Lexical Universality: An Analysis of Differences in Japanese Existential Expressions as Revealed by Event-Related Brain Potentials

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1 Introduction

A growing number of evidences from Event-Related Potentials (ERP) suggest that the syntactic component is distinguishable from other components in human brains such as the one for lexicon. It is well known that syntactic anomalies cause the response called P600 [Osterhout 95]. It is also known that semantic anomalies induce particular responses called N400 [Kutas 80]. We can thus draw from these evidences that there are at least two different components for human linguistic capabilities, one of which is syntactic and the other lexical [Friederici 04].

Given the clear distinction between the syntactic and lexical components, we are encouraged to investigate how these two components interact with each other. A series of studies revealed that the violation of agreement between the subject and verb causes a particular pattern of responses called Left Anterior Negativity (LAN) [Friederici 03], which is observed after 300-500 msec upon encountering anomalies.

The existence of various responces to semantic anomalies indicates the existence of different types of information encoded in lexical items. While the information concerning agreement such as number, gender, and person is morphologically evident in Indo-European languages, Japanese as language lacks with these features. That is, the agreement structure between the subject and verb with respect to number, gender, and person is missing for Japanese. We can however find in Japanese a sort of agreement structure between the subject and verb, which we often term with the notion of *animacy*. The information concerning animacy is certainly different from the one concerning number, gender, and person, but contributes to constructing proper sentences, syntactically or semantically.

We thus regard these different types of information as belonging to the same category in the sense that they are forming the interface between syntax and lexicon. We are interested in how these different groups of features, one pertaining

to Indo-European languages and another pertaining to Japanese, are related with each other. If we discover similar responses to anomalies in animacy of Japanese, that is, if we discover LAN in Japanese, we can assume a universality concerning the syntactic component pertaining to both Indo-European languages and Japanese. If not, we have to elaborate on our notion of the interface between syntax and lexicon as widely accepted, so that our notion fits with the result. We found in fact the latter is the case through our experiments and we are forced to elaborate on the notion of the syntax-lexicon interface.

The paper is organized as follows. We firstly show the examples of animacy violation in Japanese in next section. Secondly, we show the result of our experiment and discuss what our result suggests to language comprehension.

2   Animacy in Japanese

The verbs of Japanese to express existence of things or events are sensitive to animacy. The verb, IRU, takes as its subject an animate object, which we call dynamic noun (DN) in the following. The verb, ARU, takes as its subject an inanimate object, which we call static noun (SN). Given the difference, we can construct four types of combinations of subjects and verbs, half of which are correct and the other half incorrect as below:

(1) a. (DN - IRU)
     teNin-ga   kaunta-ni   IRU.
     clerk-Nom counter-Loc exist
     'There is a clerk at a counter.'

   b.*(DN - ARU)
     teNin-ga   kaunta-ni   ARU.
     clerk-Nom counter-Loc exist
     'There is a clerk at a counter.'

   c. (SN - ARU)
     terebi-ga   chanoma-ni   ARU.
     television-Nom living-room-Loc exist
     'There is a television at a living room.'

   d.*(SN - IRU)
     terebi-ga   chanoma-ni   IRU.
     television-Nom living-room-Loc exist
     'There is a television at a living room.'

3   Result

Eleven subjects, who are all native Japanese speakers, were visually provided the sentences that are categorized into one of the four types, i.e., (1a), (1b), (1c) and (1d). Figure 1 shows the results of our experiment. We employed EEG with eight channels put to F7, F3, C3, P3, F8, F4, C4, and P4 according to 10-20 system location. The target periods of analysis were the one between 300-400 msec and another between 600-700 msec. We performed repeated 2-way analysis

of variance (ANOVA) on eight levels of Electrode and four levels of Condition to each time window.

The reaction to each type is compared with that to another as below. There are four conditions:

DN effect (1a)DN-IRU vs (1b)*DN-ARU

IRU effect (1a)DN-IRU vs (1d)*SN-IRU

SN effect (1c)SN-ARU vs (1d)*SN-IRU

ARU effect (1c)SN-ARU vs (1b)*DN-ARU

Each condition is arranged from top to bottom in Figure 1, respectively. The first half of conditions, [DN effect] and [IRU effect], exhibit the feature, *animate*, while the second half of conditions, [SN effect] and [ARU effect], exhibit the feature, *inanimate*. The gray bars indicate that the difference between correct and incorrect sentences is significantly large within the period.

We observed in all cases the negative effect between 300-400 msec, which is thought to be N400, not LAN, because the negativity was detected by most electrodes, not limited to those sensing left anterior side, namely, F3 and F7. The positive effect between 600-700 msec was found only for the cases of [DN effect] and [IRU effect], which were found in the posterior side. The response is thought to be late positive component (LPC).

4 Discussion

We did not find LAN to Japanese existential expressions. We can think therefore the animacy agreement is *not* syntactic phenomenon, but lexically semantic. This is one interpretation possible of our result.

There is however alternative view considering the result where [DN effect], the comparison between (1a) and (1b), and [IRU effect], the comparison between (1a) and (1d), exhibited LPC. Although some regard LPC as being dependent on N400, the response may be seen as an independent factor. That is, the response can be thought to be P600, which is regard to have something to do with syntactical processing. If it is the case, how can we interpret the result?

One possible interpretation is that the effects of dynamic nouns (DN) and IRU (animate verb) are both syntactic and semantic, contrary to widely accepted view such that syntactic and (lexical) semantic factors never interact with each other. The response may be thought to indicate an existence of the interface between syntax and lexical component.

The feature pertaining to dynamic noun (DN) and the verb, IRU, is *animate*, which is thought to cause the effect of P600. Backing to the evidence of LAN, the features of number, gender, and person of Indo-European languages are thought to contribute to constructing proper sentences. Althgouh the animacy is not morphologically evident in Japanese, we think that the information is coded into lexicon as the information concerning number or person is encoded into lexicon in Indo-European languages.

5 Conclusion

We have shown through our experiment that Japanese existential expressions, dynamic noun (DN) and IRU (animate verb), cause both N400 and P600. We think based on the evidence that the feature *animate* is encoded into both dynamic noun and IRU.

The difference between two groups of features, one found in Indo-European languages and the other in Japanese, lies in the types of feature values. The values for number, gender, and person features are all discrete, e.g., the value for number is either *singular* or *plural*. On the other hand, the values for animacy is either *true* or *false*, i.e., a boolean value. We did not find the response, P600, to sentences involving inanimate lexical items. We believe thus that P600 represents *true* value to the feature, animate.

Although we found the difference between Indo-European languages and Japanese, the difference may reduce to the different data types to features, i.e., discrete or boolean. We are however still in early stage of our investigation and more experiments are required to argue for the claim.

References

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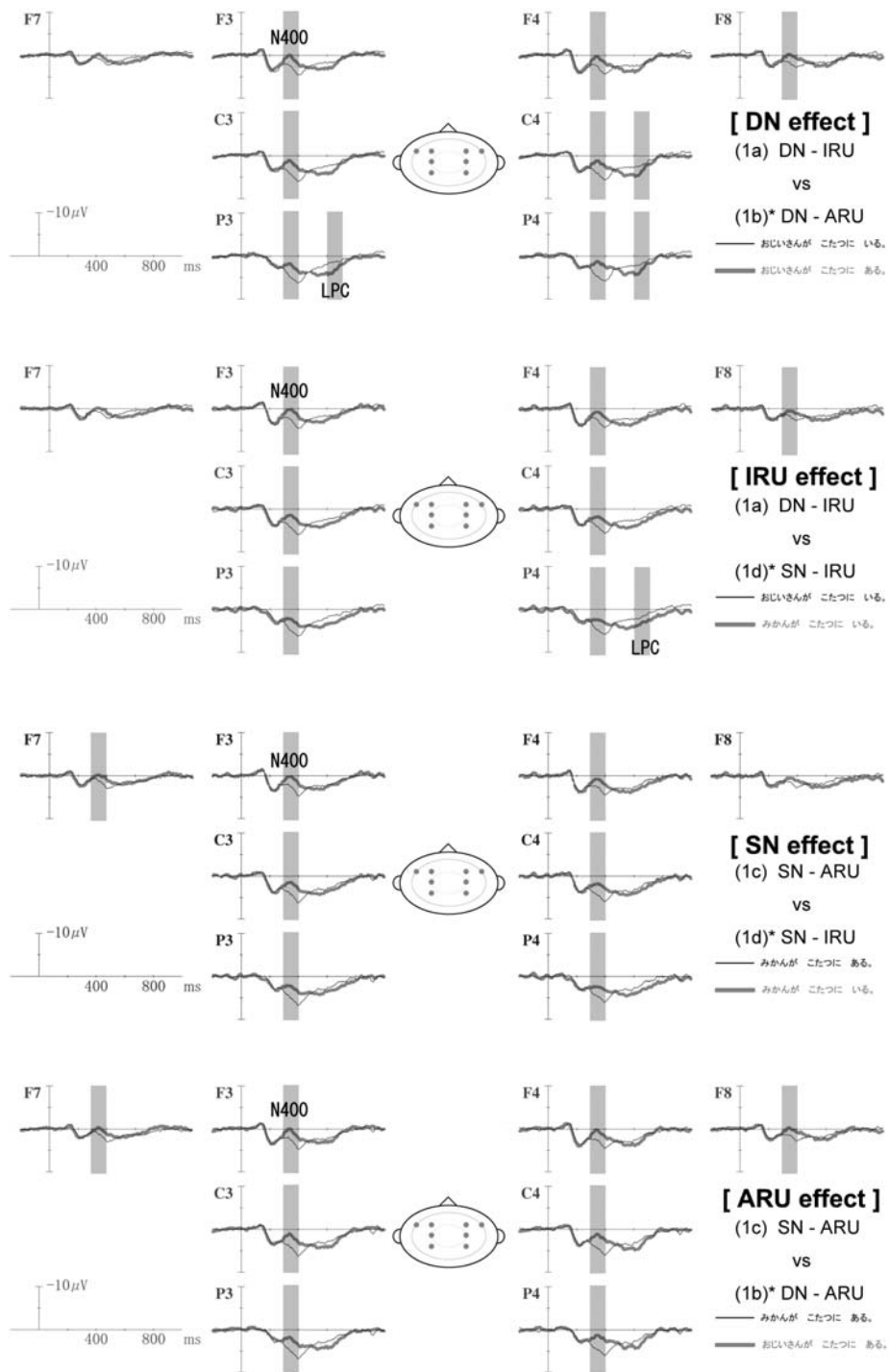[Osterhout 95] Osterhout, L. and Mobley, L. A.: Event-related brain potentials elicited by failure to agree, *Journal of Memory and Language*, Vol. 34, pp. 739–773 (1995)

Figure 1: Result of Experiment