A subject-object locality effect in comprehension: Evidence from Japanese

Shinnosuke Isono and Yuki Hirose (University of Tokyo)

Sentence processing is subject to effects of the working memory limitations. One of such effects is the *locality effect,* i.e., longer dependencies take longer to process [1, 2]. While most studies have investigated locality effects between elements that have a dependency, such as a verb and its arguments or a filler and its gap (e.g., [3, 4]), it was recently proposed [5] that there can be locality effects between clausemates. This prediction derives from the pre-verb reactivation hypothesis, according to which introduction of a new element to a clause reactivates earlier elements of the same clause [6]. The pre-verb reactivation hypothesis accounts for the frequent lack of locality effects between verbs and their arguments in verb-final languages (e.g., [7, 8]).

The current study investigates whether locality effects can be found between clausemates as predicted by the pre-verb reactivation hypothesis in a Japanese self-paced reading experiment. The design of the experiment is an improved version of a previous study [5]. An example set of critical sentences is shown in Table 1. Three factors were manipulated. The *distance* between two nouns N1 (the matrix subject) and N2 (described below) was manipulated by the length of the modifier to N2. In the [–distance] condition it was an indefinite marker *toaru* (とある)*,* while in the [+distance] condition it was a three-word adjectival phrase or relative clause. If there is a locality effect between N1 and N2, N2 should be read more slowly at N2 in the [+distance] condition than in the [–distance] condition. However, the effect of distance at N2 could also be attributed to the processing of the longer modifier. While the previous study [5] factored out the effect of modifier processing statistically, the current study dissociates the effect of modifier processing and the locality effect of interest at N2 by crossing the distance factor with the *clausemate* factor, which refers to whether N2 is a matrix element (an accusative or dative object) or not (a genitive noun modifying the following noun). Thus, while the effect of modifier processing should be observed as a main effect of distance, the clausemate locality effect should be observed as an interaction such that the [+distance, +clausemate] condition takes longer to read than others. Finally, the *accusativity* factor is added to distinguish two possible sources of the pre-verb reactivation of the subject: if any clausemate can reactivate preceding clausemates [5, 6], there should be no effect of case; if thematic role assignment is the source of pre-verb reactivation [9], an accusative noun but not a dative noun should reactivate the subject by making a transitive structure highly likely.

The experiment is conducted online at PCIbex Farm (https://farm.pcibex.net/). 40 native speakers of Japanese have participated so far. 24 sets of critical sentences were prepared, each containing 12 sentences, six of which are like those listed in Table 1, and the other six had N1 and N2 switched. These sentences were distributed in a Latin square design and presented with 48 filler sentences in a pseudorandomized order. The reading times at N2 were analyzed by linear-mixed effect modeling [10]. A full model with all main effects and interactions as fixed effects and as by-participant and by-item random effects [11] was fit, and the random slopes with the least variance were iteratively removed until a non-singular convergence is obtained.

Mean reading times of the critical region (N2) by condition are shown in Figure 1, and the model estimates in Table 2. The main effect of accusativity was not expected, but this is possibly due to relative unexpectedness of a dative noun compared to an accusative noun. Crucially, there was a significant interaction of distance and clausematehood. Nested comparison indicates that this was driven by the [+distance, +clausemate] condition being longer than other conditions. On the other hand, the interaction of distance and accusativity was not significant. Thus, **there was a significant locality effect between the subject and the accusative/dative object, as predicted by the pre-verb reactivation hypothesis** (especially the version in which any clausemates trigger the reactivation of earlier ones) and in line with the previous result [5]. This result contributes to the cross-linguistic theory of memory limitations in sentence processing by showing that locality effects are not missing from verb-final languages; rather, the difference between languages lies in which elements are reactivated when.

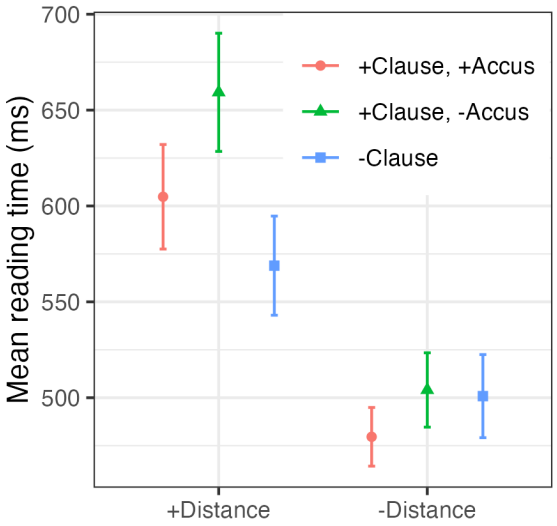
	Modifier to N1	N1	Modifier to N2	N2 (Critical)
+ Distance + Clausemate + Accusative		とある|教授が|りんごが|心から|好きな|青年を|手紙で|褒めた。 INDEF prof-Nom apple-Nom heart-from like-Attr youth-**Acc** letter-in praise-Past "A professor praised in a letter a youth who loves apples with all his heart. "		
+ Distance + Clausemate – Accusative		とある|教授が|りんごが|心から|好きな|青年に|手紙を|書いた。 INDEF prof-Nom apple-Nom heart-from like-Attr youth-**Dat** letter-Acc write-Past "A professor wrote a letter to a youth who loves apples with all his heart. "		
+ Distance – Clausemate		とある|教授が|りんごが|心から|好きな|青年の|手紙を|読んだ。 INDEF prof-Nom apple-Nom heart-from like-Attr youth-**Gen** letter-Acc read-Past "A professor read a letter of a youth who loves apples with all his heart. "		
– Distance + Clausemate + Accusative	りんごが|心から|好きな|教授が| apple-Nom heart-from like-Attr prof-Nom "A professor who loves apples with all her heart praised a youth in a letter."		とある|青年を|手紙で|褒めた。 INDEF youth-**Acc** letter-in praise-Past	
– Distance + Clausemate – Accusative	りんごが|心から|好きな|教授が| apple-Nom heart-from like-Attr prof-Nom "A professor who loves apples with all her heart wrote a letter to a youth."		とある|青年に|手紙を|書いた。 INDEF youth-**Dat** letter-Acc write-Past	
– Distance – Clausemate	りんごが|心から|好きな|教授が| apple-Nom heart-from like-Attr prof-Nom "A professor who loves apples with all her heart read a letter of a youth."		とある|青年の|手紙を|読んだ。 INDEF youth-**Gen** letter-Acc read-Past	

Table 1. An example set of critical sentences. Unlike the English counterpart, 青年に "to a youth" can only attach to the verb and not to the object 手紙 "letter".

	β	SE	df	t	p	
Intercept	555.45	29.47	41.02	18.85	<2e-16	***
Distance	60.05	18.00	40.92	3.34	0.002	**
Clausemate	12.96	8.07	38.24	1.61	0.116	
Accusative	-20.40	8.63	698.73	-2.36	0.018	*
Dist:Clause	**16.86**	**7.54**	**713.37**	**2.24**	**0.026**	*
Dist:Accus	-4.64	8.63	697.29	-0.54	0.591	

↑Table 2. Model estimates for reading times at N2. **Bold** indicates the effect of our main interest. Significance codes: *** p<0.001, ** p<0.01, * p<0.05, . p<0.1

→ Figure 1. Mean reading times at N2 by condition. Error bars indicate standard errors.



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