

How Function Assignment and Word Order are Determined: Evidence from Structural Priming Effects in Japanese Sentence Production

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Abstract

Using a structural priming paradigm, the details of sentence production model have been investigated substantially, specifically the processes in grammatical encoding level. Many studies provide evidence that the function assignment stage and the constituent assembly stage are processed separately in grammatical encoding. However, it is less known whether these two stages interact with each other during the processes, and if so, how the processes are executed. In this study, we report three structural priming experiments in Japanese, in which function assignment and word order were manipulated independently and simultaneously in order to examine the processes at two stages directly. Our results revealed that priming effects patterns were different depending on whether the effects occur at function assignment stage or at constituent assembly stage. Based on the current findings, implications for the recent models of sentence production are discussed, from the perspective of the grammatical function assignment and word order determination.

Keywords: Structural Priming; Sentence Production; Active/Passive sentence

Introduction

People can express thoughts by conveying them through language. Speakers can often express their meaning in several ways by using different linguistic expressions. For example, a transitive event in which a dog is chasing a cat can be expressed by an active sentence (the dog is chasing the cat) as well as by a passive sentence (the cat is being chased by the dog). How do speakers put words together, and choose a syntactic structure? Many decisions must be made during the production process. How these decisions are made and how these decisions generate a linguistic expression, especially how the grammatical function roles and word order are determined during the processing are the central issues of sentence production.

Current models of sentence production widely assume that language production has three levels: message encoding level, grammatical encoding level, and a phonological and phonetic encoding level (e.g., Bock and Levelt, 1994, Ferreira and Slevc, 2007). Grammatical function assignment

and word order are assumed to be determined during the grammatical encoding level, in which speakers encode the preverbal message into a grammatically well-formed linguistic message. The grammatical encoding level is comprised of two separate encoding stages: the function assignment stage in which thematic roles such as agent and patient are assigned to grammatical functions and the constituent assembly stage in which word order is processed. For example, the choice of active/passive alternations is assumed to take place in the function assignment stage, in which the agent role is mapped to the subject and the patient role to the non-subject in the active voice, and the opposite mapping takes place in the passive voice. However word order is assumed to be left unspecified at this point. In the subsequent stage, the constituent assembly stage, word order is processed, such as in the case of the canonical/scrambled word order alternations in Japanese.

In contrast several studies have provided empirical evidence that suggests function assignment and word order are computed simultaneously (Bernolet, Hartsuiker, & Pickering, 2007; Branigan, Pickering, & Tanaka, 2008). Most production models assume that these two stages in the grammatical encoding level are computed separately, (e.g., Hartsuiker & Westenberg, 2000; Vigliocco & Nicol, 1998). Therefore, there is still controversy about whether grammatical functions and word order are encoded separately in different stages. Furthermore, less is known about how these two stages are computed during the production processes, that is whether or not these two stages interact with each other and if so, how the processes are executed.

A structural priming paradigm has often been used to investigate the details of the production model. Structural priming is known as the speaker's tendency to reuse syntactic structures that they have recently produced or comprehended (Bock, 1986). Using a picture description task, Bock (1986) found that after repeating a prime sentence participants were more likely to describe a subsequent target picture with the structure that they had just repeated in the prime sentence. For example, more

passive sentences were produced after passive primes than after active primes. Since previous studies have shown that structural priming is sensitive to syntactic/structure factors between the prime and target pairs (e.g., Bock, 1989, Bock & Loebell, 1990), the structural priming paradigm has been used to investigate the details of the processes in the grammatical encoding level specifically. However empirical evidence supporting the two separate stages model and the one stage model both come from research using the structural priming paradigm (e.g., the separate stages model: Hartsuiker & Westenberg, 2000; Shin & Christianson, 2009; the one stage model: Bernolet, Hartsuiker & Pickering, 2007; Tanka, 2007).

In this study, we investigated whether the function assignment stage and the constituent assembly stage are independent of each other in the grammatical encoding level. Moreover we aimed to investigate the details of how the function assignment stage and the constituent assembly stage are computed during the production processes, that is whether the processes of grammatical function assignment and word order determination interact with each other and if so, how the processes are executed.

In order to answer these questions we used Japanese and conducted three structural priming experiments. The relatively free word order of Japanese allowed us to manipulate function assignment and word order independently. In Japanese, besides mapping a thematic role to the subject (active/passive sentence), one can choose to place the subject at the first position before the non-subject in the sentence, namely, canonical word order (SOV word order), or after the non-subject, in scrambled word order (OSV word order). This word-order variation in Japanese allows us to manipulate the grammatical functions independent of overlap in the word order between prime and target pairs and enable us to investigate the function assignment stage and the constituent assembly stage separately.

If the two stages are computed simultaneously, we would expect to see structural priming effects only when both function assignment and word order match between the prime and the target pairs. If the function assignment stage and the constituent assembly stage are independent of each other, we would expect to see structural priming effects when only one function assignment or word order is shared between the prime and the target pairs (i.e., OSV-passive and SOV-passive pairs; OSV-passive and OSV-active pairs). Moreover, if the processes of two stages interact with each other, we would expect to find structural priming effects between the prime and target pairs interacted with grammatical function assignment and word order determination process.

In Experiment 1, we examined whether the pure structural priming effects of active and passive sentences in Japanese can be observed when conceptual factors were controlled. In Experiment 2, we looked at whether priming effects can be found when function assignment is matched between prime-target pairs, even without sharing the word order, like OSV-

passives and SOV-passives pairs. In Experiment 3, we manipulated function assignment and word order independently and simultaneously in order to look at whether the priming effects can be observed across the two stages.

Experiment 1

In Experiment 1, we examined structural priming effects of active and passive sentences in Japanese. If the locus of the voice priming effects occurs at the function assignment stage, i.e. the assignment of the subject to agent role in active sentences or patient role in passive sentences, we expect to observe priming effects.

Method

Participants Twenty students, all native speakers of Japanese at Hiroshima University participated in the experiment (13 females and 7 males, the mean age was 22.1 years). Participants were paid 500 yen for their participation. Throughout the experiment, a female native speaker of Japanese acted as the confederate.

Materials The prime was either an active or a passive sentence: (1) active prime and (2) passive prime. A target picture (Figure 1) was presented immediately after the prime. Two sets of 80 items were created: a confederate set and a participant set. The confederate set consisted of 80 sentences (20 prime and 60 filler sentences), and the participant set consisted of 80 simple black and white line drawings (20 target and 60 filler pictures). In addition, we prepared two sets of 36 simple black and white line drawings for a picture recognition task.

- (1) sapootaa-ga sakkaa sensyu-o ooensi-teiru.
fans-NOM soccer player-ACC cheer
“The fans are cheering the soccer player.”
- (2) sakkaa sensyu-ga sapootaa-ni ooen-sare-teiru.
soccer player-NOM fans-OBL cheer-PASSIVE
“The soccer player is being cheered by the fans.”



Figure 1: Example of a target picture. A girl chasing a boy.

To ensure that the observed effects are purely structural in nature, conceptual factors such as event type, animacy of NPs, and viewpoint shifts were carefully controlled in the prime/target pairs. That is, our experimental items only involved human entities for both agent and patient, minimizing the bias of conceptual accessibility. The event type between primes and targets was paired among positive, negative or neutral types, in order to eliminate the possibility that the event similarity facilitates the use of same viewpoint between the prime/target pairs.

Procedure We adopted a confederate-participant dialogue-style setting (Branigan, Pickering & Cleland, 2000). Participants were told that the study was investigating how people communicate to each other. Participants were asked to describe pictures in turn with the confederate. The experiment always began with the confederate's description. The confederate pretended to describe the picture even though the prime sentence was visually presented on screen. Next, participants were asked to repeat the prime sentence loudly, while memorizing and creating a mental image of the picture. Then, participants described the target picture on the screen and the confederate repeated the description and pretended to memorize it. The experiment consisted of three blocks, and after each block, participants and the confederate were asked to complete a picture recognition task in which a set of pictures was presented. Participants and the confederate were asked to decide whether these pictures matched the description given by the partner during the block.

Results and Discussion

Priming effects were observed even after conceptual factors being strictly controlled (Figure 2). The results showed that, more passive sentences were produced after passive primes (11.5%) than active primes (1.5%), indicating a clear priming effect ($F_1(1,19)=10.94, p<.001$; $F_2(1,19)=17.36, p<.001$).

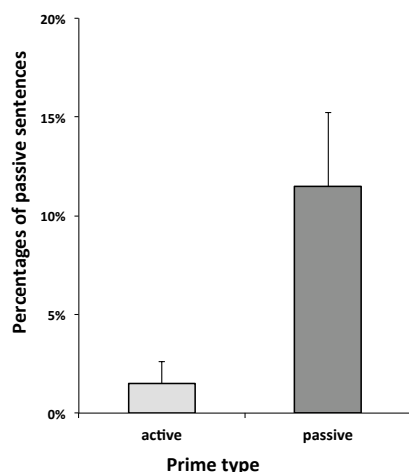


Figure 2: Percentages of passives in each condition.

After participants heard passive primes (i.e., assign the sentence subject to patient role) from the confederate, they tended to use passive sentences more often than after they heard active primes (i.e., assign the sentence subject to agent role). Because the conceptual factors between prime and target pairs have been carefully controlled in Experiment 1, the priming effects are most likely due to the processes in the function assignment stage.

However, there is an alternative explanation to the priming effects in Experiment 1. The passive primes and the produced passive sentences shared the same patient-agent thematic role order, but the active primes and the produced passive sentences do not. Since previous studies have demonstrated that the thematic role order did affect the priming effects (e.g., Chang, Bock, & Goldberg, 2003), it is possible that the locus of the priming effect occurs outside the function assignment stage. In experiment 2 we addressed these concerns.

Experiment 2

In Experiment 2, we looked at whether priming effects can be found when function assignment is matched between prime-target pairs, even without sharing the word order, like OSV-passives and SOV-passives pairs. If function assignment and word order are computed simultaneously, the effects observed in Experiment 1 are expected to disappear in Experiment 2. In contrast, if function assignment is responsible for the priming effects, and it can be processed separately from word order, then we expected to observe the priming effects again.

Method

Participants Twenty students, all native speakers of Japanese, at Hiroshima University participated in the experiment (11 females and 9 males, the mean age was 22.8 years). Participants were paid 500 yen for their participation. Throughout the experiment, a female native speaker of Japanese acted as the confederate.

Materials The materials were similar to those in Experiment 1, except we changed the word order of the subject and non-subject (oblique object) in the passive prime as in (3). This time the agent-patient order in active primes and passive primes was controlled.

- (3) sapootaa-ni sakkaa sensyu-ga ooen-sare-teiru.
fans-OBL soccer player-NOM cheer-PASSIVE
“The soccer player is being cheered by the fans.”

Procedure The procedure was identical to Experiment 1.

Results and Discussion

The voice priming effects observed in Experiment 1 was replicated (Figure 3). Participants produced more passive sentences after passive primes (6%) than active primes (2%). The main effect of prime type was marginally significant in the participant analysis and significant in the analysis on items ($F_1(1,19)=3.43, p=.08$; $F_2(1,19)=4.63, p<.05$). Participants showed a tendency to reuse a passive sentence after passive primes, even though function assignment only was shared between the passive primes and the produced passive targets, and the thematic order was also unmatched, priming effects were found again. Thus the results from

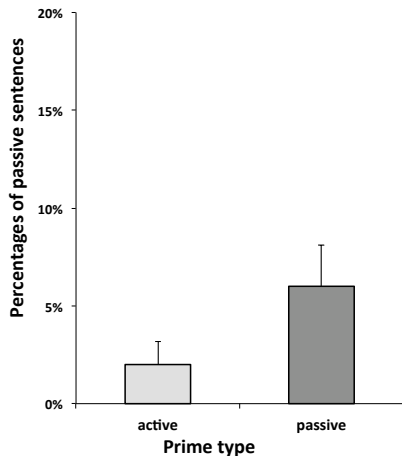


Figure 3: Percentages of passives in each condition.

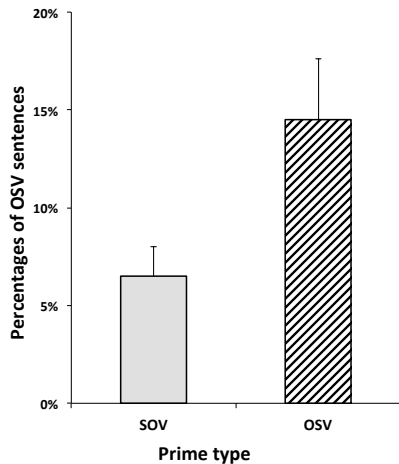


Figure 4: Percentages of OSVs in each condition.

Experiment 2 suggest that the voice priming effects in Experiment 2 are due to the processes in the function assignment stage.

In addition to the voice priming effects, we discovered another interesting finding. Participants produced more scrambled sentences (scrambled active sentences: OSV-active) after passive primes (OSV word order, 14.5%) than after active primes (SOV word order, 6.5%) (Figure 4). Analyses revealed a main effect of word order priming effect was marginally significant in the participant analysis and significant in the analysis on items (SOV-active) ($F_1(1,19)=3.94, p=.06$; $F_2(1,19)=11.50, p<.005$), meaning that more OSV-active were produced after the scrambled passive primes (OSV-passive) than canonical active primes.

The word order priming effects that were found between OSV-passive and OSV-active suggest that the word order determination processes occurred in the constituent assembly stage (place the subject before or after the non-subject) and could be primed separately from the function

assignment stage (assign an agent role to subject or non-subject NPs).

Results from the Experiment 1 and Experiment 2 strongly support that the function assignment stage and the constituent assembly stage are independent of each other in the grammatical encoding level, and the grammatical function roles and word order are determined separately during the processes.

However, since we did not manipulate the conditions in active voice systematically, whether the word order priming effects across voice between OSV-passive and OSV-active pairs in Experiment 2 reflected purely word order priming effects is unknown. Moreover whether function assignment and word order determination processes interacted with each other and if so how the processes are computed is left unknown. We examine these questions in Experiment 3.

Experiment 3

In Experiment 3 we manipulated function assignment and word order independently and simultaneously in order to examine the interaction between two stages directly.

Method

Participants Thirty-three students, all native speakers of Japanese at Hiroshima University participated in the experiment (25 females and 8 males, the mean age was 21.5 years). Participants were paid 500 yen for their participation. Throughout the experiment, a female and a male native speakers of Japanese acted as the confederate.

Materials The prime was either an active or a passive voice sentence with canonical (SOV) or scramble (OSV) word order. (1) SOV-active prime, (2) SOV-passive prime OSV-active prime, and (3) OSV-passive prime were similar to those in Experiment 1 and 2. In addition, we created a (4) OSV-active prime condition. Two sets of 120 items were created: a confederate set and a participant set. The confederate set consisted of 120 sentences (32 prime and 88 filler sentences), and the participant set consisted of 120 simple black and white line drawings (32 target and 88 filler pictures). In addition, we prepared two sets of 60 simple black and white line drawings for a picture recognition task.

- (4) sakkaa sensyu-o sapootaa-ga ooensi-teiru.
 soccer player-ACC fans-NOM cheer
 “The fans are cheering the soccer player.”

Procedure The procedure was identical to Experiment 1 and 2.

Results and Discussion

Again, the voice priming effects and the word order priming effects were observed.

Figure 5 shows the proportion of SOV-passive sentences in each conditions. The interaction of voice and word order

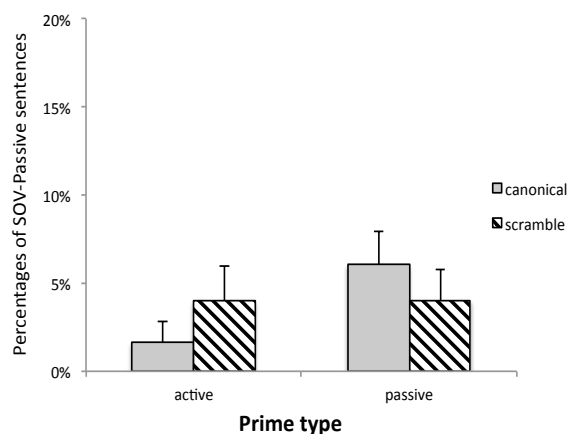


Figure 5: Percentages of SOV-passives in each condition.

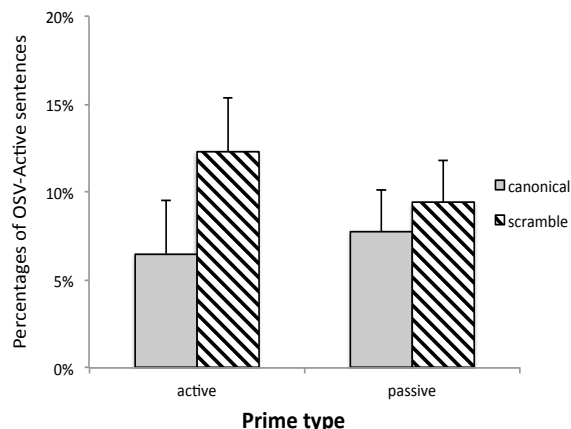


Figure 6: Percentages of OSV-actives in each condition.

was significant in the participant analysis and marginally significant in the analysis on items ($F_1(1,32)=7.43$, $p<.05$; $F_2(1,31)=3.31$, $p=.08$).

Contrasts across SOV word order conditions revealed that more SOV-passive sentences were produced after SOV-passive primes (6%) than after SOV-active primes (1.6%) ($F_1(1,32)=9.06$, $p<.01$; $F_2(1,31)=7.30$, $p<.05$). This pattern of result is identical to those in Experiment 1, which reflected a voice priming effect.

The tendency of difference was also found in active prime conditions – more SOV-passive sentences were produced after OSV-active (4%) than after SOV-active (1.6%) ($F_1(1,32)=4.73$, $p<.05$; $F_2(1,31)=2.17$, $p=.15$). The voice priming effects between OSV-active prime and SOV-passive target suggests that the similarity between these sentence types, although both function assignment and word order were different between the prime/target pairs. Although the conceptual factors were strictly controlled in Experiment 3, this finding suggests the locus of this priming effects might occur outside the grammatical encoding level.

In contrast, the results showed that in OSV-active responses only the main effect of word order was significant ($F_1(1,32)=7.01$, $p<.05$; $F_2(1,31)=5.28$, $p<.05$). More OSV-actives were produced after OSV primes than after SOV primes (Figure 6). This result suggests that after an active voice is selected at function assignment stage, the word order is determined at the constituent assembly stage, and affect by both OSV-active and OSV-passive primes. Again the results showed that word order determination occurs indecently from the function assignment stage.

Taken together, the findings from the voice priming suggest that various factors affect and complicate the processes at function assignment stage (assign an agent role to subject or non-subject NPs). However, the foundlings from the word order priming suggest that the processes at constituent assembly stage are rather straightforward only be influenced by word order determination.

General Discussion

Three experiments investigated the production processes of the two stages in the grammatical encoding level. In particular, we examined whether the function assignment stage and the constituent assembly stage are processed separately or simultaneously and how the processes are computed.

Using a structural priming paradigm in Experiment 1, we demonstrated that the priming effects of passive voice occur in the function assignment stage, which has a major influence on the choice of active or passive voice, even when the active voice is highly favored. The results from Experiment 2 further confirmed that the priming effects are raised due to the processes in the function assignment stage. Moreover the word order priming effects were found across active and passive voice, which suggested that word order was determined independently of the function assignment stage, in the constituent assembly stage. The results from Experiment 3 further confirmed that the function assignment stage and the constituent assembly stage are computed separately during the production processes. Moreover the pattern of the voice priming effects and the word order priming effects are different according to the stages.

The results from Experiment 3 show the similarity between the OSV-actives and SVO-passives, in this case both function assignment and word order were different between the prime/target pairs. This is consistent with previous studies (e.g., Prat-Sala & Branigan, 2000). Prat-Sala and Branigan (2000) demonstrated that Spanish speakers tend to produce dislocated active sentences (OVS word order) instead of using passive sentences when the patient is more salient than the agent (a language setting which facilitates the production of passives). The authors interpreted that the results suggest that conceptual factors may be associated with variations in word order directly, and the way in which the factors influence is constrained by the syntactic options available within that language.

Prat-Sala and Branigan (2000) suggested the similarity between the dislocated actives and passives when producing an event in which the patient is more salient than the agent (e.g., a sentence emphasis on the patient). In Japanese, both passive sentence and OSV-active are assumed to put emphasis on the patient (Shibatani, 1985, 1990). An explanation of the priming effects found in Experiment 3 between OSV-actives and SVO-passives, might occur outside the grammatical encoding level, that it is due to the similarity between the OSV-active and SOV-passive, which both put emphasis on the patient. For example, after participants heard SOV-passive primes from the confederate, both passive voice and OSV word order were more available than usual at the grammatical encoding level. Although the event type between prime and target pairs were controlled, processing a passive prime might explain the emphasis on the patient roles. If the emphasis of the patient role is persistent between the prime and target pairs, because the active voice was highly favored as conceptual factors were controlled in our study, participants might have chosen an OSV-active over an OSV-passive or SOV-passive, in order to make the patient more salient than the agent. This explanation is consistent with the findings in Bernolet, Hartsuiker, and Pickering (2009), and can be explained by the current model of sentence production which assumes that perspective meaning, a sub-component in the preverbal message level, can affect constituent assembly stage directly. Further studies are needed to examine whether the priming effects between SOV-passive and OSV-active in our study were due to word priming effects or the persistence of emphasis in the patient role. Further studies are needed to examine whether the persistence of emphasis in the patient role can influence the priming effects in the grammatical encoding level.

In conclusion, our findings provide support for a two-stage production model with two separate stages within the grammatical encoding level, namely the function assignment stage and the constituent assembly stage. Moreover, our findings suggest that various factors affect and complicate the processes at the function assignment stage; however, the processes at the constituent assembly stage are rather straightforward by the syntactic options available in that language.

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