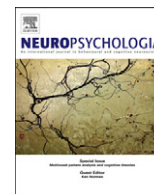




ELSEVIER

Contents lists available at SciVerse ScienceDirect

## Neuropsychologia

journal homepage: [www.elsevier.com/locate/neuropsychologia](http://www.elsevier.com/locate/neuropsychologia)

## Electrophysiological responses to argument structure violations in healthy adults and individuals with agrammatic aphasia

Aneta Kielar<sup>a,b</sup>, Aya Meltzer-Asscher<sup>a,b,\*</sup>, Cynthia K. Thompson<sup>a,b,c</sup>

<sup>a</sup> Aphasia and Neurolinguistics Research Laboratory, Northwestern University, Frances Searle Building, 2240 Campus Drive, Evanston, IL 60208, USA

<sup>b</sup> Department of Communication Sciences and Disorders, Northwestern University, Evanston, IL 60208, USA

<sup>c</sup> Department of Neurology, Northwestern University, Evanston, IL 60208, USA

### ARTICLE INFO

#### Article history:

Received 9 February 2012

Received in revised form

29 August 2012

Accepted 4 September 2012

Available online 26 September 2012

#### Keywords:

Verb argument structure

Event related potentials

Language-related brain potentials

N400

P600

Semantic processing

Agrammatic aphasia

### ABSTRACT

Sentence comprehension requires processing of argument structure information associated with verbs, i.e. the number and type of arguments that they select. Many individuals with agrammatic aphasia show impaired production of verbs with greater argument structure density. The extent to which these participants also show argument structure deficits during comprehension, however, is unclear. Some studies find normal access to verb arguments, whereas others report impaired ability. The present study investigated verb argument structure processing in agrammatic aphasia by examining event-related potentials associated with argument structure violations in healthy young and older adults as well as aphasic individuals. A semantic violation condition was included to investigate possible differences in sensitivity to semantic and argument structure information during sentence processing. Results for the healthy control participants showed a negativity followed by a positive shift (N400–P600) in the argument structure violation condition, as found in previous ERP studies (Friederici & Frisch, 2000; Frisch, Hahne, & Friederici, 2004). In contrast, individuals with agrammatic aphasia showed a P600, but no N400, response to argument structure mismatches. Additionally, compared to the control groups, the agrammatic participants showed an attenuated, but relatively preserved, N400 response to semantic violations. These data show that agrammatic individuals do not demonstrate normal real-time sensitivity to verb argument structure requirements during sentence processing.

© 2012 Elsevier Ltd. All rights reserved.

### 1. Introduction

Auditory sentence comprehension requires rapid analysis of complex auditory signals and construction of syntactic structures and meaning representations. Models of language processing suggest that phonological, syntactic and semantic information is accessed and coordinated within milliseconds in order to successfully understand sentences (Friederici, 2002; Friederici & Kotz, 2003; Hagoort, 2003; Kaan & Swaab, 2002). In particular, integration of information associated with verbs is essential for successful sentence comprehension. Verbs are central elements in this process because they specify the number of arguments that appear in the sentence, the thematic roles of these arguments (e.g., *agent*, the performer of an action; *theme*, the recipient of the action), the syntactic positions in which they occur (subject, direct object, etc.) and their syntactic realization (noun phrase, prepositional phrase, clause, etc.; This information is also referred to as *subcategorization* information). For instance, the intransitive

verb *sneeze* requires only one, external, argument (an agent) as in: *John sneezed*. In contrast, the transitive verb *fix* requires two arguments (an agent and a theme) as in: *John fixed the car*. Other verbs take three arguments, requiring an agent, a theme, and a goal (e.g., *John gave the book to the teacher*).

A growing number of studies demonstrate that argument structure information of verbs is immediately and automatically activated during sentence processing (Carlson & Tannenhaus, 1988; MacDonald, Pearlmutter, & Seidenberg, 1994; Mauner & Koenig, 2000; Shapiro, Brookins, Gordon, & Nagel, 1991; Shapiro, Gordon, Hack, & Killackey, 1993; Shapiro & Levine, 1990; Trueswell & Kim, 1998). For example, in a series of studies using a cross-modal lexical decision task, Shapiro and colleagues showed that lexical decision times to visually presented targets were longer when presented in the vicinity of verbs with more argument structure/subcategorization options. In addition, it has been shown that verbs prime for their arguments (Ferretti, McRae & Hatherell, 2001), and that a verb's thematic specifications are used to pro-actively restrict the domain of subsequent reference (Altmann & Kamide, 1999).

Verb argument structure processing ability in individuals with Broca's (agrammatic) aphasia, however, is unclear. Several studies have found impairments in producing verbs and sentences with

\* Corresponding author at: Aphasia and Neurolinguistics Research Laboratory, Northwestern University, Frances Searle Building, 2240 Campus Drive, Evanston, IL 60208, USA. Tel.: +1 847 467 7591; fax: +1 847 467 7377.

E-mail address: [a-meltzer-asscher@northwestern.edu](mailto:a-meltzer-asscher@northwestern.edu) (A. Meltzer-Asscher).

complex argument structures. For example, Kim and Thompson (2000) found that for English-speaking agrammatic individuals, three-argument verbs were more difficult to produce than two-argument verbs. A similar deficit was found in sentence production, evidenced by greater difficulty when producing sentences with more arguments as compared to those with fewer arguments (Thompson, Dickey, Cho, Lee, & Griffin, 2007; Thompson, Lange, Schneider, & Shapiro, 1997). These effects have been observed across different languages including English (Kim & Thompson, 2004; Thompson 2003) German (De Bleser & Kauschke, 2003), Dutch (Jonkers & Bastiaanse, 1996, 1998), Italian (Luzzatti et al., 2002), Hungarian (Kiss, 2000), and Russian (Dragoy & Bastiaanse, 2009).

The nature of this deficit, however, is not completely understood. Some findings suggest that the lexical representation of verb argument structure may be preserved in individuals with agrammatic aphasia. For example, studies have shown normal activation of argument structure and subcategorization information in cross-modal lexical decision tasks such as the ones discussed above (Shapiro & Levine, 1990; Shapiro et al., 1993). In addition, the agrammatic participants in Kim and Thompson (2000, 2004) showed no effect of argument structure complexity on comprehension in a word-to-picture matching task, performing at normal levels.

In two studies, Kim and Thompson (2000, 2004) also tested patients' ability to detect verb argument structure violations in a grammaticality judgment task in sentences with a missing obligatory argument (e.g. *\*The woman is giving the sandwich*; *\*The boy is carrying*) or with a noun phrase following an intransitive verb (e.g. *\*The dog is barking the girl*). In both studies, agrammatic participants performed at near normal level (means 93.6% correct, 92.1% correct, respectively). Grodzinsky and Finkel (1998) found a similar pattern in a study testing verb argument structure (and other syntactic) violations. In that study some sentences contained violations similar to those of Kim and Thompson: transitive verbs lacking an obligatory direct object (*\*The children threw*). In addition, they included verbs with semantically inappropriate complements (*\*The children sang the football over the fence*). Results showed mean performance at 91% correct.

Notably, grammaticality judgment is an off-line task, where participants make their responses after sentences have been fully presented. In contrast, on-line measures allow observation of the sentence processing as it unfolds in time. Event-related potentials (ERPs), in particular, provide continuous records of cognitive activities associated with language processing, and can thus offer more direct information as to the underlying cause of sentence processing impairments in agrammatic aphasia.

ERPs have been used extensively to investigate the time course of semantic and syntactic processes involved in language comprehension. Processing of semantic anomalies has been shown in many studies to be associated with a centro-parietally distributed negativity peaking around 400 ms post stimulus onset, labeled the 'N400'. In a pioneering study, Kutas and Hillyard (1980) found that the N400 component is elicited by presentation of semantic anomalies, indicating that it is sensitive to the semantic relations between individual words in the preceding language input. Subsequent studies in both auditory and visual domains found similar effects, suggesting that N400 amplitude reflects semantic processing, associated with restrictions resulting from sentence or discourse context (Connolly & Phillips, 1994; Friederici, Pfeifer, & Hahne, 1993; Holcomb, & Neville, 1990; Munte, Heinze, & Mangun, 1993; Rösler, FriedericiPütz, & Hahne, 1993; Osterhout & Nicol, 1999; van Berkum, Brown, & Hagoort, 1999). The N400 component also has been associated with lexical-semantic integration (Brown & Hagoort, 1993; Osterhout & Holcomb, 1992), with increasing semantic integration demands associated with increases in N400 amplitude.

In contrast to N400 semantic violations, manipulations of syntactic structure are associated with two main ERP components: a left anterior negativity (LAN) between 100 and 500 ms, and a late centro-parietal positivity peaking at around 600 ms, labeled the 'P600'. The P600 component has been found to be sensitive to a variety of syntactic anomalies, including phrase structure violations (Friederici, Hahne, & Mecklinger, 1996; Neville, Nicol, Bars, Forster, & Garrett, 1991), errors of agreement (Coulson, King, & Kutas 1998; Osterhout & Mobley, 1995), verb inflection (Gunter & Friederici, 1999; Osterhout & Nicol, 1999), and subcategorization violations (Ainsworth-Darnell, Shulman, & Boland, 1998; Osterhout, Holcomb, & Swinney, 1994). The P600 also has been found for garden-path sentences as well as other grammatical, but syntactically nonpreferred, constructions (Osterhout & Holcomb, 1992, 1993; Osterhout et al., 1994). More recently, the P600 component has been conceived of as an index of syntactic reprocessing cost (Osterhout et al., 1994), syntactic complexity or ambiguity (van Berkum, Brown, & Hagoort, 1999), or syntactic integration difficulty in general (Kaan, Harris, Gibson, & Holcomb, 2000). Based on these findings, it has been proposed that this late positivity reflects processes of syntactic reanalysis and repair (Friederici et al., 1996; Friederici & Kotz, 2003; Friederici & Meyer, 2004; Friederici & Weissenborn, 2007; Gunter, Stowe, & Mulder, 1997).

Several ERP investigations have found distinct electrophysiological signatures for different aspects of verb processing. Specifically, violations of subcategorization requirements (e.g. *\*The cousin visited to the violinist* instead of *The cousin visited the violinist*) are associated with a LAN-P600 pattern, related to syntactic processing, as mentioned above. In contrast, violations of the correct number of arguments (e.g. *\*The cousin dawdled the violinist*) elicit a biphasic N400-P600 pattern (Friederici & Frisch, 2000; Friederici & Meyer, 2004; Frisch et al., 2004), reflecting both semantic and syntactic violations. This latter pattern has been interpreted to reflect different aspects of lexical-thematic integration process. The N400 results from difficulty in integration of thematic information when obligatory arguments are missing (e.g., *\*John gives a car*), or when illicit arguments are present (e.g., *\*John sleeps a bed*), whereas the P600 reflects an attempt at syntactic reanalysis or repair following thematic integration failure. This interpretation is consistent with Frisch and Schlesewsky (2001) who found an N400-P600 pattern for German sentences with two noun phrases marked as grammatical subjects, arguably causing a similar failure of thematic integration. It is likewise consistent with the idea that the P600 effect does not reflect the detection of outright syntactic or semantic violations. Rather, it reflects accommodation processes arising from a surprising or dispreferred sentence continuation, as argued by Friederici and Frisch (2000).

Event-related potentials also have been used to study language deficits in aphasia. Several ERP studies investigated aphasic participants' lexical-semantic processing. In one such study, Swaab, Brown, and Hagoort (1997) investigated ERP responses to auditorily presented sentences containing a semantically anomalous word in sentence final position (e.g., *\*The girl dropped the candy on the sky*). The authors found that as a group, patients showed a preserved N400 effect to semantic violations. However, these effects were modulated according to the degree of comprehension deficit, such that individuals with severe comprehension deficits showed a reduced and delayed N400 effect, whereas those with mild deficits showed N400 patterns similar to those of normal controls. Similar results are reported in Hagoort, Brown, and Swaab (1996) in a study using unrelated and related word pairs. In another study in Dutch, Wassenaar and Hagoort (2005) reported a reduced and delayed N400 effect to semantic violations for patients with Broca's aphasia in the visual modality.

Download English Version:

<https://daneshyari.com/en/article/7322154>

Download Persian Version:

<https://daneshyari.com/article/7322154>

[Daneshyari.com](https://daneshyari.com)