerning morphosyntactic deficits (Thompson et al. 2012b, 2013).

When it comes to morphological processing, the majority of studies in PPA-G, thus far, have examined inflectional morphology (Thompson & Mack 2014 among others) while derivational morphology has been examined in the semantic variant of PPA (PPA-S) only (Auclair-Ouellet et al. 2016; Kave et al. 2012; Meteyard & Patterson 2009). It is reported that in PPA-S, while derivational rules are preserved, patients have difficulties in the final stage of word production, in which combination of the

two morphemes is validated semantically. This stage involves semantic processing, thus, it is an expected finding in PPA-S, which is characterized by semantic deficits.

However, when it comes to inflectional morphology, it appears to be relatively intact in PPA-S variant but not in PPA-G. Specifically, PPA-G is characterized by deficits in the production of correct grammatical endings in verbs and regarding comprehension, patients show declined sensitivity to agreement and tense violations (Thompson & Mack 2014).

No studies have been performed up to now on compounding in any variant of PPA. In contrast, compound production abilities have been assessed in different types of aphasia caused by stroke (Semenza et al. 1997 among others) and dementia with emphasis on Alzheimer's disease (Chiarelli et al. 2007) by using naming tasks. These studies revealed significant deficits in the domain of compounds both in aphasia as well as in dementia. Taking into account the above, the present study aims at shedding light in the language abilities of Greek-speaking patients with PPA-G by investigating a specific domain, namely the production of compounds elicited by a *naming by definition task*.

In the present study we tested whether PPA-G is associated with impaired morphological processing during compound naming. Given the reported difficulties in the grammatical aspects of speech, morphological deficits are expected in PPA-G. However, naming errors in StrAgr suggest that patients respect morphological structure and that their difficulties lie on the phonological form of compounds (Badecker 2001; Semenza et al. 1997 among others). Thus, based on the symmetry between PPA-G and StrAgr concerning morphosyntactic deficits (Thompson et al. 2012a), we expect common deficits in compound naming. Although problems in application of morphological rules are not entirely out of our assumptions, if this happens, it will be an indication that agrammatism affects differently PPA and stroke aphasia in compound naming. The hypotheses will be fully developed in Section 4.

2. Compounding in Modern Greek

Compounding is defined as one of the morphological processes of the formation of new words, combining either words or stems (Ralli 2013) depending on the language.

As we can see in (1), in Modern Greek (MG) we have mostly a combination of stems (e.g., 'eriθr' and 'derm') for the creation of compound (e.g., *eri'θrodermos*/'redskin'), unlike in English where compounds are created by the

combination of words.

(1a) MG: eri'θrodermos < eri'θros 'derma

(1b) English: redskin < red skin

The main characteristics of MG compounds according to Ralli (2013) are the following: MG compounds have a single stress and contain a semantically empty element (-o-), situated between the two constituents (e.g., 'kukl-o-spito' < 'kukla' 'spiti'), ensuring a transition between the first and the second constituent in a compound formation.

Moreover, compounds can be classified in various ways depending on their specific features. Firstly, we have three major grammatical categories, nouns (e.g., *ku'klospito*/'doll-house'), adjectives (e.g., *as'promavros*/'black&white') and verbs (e.g., *xarto'pezol*/'play cards') which combine constituents of various grammatical categories.

Secondly, compounds can be classified regarding the semantic relations holding between their constituents. Specifically, there are compounds with dependency relation between the two constituents, which is subdivided into *subordinate compounds*, in which the first constituent is an argument of the second (e.g., *θiriodama'stis*/'tamer' or *xartopezol*/'play cards') and *attributive compounds*, in which the first constituent modifies the second (e.g., *'ayri'oyata* is a 'wild cat'). A separate category are the so called *coordinative compounds*, in which no dependency relation can be found between their constituents and neither of the two constituents dominates the other on both categorical and semantic grounds. For example, *'[alato'pipero]_N* is *'[salt]_N and [pepper]_N*.

Finally, concerning the existence of an internal head, there are *endocentric compounds*, in which one of the two constituents assumes the role of the head (e.g., *'ku'klospito* is 'the house of the doll'), and *exocentric compounds*, in which none of the two constituents can be seen as the head (*'kokkino'malis* is not 'a red head' but 'someone who has red head'). Table 1 summarizes the types of compounds attested in MG.

	Nouns	Verbs	Adjectives
Dependent compounds	'ku'klospito'/ 'doll-house'	'xarto'pezo'/ 'play cards'	'ilioka'menos'/ 'sunburnt'
Coordinative compounds	'alato'pipero'/ 'salt and pepper'	'pigeno'eroxome'/ 'go and come'	'as'promavros'/ 'black&white'
Exocentric compounds	-	-	'kokkino'malis'/ 'redhead'

Table 1: Examples of the major compound categories

3. Compounding in Brain-damaged Populations

Previous psycholinguistic research indicated that word frequency, semantic transparency, existence and position of the head have a central role in compound processing (Libben 2006 for a general review). The exact contribution of these variables is still unclear, and it remains an open question how the brain processes and combines constituents in order to create a compound word.

When it comes to brain-damaged populations, the majority of evidence comes from studies with aphasia, the language disorder acquired after brain damage or stroke (StrAph) while few studies have dealt with Alzheimer's disease (AD). Focusing on naming tasks, Rochford and Williams (1965) as well as Ahrens (1977) first reported the crucial role of the first constituent's frequency, known as *frequency effect*. Specifically, it seems that the higher the frequency of the first constituent, the lower the number of errors in naming. This effect, however, is not consistent in the literature (Blanken 2000; Hittmair-Delazer et al. 1994). Regarding semantic transparency, it is reported that StrAph patients performed better in transparent compounds than opaque ones (Dressler & Denes 1989).

Moreover, it is generally reported that aphasics (Agrammatic, Wernicke, Anomic) tend to produce errors that are also compounds in compound naming which is known as *compound effect* (Chiarelli et al. 2007; Semenza & Mondini 2010). For example, in Hittmair-Delazer et al. (1994), aphasic patients would say 'spindelgrammophon' (a non-existent compound) instead of *plattenspieler*/'record player', that is, they would not respond with a single word instead of a compound word. Therefore, the patients seem to have knowledge of when the target word is a compound and when it is a single word but they fail to retrieve the exact form (Blanken 2000; El-Yagoubi et al. 2008; Semenza et al. 1997). As argued by Badecker (2001), some feature of the

compound must initiate the compositional procedure evident in these errors, given that the lexicon should not contain entries that would permit neologisms to be retrieved.

In addition, among others, Semenza et al. (1997) noticed that StrAph patients not only showed a compound effect, but tended to replace compounds with other compounds respecting their internal structure when it comes to grammatical category of constituents. For example, German-speaking aphasics reported in Hittmair-Delazer et al. (1994) showed that, in substitution errors, a correctly named constituent kept its original position, i.e., in verb-noun neologisms, the verb stem correctly appeared in the first position. These errors showed that in StrAph word formation rules are spared in retrieval errors and are processed independently from the lexical form.

Regarding lexical access, the majority of studies (Badecker 2001; Chiarelli et al. 2007; Semenza et al. 1997 among others) reported that the errors in compounds naming provide evidence in favor of a lexical access through decomposition. For instance, StrAph patients made substitution errors, that is, they substituted one of the two constituents of the compound (e.g., ‘spazzarifiuti’ instead of *portarifiuti*/‘waste bin’). Moreover, they made omission errors, that is, they omitted one of the two constituents (e.g., *lettere*/‘letters’ instead of *portalettere*/‘postman’). But in these cases, according to Badecker (2001), there were prosody indications which showed that StrAgr patients realized that they were missing one constituent. In the same study, the author also reported misordering errors like ‘box post’ instead of ‘post box’, but this did not happen with single words, that is, StrAgr patients would not say ‘*dulumpen’ instead of ‘pendulum’. Thus, Badecker (2001) argued that misorderings can be observed only when the morphological structure of the target contains two lexical slots for its components. Finally, Semenza et al. (1997) in Italian and Lorenz and Zwitserlood (2014) in German, noticed that StrAgr aphasics who generally have problems with verbs, make omission errors only in the verb constituent of nominal exocentric compounds (e.g., $[[aspira]_V[polvere]_N]_N$ /‘vacuum cleaner’).

When it comes to compound naming tasks in AD, Chiarelli et al. (2007) reported omission errors but no compound effect. In particular, AD patients omitted the noun constituents of a compound in naming tasks. This effect, Chiarelli et al. (2007) argued, would be consistent with what has been found in naming of simple words, that is, AD patients are relatively more impaired in nouns than in verbs. If this is the case, these findings also provide further evidence of decomposition processes.

To sum up, this section dealt with brain-damaged populations' studies which have explored the contribution of factors that generally play central role in compound processing. The findings clearly showed that patients with StrAph name effectively the most frequent and semantically transparent compound words and the majority of their naming errors (e.g., substitutions, misorderings) are in favor of an access through decomposition. Indeed, both StrAph and AD patients seem to decompose compound words into their constituents, but only the former have knowledge of the grammatical rules and respect the morphological structure of compounds (*compound effect*).

4. The present study

In the present research, we analyze *naming by definition* data from two Greek-speaking individuals with the agrammatic variant of PPA in order to examine their morphological abilities in compound naming. We are interested in investigating whether PPA-G patients have difficulties using morphological rules in order to produce compound words and whether they share common deficits with other pathological populations (StrAgr & AD).

Additionally, we seek to explore whether the type of compound (e.g., dependent, coordinate), the grammatical category (e.g., noun, verb, adjective) or the presence of a morphological head (e.g., endocentric vs. exocentric) differentially affect naming.

4.1 Hypotheses

Given the common performance of aphasic and PPA groups in morphosyntactic tasks (Thompson et al. 2012a), we expect PPA-G patients to exhibit similar performance in compound naming with StrAgr individuals. On this basis and given the main clinical characteristics of PPA-G, our hypotheses are the following:

The *first hypothesis* concerns the so-called *compound effect*, which is regularly noticed in StrAgr's performance (Semenza et al. 1997 among others). Specifically, we assume that if PPA-G patients make errors in compound naming, these errors will continue to be compounds and not single words, that is, patients will respect the morphological status of the target word.

The *second hypothesis* concerns the preservation of the exact compound structure also with respect to the grammatical category of compound constituents (Chiarelli et al. 2007 among others). That is, we expect to find evidence of retained knowledge of the structure of the compound, that is, of respecting constituents' boundaries and

preserving the grammatical category of the compound as a whole and of their constituents.

Continuing on the *third hypothesis*, following studies about lexical access in StrAph, we expect naming errors in favor of lexical access through decomposition such as constituent substitutions and misorderings. This would be in accordance with previous findings which report effects of decomposition, an indication of the use of morphological rules in the production of compounds (Semenza & Mondini 2010).

Additionally, we expect more errors in verbal compounds (*fourth hypothesis*). This is assumed given the clinical profile of PPA-G variant (difficulties in naming verbs) and because this effect is systematically observed in StrAgr aphasia (Semenza et al. 1997 among others).

Finally, our *fifth hypothesis* concerns the role of the head. Specifically, if headedness is a factor which affects patients' naming, then endocentric and exocentric compounds will be processed in a distinct way.

4.2 Procedure

Stimuli were presented in a unique list, comprising only compound targets in a randomized order. Participants were given the definition of a word and they were asked to provide the single-word name of the specific definition. The instructions given to the participants were the following: *I will give you the definition of a word (in the form of a question) and I want you to name the word the definition refers to; If you want, you can use the words that I have given you.* But, again, the main instruction was to name the word the definition refers to. For example, we asked the question: 'how do we call 'the house of a doll'?', and we expected the answer *ku'klospito*/'doll-house'. There was no time limit for participants to provide their answer and minor phonological alterations and articulatory distortions were ignored.

4.3 Participants

Two PPA-G patients participated in this study. The first (henceforth PPA-G1) was a 79-year-old-male and the second (henceforth PPA-G2) a 58-year-old-female. Their diagnosis was done by a multidisciplinary group in AHEPA hospital (neurologists, neuropsychologists, psychologists). Specifically, their cognitive assessment was done

through the ACE-R¹ test in which PPA-G1 scored 83/100 points, an indication that he was at an earlier stage of the disease while PPA-G2 scored 47/100, which indicated a more advanced stage of the disease². Moreover, patients participated in specific tests of BDAE³ which examined their oral speech production and comprehension abilities. Table 2 summarizes patients' scores in each neuropsychological test. Finally, MRI data showed mediate cortical atrophy for PPA-G1 and fusional atrophy in cortex and cerebellum with also moderate atrophy in hippocampus for PPA-G2. We also had two healthy individuals, who were used as elderly controls. The first was a 55-year-old-male and the second a 57-year-old-female.

ACER (100)	Attention – Orientation (18)	Memory (26)	Fluency (14)	Language (26)	Visuo- spatial (16)
PPA-G1	18	26	0	25	14
PPA-G2	11	5	3	20	8
BOSTON (80)	Oral Speech Comprehension (32)	Oral Speech Production (48)			
PPA-G1	27.5	47			
PPA-G2	22	45			

Table 2: Neuropsychological test scores (ACER & Boston tests) for PPA-G patients

4.4 Materials

The stimulus set was based on Manouilidou et al. (2012) with the necessary modifications to address the research questions of the current investigation. A total of 71 MG compounds were used in the study. Specifically, 45 compounds with dependency relation (30 nouns and 15 verbs), 15 compounds with coordinate relation (5 nouns and 10 adjectives) and 11 exocentric adjectives (see Table 3). All experimental items were matched in length and frequency of constituents and whole

¹ ACE-R (**Addenbrooke's Cognitive Examination-Revised** for Greek population) is a diagnostic tool which examines both cognitive and language skills such as memory, visuospatial abilities, fluency, attention etc. For more details, see Konstantinopoulou et al. (2011).

² Although the ACE-R does not provide official patient classification in stages, it is correct to assume that lower scores indicate a larger verbal deficit given that nature of the disease (Primary Progressive Aphasia).

³ BDAE (Boston Diagnostic Aphasia Examination – Revised for Greek population). For more details, see Tsapkini et al. (2010).

forms using the SubTlex⁴ tool. Comparisons with the Mann Whitney t-test did not yield significant differences among groups of compounds ($p > 0.05$).

Type of compound	Examples
Dependent compounds	'molivo'θiki'/'pencil case', 'agri'ogata'/'wild cat', 'xarto'pezo'/'play cards', 'sigotragu'do'/'sing softly'
Coordinative compounds	'alato'pipero'/'salt and pepper', 'vorioditi'kos'/'north and south'
Exocentric compounds	'kokkino'malis'/'redhead'

Table 3: Examples of compound targets in naming task

4.5 Results

Overall results are demonstrated in Figure 1. Elderly controls responded correctly in 97% of the cases. Statistical analysis by using the chi-square test indicated that there was no significant difference between PPA-G1 and elderly controls [$\chi^2=1.8$, $p>0.05$], whereas the performance of PPA-G2 was significantly different both from the control [$\chi^2=32.5$, $p<0.001$] and PPA-G1 patient [$\chi^2=20.3$, $p<0.001$].

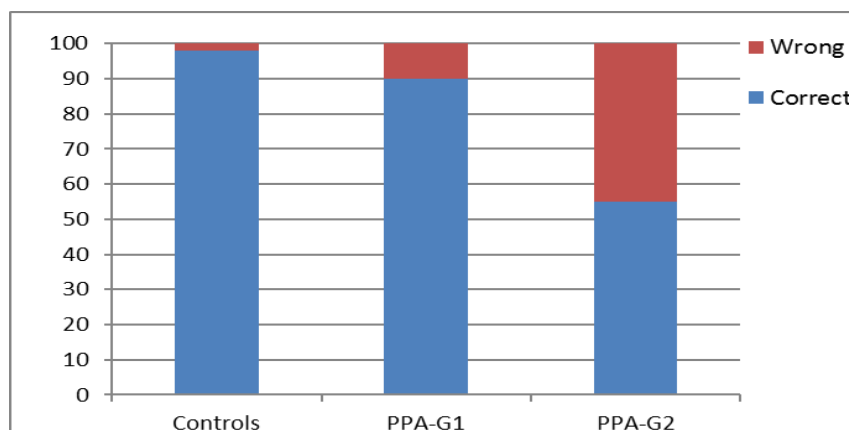


Figure 1: Percentage of correct responses both from controls and the two PPA-G patients

Figure 2 demonstrates patients' performance regarding the different types of compounds. Statistical analysis shows no significant difference between the two patients when it comes to exocentric [$\chi^2=1.5$, $p= 0.14$] and coordinative compounds

⁴ It is a database where frequencies have been posted more than 23 million words of MG. For a detailed description of the database, see Dimitropoulou et al. (2010).

[$\chi^2=3.5$, $p=0.06$] but a significant difference between the two when it comes to compounds with dependency relation between constituents [$\chi^2=14.1$, $p<0.001$]. Moreover, patients exhibited significant difference between endocentric (dependent and coordinate) and exocentric compounds (PPA-G1: [$\chi^2=4.3$, $p<0.05$], PPA-G2: [$\chi^2=26.6$, $p<0.001$]). Specifically, they made fewer errors in exocentric compounds, showing that the absence of a morphological head facilitates naming.

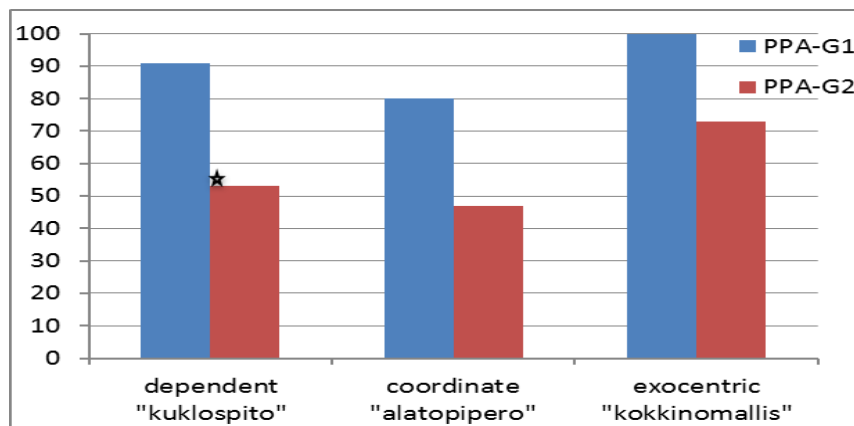


Figure 2: Percentage of correct responses in each type of compounds

Finally, Figure 3 shows results regarding grammatical categories of compounds. PPA-G2 performed significantly worse than PPA-G1, when naming nouns [$\chi^2=4.9$, $p<0.05$] as well as verbs [$\chi^2=11.2$, $p<0.001$], while results did not reach significance when it comes to adjectives [$\chi^2=0.4$, $p=0.52$]. Interestingly, in PPA-G2 patient naming verbal compounds was significantly worse than both nouns [$\chi^2=24.7$, $p<0.001$] and adjectives [$\chi^2=22.09$, $p<0.001$].

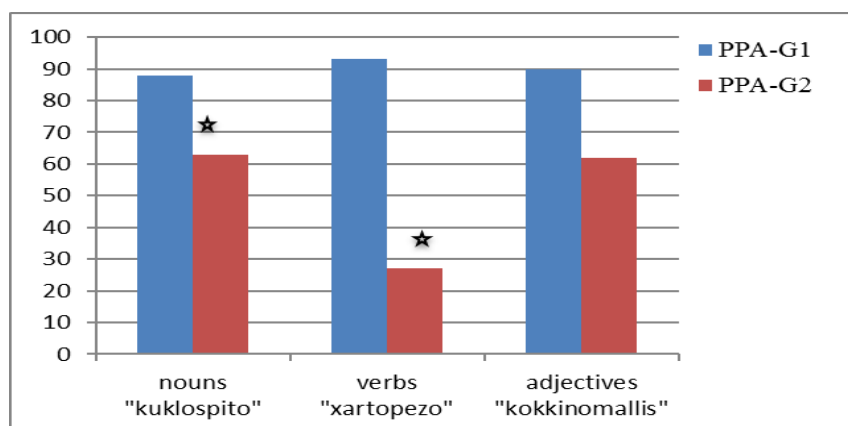


Figure 3: Percentage of correct responses in each grammatical category of compound

4.6 Error analysis

This section presents an analysis of error patterns that occurred in the production of compounds in the experiment. Firstly, PPA-G1 provided 7 erroneous responses out of 71, that is, an error percentage of 9.85%. These errors were mainly substitutions (mostly in compounds with dependency relation between constituents), single word errors and misorderings of constituents of compounds (see examples of each type of errors in Table 4).

PPA-G2's performance was significantly worse. In particular, PPA-G2 provided 32 erroneous responses (45.07%), mostly single-word errors (in dependent compounds) and circumlocutions, that is, she gave the description of the word by means of a sentence. Nevertheless, she also made fewer substitution errors and hardly any misorderings. Table 4 provides examples of error types.

Type of errors	PPA-G1	PPA-G2
Substitutions	(4/7): <i>'krea'topita'</i> / 'meat pie' instead of <i>'ti'ropita'</i> / 'cheese pie'	(4/32): <i>'krifo'vlepo'</i> / 'secretly see' instead of <i>'krifoki'tazo'</i> / 'secretly look'
Misorderings	(1/7): <i>'lefko'galanos'</i> / 'white & blue' instead of <i>'gala'nolefkos'</i> / 'blue & white'	(2/32): <i>'ksi'noglikos'</i> / 'sour & sweet' instead of <i>'gli'koksinos'</i> / 'sweet & sour'
Single-words	(1/7): <i>'mpekru'liazo'</i> / 'drink like a drunk' instead of <i>'mpekro'pino'</i> / 'drunk-drink'	(13/32): <i>'violi'tzis'</i> / 'violinist' instead of <i>'organo'pektis'</i> / 'instrument player'
Circumlocutions	(0/7)	(11/32): <i>'kipos me laxani'ka'</i> / 'a garden with vegetables' instead of <i>'laxa'nokipos'</i> / 'vegetable garden'
No answer	(1/7): -	(2/32): -

Table 4: Examples of errors in naming task from the two PPA-G patients

Results brought into light a difference between the two patients. Specifically, PPA-G1, who is at an earlier stage of the disease, made similar errors with StrAgr patients, that is, substitutions and misorderings. However, he did not differ significantly from healthy controls. It is worth noticing that StrAgr patients did not participate in this

study. Thus, the comparison between StrAgr and PPA patients is not a direct comparison stemming from the results of this experiment but it is based on the grounds of previous literature (Lorenz & Zwitserlood 2014; Semenza & Mondini 2010 for a general review). Moreover, similar results are also reported in an upcoming study which included the comparison of StrAgr aphasia and PPA-G in Greek-speaking individuals (Kordouli et al. in prep.)

In contrast, PPA-G2, who is at a later stage, made various types of errors, mostly circumlocutions and single words. These errors do not support a *compound effect* and pointing towards a difficulty with morphological structure. Finally, the only clear similarity between PPA-G2 and StrAgr patients concerns difficulties in verbal compounds as expected.

5. Discussion

The main goal of the present study was to investigate the production of compound words in PPA-G through a naming by definition task. The findings clearly indicate that PPA affects compound processing, that is, both patients made errors in naming, with PPA-G2, the patient who is at an advanced stage, making the most. This is an indication that the number of errors crucially depends on the stage of the disease. As the disease advances, naming errors increase.

Further qualitative analysis also revealed a correlation between the kind of errors and the stage of the disease, as indicated by the two different patients. For instance, at an earlier stage there are substitutions and misorderings (PPA-G1), whereas at a later stage there are mostly circumlocutions and single word errors (PPA-G2), resulting in no compound effect and possibly holistic access. In other words, it seems that PPA-G2 did not retrieve the target through constituent composition but she possibly tried to retrieve it as a whole. Because of her difficulty to find the appropriate compound word, she provided descriptions of the target (i.e., circumlocutions) or semantically related single-words. These error types are in favor of full listing models where polymorphemic words are represented as single forms in the mental lexicon and are accessed in the same way as morphologically simple words (Butterworth 1983).

The errors of PPA-G2, who is at a later stage, could be interpreted based on the framework of Levelt's model of lexical retrieval (Levelt et al. 1999). In particular, Levelt's theory conceives the production of a word as a staged process, beginning with selecting the target's word concept, *semantic level*, continuing with the *lemma*

level, where morphosyntactic information about the target word is stored and ending with the *lexeme level*, which consists of phonological target form retrieval.

The deficit in PPA-G2 patient probably lies in *lemma level*, which concerns the morphological form of a compound. Specifically, the circumlocutions and single word errors showed that the patient has a difficulty in the way compound constituents should be combined suggesting that the patient is unable to use morphological rules in order to produce a compound from its constituents. Thus, PPA-G2's performance indicates that the difficulties appear *before* gaining access to the compounds' phonological form, indicating an impaired lemma level.

Her performance is in line with the reported grammatical disturbances which generally characterize the PPA-G variant. Specifically, the impairment of an operation that involves morphological processing is an expected finding in PPA-G, because the grammatical abilities deteriorate and grammatical deficits are evident across linguistic domains in both production and comprehension (Thompson & Mack 2014) in this variant.

Given the different performance of the two patients, we could argue that the stage of the disease affects word production in a different way. Specifically, at an earlier stage, PPA-G affects naming to a lesser degree and the patient is still able to use morphological rules to produce a compound word. As the disease progresses, naming is disturbed and the problems are found at the stage which is related to morphology (lemma level).

In an attempt to correlate these results with previous literature from StrAph, we notice that symptoms of agrammatism and deterioration of grammar both in PPA-G and StrAgr aphasia did not guarantee the same performance in all domains of grammar. Therefore, in contrast with StrAgr aphasia which is supposed to affect the phonological form of the compound (Semenza & Mondini 2010), PPA-G seems to affect the morphological form of a compound word. In order to examine the effects of agrammatism in stroke-induced and primary progressive aphasia in Modern Greek, Kordouli et al. (in prep.) compared PPA-G and StrAgr patients on compound naming and found that there are differences in their performance which replicate previous findings.

Moreover, no correlation between the number of errors and the type of compound (dependent, coordinate) was found which means that the distinct characteristics of each type, that is, the different semantic relations between their constituents do not

affect naming. However, the significantly better performance in exocentric compounds indicates that the existence of the head into internal structure does affect naming. Finally, we have hints that the grammatical category, that is verbs, influences the naming only at a later stage of the disease, which is a clear similarity with StrAgr patients.

6. Conclusion

The present study examined the ability of PPA-G patients in a naming by definition task in MG compounds. It seems that the stage of the disease plays a key role in patients' performance with an advanced stage being associated with more errors in compound naming. Furthermore, the type of errors, namely, circumlocutions and single-word errors, points towards a morphological deficit, that is, an unawareness of compound status, compound structure and rules of compounding. Finally, it seems that the existence of the head in the compound structure disrupts performance, suggesting that the role of the head does play role in naming. Given that the present study is the first one dealing with compound processing in PPA, more detailed studies are required in order to further clarify the production mechanisms for compounds in PPA-G.

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