Journal of Neurolinguistics xxx (xxxx) xxx–xxx

Contents lists available at ScienceDirect

Journal of Neurolinguistics

journal homepage: www.elsevier.com/locate/jneuroling

Compound production in agrammatism: Evidence from stroke-induced and Primary Progressive Aphasia☆

Konstantina Kordouli[a,*], Christina Manouilidou[b], Stavroula Stavrakaki[c], Dimitra Mamouli[d], Katerina Afantenou[c], Panagiotis Ioannidis[d]

[a] Department of Philology, Linguistics Section, University of Patras, Greece
[b] Department of Comparative and General Linguistics, Faculty of Arts, University of Ljubljana, Slovenia
[c] Department of Italian Language and Literature, Aristotle University of Thessaloniki, Greece
[d] Faculty of Medicine, Aristotle University of Thessaloniki, Greece

ARTICLE INFO

Keywords:
Stroke aphasia
Primary progressive aphasia
Agrammatism
Compounding
Morphology
Production

ABSTRACT

The present multiple case study investigates the production of compound words in three Greek-speaking individuals with agrammatism, as a symptom either of stroke-induced aphasia or Primary Progressive Aphasia (PPA). Two off-line tasks were conducted, a *picture naming* and a *production by definition task*, using different types of compounds, in order to examine patients' ability to produce complex morphological structures and the impact of specific compound properties. Results showed that all patients' performance was significantly more impaired compared to healthy controls. Qualitative analysis revealed different error patterns for each pathological condition, suggesting that agrammatism in stroke-induced and primary progressive aphasia does not necessarily result in the same deficits when it comes to morphological processing. Moreover, heterogeneous results emerged for the two PPA patients which further highlight the progressive nature of PPA as a crucial factor in complex word retrieval.

1. Introduction

When it comes to morphological processing, the investigation of word-formation operations, that is, *inflection*, *derivation*, and *compounding* is very crucial in brain-damaged populations, given that most of them exhibit deficits at the lexical level. By examining patients' abilities in each morphological operation, we are able to disentangle the type of knowledge required (lexical, morphological, grammatical, semantic) that could be selectively affected by patients' deficits. Despite the fact that the outcome of all three operations is the formation of a unique lexical item by using morphological rules, each has its own particularities. Specifically, *inflection* creates different forms of a word by combining a stem with a finite number of inflectional affixes which convey morphosyntactic information about the words they modify i.e., number, person, tense, case, etc. (e.g., *walk* > *walk-ed, cat* > *cat-s*). Thus, for the correct production of an inflected word, individuals need to use their knowledge of grammar and morphology in selecting the affix which best conveys the grammatical meaning they need to produce and also in evaluating the right grammatical category of the base, given that affixes select for specific grammatical categories.

Similarly, *derivation* also involves knowledge of morphological rules as derivational affixes are added to stems. These affixes, however, do not carry morphosyntactic features but mostly *semantic* as they form a new meaning (Bauer, 2008; Booij, 2013, pp.

☆ This work is supported by Grant EO43, Research Committee of the University of Patras (Program K. Karatheodori).
* Corresponding author.
E-mail address: konkordouli@gmail.com (K. Kordouli).

https://doi.org/10.1016/j.jneuroling.2018.02.009
Received 28 July 2017; Received in revised form 27 February 2018; Accepted 28 February 2018

255–273). However, for the correct production of a derived word grammatical knowledge is also required, given that combinatorial processes involve evaluation of grammatical category of the stem as well as of various grammatical features of the base, as it is the case, for example, with the prefix *re*-in English, which requires an internal affected argument and selects unaccusative verbs (e.g., *reemerge*) and transitive accomplishments (e.g., *rebuild*), but not unergative (**redance*), not transitive achievements (**rekick*) and not stative verbs (**rebelieve*), thus being liable to argument structure constraints of the base it attaches to (Horn, 1980; Manouilidou & Stockall, 2014; Marantz, 2007).

On the other hand, *compounding* involves the combination of two lexical items (Dressler, 2006) and not of one lexical item and a bound affix as in the other two processes. The new lexical item combines the meanings of the constituent lexemes and several studies highlight the crucial role of constituents' semantic transparency and their semantic relations in compound processing (see Fiorentino & Poeppel, 2007; Gagné & Spalding, 2009; Manouilidou, Ralli, & Kordouli, 2012, among others). However, the creation and interpretation of a compound is not merely a result of *semantic* processes. Frequency, length and headedness (as a carrier of semantic but also grammatical information which characterizes the whole of compound) are also properties which impact the processing of compounds (Andrews, Miller, & Rayner, 2004; Arcara, Marelli, Buodo, & Mondini, 2013; El Yagoubi et al., 2008; Jarema, Perlak, & Semenza, 2010; Libben, Gibson, Yoon, & Sandra, 2003; Marelli, Crepaldi, & Luzzatti, 2009). This is particularly relevant in languages with rich morphology such as Greek, where the creation of a compound requires the evaluation of *grammatical* features (i.e., grammatical category, gender, inflectional class) of both constituents as well as certain *morphological* transformations of constituents in order to fit in the appropriate compound structure (see subsection 1.2). Hence, the correct production of a compound requires the combination of grammatical knowledge, as well as morphological and semantic, thus, making it a particularly interesting domain of study when it comes to populations with different types of deficits.

In the current study, we seek to investigate how individuals with stroke-induced agrammatism (StrAgr) and agrammatism induced by Primary Progressive Aphasia (PPA-G) *produce* and *name* compounds. Given that compounding fits within the realm of grammatical, morphological and semantic processing, the study will allow us to investigate how these types of knowledge interact at the word level and how they are affected in two populations who are characterized by similar grammatical deficits, especially at the sentence level, but different performance at the word level. In what follows we will provide information regarding the populations under investigation with a special focus on previous research highlighting their performance on morphological processes. Also, a brief section on Greek compounding will shed light on the particularities of this operation in the specific language, stressing the involvement of various types of knowledge for the creation of a compound.

1.1. Morphological processing in StrAgr and PPA-G

Stroke-induced agrammatic aphasia (StrAgr) is a form of aphasia which results from injury (e.g., trauma or stroke) to speech and language brain areas (Thompson, den Ouden, Bonakdarpour, Garibaldi, & Parrish, 2010; Vanier & Caplan, 1990, pp. 37–113). Although there is heterogeneity among agrammatic individuals in the deficit patterns they present, a bulk of studies reports that many StrAgr patients exhibit non-fluent/effortful speech and impairments in comprehension and production of complex syntactic structures (Caplan & Hildebrandt, 1988; Grodzinsky, 2000). Moreover, a disproportionate damage in function words compared to content words (Goodglass & Menn, 1985, for a review), and a predominant impairment of verbs compared to nouns have almost always been found in StrAgr individuals (Miceli, Silveri, Villa, & Caramazza, 1984; Zingeser & Berndt, 1990). In addition to dissociations concerning grammatical category, patients also present with argument structure deficits (Thompson, Lange, Schneider, & Shapiro, 1997, 2012b, 2013b). Specifically, they evince greater difficulties with verbs requiring a greater number of arguments, that is, transitive verbs are more impaired than intransitives (Luzzatti et al., 2001; De Bleser & Kauschke, 2003).

Primary Progressive Aphasia is a clinical syndrome caused by a neurodegenerative disease, in which the language is the main area of dysfunction for at least the initial stages of the disorder, while other cognitive functions such as memory, behavior and visuospatial abilities deteriorate as the disease progresses (Mesulam, 1982, 2013). Based on language impairments and neuropathological criteria, three major PPA variants have been identified (Gorno-Tempini et al., 2011, 2004; Maruta, Pereira, Madeira, De Mendonça, & Guerreiro, 2015; Mesulam, Wieneke, Thompson, Rogalski, & Weintraub, 2012, 2009): *semantic PPA* (PPA-S), which is linked to deficits in semantic knowledge and object naming; *logopenic PPA* (PPA-L), which is characterized by impaired word retrieval and sentence repetition; and *non-fluent/agrammatic PPA* (nfa-PPA), which is associated with two core features, effortful speech and/or agrammatism in language production; either of which is sufficient for classification. Group studies which examined connected speech samples in nonfluent/agrammatic PPA documented inconsistencies regarding the emergence of features of frank agrammatism in this variant (i.e., omission and/or substitution of grammatical morphemes with associated grammatical errors) (see Graham et al., 2016; Wilson et al., 2010). Given the dissociation between fluency and grammatical ability in nfa-PPA, the term *agrammatic PPA* (PPA-G) appeared in order to refer to cases where grammatical impairments are a prerequisite with or without halting speech (Mesulam et al., 2009; Thompson & Mack, 2014; Thompson et al., 2012). Although some studies have also reported subtle grammatical deficits in PPA-S and PPA-L variants (Meteyard & Patterson, 2009; Wilson et al., 2010), PPA-G patients present with grammatical impairments distinct from those associated with the other PPA types. Specifically, PPA-G individuals exhibit agrammatic deficit patterns, namely, difficulties in producing grammatical sentences, frequently labored articulation and lack or misuse of function elements, i.e., tense, possessives and pronouns (Thompson & Mack, 2014).

Agrammatism is the core clinical feature in both StrAgr aphasia and PPA-G, albeit brain damage associated with distinct pathophysiological causes. Stroke aphasia emerges due to a cerebrovascular event which disrupts cortical and/or subcortical language networks, whereas in PPA the underlying neurodegenerative disease affects the language regions gradually and progressively. This means that even though these regions are compromised, they may continue to function (Mesulam, 1982, 2007; Sonty et al., 2003).