Journal of Neurolinguistics 44 (2017) 107–119

Contents lists available at ScienceDirect

Journal of Neurolinguistics

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

Effects of word order and morphological information on Japanese sentence comprehension in nonfluent/agrammatic variant of primary progressive aphasia

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ARTICLE INFO

Article history:
Received 4 October 2016
Received in revised form 21 March 2017
Accepted 26 March 2017
Available online 7 April 2017

Keywords:
Heuristics
Morphological information
Particle
Primary progressive aphasia
Sentence comprehension
Word order

ABSTRACT

A clinical feature of the nonfluent/agrammatic variant of primary progressive aphasia (naPPA) is asyntactic comprehension. Previous studies have suggested that patients with asyntactic comprehension will probably rely on heuristics, such as considering the first noun as the agent. Japanese is a subject–object–verb language with a flexible word order and overt morphology; therefore, as subject-initial word order can be reordered by a transformation termed as scrambling, the flexible word order and rich morphology in Japanese may affect the sentence comprehension deficits in naPPA. This study aims to clarify the effects of word order and morphological information, such as case particle or verb inflection, on the comprehension of Japanese sentences in naPPA. Four patients with naPPA and 14 age-matched healthy controls were tested. Sentence comprehension was assessed using picture–sentence verification tasks with semantically reversible sentences. Four different sentence types were tested: subject-initial active (agent-first), scrambled active (theme-first), subject-initial passive (theme-first), and scrambled passive (agent-first). Compared with healthy controls, all patients demonstrated lower performance accuracy for the noncanonical sentences; however, there were no significant differences in performance accuracy for the canonical sentences. For the noncanonical sentences, all patients performed at significantly above chance levels for both the subject-initial and scrambled passive sentences but performed at chance levels for the scrambled active sentences. These results indicated that patients with naPPA would not only resort to the heuristics based on word order but will also intermittently use morphological information, and the heuristics would conflict with morphological information for the scrambled active sentences, which affects sentence comprehension deficits in naPPA.

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http://dx.doi.org/10.1016/j.jneuroling.2017.03.006
0911-6044/

1. Introduction

Primary progressive aphasia (PPA) is a neurodegenerative disorder characterized by declining language ability and frontal atrophy (Grossman, Rhee, & Moore, 2005). A type of PPA known as nonfluent/agrammatic variant of PPA (naPPA) presents with the clinical characteristics of grammatical simplification and language production errors, effortful speech with speech sound errors, and asyntactic comprehension (Gorno-Tempini et al., 2011; Grossman, 2012). Asyntactic comprehension, a condition characterized by the impaired comprehension of sentences with syntactically complex structures, can be caused by several neurological profiles, including not only naPPA but also focal lesions such as cerebrovascular disease and glioma in the left inferior frontal gyrus (IFG) or left lateral premotor cortex (LPMC) (Druks & Marshall, 1995; Kinno et al., 2009; Peelle et al., 2008; Pulvermuller, 1995). However, unlike focal lesions, naPPA is associated with the gradual and selective loss of cortical neurons in the language network, which leads to more subtle perturbations and dissociations (Mesulam, 2013). Neuropsychological evaluations of sentence comprehension in patients with naPPA have, therefore, provided new insights into understanding asyntactic comprehension.

Asyntactic comprehension has been found to be most prevalent for sentences with noncanonical word order, such as passive sentences (Caramazza & Miceli, 1991; Caramazza & Zurif, 1976; Kinno et al., 2009). The classic model for asyntactic comprehension is the mapping deficit hypothesis (Myrna F Schwartz, Linebarger, Saffran, & Pate, 1987), which suggests that asyntactic comprehension is because of deficits in utilizing syntactic information to assign thematic roles to the noun phrase (NP) in a sentence. Although several hypotheses have been proposed to account for these deficits (Beretta & Campbell, 2001; Burchert, De Bleser, & Sonntag, 2003; Grodzinsky, 1995, 2000; Hanne, Burchert, De Bleser, & Vasishth, 2015; O'Grady & Lee, 2001; Thompson & Choy, 2009), it is a common understanding that asyntactic comprehension may stem from the deficits in using not only syntactic information, such as word order, but also morphological information, such as case particle or verb inflection. To determine suitable explanations for the sentence comprehension deficits in patients with naPPA, the effects of both the syntactic and morphological information should be considered.

Japanese is a subject–object–verb language with overt case morphology. Grammatical functions are first marked by postposition particles that in turn allows for the assignment of thematic roles (Table 1). The generative model can linguistically explain the Japanese passive sentence. Consider the following Japanese sentences:

(1a) *Taro-ga Jiro-o oshita* ("*Taro pushed Jiro*")
(1b) *Jiro$_i$-ga Taro-ni* $\boldsymbol{t_i}$ *osareta* ("*Jiro$_i$ was pushed* $\boldsymbol{t_i}$ *by Taro*")

(1a) is a subject-initial active sentence and (1b) is a subject-initial passive sentence. The particle "*-ga*" is a nominative case particle, "*-o*" is an accusative case particle, and "*-ni*" is an oblique case particle. In addition, passiveness is also marked in the verb-suffix conjugation (*-areta*). This type of passivation is the so-called direct passive and exhibits the characteristics of the English passive. As shown in (1b), the logical object (i.e., theme) appears as the grammatical subject and the logical subject (i.e., agent) appears as the "*ni*-phrase," corresponding to the "by-phrase" in English (Hagiwara, 1993). In the generative model, (1b) is generated from (1a) by moving the object/theme NP "*Jiro-o*" to the initial position, with verb inflection. Then, the NP "*Jiro-o*" leaves a trace ($\boldsymbol{t_i}$).

Due to this rich morphology, Japanese has a flexible word order; therefore, subject-initial word order can be reordered by a transformation termed as "scrambling" (Karimi, 2003; Nemoto, 1999; Sabel & Saito, 2005). The generative model can also linguistically explain scrambled active and passive sentences. Consider the following active sentences:

(2a) *Taro-ga Jiro-o oshita* ("*Taro pushed Jiro*").
(2b) *Jiro$_i$-o Taro-ga* $\boldsymbol{t_i}$ *oshita* ("*Taro pushed Jiro*").

(2a) is a subject-initial active sentence and (2b) is a scrambled active sentence. (2b) is generated from (2a) by moving the object/theme NP "*Jiro-o*" to the initial position, without verb inflection. Then, the NP "*Jiro-o*" leaves a trace ($\boldsymbol{t_i}$). Now, consider the following passive sentences:

Table 1
Examples of the four two-argument sentences.

	Active sentence "*Taro pushed Jiro*"			Passive sentence "*Jiro was pushed by Taro*"		
Subject-initial	*Taro-ga* subject/agent *Taro*	*Jiro-o* object/theme *Jiro*	*Oshita* *pushed*	*Jiro-ga* subject/theme *Jiro*	*Taro-ni* oblique/agent *by Taro*	*Osareta* *was pushed*
Scrambled	*Jiro-o* object/theme *Jiro*	*Taro-ga* subject/agent *Taro*	*Oshita* *pushed*	*Taro-ni* oblique/agent *by Taro*	*Jiro-ga* subject/theme *Jiro*	*Osareta* *was pushed*

Note: Japanese translations, in which each noun is labelled as subject/object/oblique and agent/theme, and word-for-word English translations are shown.