

The timing of verb selection in Japanese sentence production

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**Abstract**

Many influential models of sentence production (e.g., Bock & Levelt, 1994; Kempen & Hoenkamp, 1987; Levelt, 1989) emphasize the central role of verbs in structural encoding, and thus predict that verbs should be selected early in sentence formulation, possibly even before the phonological encoding of the first constituent (Ferreira, 2000). However, the most direct experimental test of this hypothesis (Schriefers, Teruel & Meinhausen, 1998) found no evidence for advance verb selection in verb-final (SV and SOV) utterances in German. The current report, based on a multi-word picture-word interference task (Meyer, 1996; Schriefers et al., 1998) demonstrates that in Japanese, a strongly verb-final language, verbs are indeed planned in advance, but selectively before object noun articulation and not before subject noun articulation. This contrasting pattern of advance verb selection may reconcile the motivation for advance verb selection in structural encoding while explaining the previous failures to demonstrate it. Potential mechanisms that might underlie this contrasting pattern of advance verb selection are discussed.

*Keywords:* sentence production, advance planning, picture-word interference, Japanese

## Introduction

Uttering a sentence requires that a single message be converted into a sequence of words. There is widespread agreement that this conversion occurs incrementally, meaning that speaking can begin before the entire utterance is planned. A strong version of the incrementality hypothesis (e.g., Brown-Schmidt & Konopka, 2008; Brown-Schmidt & Tanenhaus, 2006; Griffin, 2001; Iwasaki, 2011; Schriefers, Teruel & Meinschausen, 1998) posits that the sentence plan is, most of the time, developed in the same order that the words are uttered, i.e., the first word is planned first, the second word second, and so on. This strong version of the incrementality hypothesis holds that the sentence plan is developed on a *just in time* basis, such that words are planned right before they are uttered. This approach might be beneficial for reducing memory demands and avoiding interference between multiple activated lexical items, but it requires that utterance plans be flexibly adjusted to the word order demands of a language, so as to avoid ‘look-ahead’ in planning. The best tests of this strong incrementality arise in situations where words that play a central role in the organization of a sentence are forced to appear late in the utterance, due to the word order constraints of a language. Here we examine just such a case, focusing on evidence for look-ahead effects in Japanese, a language whose word-order constraints force verbs to appear in utterance-final position.

### The timing of verb selection in sentence production

Linguistic and psycholinguistic evidence suggests that verbs are critical for structural processing. This points to the early encoding of verbs in utterance formulation. Accordingly, many influential models of sentence production (e.g., Bock & Levelt, 1994; Ferreira, 2000; Garrett, 1980, Kempen & Hoenkamp, 1987; Levelt, 1989) adopt the view that the verb’s syntactic representation (i.e., *lemma*; Kempen & Huijbers, 1983) guides structural processes, and

thus they predict that a verb's lemma is selected before the relevant structural processes are performed. Most explicitly, Ferreira (2000) argued that selection of a verb's lemma (or the head of any phrase) must be performed before phonological encoding of the first phrase of a sentence is finalized.

Despite the emphasis on verbs' early encoding in models of sentence production, the experimental evidence from tests of this issue is equivocal at best. Some suggestive evidence for advanced verb selection comes from Kempen & Huijbers (1983), who found that changing the target verbs between experimental blocks delayed speech onset for both verb-subject and subject-verb sentences in Dutch, though with a greater delay for verb-subject than subject-verb sentences. This suggests that either verbs' conceptual representation, their lexical representation, or both are at least partially planned in advance, although the results are ambiguous between these three interpretations. In addition, Schnur, Costa & Caramazza (2006) and Schnur (2011), using the multi-word picture-word interference task (Meyer, 1996), found that distractors that are phonologically related to the target verb in SV and SVO utterances facilitated speech onset, suggesting that even the phonological representation of a verb is encoded in advance. However, this evidence is hard to interpret because facilitative effects may alter normal planning in favor of advance planning of verbs, due to potential feedback activation from the phonological level to higher levels, and because these findings conflict with existing evidence that suggests a narrow scope of planning at phonological levels (e.g., Griffin 2001; Meyer, 1996; Meyer, Sledersink & Levelt, 1998; Wheeldon & Lahiri, 1997). Nevertheless, the studies by Schnur and colleagues are broadly consistent with models that posit advance selection of verbs. On the other hand, the most direct experimental test of the issue failed to provide evidence for advance verb selection. Schriefers and colleagues (1998) used an extended version of the picture-word interference

paradigm in German. In five experiments, participants were presented with action pictures with distractor words. Participants' task was to describe the picture as quickly as possible using either a verb-initial or verb-final clause, while ignoring distractors. Schriefers and colleagues reasoned that if verb selection occurs prior to utterance onset then the Semantic Interference (SI) effect, a relative delay of utterance onset due to semantic relatedness between target and distractor verbs, should obtain even in verb-final utterances. However, distractors that were semantically related to the target verbs elicited SI effects only in verb-initial utterances. These findings led some researchers to conclude that verb selection is not necessarily performed in advance (Allum & Wheeldon, 2007; Iwasaki, 2011). This paper attempts to reconcile the theoretical motivation for advance verb selection and the previous empirical failure to demonstrate it by examining the timing of verbs' lemma selection at two different points in sentences: before object and before subject noun articulation.

### **Linguistic Contrasts between Subjects and Objects**

Linguistic analyses suggest that objects are more strongly dependent on verbs than subjects in many respects. First, it has sometimes been argued that a verb and its internal arguments constitute the verb's argument structure while external arguments are not part of such a structure (cf. Marantz, 1984; Kratzer, 1996, 2002). This claim is derived from the observation that the choice of the object, but not the subject, has a significant impact on the meaning of the verb. Second, verbs do not select the subject in the same sense that they select objects – a subject is obligatorily present regardless of the properties of the verb, while the presence/absence of an object depends on the subcategorization property of the verb. Third, subjects and objects are considered to receive case from different sources. The case-assigner of object nouns is generally considered to be the lexical head V(erb), while that of subject nouns is considered to be the

functional head I(nflection) in nominative-accusative languages. Finally, objects possess a closer constituency relationship with the verb. In a transitive sentence, the verb and the object noun phrase together form a verb phrase, while a subject noun phrase and a verb do not by themselves form a syntactic constituent under most accounts. These linguistic analyses all suggest that object nouns are more closely associated with verbs than subject nouns, both syntactically and semantically.

### **The Current Study**

Given the difference between subject and object nouns in terms of their dependency on verbs, it is possible that verb selection might be required before object articulation, but not before subject articulation. To test this hypothesis we adopted the extended picture-word interference paradigm (Meyer, 1996; Schriefers et al., 1998) to Japanese, with some modifications. We exploited two properties of Japanese: strict head-finality and liberal argument dropping. Specifically, in order to probe the timing of verb selection both before subject and object articulation based on speech onset latency, one needs to be able to naturally elicit two types of sentences: one starting with an object noun phrase, another starting with a subject noun phrase, preferably in canonical word order. This condition can naturally be met with Japanese. Japanese allows complete sentences consisting either of subject-verb (SV) or object-verb (OV) sequences. The OV structure allows us to test whether verbs are selected prior to object noun phrase articulation. SV and OV utterances are both naturally producible grammatical sentences in Japanese, and they can be closely matched in terms of the length of their initial noun phrase. Therefore, they are well suited for comparing the status of advance verb planning before subjects and objects are uttered.

The three experiments reported here used a similar picture-word interference design and are closely related to each other. Experiment 2 was a phrase-production task that tested the key question of the current study: whether verbs are planned before object articulation but not before subject articulation. Experiment 1 was a single-word production task eliciting only verbs, to verify the effectiveness of the picture-distractor pairs used in Experiment 2. Example stimuli used in Experiments 1 and 2 are illustrated in Figures 1 and 2 below. Experiment 3 was also a single-word production task eliciting only nouns, to verify that any interference effects observed in Experiment 2 were reflections of verb planning rather than noun planning. These three experiments in concert are necessary to attribute the presence/absence of a verb-based semantic interference effect to the presence/absence of advance selection of verb lemmas.

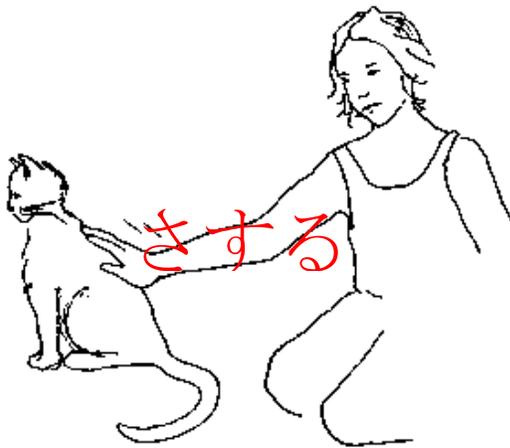


Figure 1. Sample picture for transitive verbs and OV sentences with the semantically related distractor word superimposed. Target utterance (in Experiment 2): Neko-o (the cat-accusative) naderu (pet). Distractor verb: sasuru (rub)



Figure 2. Sample picture for intransitive verbs and SV sentences with the semantically related distractor word superimposed. Target utterance (in Experiment 2): inu-ga (the dog-nominative) hoeru (howl). Distractor verb: naku (cry)

## Experiment 1

### Participants

Twenty-four students from Hiroshima University in Japan participated in all three experiments in exchange for 500 yen.

### Materials

Twenty-four action pictures were chosen from the UCSD International Picture Naming Database (Szekely et al., 2004): half corresponding to transitive verbs, and the other half corresponding to intransitive verbs. For each picture two types of distractors were chosen, one semantically related to the target verb and the other unrelated to the target verb. The related distractor words were all used as the unrelated distractors for other pictures, such that the set of distractor words was identical in the related and unrelated conditions. This ensured that uncontrolled parameters of the distractor words such as frequency, length and orthographic

complexity could not differentially affect speech onset latencies in related and unrelated conditions.

### **Procedure**

Participants were tested in a sound-attenuated, dimly lit room with an experimenter present. In a familiarization phase they first saw each picture and produced the associated target verb, and then practiced the action-naming task using pictures and distractors that were not included in the experimental set. In the experimental session for Experiment 1, participants were instructed to produce one word that describes the action depicted by each picture as soon and as accurately as possible. On each trial a fixation-cross appeared at the center of the screen for 500 ms with a brief click sound (used for calculating speech onset), and then an action picture appeared simultaneously with a written distractor word. The distractor word disappeared after 300 ms, while the picture remained for 1500 ms. A 3000 ms black screen separated the trials. Participants saw each picture twice, in the related and unrelated conditions, in different blocks. The ordering of pictures within a block was randomized for each participant, and the presentation of a picture with the related distractor in the first vs. second block was counterbalanced across participants.

### **Analysis**

For each trial, speech onset latency was manually measured, specifically, the interval between the click sound and the onset of speech minus 500 ms, using Praat (Boersma & Weenink, 2012). The measurer was blind to the conditions, although he could identify the target utterances. Any trials with disfluencies, audible non-speech noise before utterance onset, or speech onset of more than 2000 ms were excluded. In addition, for each participant, trials with

response times more than two standard deviations away from that individual's mean RT were excluded. In total, 12.7% of the data points were excluded.

## Results

A mixed effects model with maximal random effects structure was constructed, followed by model simplification based on a maximum likelihood ratio test. As a result, the random slope of any factor by item or by subject was not significant (all  $ps > 0.15$ ). Thus, we report the model with by-subject intercept and by-item intercept. This analysis revealed an effect of relatedness ( $\beta = 31.03$ ,  $SE = 10.93$ ,  $|t| = 2.84$ ,  $p < 0.01$ ). In both models, neither the effect of transitivity nor the interaction between relatedness and transitivity was significant (all  $ps > 0.85$ ).

In order to make a comparison between this experiment and Experiment 2, we conducted planned comparisons with Bonferroni correction between related conditions and unrelated conditions for transitive and intransitive verbs. Both transitive ( $\beta = 33.55$ ,  $SE = 10.96$ ,  $z = 3.06$ , adjusted  $p < 0.01$ ) and intransitive verbs ( $\beta = 28.26$ ,  $SE = 10.77$ ,  $z = 2.62$ , adjusted  $p < 0.01$ ) independently showed a reliable semantic interference effect.

Verb type	Relatedness	
	Related	Unrelated
Intransitive	786 [89]	760 [77]
Transitive	794 [84]	761 [82]

Table 1. Mean RTs based on participant means in milliseconds as a function of Verb type and Relatedness in Experiment 1: standard deviations in square brackets.

## **Discussion**

The aim of Experiment 1 was to test whether the set of verb distractors would reliably elicit a semantic interference (SI) effect. The results clearly show that the verb distractors were indeed effective in eliciting an SI effect regardless of transitivity. Hence, the same verb-distractor pairs were suitable for testing sentence production in Experiment 2.

## **Experiment 2**

### **Participants**

The same set of participants as in Experiment 1 participated in Experiment 2 after the completion of Experiment 1 and Experiment 3, following a short break.

### **Materials**

The same set of picture-distractor pairs was used with identical presentation parameters. The target nouns preceding the target verbs were matched in mean length (number of moras: 2.33 for the transitive condition and 2.5 for the intransitive condition). The transitive condition targeted 11 inanimate and 1 animate nouns, and the intransitive condition targeted 8 inanimate and 4 animate nouns. As participants saw the same set of pictures and distractors in Experiment 1, they had seen each picture four times by the end of the Experiment 2.

### **Procedure & Analysis**

The same procedure was followed as in Experiment 1, except that participants were instructed to describe the action depicted in the pictures in sentential forms using two words, i.e., a noun, inflected with a case particle, followed by a verb. This elicited an SV sentence for the intransitive action pictures, and an OV sentence for the transitive action pictures. The same analysis procedure was adopted as in Experiment 1. In total, 11% of the trials were excluded.

### **Results**

The same mixed effects model analysis procedure was applied as in Experiment 1. After model simplification based on maximum likelihood ratio tests, the model with by-subject intercept and by-item intercept revealed a marginally significant interaction ( $\beta = 25.20$ ,  $SE = 13.08$ ,  $|t| = 1.93$ ,  $p = 0.054$ ). There were no main effects of relatedness or transitivity ( $ps > 0.7$ ).

As in Experiment 1 we conducted planned comparisons with Bonferroni correction between related and unrelated conditions for OV and SV sentences. These analyses showed that verb-related distractors significantly delayed sentence onsets in OV sentences ( $\beta = 26.53$ ,  $SE = 9.11$ ,  $z = 2.91$ , adj.  $p < 0.01$ ), but not in the SV condition ( $p > 0.95$ ).

Also, a post-hoc comparison of noun frequencies between OV and SV conditions was conducted to ensure that the differential effect of relatedness on OV and SV conditions was not attributable to the properties of the nouns. Based on the Tsukuba Web Corpus (<http://corpus.tsukuba.ac.jp/>), the mean log frequencies of nouns did not differ between the transitive and intransitive condition, although there was a trend toward a difference in a two-tailed t-test ( $p = 0.11$ ). However, a further test using individual items found no correlation between noun frequency and the amplitude of the effect of semantic relatedness ( $r = 0.07$ ,  $p > 0.7$ ).

## Discussion

This experiment showed a semantic interference effect in object-initial sentences but not in subject-initial sentences. Specifically, distractors that were semantically related to the sentence-final verb delayed the utterance of the sentence-initial noun, but only when the sentence-initial noun was a direct object. Note that the same set of picture-distractor pairs was used as in Experiment 1, where SI effects were reliably obtained for transitive and intransitive verbs alike. Therefore, we can be confident that the contrast observed in Experiment 2 is a

consequence of the sentence production task, and not simply a result of poor selection of picture-distractor pairs. Note also that previous research tends to report more consistent semantic interference for intransitive than transitive verbs (Schnur et al., 2002; Tabossi & Collina, 2004). Therefore, it is unlikely that the observed contrast between SV and OV conditions are due to the smaller amplitude of semantic interference in SV conditions.

The contrast between SV and OV sentences is consistent with our hypothesis that verbs are selected before the onset of objects but not before subjects, reflecting the closer dependency of objects on verbs. The contrasting pattern of SI effects casts in a new light the previous failure to find an SI effect in verb-final utterances in German (Schriefers et al., 1998). Specifically, it seems premature to draw the conclusion that a producer can dispense with verb information when processing all of a verb's arguments in verb-final utterances. Certainly, our results do not show that speakers retrieve the verb's syntactic information before articulating the object in every utterance. However, it shows that Schriefers et al.'s (1998) findings are, in fact, consistent with the claim that verb choices guide structural processes in sentence planning. Instead, the absence of a SI effect in Schriefers et al.'s data and in the SV condition here, combined with the presence of a SI effect in the OV condition here, is likely due to the selective nature of the advance planning mechanism for verbs.

Sentence type	Relatedness	
	Related	Unrelated
SV	766 [85]	764 [89]
OV	764 [103]	736 [80]

Table 2. Mean RTs in millisecond as a function of Verb type and Relatedness in Experiment 2; standard deviations in square brackets.

### Experiment 3

#### Participants

The same set of participants as in Experiment 1 and Experiment 2 participated in Experiment 3, except that one participant was excluded due to recording failure. The order of Experiments 1 and 3 was counterbalanced across participants.

#### Materials

24 new pictures from the IPNP were chosen to elicit the bare target nouns from Experiment 2, i.e., without associated actions. The distractor words, as well as the pairing between target nouns and distractor words, were kept constant as in Experiments 1 and 2.

#### Procedure & Analysis

The procedure was identical to Experiment 1, except that participants were instructed to describe the object depicted in the pictures in one word i.e., a noun. The analysis procedures were identical to Experiments 1 and 2.

#### Results

Speech onset latency did not significantly differ across conditions. No effect of transitivity, relatedness, or interaction was found ( $ps > 0.35$ ). Mean RTs based on the participants analysis are shown in Table 3 below.

	Relatedness	
Verb type	Related	Unrelated

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<b>Subj. Nouns</b>	<b>652 [77]</b>	<b>660 [79]</b>
<b>Obj. Nouns</b>	<b>642 [81]</b>	<b>647 [81]</b>

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Table 3. Mean RTs in millisecond as a function of Verb type and Relatedness in Experiment 3; standard deviations in square brackets.

### **Discussion**

The results of Experiment 3 suggest that there was no systematic relationship between the target nouns and distractor verbs that affected utterance onset. This means that the difference in the SI effect between Experiments 1 and 2 cannot be attributed to an accidental relation between the subject/object nouns and the distractor verbs.

#### **General Discussion**

The results of the current studies indicate that semantic interference (SI) from distractors related to non-initial verbs – a marker of advance verb selection - is obtained selectively before object noun articulation (Experiment 2). This selectivity is not likely to be due to the ineffectiveness of the semantic distractors for intransitive verbs (Experiment 1) or to an accidental relation between the preceding nouns and the distractors (Experiment 3). The SI effects in Experiment 1 and Experiment 2 are shown in Figure 5. These findings may reconcile the apparent conflict between the need for verb selection in order to determine the syntactic/semantic properties of pre-verbal arguments and the lack of verb-related SI effects on before subject noun articulation in Schriefers et al. (1998). Based on this pattern of results, we argue that advance verb selection is selectively performed before object nouns, but not before subject nouns.

Before we outline the potential mechanism underlying the selective nature of advance verb planning, it is worth noting that the current result at first seems to conflict with previous

findings in the scope of planning literature. In particular, the results of Experiment 2 might be regarded as in conflict with a previous finding by Meyer (1996), where the lemma of the second noun in a sentence like “*the dog is next to the baby*” appeared to show evidence of advance planning. That is, it appeared that object nouns, positioned after the predicate, were planned before articulation of the subject noun phrase (*the dog*). If a word that appears after a predicate is already planned, this invites the conclusion that the predicate is also planned. However, this conclusion derives from the assumption that the scope of planning at the lemma level is already linear. This assumption is, as far as we know, not warranted. In fact, the production model of Bock & Levelt (1994) assumes that linearization does not occur not until the positional processing stage, which is subsequent to lemma selection. Also, it is important that speakers repeated the same structure (either *A and B* or *A is next to B*) throughout the experimental session in Meyer (1996), potentially expanding the scope of planning. The current experiment did not allow such formulaic production. Thus, it may not be appropriate to directly compare Meyer (1996) and the current experiments.

In addition, the absence of a semantic interference effect in SV conditions in Experiment 2 appears to be at odds with findings by Kempen & Huijibers (1983) and Schnur et al. (2002), which suggest that a verb’s lemma selection occurs even before subject noun articulation. One crucial difference between the current experiment and the previous experiments is that their target utterances had less variation in the pre-verbal noun phrases (4 variants in Kempen & Huijibers (1983) 2 variants in Schnur et al. (2002), and 24 variants in the current experiments). Also, Schnur and colleagues’ preverbal noun was a pronoun (*she or he*), which is particularly easy to process. Thus, although our results and Schriefers et al.’s (1998) results suggest that a verb’s lemma is not necessarily retrieved in advance of the articulation of subject nouns, it might

under some circumstances be retrieved in advance of that point, in situations where there is less response variability and hence less processing difficulty in the preceding words (cf. the retrieval fluency hypothesis; Griffin, 2003).

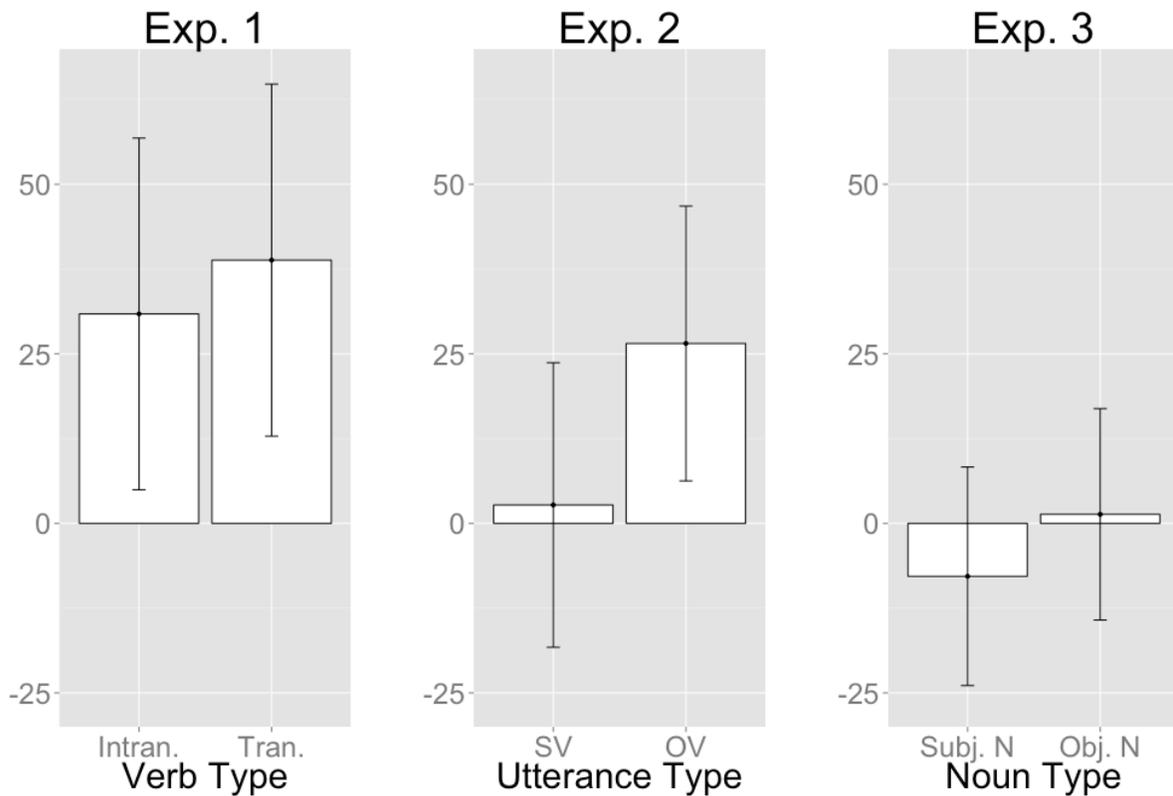


Figure 5. SI effect by Verb Type (Exp. 1) and Utterance Type (Exp. 2) and Noun Type (Exp. 3), estimated from the statistical model. Error bars represent 95% confidence intervals.

There are at least three classes of possible mechanisms that could explain the selective pattern of advance verb planning observed in Experiment 2. The first possibility, which in a broad sense falls under the lexicalist view of sentence production, is that encoding some structural dependency relations between verbs and their arguments requires the advance selection

of verbs. One such potential dependency relation is the assignment of case to verbs' arguments. Under this account, the selective pattern of advance verb selection we observed in Experiment 2 can be explained by a difference in how grammatical case is assigned between subject nouns and object nouns. As noted in the Introduction, accusative case is usually assigned by the lexical head V(erb), whereas nominative case is usually assigned by the inflectional head I(nflection). Thus, the necessity to assign accusative case via a verb head may require that the verb's lemma be selected before the encoding of the object noun is completed. Alternatively, it is possible that the building of structural representations itself is dependent on verbs (e.g., Ferreira, 2000). This is a stronger lexicalist position than the first alternative, in the respect that even the most elementary structural process of building or retrieving phrase structure is considered to be dependent upon verbs under this account. In other words, the current experiments may be interpreted as evidence of partial lexical guidance in phrase structure building: structure building for the subject noun position might not be dependent on verbs, whereas structure building for the object noun position would be crucially dependent on verbs.

The second possibility, which falls under a non-lexicalist view of sentence production, in which structure building can independently occur without lexical retrieval, is that the selective advance selection of verbs observed here is due to syntactic constituency determining the scope of lemma selection. This possibility is broadly consistent with the proposal that syntactic phrases define the default scope of lemma planning (e.g., Smith & Wheeldon, 1999). This idea implies that phrase structure representations can be built prior to lemma selection (unlike the lexicalist account described as the first possibility above), and that such structural representations control the dynamics of lemma selection processes. Although we are not aware of specific claims that the verb phrase defines the scope of planning, our data are consistent with the idea that the

syntactic phrase is a determinant of the scope of planning at the lemma level. In this view, the dynamics of lemma selection is controlled by such higher-level syntactic schemes.

The final possibility is that it is the structure of semantic/conceptual representations, rather than syntactic phrases, that is the source of the contrasting pattern that we observed in the current study. Specifically, it is possible that internal arguments and verbs constitute an integrated unit that is planned together at the lemma level or higher, e.g., the message level. This is consistent with the linguistic analysis of Kratzer (1996, 2002), although it is unclear whether semantic representations in linguistic theory should be equated to message level representations in production models. Kratzer argued that external arguments should be excluded from the argument structure of predicates, and suggested instead that inflectional heads introduce external arguments. If this is the case, then advance verb selection may be due to the semantic necessity to compute a predicate and its internal argument in tandem, or at least temporally closely, either at the conceptual or the lemma level.

### **Conclusion**

The current study used an extended picture-word interference paradigm to probe the time course of verb planning, using Japanese as a test case due to its strongly verb-final word order. The results suggest that verb selection occurs selectively before articulation of the object noun, but not the subject noun in Japanese. This may reconcile past failures to find evidence for advance verb selection (Schriefers et al., 1998) with models that posit a central role for verbs in structural processes (Levelt, 1989; Kempen & Hoenkamp, 1987; Bock & Levelt, 1994; Ferreira, 2000).

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