Journal of Neurolinguistics 33 (2015) 118–127

Contents lists available at ScienceDirect

Journal of Neurolinguistics

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

Neural basis for processing hidden complexity indexed by small and finite clauses in Mandarin Chinese

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ARTICLE INFO

Article history:
Received 27 March 2014
Received in revised form 19 August 2014
Accepted 19 August 2014
Available online 11 September 2014

Keywords:
Language processing
Syntax
Semantics
Mandarin Chinese

ABSTRACT

In this study we investigate how the human brain processes small clauses and finite clauses. Small clauses are instances of 'simpler' syntax in the sense that they do not involve operations such as Move and Tense, and have been argued to represent an earlier stage of syntactic evolution before the development of fully-fledged syntax (Bickerton, 1990; Jackendoff 2010; Uriagereka, 2008). Understanding how the brain processes instances of different levels of syntactic complexity may further our understanding of (i) the analytical functions of specific brain regions, and (ii) the distribution of labor in the interpretation or different levels of syntax. To pursue this hypothesis, we ask whether small clauses require different analytical processes than regular syntax. This report provides evidence that they do. In an fMRI study of syntactic processing in a group of Mandarin speakers, small clauses showed greater activation of areas involved in semantic processing. In addition, both small and finite clauses showed substantial activation of areas implicated in syntactic and semantic processing, including significant RH activation.

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http://dx.doi.org/10.1016/j.jneuroling.2014.08.005

We interpret these findings with reference to Levinson's articulatory bottleneck: structures which appear simpler in terms of syntactic production may require more effort in parsing.

1. Introduction

In the growing field of evolutionary linguistics, one fundamental question regarding the human language faculty is whether it evolved gradually or not. While Chomsky and the Minimalist school suggest that syntax is too abstract for gradual adaptive evolution, Darwinian approaches would argue in favor of such gradual evolution. Indeed even within Minimalist Syntax scholars such as Progovac argue for a gradual evolution of grammar (Progovac, 2010).

While a sudden mutation as the one implied in Chomsky's approach is difficult to prove or disprove, gradual theories of evolution can be tested. In evolutionary approaches to language a useful concept to discuss the type of evolution that might have led to modern language is the notion of proto-syntax (Bickerton, 1990; Hurford, 2012; Jackendoff, 1999, 2002, 2010). In this view we envisage a series of different stages of evolution which include a purely symbolic phase, a phonetic phase and then, immediately preceding the development of hierarchical phrase structure, a proto-linguistic phase (Jackendoff, 1999, 2002, 2010). The proto-linguistic phase – or proto-syntax – can be identified by a number of linguistic 'fossils', i.e. properties of proto-syntax that still survive in modern languages. These fossils are universal in language and behave in particular ways: in particular they emerge early on in language development and they are retained in aphasia, suggesting that they might trigger a different kind of processing from fully-fledged syntax. They include formulaic speech, Noun–Noun compounds as well as adverbial and prepositional phrases, in other words phrases where semantic relationship is established by linear order only and not signaled by any higher order hierarchical structure. A type of structure that has been categorized as proto-syntax is the small clause. Small clauses are simply put argument-predicate constructions, such as 'Mary angry' that allegedly existed before Merge, Move and Tense and as such may belong to an 'older' stage of the language faculty (Progovac, 2010; Uriagereka, 2008).

In this study we test whether small clauses are processed differently in the human brain from non-finite clauses. If small clauses are indeed part of proto-syntax and represent an earlier stage in the evolution of human language, we might expect to find a difference in the way in which they are processed. In particular, we aim to uncover (a) whether small clauses are processed in different areas of the brain from finite clauses, and (b) whether they require more or less processing than finite clauses. The answers to these questions bear significance for our understanding of linguistic complexity.

How linguistic complexity should be defined is a central issue in linguistics and holds the key to a major aspect of the study of language. If language is indeed a biological trait of humans, as argued by Chomsky and the generative school, then languages must be of approximately equal complexity (or simplicity) overall, even if they may differ in the complexity of sub-domains of grammar (say morphology vs. syntax). If on the other hand language is part of human culture, different languages could show different degrees of complexity, related to the complexity of the cultural system in which they evolve. The presence of morpho-syntactic processes is often linked to higher complexity, while their absence is typically seen as an instance of simplicity. But this only relates to the production side of language. What about processing? Is there a direct or an inverse correlation between complexity in production and processing?

We first briefly review what is known about the neural basis of syntactic processes (see Fedorenko, Nieto-Castañón, & Kanwisher, 2012). A number of brain regions have been found to play a role in syntactic processing. The first and most influential one is Broca's area, defined as including the opercular and triangular portions of the left inferior frontal gyrus, IFG. Carramazza and Zurif (1976) showed the difficulties encountered by agrammatic aphasics when interpreting structures where the order of the noun phrases does not correspond to the order of thematic roles. Regions around this area