How conceptual accessibility affect sentence production: Evidence from Chinese JFL learners with a focus on animacy information

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博士論文

How conceptual accessibility affect sentence production: Evidence from Chinese JFL learners with a focus on animacy information
（中国人日本語学習者の日本語文産出における概念接近度の影響―有生性情報に焦点をあてて―）

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1. INTRODUCTION

1.1 Background

Language production, as well as language comprehension, is a critical issue in a variety of fields, including SLA and psycholinguistics. Language production may reflect a process in which an intended message is serially processed before being transferred into a specific form: as Bock and Levelt (1994) hypothesized, elements in an utterance undergo lexical selection first, then function assignment, the linear order fixation, and inflection at last. Numerous factors are identified as having an effect on this processing, including conceptual information (e.g., prototypicality, givenness, and animacy) and lexical information, such as the length of noun phrases. Certain factors have a consistent effect across languages. The content we produce will reflect the effects of these factors on serial processing. Language studies, such as error analysis and contrastive studies, focus on language production as well, but primarily on written production. Nonetheless, these studies indicate that different characteristics have been realized in different languages: for example, in Japanese, human nouns are preferred as sentence subjects, whereas inanimate nouns can naturally function as animate nouns in Mandarin Chinese (Zhang, 2001); additionally, passive sentences with an inanimate subject and animate oblique object can be used normally in Chinese (e.g., my wallet was stolen by the thief), whereas it is more common to convey the same event using active sentences with an animate-subject in Japanese (Liu, 2007). As a result of these distinctions, speakers frequently make errors when speaking foreign languages.

Linguistic studies usually attribute errors to the influence of speakers' native languages or a lack of knowledge about particular grammar item. Nevertheless, the mystery surrounding how speakers process a language persisted. Previous studies have demonstrated the effect of conceptual information on different processing levels during sentence production. Recognizing the effect of conceptual accessibility on the production process may aid us in better understanding how speakers process different languages and in determining the appropriate interpretation for errors made by L2 learners.

1.2 The Purpose of the Study

The purpose of this study was to investigate the mechanism of sentence production of Chinese JFL learners with a particular emphasis on the animacy effect, in order to gain a better understanding of their linguistic processing during speech.

The purpose of experiment 1 is to investigate the effect of conceptual information (animacy) on the processing of Japanese sentence production by both Japanese native speakers and Chinese JFL learners. We expect to observe distinct processing of animacy information and a different mechanism in the production of L1 and L2 Japanese speakers when these two groups are compared. A sentence-recall task was conducted to observe the animacy effect on grammatical function assignment, specifically the determination of voice, via participants' production of active or passive transitive sentences; the task was also used to observe the animacy effect on the determination of the linear sequence of noun phrases, specifically the choice to place the animate or inanimate noun in an earlier position, in both transitive sentences and NP conjunction structures.

Since the sentence-recall task included sentence comprehension, the purpose of experiment 2 is to discuss the relationship between sentence comprehension and subsequent production. To accomplish this, we examined Chinese JFL learners' capacity for sentence comprehension (particularly for sentences with scrambled word order) using a visually presented reading task combined with a grammaticality judgement task. To assess participants' comprehension of stimuli in experiment 1, we created stimuli for sentence-comprehension task using the same experimental items. To examine the effect of different word orders (canonical or scramble) on sentence comprehension, we altered the word order for all stimuli used in the comprehension task. We divided the participants into two groups according to their grammaticality judgement score. Then, we examined how animacy information is processed in the production of Chinese JFL learners with varying comprehension abilities.

The purpose of experiment 3 is to validate the animacy effect observed in experiments 1 and 2 on Chinese JFL learners' sentence production and to observe implicit learning of animacy processing via a structural priming method. A picture-description task that allowed for more natural utterances was used to determine whether animacy information affects Chinese JFL learners' production in a different task and whether this effect could be facilitated by exposure to animacy processing. Transitive sentences are manipulated for voice, word order and the thematic role of

animate nouns to correspond to the animate subject assignment and animate-inanimate sequence respectively. In addition, experiment 3 aims to observe differences in the sensitivity Chinese JFL learners to various animacy processing.

1.3 Organization of the Dissertation

Chapter 1 mentioned the background and purpose of the present study. Chapter 2 introduced sentence production models and primarily reviewed previous studies on the effect of conceptual accessibility on language production, on the accounts for language processing. We also introduced empirical studies on native Chinese speakers, as well as the error analysis, which revealed how Chinese JFL learners produced sentences. Chapter 3 introduced the details of experiment 1. Chapter 3.2 to 3.5 described the goal and experimental design; the results of experiment 1 were mentioned in chapter 3.6.1 and 3.6.2 for different syntactic structures and participants. Chapter 3.7 discussed the results of experiment 1, with chapter 3.7.1 and 3.7.2 focusing on the animacy effect, and chapter 3.7.3 on the sentence production mechanisms for both groups of participants. Chapter 4 described experiment 2 in detail. Chapter 4.1 reviewed previous studies on the scrambling effect on sentence comprehension. Chapter 4.2 to 4.6 described the goal and experimental design of experiment 2; chapter 4.7 presented the results of experiment 2, and chapter 4.8 discussed the results of sentence comprehension and production. Chapter 5 introduced the details of experiment 3, and chapter 5.1 discussed its purpose; chapter 5.2 introduced previous studies on structural priming. Chapter 5.3 to 5.6 introduced the experimental design; the results of experiment 3 were presented in chapter 5.7, with the grouping in chapter 5.7.1 and the results of sentence production in chapter 5.7.2. Chapter 5.8 discussed these findings.

Chapter 6 presented a general discussion on results of the present study. An review on the animacy effect observed in the Japanese sentence production was presented in chapter 6.1, and a hypothesis about the sentence production mechanism used by Chinese JFL learners was described in chapter 6.2. Chapter 7 summarized the findings on Japanese sentence production and unresolved issues in the present study.

2. LITERATURE REVIEW

2.1 The Process of Sentence Production

People's utterances could reflect the nature of their thoughts and their manipulation during sentence production. To construct an utterance, one must first determine what to say (namely the message), and then select an appropriate syntactic frame to convey the message.

Prior to being converted to a specific surface form, it is assumed that the intended message will undergo a series of processing steps during production. According to the speech production model of Levelt (1989), the language production process is divided into three stages: *conceptualization*, *formulation,* and *articulation*. During the conceptualization stage, speakers plan the messages they will utter, retrieving and extracting the concepts associated with the messages. These retrieved concepts are then assigned appropriate phonological and syntactic forms during the formulation stage, and finally expressed as utterances via motor movement during the articulation stage.

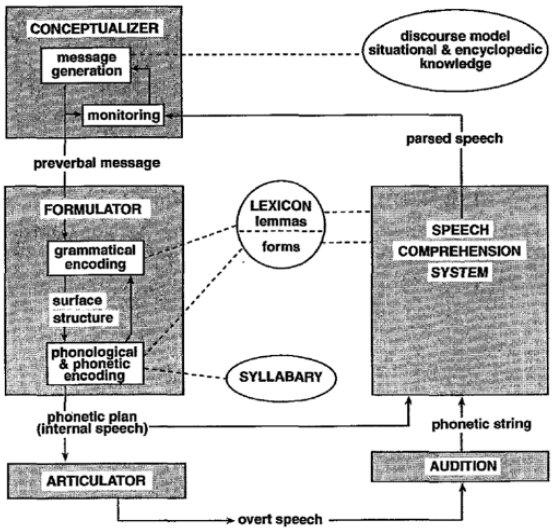

Figure 1. The speech production model of Levelt (Levelt, 1989: p.9)

More specifically, during the conceptualization stage, speakers activate and access relevant concepts in order to create a conceptual representation. At this point, it is demonstrated that conceptual accessibility, as defined by various concepts such as imageability (Bock & Warren,1985),

prototypicality (Kelly, Bock, & Keil, 1986), givenness (Bock & Irwin, 1980, etc.), and animacy (Tanaka, Branigan, McLean, & Pickering, 2011, etc.), has an effect on the priority of accessing concepts. In other words, the more accessible a concept is, the more likely it will be activated first and exert influence over subsequent processing.

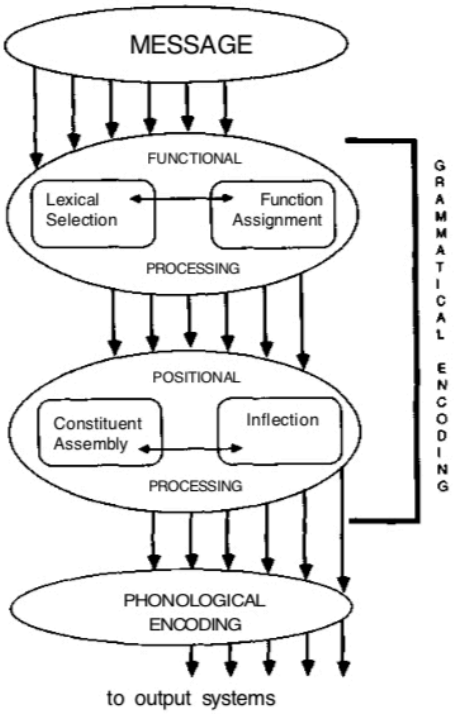

Figure 2. An overview of grammatical encoding processes (Bock & Levelt, 1994: p.946)

Subsequently, the conceptual representation must be formulated into both syntactic and phonological forms. Thus, the formulation stage comprises two processes: *grammatical encoding,* which involves the construction of syntactic representations (syntactic forms), and *phonological encoding,* which involves the generation of phonological structures. We begin with the grammatical encoding. Bock and Levelt (1994) further suggested two processes among grammatical encoding, *functional processing,* and *positional processing*. More precisely, they suggested that the functional processing involves two steps: the first step, lexical selection, where speakers choose appropriate words from their mental lexicon for concepts; the second step, function assignment, where speakers identify the syntactic relationship between arguments and assign them with specific grammatical functions (e.g., subject, object, and predicate in a two-arguments transitive event). The following

positional processing is assumed to include two additional steps: speakers first assemble constituents to determine the order of different words; they then decide on the inflection of words based on the needs for utterance (e.g., the past tense). Following these manipulations, speakers determine the phonological structure of the message during phonological encoding and finally produce the utterance via vocal organ movement.

As illustrated in Figures 1 and 2, the process of sentence production is assumed to be incremental (e.g, Levelt, 1989; Bock & Levelt, 1994), and thus the order wherein constituents emerge in an utterance may, in turn, reflect the order in which concept are activated and processed. In general, the first activated concept will complete the assignment of grammatical function preferentially during functional processing; similarly, the first activated concept will be assigned to a specific position in a sentence preferentially during positional processing. Hence, factors affecting the priority of conceptual accessing may also have an effect on subsequent formulation at all levels.

2.2 The Effect of Conceptual Accessibility on Language Production

Prior to discussing the accessibility of conceptual information, it appears as though syntactic information has its own accessibility. Keenan and Comrie (1977) established the following general hierarchy by studying approximately fifty languages.

(1) The Accessibility Hierarchy (Keenan & Comrie, 1977):
Subject > Direct object> Indirect Object > major Oblique case NP > Genitive > Object of Comparison

The accessibility hierarchy indicates the relative accessibility of grammatical functions of noun phrases within a simple main clause. In other words, during grammatical processing, the subject function is typically accessed first, followed by the direct object function, the indirect object function, and so on. Based on this hierarchy, numerous studies have examined how conceptual features (e.g., animacy, gender) or conceptual information (e.g., semantic role, salience in the discourse) and grammatical information interact to affect the functional assignment of constituents using psycholinguistic approaches.

As previously mentioned, several factors have been demonstrated to influence the conceptual accessibility of a concept (the ease of accessing concepts). For example, Bock and Warren (1985) provided evidence that the imageability of noun phrases has an effect on their placement in grammatical relations: more imageable (accessible) constituents tend to appear in higher functions than those less imageable constituents. More specifically, in the speech of native English speakers, entities that are more imageable/accessible are frequently assigned as sentence subjects. These findings confirmed the interaction between conceptual accessibility and grammatical function accessibility.

Kelly et al. (1986) found an effect of prototypicality: native English speakers tend to recall noun phrase conjunctions with prototypical entities preceding non-prototypical entities, and recall prototypical entities as sentence-initial subjects. Givenness has also been shown to influence speakers' sentence choices: English speakers tend to produce sentences that allow given information positioned earlier and new information later, resulting in given-new ordering (Bock & Irwin, 1980). Similarly, Ferreira and Yoshita (2003) found that the availability of information has an effect on grammatical encoding in Japanese sentence production: Japanese speakers tend to modulate the word order in order to have given arguments preceding new arguments. In addition, Chang (2009) investigated the processing biases in the word order of Japanese and English and found a strong long-before-short bias in Japanese (which is also present in Mandarin Chinese), but a short-before-long bias in English.

Apart from these factors, animacy has also been widely discussed. The referential hierarchies of Silverstein (1976) revealed a constraint on the preference for animacy. Silverstein proposed that entities at the top of the hierarchy (animate entities such as humans and animals) are more prototype agents, while the entities at the bottom (inanimate entities such as elements and toponym) are more prototypical patients, highlighting the correlation between animacy and syntactic roles. Psycholinguistic studies have exaimed the effect of animacy on the production of diverse languages. In the picture description task of Bock, Loebell, and Morey (1992), there is a tendency for English native speakers to produce passives with animate patients as sentence subjects. Given the limited word order in English, this tendency can also be interpreted as a preference for animate entities to appear in earlier positions. Furthermore, in the sentence recall study of Branigan and Feleki (1999), Greek speakers tend to recall sentences with animate entities preceding inanimate entities even when

the subjects are not animate nouns. Their experiment demonstrated that animacy directly influences the choice of word order, but had no effect on speakers' choice of grammatical function assignment, in contrast to what suggested for English speakers in Bock and Warren (1985). Tanaka et al. (2011) used a sentence recall task to investigate the sentence production of Japanese native speakers. The results showed that Japanese native speakers are more likely to recall active sentences with animate subjects or sentences with animate entities in the first position. Moreover, these tendencies are independent of one another, implying that conceptual features have a direct effect on both functional and positional processing. As above, the inherent characteristics of concepts or their semantic information affect language production at different levels.

To summarize, previous studies have demonstrated that animacy has an effect on grammatical function assignment which refers to functional processing during grammatical encoding (Bock & Warren, 1985; Tanaka et al., 2011, etc.): speakers tend to assign higher functions in the Accessibility Hierarchy to conceptually more accessible entities, which reflects a tendency that animate entities are easier to be produced as sentence subjects in different languages (English, Japanese, etc.). Likewise, animacy has been demonstrated to influence word order, referring to positional processing: in some languages (e.g., Greek, Spanish, and Japanese; Branigan & Feleki, 1999; Prat-Sala & Branigan, 2000; Tanaka et al., 2011, etc.), speakers tend to preferentially produce animate entities first rather than inanimate entities, in spite of their grammatical function or thematic roles. Chang (2009) also found that animacy influences the syntactic function assignment in English but the order of syntactic functions in Japanese. Taken together, the animate-first and animate-high (function) principles are considered as the representations of animacy effect.

Furthermore, Hwang (2018) presented a sentence-assembly task to investigate the interaction of semantic roles and grammatical roles: they found that in Korean, speakers tend to assign nouns with agent roles as sentence subjects and also tend to produce constituent structures with the agent preceding the patient. This suggested that conceptual information such as thematic roles had an effect on grammatical encoding.

In summary, there is wealth of evidence indicating the influence of conceptual accessibility on syntactic choice during sentence production, and these influences may vary by language.

2.3 Theories of Language Processing

Previous studies have examined the influence of conceptual accessibility on functional processing and positional processing. However, there are still disagreements about how precisely these factors affect the levels of grammatical encoding. As presented above, animacy was found to affect the selection of grammatical function but not the determination of word order; consequently, Bock and Warren (1985) proposed a grammatical function model in which conceptual accessibility only has an effect on functional processing. Bock et al. (1992) provided evidence of the separation between functional and positional processing through a sentence priming paradigm. Their findings supported a direct-mapping process, which implies a single structural-syntactic level.

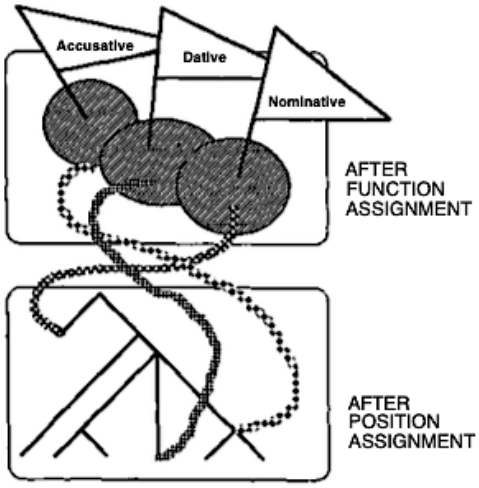

Figure 3. The relationship between grammatical functions (after function assignment) and grammatical relations (after position assignment) (Bock & Levelt, 1994: p.963).

Accordingly, Bock and Levelt (1994) referred to traditional case terminology as the grammatical functions (the result of function assignment), and traditional grammatical relations terminology as the results of position assignment. Considering the constraint of word order in languages like English and Mandarin Chinese, traditional grammatical functions can only be structurally marked, whereas they can be morphologically marked in case languages such as Japanese and Korean. Hence, such definitions seemed more rational in configurational languages than in case languages, as the subject does not always have to appear at the beginning of a sentence. Also, they proposed a one-to-one correspondence between function (underlying roles) and position assignments

(surface roles), regarding the regularity of function assignment as uniformity of conceptual representation (the message/event itself) rather than that of grammatical representation.

Since higher grammatical functions tend to be assigned in earlier sentence positions than lower grammatical functions, conceptual accessibility is considered to influence positional processing indirectly. This refers to a two-stage model in which conceptual accessibility does not simultaneously influence both functional processing and positional processing.

Conversely, De Smedt (1990) proposed a parallel account, also known as a one-stage model: in this account, grammatical functions and word order are determined concurrently, implying that conceptually more accessible entities are retrieved earlier than less accessible entities and claim both higher grammatical functions and earlier word order positions simultaneously. Thus, speakers sometimes prioritize the grammatical function over word order and sometimes the word order over grammatical function. Based on this account, more accessible concepts are predicted to appear first in noun phrase conjunctions. Besides, there is also a word order account (De Smedt, 1994) that is diametrically opposed to the grammatical function model. According to this model, word order is determined prior to the assignment of grammatical functions; thus, more accessible concepts would take precedence over less accessible concepts irrespective of their grammatical functions, suggesting a direct influence of conceptual accessibility on word order processing. Likewise, Cai, Pickering, and Branigan (2012) conducted a structural priming task in which speakers used the conceptual information (thematic roles in their study) to construct functional and positional representations in Mandarin Chinese, and proposed a similar one-stage model wherein functional and constituent-structural information are co-represented: this suggests that conceptual information influences both functional and positional processing in parallel, without knowing the sequence. In addition, they asserted that Mandarin Chinese has a more robust conceptual-to-linear mapping.

Nevertheless, studies of Japanese (Tanaka et al., 2011) and Korean production (Hwang, 2017) have suggested models that contradict all previous accounts. Though Tanaka et al. (2011) found support for a two-stage model in Japanese sentence production, their account differed from that of English in terms of whether conceptual accessibility functioned at both levels of processing: animacy as an measure of conceptual accessibility was found to affect the traditional grammatical function assignment of constituents despite their linear sequence, and to affect the linear position assignment of constituents equally in spite of their grammatical functions. Hwang (2017) used thematic roles as

the index of conceptual accessibility and discovered that native Korean speakers tended to assign the subject function to the agent entity and also tended to place the agent entity in the sentence-initial position. This tendency is compatible with a combination of both the one-stage model and two-stage model. Taken together, it seems easier to distinguish the effect of conceptual accessibility on functional and positional processing respectively in Japanese and Korean. This could be attributed to the inherent property of case languages with relatively flexible word order, which allows the disagreement between higher grammatical functions and earlier sentence positions. In contrast to English, the consequences of function assignment should be defined in terms of traditional grammatical relations terminology (subjects, objects, direct object, and so on), and the consequences of position assignment should be defined as linear sequences.

Numerous accounts above indicate that both the magnitude of the influence of conceptual accessibility and the mechanism of grammatical encoding may be related to the properties of languages. Even though reaching a clear conclusion is difficult, we still aim to observe the possible mechanism at work in the sentence production of Chinese and Japanese native speakers and determine whether our findings corroborate existing accounts.

2.4 Studies on Native Chinese Speakers

Though research on the influence of conceptual accessibility (conceptual information) in Mandarin Chinese are limited, there was some empirical evidence supporting the animacy effect on Chinese sentence production and comprehension.

Philipp, Bornkessel-Schlesewsky, Bisang, and Schlesewsky (2008) observed the animacy effect on Chinese sentence comprehension through an ERP study: no animacy effect was observed on the first argument at the beginning of simple verb-final construction, but an N400 effect was observed when participants realized the first inanimate argument was the actor (for example, *xiaodao ba tiaozhanzhe cisi-le* 'The knife has stabbed the contender'). These findings confirmed the important role of animacy in recognizing the semantic relationship between arguments, though it was not functional initially.

Wu, Kaiser, and Anderson (2012) employed a self-paced reading task to investigate how animacy affects real-time processing of Chinese relative clauses (RCs), based on animacy patterns found in corpus. They found that SRCs (subject-extracted) and ORCs (object-extracted) were equally

straightforward to interpret when RCs contained animate subjects and inanimate objects, while ORCs presented a greater interpretive challenge than SRCs when the animacy arrangement was inverted (an inanimate subject and an animate object). As evidenced by the general head-animacy effect, the parser is considered to be sensitive to the semantic properties of nouns, and animacy does indeed play an important role in guiding the processing of RCs in Chinese.

Kwon, Ong, Chen, and Zhang (2019) studied both the production and comprehension of relative clauses in Mandarin Chinese. The production results revealed an animacy effect on RC attachment: animate NPs are more likely to be modified by RCs than inanimate NPs are, even when the RCs lead to high attachment (i.e., modify the latter noun phrase): for instance, Chinese speakers were more likely to modify the '*nongfu*' (farmer) in both complex noun phrases such as ".....*de nongfu de nongchang*" (The farm of the farmer that.....) and ".....*de nongchang de nongfu*" (The farmer of the farm that.....) (note the inverse word order in Chinese). However, the animacy effect was restricted only in the comprehension of subject-extracted RCs, which reveals the fact that animacy effect can be constrained by structures.

The corpus analysis of Hsiao and MacDonald (2013) revealed a surprisingly similar animacy arrangement in both main and relative clauses to other languages: especially the tendency of animate subjects and inanimate objects in main clauses, as well as the tendency of animate head nouns in SRCs and inanimate head nouns in ORCs. Hsiao and MacDonald (2016) further investigated the influence of head noun animacy on the choice of RC forms through a picture description task: while there was also a high passive rate for inanimate entities (75%), they found an overwhelming passive preference for animate entities (98%), confirming the animacy effect on the structure choice of RCs in Mandarin Chinese, and especially revealing a tendency for Chinese speakers to preferentially assign animate nouns as subjects rather than inanimate nouns.

Yan and Dong (2011) used both the sentence-recall and the RSVP picture-event description tasks to confirm animacy effect in NP conjunctions production, but found a significant preference for animate-leading NP conjunctions over inanimate-leading NP conjunctions only in picture-description task: for example, recalling "*liulanghan zai mosheng-de chengshi li zhaodao-le xingfu he qizi*" (The tramp found his happiness and wife in a strange city) as "*liulanghan zai mosheng-de chengshi li zhaodao-le qizi he xingfu*" (The tramp found his wife and happiness in a strange city). Especially, this animacy effect became stronger when an animate picture was presented earlier than

an inanimate picture. They argued the lack of significant effect in sentence-recall task to the disadvantage that memory task yet differs from natural speech.

According to existing research, language production studies taking Chinese speakers as objects have mainly focused on the animacy effect in relative clauses and NP conjunctions, with little attention paid to other structures.

Zhou, Ye, Cheung, and Chen (2009) concluded that, consistent with previous research, the processing of Mandarin Chines follows the cross-linguistic preference for subject-initial order. More specifically, Do and Kaiser (2019) examined the start point for grammatical encoding using a production-during-eye-tracking task: for both English and Chinese native speakers, participants looked first at the sentence subject rather than the object; in addition, both native speakers tended to preferentially produce subjects. These results demonstrated that subject function assignment also plays an important role in Chinese speakers' linguistic encoding. However, there was little discussion of the effect of conceptual information (or conceptual accessibility) on the processing of Mandarin Chinese. Observation of the effect of conceptual information on Chinese native speakers' production is also limited. Thus, further research with Chinese native speakers is necessary to determine whether the factors discussed above have an effect on grammatical encoding in sentence production of Chinese speakers, as well as the extent to which these factors have an effect.

2.5 Error Analysis and Japanese Sentence Production of Chinese JFL learners

We focus on the sentence production of Chinese JFL learners in the present study. One critical difference between Mandarin Chinese and Japanese lies in the word order. The linear sequence of a simple transitive sentence in Mandarin Chinese is limited as SVO. As a result, the traditional grammatical function of nouns (phrases) in a sentence is limited by the SVO order, in which the first argument is generally defined as the sentence subject, despite the controversy over the distinction between theme and subject. In contrast, Japanese allows for considerable flexibility in word order, with both SOV and OSV orders being acceptable in a sentence. By combining case particles, it is possible to present the grammatical function assignment and the linear position assignment of arguments independently. Thus, in comparison to studies that focus exclusively on the production of Mandarin Chinese, taking Chinese JFL learners as target enables us to investigate the sentence production process of Chinese speakers, especially the influence from conceptual accessibility to

functional processing and positional processing, respectively. Moreover, we are able to observe differences in the conceptual processing and grammatical encoding mechanisms between their native and foreign languages.

Though research on the similarity/difference in conceptual information processing between L1 and L2 production of Chinese speakers was highly limited, we found typical examples that may reflect the processing of animacy information from the error analysis studies of Chinese JFL learners. For example, when uttering pseudo-passive sentences such as *watashi-wa kata-o sensei-ni tatakareta* (I have my shoulder tapped by the teacher) or *watashi-wa kami-o haha-ni kirareta* (I have my hair cut by mom), Chinese JFL learners were found to make mistakes when describing the same events in a grammatically correct but unnatural form as *watashi no kata-wa sensei-ni tatakareta/watashi no kami-ha haha-ni kirareta*, as suggested in Feng (1993) and Wang (2008). Also, they sometimes utter unnatural passives with an inanimate entity to be the sentence-initial argument, such as *shiawase-na seikatsu-wa watashitachiikka-ni okurareteiru* 'the happy life was spent by my family' (Gu & Xu, 1980), *gohan-wa watashi-ni taberareta* 'the rice was eaten by me' (Feng, 1993). Moreover, sometimes they produced passives with animate entities as the patient and inanimate entities as the agent which is also seemed to be unnatural, such as *(otoko-ga) ishi-ni korobareta* (the man stumbled against the stone) following the use of Chinese (Zhang, 2014). As claimed by Zhang (2001) and Feng (1993), the frequency for inanimate entities to be subjects and agents in passives is higher than in Japanese, which influenced their Japanese sentence production.

More specifically, Zhang (2001) suggested there exists a ranking of the priority for nouns to appear as sentence subjects in Japanese (which seems to be a simplification of Silverstein's referential hierarchy): the first personal pronoun > human referents (nouns or pronouns) > nouns refer to inanimate entities. This ranking is considered to be cross-linguistic (English, Russian, etc.) and could be reflected in the choice of sentence structures. For example, Japanese native speakers seem to generally utter sentences like (2) rather than (3): they prefer active sentences with animate subjects rather than passives with inanimate subjects when animate entities bear the agent role and inanimate entities bear the patient role.

(2) 僕、例の酒を飲んでしまった。 (I drank that glass of sake.)

Boku, reino-sake-o nondeshimatta.

(3) 例の酒が僕に飲まれた。 (That glass of sake was drunk by me.)

Reino-sake-ga boku-ni nomareta.

Conversely, Zhang (2001) claimed that there is no such ranking of nouns in Mandarin Chinese, and thus passive sentences with inanimate subjects and animate oblique objects like (3) are frequent and natural in Mandarin Chinese: for the event "the new cloth that mom bought was soiled by the child", the active sentence *Mama, wo ba yifu nongzang-le* (Mom, I stained the cloth) and the passive sentence *Mama, yifu bei wo nongzang-le* (Mom, the cloth was stained by me) are equally acceptable. Hence, Zhang suggested that the absence of noun phrase ranking in L1 Chinese may contribute to the error of L2 Japanese passives by Chinese JFL learners, resulting in sentences like "*aitsu no jitensya (-ga), boku-ni nottekoraremashita*" (his bicycle was ridden here by me).

The influence of noun phrase ranking exists not only in oral/written production but also in literature. Zhang (2001) quoted sentences from literature works and attached natural Japanese translation: the corresponding translation for "这个字终于被我写像样了" (this character is finally written well by me) should be「私はとうとうこの字を上手に書けるようになった」(I have finally mastered the art of writing this character well) which is considered to be natural in Japanese, rather than「この字はついに私によってまともに書かれた」. Similarly, Shioiri (2017) collated and summarized Japanese transitive sentences that corresponding to the BEI passives in Mandarin Chinese and found that the corresponding Japanese translation for inanimate-subject passives of Chinese was more likely to be transitive actives: for example, (a) ".....有几粒玉米被啃了下来" (a few grains of corn were nibbled off) was translated as「五、六粒かじりとった」(.....nibbled off a few grains of corn); (b) "'却之'练习写下的一张张小楷、被两个孩子拿去欣赏品味" (the pieces of Quezhi's practice writing of the small regular script was taken by two children to appreciate) was translated as「却之が練習に書いた字を姉弟は手にとって鑑賞した」(two children took pieces of Quezhi's practice writing of the small regular script to appreciate).

These different expressions to some degree revealed a difference in subject assignment between Mandarin Chinese and Japanese, that is, Japanese native speakers tend to assign animate nouns as sentence subjects, whereas animacy appears to have no influence on the choice of Chinese native speakers. However, such a view contradicts to previous empirical studies that have directly or indirectly demonstrated the influence of animacy information on grammatical encoding in Chinese,

the animacy effect thus remained ambiguous in the speech of Chinese speakers. Especially, the animacy effect is not reflected in the Japanese production of Chinese JFL learners. While studies focusing on error analysis revealed some characteristics of Chinese JFL learners' processing of Japanese sentences, we yet lack observation and analysis on the mechanism of their Japanese sentence processing.

In addition, error analysis studies normally attribute the cause of errors to the influence from L1 or a lack of L2 knowledge. However, do Chinese JFL learners apply the same processing to L2 Japanese sentences as in L1 Chinese? Or do their errors result from the different processing of animacy information? To address these issues, an experimental study is necessary. Thus, we propose examining the specific influence of animacy information in Chinese JFL learners' Japanese sentence production and comparing it to that of Japanese native speakers in order to determine the similarities or differences between the conceptual processing and grammatical encoding of the two groups.

Furthermore, as a result of analyzing the Ludong University speech corpus, Sugimura (2010) found that Chinese JFL learners frequently misused the *-ga* case particle (e.g., *Keitaidenwa-ga (o) otoshimashita* 'My telephone was lost' or *Watashi-wa kotoshi-wa nihongo-ga (o) benkyoushimasu* 'I, in this year, will learn Japanese'). The excessive use of the *-ga* case-marker may reflect a preference for subject function; indeed, it is possible that Chinese JFL learners first activate the subject function and then preferentially assign it to the corresponding concept during functional processing. An empirical examination of this possibility is necessary.

As can be seen, while both Japanese and Chinese have been found to exhibit an animacy effect on sentence production, the processing of animacy information appears to differ in the Japanese sentence production of Chinese JFL learners. However, the effect of animacy on Chinese JFL learners' syntactic choice has not yet been examined in terms of sentence production, especially for simple transitive sentences.

Besides, Tamaoka, Zhang, and Makioka (2019) found no significant difference in the frequency with which animate or inanimate nouns are assigned as subjects in sentences containing transitive words. This finding contrasts with Tanaka et al. (2011), who asserted a significant tendency for animate nouns to be assigned as subjects rather than inanimate nouns. Thus, we consider retesting the sentence production of native Japanese speakers to support previous studies.

3. EXPERIMENT 1

3.1 Goal

We aim to investigate the Japanese sentence production mechanism of Chinese JFL learners through a psycholinguistic experiment in order to gain a better understanding of their processing during conceptualization and formulation. To accomplish this, we examine the effect of animacy information on both functional and positional processing during the process of grammatical encoding.

While errors detected in Chinese JFL learners' Japanese sentence production appear to reflect a different processing of animacy information, this may be unreliable due to the fact that the target production of error analysis can be influenced by factors such as the purpose or context of production. Thus, given the shared nature of animacy effect in L1 Japanese and Chinese languages (e.g., a tendency for an animate noun precede an inanimate one) as suggested in previous studies (e.g., Tanaka et al., 2011; Yan & Dong, 2011), and the potential influence of L1 on L2 processing, we predict that when subjects produce Japanese transitive sentences in an experimental environment in which factors affecting their utterances are controlled, animacy would affect the syntactic choice of Chinese JFL learners and they would tend to assign animate nouns as the subject and place animate nouns at an earlier position as in the case of Japanese native speakers.

The processing of animacy information was observed using a sentence-recall task. Attributed to the reason that speakers' immediate memory for a sentence is thought to be conceptual-based (Potter & Lombardi, 1990), it is generally easier for them to memorize the gist of the sentence rather than the specific syntactic form. Additionally, as syntactic biases could be revealed in speakers' restatement, recall paradigms may be appropriate for studying the sentence production process (Bock & Irwin, 1980). We replicated the sentence-recall task of Tanaka et al. (2011), in which participants listen to a set of sentences at one time and recall them immediately after completing the listening comprehension.

3.2 Participants

A total of 37 participants, including 25 Chinese JFL learners and 12 Japanese native speakers, were recruited from graduates and undergraduates at universities in Osaka and Kobe participated with payment. All the Chinese JFL learners were native Mandarin Chinese speakers who had passed the

Japanese Language Proficiency Test (JLPT) at the N1 level, with an average score of 137 over a range of 102–180.

We did not administer any additional proficiency tests as the majority of proficiency tests are based on JLPT prior exam questions. Indeed, while JFL learners are considered to achieve a certain level of Japanese grammatical ability, they are not always able to produce fluent and precise utterances. In addition, the sentence-recall task requires a high level of comprehension ability to ensure that participants fully understand the meaning of sentences, as well as a high level of expression ability to ensure that participants can produce complete sentences as possible as they can. Thus, by having JFL learners with a higher level of proficiency (adequate vocabulary and grammar ability) as our objects, we can avoid extra influences that arise from a lack of proficiency.

3.3 Stimuli

We tested the influence of animacy on the construction of syntactic representations (syntactic forms) in the Japanese sentence production of Chinese JFL learners using transitive and NP conjunction structures. We referred to Tanaka et al. (2011)'s stimulus to generate 42 items that describe transitive events (among which 5 items were directly reused). We needed to generate scenarios of transitive events and determine experimental items first, and then verify the familiarity of words utilized in our stimuli against the Japanese Word Familiarity Database of NTT. Eventually, the average value of auditory familiarity was 5.839 on a 7-point scale.

Each item comprised a prepositional phrase, an animate noun (e.g., the human), an inanimate noun (e.g., the environment), and a verb phrase. We distributed the 42 items according to six conditions, two of which were NP conjunction conditions and four of which were transitive conditions (an example of each is shown in Table 1). The same prepositional phrases and noun phrases were used to construct NP conjunction structures.

More specifically, for NP conjunctions, we manipulated the order of noun phrases to create two conditions, each with 42 sentences (conditions 1 and 2 as shown in Table 1). For transitive conditions, 42 transitive sentences were altered in terms of voice (active or passive) and word order (canonical or scrambled) to generate four new variants corresponding to four conditions (conditions 3 to 6 as shown in Table 1). To eliminate the influence of inanimate agents (which are generally unfamiliar to speakers), we restricted animate words to the semantic role of agent and inanimate nouns to the semantic role of

patient. Additionally, we created 24 intransitive sentences as filler items, half of which contained animate subjects and half of which contained inanimate subjects. There was a total of 276 sentences used in this experiment.

Table 1

Conditions and examples of experimental sentences

Condition 1: NP conjunction with [Animate-Inanimate] order
報告によると、人間と環境は深く関わっている。
According to the report, humans and the environment were deeply involved.
Condition 2: NP conjunction with [Inanimate-Animate] order
報告によると、環境と人間は深く関わっている。
According to the report, the environment and humans were deeply involved.
Condition 3: SOV-active sentence
報告によると、人間が環境を破壊した。
According to the report, humans ruined the environment.
Condition 4: OSV-active sentence
報告によると、環境を人間が破壊した。
According to the report, humans ruined the environment.
Condition 5: SOV-passive sentence
報告によると、環境が人間によって破壊された。
According to the report, the environment was ruined by humans.
Condition 6: OSV-passive sentence
報告によると、人間によって環境が破壊された。
According to the report, the environment was ruined by humans.

Through participants' production of active or passive sentences, we observed the animacy effect on grammatical function assignment, specifically the determination of voice. In addition, we observed the animacy effect on the linear sequence of noun phrases by the determination of word-order, namely the choice to place the animate or inanimate noun in an earlier position.

3.4 Procedure

As previously stated, we replicated the sentence-recall task used in Tanaka et al. (2011). Participants took part in the experiment individually. Prior to testing phase, participants were asked to study the meaning of the words that would be used in the subsequent phase to ensure that they understood the experimental phrases correctly. Participants were instructed to read the words aloud to familiarize themselves with the pronunciation of all words; if they understood the meaning of a word, they were instructed to hit the space button to proceed. We conducted a review following their learning of the entire list to ensure that participants correctly pronounced and understood the words. This phase lasted approximately 10 minutes.

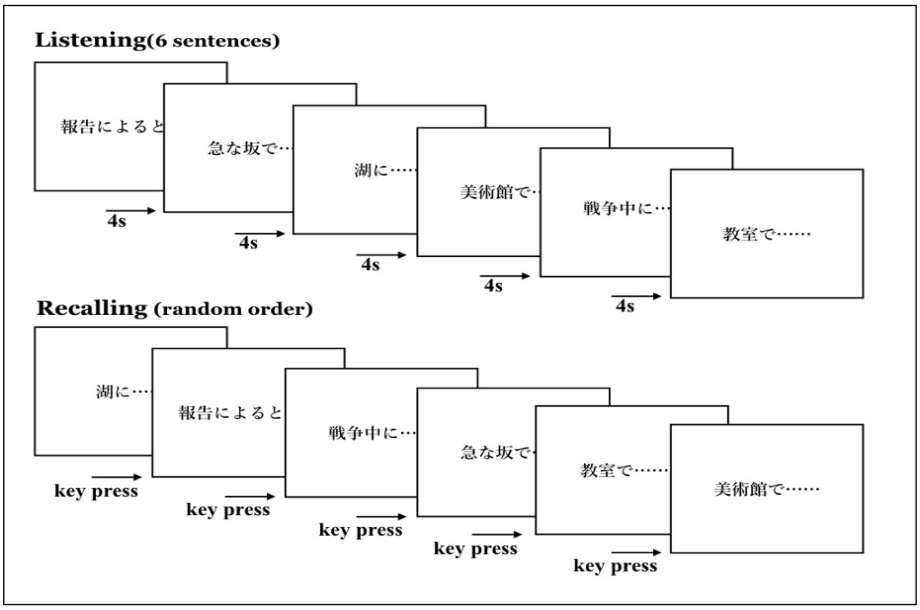

Figure 4. The paradigm of procedure in the sentence-recall task in experiment 1.

In the subsequent testing phase (the sentence-recall task), each participant received eight trials. Each trial began with participants listening to a set of six Japanese sentences recorded by a female native Japanese speaker. During the listening phase, each spoken sentence was accompanied by a text screen that changed automatically after each sentence. The screen displayed only the prepositional phrase, which remained visible for a 4-second interval following the recording to allow participants to consolidate their memory. Participants were instructed to maintain their focus on the computer

screen while listening, as the prepositional phrases were always displayed along with the complete sentence recordings.

After listening to the six sentences, participants were asked to recall them. As a reminder, the identical prepositional phrases were presented in a random order. Participants were instructed to read the prepositional phrase aloud before attempting to recall the sentence. They were instructed to produce as complete a sentence as possible. To avoid any disfluency, Hiragana was employed to support the Kanji of all prepositional phrases. There was no time limit for recalling sentences, and as participants completed one, they were given the next phrase to recall. The procedure for one trial is depicted in Figure 4. Each set of stimuli consisted of three or four experimental sentences and two or three fillers. As a result, each participant received 48 sentences, 30 of which were experimental sentences and the remaining 18 were fillers. Each item was presented only once with one variant from conditions one to six. We took a break after every two trials to ensure that participants maintained their concentration throughout the experiment. Prior to beginning the experimental trials, all participants completed a practice trial consisting of two intransitive sentences (one with an animate subject and one with an inanimate subject), one active transitive sentence with an animate subject and an inanimate object, two passive sentences (both with animate NPs), and one NP conjunction sentence that were unrelated to the experimental stimuli.

It is remarkable that, while we referred to the experiments of Tanaka et al. (2011), we made some modifications to improve the performance of JFL learners. First, we reduced the number of sentences to memorize in each trial from eight (in Tanaka et al.,2011) to six. We conducted a pilot test in which participants listened to 8 sentences at once, but the results indicated that both native Japanese speakers and Chinese JFL learners had an extremely low percentage of required sentence recall (average 36.5 percent and 37.9 percent for native and JFL learners respectively). Second, Tanaka et al. (2011) established an eight-seconds time limit for sentence recall, but we canceled it during recall due to the low number of complete sentences produced within that time limit. Chinese JFL learners, in particular, took longer to retrieve noun and verb phrases and also to construct a sentence than native speakers. As a result, L2 participants frequently fail to recall the entire sentence in time, lowering the overall rate of complete sentence production. Finally, we introduced a self-paced word learning session for all participants, as there is no reference to word frequency for Chinese JFL learners. Moreover, since the frequency of certain words in he experimental sentences is low, we cannot

guarantee that participants will immediately understand the pronunciation and meanings (even for native Japanese speakers); additionally, there are words in Japanese that have the same pronunciation but different meanings. Thus, a word learning session is required for both native speakers and Chinese JFL learners to ensure that participants comprehend our stimuli accurately. We compared the results of the formal experiment to the pre-test which did not include a word learning session, and found that both JFL learners and native speakers significantly improved their memory and recall.

3.5 Scoring

Responses produced by participants were classified into five categories as follows. Responses were classified as *Same* when participants recalled the original gist and syntactic structure of sentences they listened to, and when participants replaced original words with synonyms or near-synonyms without altering the meaning or syntactic structure.

Table 2

Scoring categories and examples

Original	Category	Recalled as
Ningen-*ga* kankyou-*o* hakaishita.	Same	Ningen-*ga* kankyou-*o* hakaishita.
		Jinrui-*ga* kankyou-*o* hakaishita.
	Voice inversion	Ningen-*niyotte* kankyou-*ga* hakaisareta.
	Word-order inversion	Kankyou-*o* ningen-*ga* hakaishita.
	Word-order +Voice inversion	Kankyou-*ga* ningen-*niyotte* hakaisareta.
	Other	Kankyou-*o* kowashita/ Ningen-*ga* kowashita., etc.

Responses were classified as *Voice inversion* (Vi) when participants recalled the original linear sequence of noun phrases with only the grammatical function inverted (e.g., recalled *ningen-niyotte kankyou-ga* as *ningen-ga kankyou-o* or *ningen-ga kankyou-niyotte*, vice versa). Responses were classified as *Word-order inversion* (Wi) when participants recalled a reversed linear sequence of noun phrases without altering their grammatical function (e.g., recalled *ningen-ga kankyou-o* as *kankyou-o ningen-ga*, vice versa). Take note that we allowed for misinterpretation of original thematic relations.

Responses were scored as *Word-order + Voice inversion* (Wi+Vi) when participants altered both the linear sequence and grammatical function of noun phrases. Importantly, when Chinese JFL learners misremembered the case particle (e.g., recalled *-ga* as *-wa*, or *-niyotte* as *-ni*), or the verb conjugation (e.g., recalled *yobareta* as *yobirareta*), we classified these responses as above only if the sentence meaning remained unchanged. Responses contained a dropped argument or were recalled with an ambiguous meaning, were scored as *Other*.

Here is our prediction: if animacy has an effect on the assignment of grammatical function (refers to functional processing), we predict that participants will recall more voice inversions in spite of the relative linear sequence between animate nouns and inanimate nouns when original sentences contained inanimate subjects and animate oblique objects. If animacy has an effect on the choice of word order (refers to positional processing), we predict that participants will recall more word-order inversions regardless of the grammatical function of noun phrases when inanimate nouns precede animate nouns (In-An order) in the original sentences.

Furthermore, we predict that animacy affects both functional and positional processing in the sentence production of native Japanese speakers, thus participants will be more likely to produce animate subjects or animate entities in the first position of sentences, based on the findings of previous research. In comparison, we predict that there will be no animacy effect on Chinese JFL learners' functional processing or positional processing, and that participants will tend to produce sentences in SOV order, with animate or inanimate nouns equally assigned as sentence subjects, as an influence of the limited SVO word order in Mandarin Chinese.

3.6 Results

Participants who remembered less than 70% of the experimental sentences were excluded from the analysis due to the appearance of a memory capacity effect. As a consequence, the data of 18 Chinese participants (8 male and 10 female) and 10 Japanese participants (3 male and 7 female) were analyzed. Chinese JFL learners had an effective production rate of 82.78 percent, whereas Japanese native speakers had an effective production rate of 84.67 percent (proportion of responses excluding those scored as *Other*). For our purpose, we focused exclusively on inversions, analyzing the data separately for *Word-order inversion* in NP conjunction conditions and all other types of inversions in transitive conditions. In analyses of transitive conditions, we focused primarily on *Voice* and *Word-*

order inversion, as *Word-order + Voice inversion* accounted for only 2% of total responses produced by Chinese participants and 3% of total responses produced by Japanese participants.

Table 3

Frequency of Responses by Chinese JFL learners (18 participants)

Animacy	Voice	Word order	Recalled responses				
			Same	Vi	Wi	Wi+Vi	Other
An-In	Active	SOV	78	2	1	1	5
	Passive	OSV	25	22	25	0	9
		Conj.	56	0	9	0	16
In-An	Active	OSV	12	29	26	3	12
	Passive	SOV	57	2	8	8	10
		Conj.	44	0	27	0	13

Table 4

Frequency of Responses by native Japanese speakers (10 participants)

Animacy	Voice	Word order	Recalled responses				
			Same	Vi	Wi	Wi+Vi	Other
An-In	Active	SOV	37	2	1	3	3
	Passive	OSV	21	15	5	1	5
		Conj.	33	0	6	0	8
In-An	Active	OSV	12	6	24	0	7
	Passive	SOV	29	2	3	6	5
		Conj.	30	0	10	0	7

Separate analyses of *Voice inversion* and *Word-order inversion* were conducted on Chinese JFL learners and native Japanese speakers. Table 3 and 4 showed the frequency of responses in each condition for the two groups. Since the semantic roles of NPs are fixed, the animacy of the first noun in sentences in conditions 3 to 6 is also fixed: for example, the first noun in sentences in the SOV

active condition must be an animate entity, whereas the first noun in sentences in the SOV passive condition must be an inanimate entity.

3.6.1 NP conjunction conditions

We conducted a repeated-measures *t*-test to observe the *Word-order inversion* in NP conjunction conditions.

In the production of Chinese JFL learners, there was a significant difference in the frequency of *Word-order inversion* between the two conditions (t (17) = −3.729, $p < .01$), as illustrated in Figure 5. Chinese participants were found to invert the linear sequence of noun phrases more often when recalling NP conjunctions with inanimate nouns preceding animate nouns (e.g., recall *kankyou to ningen-ga fukaku kakawatteiru* as *ningen to kankyou-ga...*). This result indicates that Chinese JFL learners prefer to produce animate nouns first, implying that animacy has an effect on the determination of linear sequence in NP conjunction structures, as previously demonstrated in a study of Chinese native speakers (Yan & Dong, 2011).

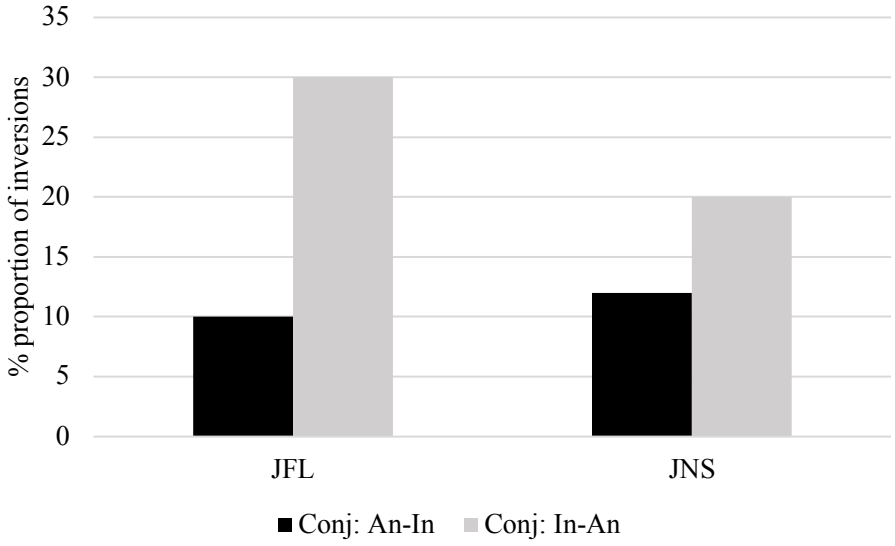

Figure 5. Proportions of word-order inversions produced in NP conjunction conditions (%).

Conversely, for native Japanese speakers, we found no significant difference in the frequency of *Word-order inversion* between conditions (t (9) = −1.078, *n.s.*). For native Japanese speakers, it

appears as though animacy information has no effect on the arrangement of linear sequence in NP conjunctions, which is consistent with the finding of Tanaka et al. (2011).

3.6.2 Transitive conditions

3.6.2.1 Chinese JFL learners

The percentage of each inversion type in transitive conditions is shown in Figure 6. We conducted a repeated-measures one-way ANOVA with *Condition* as the independent variable to determine how the inversions varied between conditions. Additionally, we conducted a repeated-measures two-way ANOVA with *voice* (active or passive) and *word order* (SOV or OSV) as independent variables and the amount of *Voice* or *Word-order inversion* as the dependent variable, to determine the difference in the frequency of inversions and whether the difference was caused by sentences with different voices or sentences with different word order.

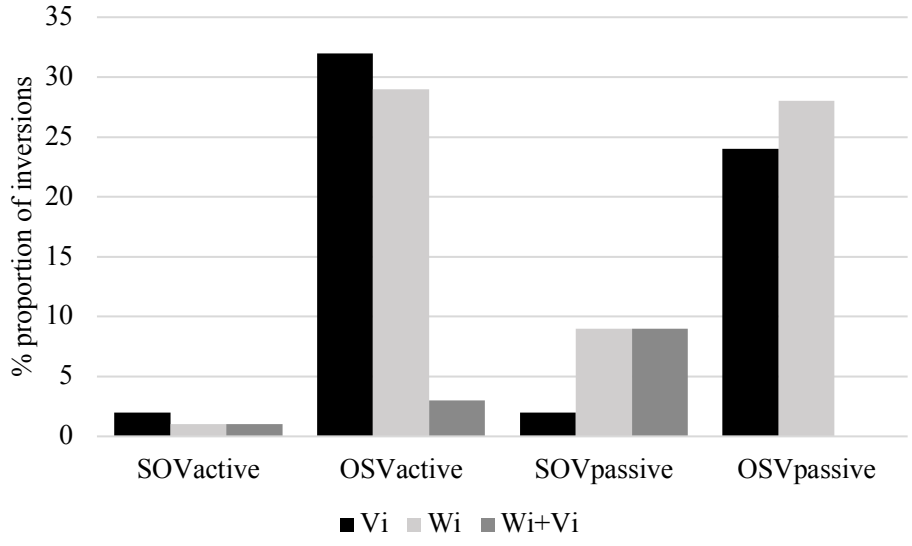

Figure 6. Proportions of inversions recalled in transitive conditions of Chinese JFL learners (%).

For *Voice inversion*, the one-way ANOVA revealed a significant difference between conditions (F (3, 51) = 12.321, $p < .01$): more inversions were produced under both OSV active and passive conditions without difference between the two. Results of the two-way ANOVA showed a main effect of *word order* (F (1, 17) = 64.635, $p < .01$), while neither the main effect of *voice* nor the interaction of *voice* and *word order* was found significant. This result indicates that *Voice inversion* occurred more

frequently when recalling OSV sentences than SOV sentences but was not different between active and passive sentences.

Regarding *Word-order inversion*, more inversions were observed under both OSV conditions (F (3, 27) = 12.902, $p < .01$). Similarly, only the main effect of *word order* was found to be significant (F (1, 17) = 33.320, $p < .01$), indicating that more word-order inversions occurred when recalling OSV sentences than when recalling SOV sentences.

Additionally, we compared inversions within each condition using a repeated-measures one-way ANOVA with *Inversion Type* as the independent variable, and found no significant difference in the frequency of *Voice inversion* and *Word-order inversion* under any condition. Thus, the results above indicated that sentence type preference appears to have no influence.

3.6.2.2 Native Japanese speakers

In terms of sentence recall by native Japanese speakers, Figure 7 illustrated the percentage of each inversion type in transitive conditions. We performed the same statistical analyses as we did in the production of Chinese JFL learners.

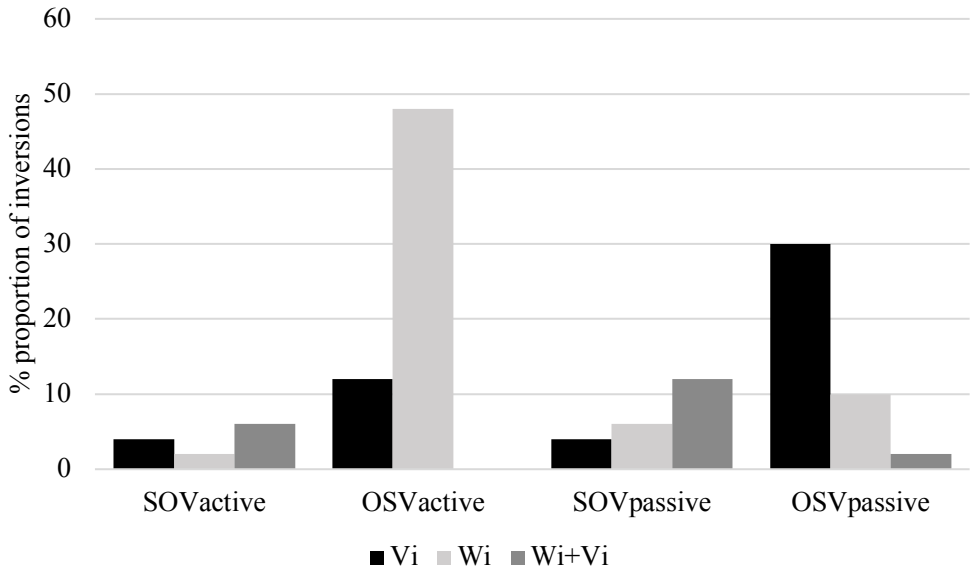

Figure 7. Proportions of inversions recalled in transitive conditions of native Japanese speakers (%).

With respect to *Voice inversion*, inversions were produced more frequently under the OSV passive condition than under the SOV conditions (F (3, 27) = 4.725, $p < .01$). The results of two-way ANOVA revealed a main effect of *word order* (F (1, 9) = 10.793, $p < .01$), indicating that there were more voice inversions when recalling OSV sentences than SOV sentences. Regarding *Word-order inversion*, inversions were found to be significantly more frequent under the OSV active condition than under any other conditions (F (3, 27) = 17.547, $p < .01$). The interaction between *voice* and *word order* was found to be significant (F (1, 9) = 17.332, $p < .01$).

Comparisons within each condition revealed that *Word-order inversion* was significantly more frequent than *Voice inversion* under the OSV active condition (F (2, 18) = 29.662, $p < .001$). By contrast, participants produced numerically more frequent *Voice inversion* than *Word-order inversion* in the OSV passive condition, but the difference was not statistically significant.

3.7 Discussion

3.7.1 Animacy effect on sentence production of Chinese JFL learners

We began by discussing the recall of NP conjunction structures. In comparison to NP conjunctions involving the animate-inanimate sequence, Chinese JFL learners inverted the inanimate-animate sequence more frequently, resulting in NP conjunction structures with the animate noun preceding the inanimate noun. Given the fact that both noun phrases were subjects, speakers were unable to determine word order based on the accessibility of grammatical function. Thus, we believe that conceptual accessibility became effective and had a direct impact on positional processing, giving rise in the allocation of animate nouns with greater accessibility to earlier positions. Furthermore, this tendency was detected in both L1 Chinese and L2 Japanese production, indicating that animacy information processing may be widespread in the pre-linguistic stage of language production.

Concerning the production of transitive sentences, Chinese JFL learners tend to invert the grammatical function or linear sequence of noun phrases in OSV sentences in order to convey the same meaning in SOV sentences: for example, recalling *kankyou-o ningen-ga hakaishita* as *kankyou-ga ningen-niyotte hakaisareta*, or recalling *ningen-niyotte kankyou-ga hakaisareta* as *ningen-ga kankyou-o hakaishita* by inverting the functional assignment; recalling *kankyou-o ningen-ga hakaishita* as *ningen-ga kankyou-o hakaishita*, or recalling *ningen-niyotte kankyou-ga hakaisareta* as *kankyou-ga ningen-niyotte hakaisareta* by inverting the constituent sequence. We assumed that

animacy information had no effect on these inversions since the first nouns of OSV sentences in active and passive conditions were respectively animate and inanimate entities. Nonetheless, there were indeed a small number of inversions under the SOV conditions, particularly under the SOV passive condition: for instance, recalling *kankyou-ga ningen-niyotte hakaisareta* as *ningen-niyotte kankyou-ga hakaisareta* (Wi) or *ningen-ga kankyou-o hakaishita* (Wi+Vi). Although these inversions were numerically few and not statistically significant (only 9% each), we could not rule out the possibility of an animacy effect on such production by Chinese JFL learners.

In conclusion, we found a preference for subject function in the transitive sentences production of Chinese participants, while not an influence of animacy information. Thus, we assume that Chinese JFL learners generate Japanese transitive sentences via the following mechanism: animacy, as conceptual information, appears to have no effect on the retrieval priority of concepts during conceptualization where speakers reconstruct a given message. During grammatical encoding, speakers first activate the subject function in functional processing. They, on the other hand, tend to combine the subject function with the first remembered concepts (noun phrases) rather than with specific animate nouns. In the subsequent positional processing, they tend to place the subject noun at the beginning of a sentence first rather than the animate noun.

3.7.2 Animacy effect on sentence production of native Japanese speakers

Given that we found no effect of animacy on the determination of linear sequence in NP conjunction structures, we hypothesize that another factor, such as lexical accessibility, influenced the linear construction of NP conjunctions in the production of Japanese native speakers.

When it came to transitive sentences, the inversion tendencies of native Japanese speakers varied according to the OSV transitive conditions. For example, the results suggested that native Japanese speakers prefer to simply reverse the word order of an OSV active sentence rather than invert the voice. More precisely, when recalling OSV active sentences such as *kankyou-o ningen-ga hakaishita*, participants tended to invert the linear sequence of noun phrases to produce *ningen-ga kankyou-o hakaishita* (word-order inversion), rather than changing the grammatical function assignment to *kankyou-ga ningen-niyotte hakaisareta*. When recalling OSV passive sentences such as *ningen-niyotte kankyou-ga hakaisareta*, though this tendency was not statistically significant, they tended to invert the grammatical function of noun phrases, producing *ningen-ga kankyou-o hakaishita*,

rather than simply inverting the linear sequence, such as *kankyou-ga ningen-niyotte hakaisareta*. Although the inversions were of varying types, it is clear that native Japanese speakers prefer the SOV active structure with an animate noun as the subject.

According to the results of the production of transitive sentences, native Japanese speakers, like Chinese JFL learners, appear to preferentially organize SOV structures and they also tend to first assign the subject function to animate nouns rather than inanimate nouns. From the perspective of the sentence production mechanism, it was found that animacy had an effect on the way concepts were accessed during conceptualization, with animate entities were activated first. Additionally, native Japanese speakers activated the subjects first in functional processing during grammatical encoding. As a result, they prioritize the subject function over animate nouns and produce animate subjects. When it comes to positional processing, however, they prefer to place the subject in the first position of sentences rather than the animate noun. This is consistent with the fact that Japanese participants expressed no preference for beginning sentences with non-subject animate nouns.

3.7.3 The sentence production mechanism of L1 and L2 Japanese speakers

Based on the results of our sentence-recall task, we attempted to compare the sentence production mechanism of Chinese JFL learners and Japanese native speakers. The recall of experimental sentences revealed different processing of animacy information: in short, Japanese native speakers activate animate nouns first during conceptualization, whereas Chinese JFL learners do not. In contrast, when producing NP conjunction structures, this animacy effect was observed in the production of Chinese JFL learners but not in the production of native Japanese speakers.

During functional processing, both groups of participants activated the subject first, confirming the higher accessibility of the subject phrase as suggested by the Accessibility Hierarchy of Keenan and Comrie (1977). Even though the word order is relatively free in Japanese, the subject function retains a high priority, as it does in languages with a more restricted word order (e.g., English and Chinese). However, when recalling transitive sentences, the animacy information contained in noun phrases influenced the grammatical function assignment of Japanese native speakers, but not of Chinese JFL learners, since Chinese participants lacked a preference for assigning animate nouns as the subject. In positional processing, it is assumed that earlier positions are activated before later positions. Hence, both L1 and L2 Japanese speakers tend to frequently combine the more

grammatically accessible subjects with the earliest positions in order to produce canonical sentences (SOV).

Through a sentence-recall task, Tanaka et al. (2011) discovered a tendency for native Japanese speakers to assign animate nouns as subjects regardless of word order (e.g., recall *booto-ga ryoshi-niyotte hakobareta* as *booto-o ryoshi-ga hakonda*), as well as to assign animate nouns as the first noun of a sentence regardless of its grammatical function (e.g., recall *booto-ga ryoshi-o hakonda* as *ryoshi-o booto-ga hakonda*). Thus, animacy was considered to exert a direct influence on the grammatical encoding process, even though such effect was not observed in the production of NP conjunctions.

Tanaka et al. (2011) explained these findings by positing that syntactic processing reflects the ease with which conceptual factors can be combined to form a message, and that conceptual accessibility has a direct effect on both the way grammatical functions are assigned and the way word order is determined. More specifically, during conceptualization, an animate concept is activated and undergoes functional processing first. Simultaneously, the subject function is activated earlier than other functions during functional processing, in accordance with the accessibility of grammatical function. However, the animate noun is not always the subject according to the sentence meaning, and the combination of the first activated subject function and the animate concept may be optional. Additionally, the more accessible animate concept undergoes positional processing first; thus, an animate noun assigned to a function other than the subject may be placed in an earlier position. Likewise, if the noun is inanimate or less accessible, the grammatical function with higher accessibility will undergo positional processing first but will not necessarily be assigned to an earlier position.

In our experiment, the animacy effect on positional processing of Japanese native speakers did not agree with Tanaka et al. (2011). Our Japanese participants did not tend to place a non-subject animate noun earlier in a sentence. We attribute this to the influence of experimental stimuli. Tanaka et al. (2011) examined sentences in which animate nouns also served as the patient (e.g., *bouto*$_{Agent}$*-ga ryoushi*$_{Patient}$*-o hakonda*). However, in our study, we restricted the thematic role of animate nouns to the agent. Thematic roles also differ in their own accessibility, with an agent role being generally more accessible than a patient role. Similar to conceptual accessibility, the accessibility of thematic roles affects grammatical function assignment as well, resulting in the agent being more easily assigned the subject function than the patient (Hwang, 2017). Therefore, in our experiment, animate nouns confined to the agent role appears to be more likely to be assigned as subjects. It is possible that the animacy

effect on positional processing overlapped with the influence of thematic roles on subject function. To advance our understanding of the mechanism of sentence production, further research must address both the conceptual information (animacy) and syntactic information (thematic role) contained noun phrases.

Nonetheless, despite the limitation of the thematic role, the tendency to produce animate nouns as subjects first was not observed in the production of Chinese JFL learners. Thus, we considered that thematic roles had no effect on the grammatical function assignment in this instance.

3.7.4 Factors accounting for the results of Chinese JFL learners

In reviewing the recall of Chinese JFL learners, we found that when recalling SOV transitive sentences, the original structures were rarely inverted. However, when recalling OSV transitive sentences, they tended to invert the voice or word order, producing SOV sentences by recalling *kankyou-o ningen-ga hakaishita* as *kankyou-ga ningen-niyotte hakaisareta* or *ningen-ga kankyou-o hakaishita*. While the effect of animacy was not directly observed in the transitive sentence production by Chinese participants, a preference for the subject function (*-ga*) was confirmed.

It remains unclear whether the absence of animacy effect on concept retrieval was due to differences in the processing of animacy information, or any other possible interference. We hypothesized several possible explanations, one of which was the influence of experimental method. During our sentence-recall task, we took memory capacity into account when designing our sentence-recall task and reduced the number of stimuli in each set from eight (in Tanaka et al., 2011) to six. Nonetheless, there appears as though L2 learners place a greater demand on working memory than native speakers when it comes to memorizing and recalling sentences. Therefore, while conceptual accessibility of noun phrases may have an effect on the transitive sentence production by Chinese JFL learners, its effect is somewhat limited by the short-term memory test, which requires participants to memorize multiple sentences at one time. Though we chose the sentence-recall task since it enables people to recall the gist of sentences rather than specific syntactic forms, the factors affecting the production of L2 learners seem to be more complex than those affecting L1 speakers. In future research, we will consider modifying the experimental design in order to gain a better understanding of the conceptual processing of Chinese JFL learners.

The correlation between sentence comprehension and production could also account for the result. Participants were instructed to begin the sentence-recall task by listening to sentences and comprehending their gist. Thus, the choice of syntactic structure in a subsequent production may be affected by the degree to which participants comprehended the information (semantic or syntactic) contained in a sentence.

Especially, Chinese JFL learners produced a greater number of inversions when recalling sentences with scrambled word order (OSV), implying a potential influence from OSV sentence comprehension. Previous studies (Tamaoka, 2005; Tamaoka, Chiu, Miyaoka, & Kiyama, 2010) examined the scrambling effect on sentence comprehension of Chinese JFL learners and found that sentences with scrambled word order lead to longer response times along with lower accuracy in the correctness judgment than sentences with canonical order, indicating that it is more difficult for Chinese JFL learners to comprehend sentences with OSV word order, irrespective of their proficiency in the Japanese language and the sentence length. While Tamaoka (2005) concentrated on the comprehension of active sentences containing transitive verbs, it remains unclear whether participants made the judgment based on semantic or syntactic information.

However, in the present study, while misinterpretation of sentence meaning (e.g., misinterpreting the animate noun as patient and the inanimate noun as agent) must result in a different message, we are still able to observe the processing of animacy information from the reconstruction of syntactic representation. Furthermore, given the proficiency of our Chinese participants and our requirement for recall proportion, in the present study we believe that the influence of the sentence meaning comprehension via lexical items on the production of Chinese JFL learners is limited: when they failed to comprehend a sentence, they also failed to recall or produced an incomplete sentence. Therefore, while the processing of semantic information would not influence the animacy effect on sentence production, the difficulties in processing syntactic information such as scrambled word order may affect the production mechanism in the subsequent recall, particularly in terms of the construction of syntactic representations.

To further validate the animacy effect on the Japanese sentence production of Chinese JFL learners, the potential influence of sentence comprehension will need to be examined. Thus, for further research, we intend to observe the production of Chinese JFL learners with varying abilities in sentence comprehension with scrambled word order.

4. EXPERIMENT 2

4.1 Scrambling Effect on Sentence Comprehension

As previously stated, the sentence-recall task included sentence comprehension, and Chinese JFL learners produced significantly more inversion for the original OSV sentences. As a result, we hypothesized that sentence order, particularly the OSV (scrambled) order, affected JFL learners' sentence recall. Furthermore, we believe that this influence is more effective at the grammatical level than at the semantic level.

The processing of scrambled word order in Japanese sentences has been extensively studied using different methods. Yamashita (1997) investigated the effect of word-order on the processing of Japanese sentences using a segment-by-segment, self-paced, moving-window reading task. Canonical [NP-*ga* NP-*ni* NP-*o* V] sentence and its scrambled counterpart [NP-*ni* NP-*ga* NP-*o*/NP-*o* NP-*ga* NP-*ni*/NP-*o* NP-*ni* NP-*ga* V] served as stimuli, and there were no significant differences between response times across the conditions for any position in a sentence. The same result was also observed in sentences containing a variety of verbs. These findings implied that there is no additional difficulty in processing scrambled sentences, and that the parser is unconcerned about the word order. Kobayashi (2007) used a self-paced reading paradigm to investigate the relationship between plausibility and comprehension burden when reading sentences with scrambled order. As a result, error rates were significantly higher for scrambled sentences with low plausibility than canonical sentences, did not differ when sentences had a high plausibility. Similarly, Kobayashi (2007) found no significant difference in native Japanese speakers' processing of various word orders, at least in active sentences.

However, a number of studies have suggested the opposite. Mazuka, Itoh, and Kondo (2002) found that Japanese native speakers rated scrambled sentences such as [NP-*o* NP-*ga* V] as more difficult than their canonical word order counterparts. Additionally, both the eye-movement data and self-paced reading times indicated that scrambled OSV sentences incurred a higher processing cost. Muraoka, Tamaoka, and Miyaoka (2004) discovered a similar result, namely that reaction times of scrambled simple active sentences with transitive verbs revealed a scrambling effect, while the error rated did not. In contrast, Tamaoka, Sakai, Kawahara, and Miyaoka (2003) investigated the effect of phrase-length order and scrambling on the processing of visually presented sentences using a self-

paced moving window reading task. They discovered that while reading times were not affected by phrase-length order or scrambling, error rates varied between canonical and scrambled sentences regardless of phrase-length order. Hence, they concluded that scrambled sentences are more difficult to judge as correct than canonical sentences, and that phrase-length order has little effect on cognitive processing. Furthermore, Tamaoka et al. (2005) found a scrambling effect emerged during the processing (sentence comprehension) of active sentences containing transitive verbs, ditransitive sentences, canonical passive sentences defined by case particles (*tarou-ga hanako-ni nagurareta*), and canonical potential sentences defined by grammatical functions (*hanako-ni eigo-ga hanaserudarouka*). All of the canonical sentences above were processed more quickly and accurately than their scrambled counterparts. Tanaka, Tamaoka, and Sakai (2007) observed scrambling effects on the processing of Japanese unambiguous active sentences via a syntactic priming study in addition to the sentence reading task.

Witzel and Witzel (2016) examined Japanese sentence processing using the maze task, and discovered that it takes longer to read a *-o* phrase than a *-ga* phrase, as well as a longer reading time for a scrambled sentence as a whole (NP-*o* NP-*ga* NP-*made* V). They hypothesized that processing costs are incurred as scrambled constituents incrementally integrated sentence representation. Tamaoka and Mansbridge (2019) also used eye-tracking experiments to investigate how simple sentences with different word orders are processed. The results indicated that SOV canonical sentences were processed more quickly and accurately than their OSV counterparts, with the critical NP (Nominative, *-ga*) in OSV scrambled sentences taking significantly longer to re-read than the NP-Accusative (*-o*) in SOV canonical sentences. These findings indicated that when participants read OSV sentences with a single instance of scrambling, they always read back to the crucial NP after seeing the head verb.

Brain activity research has also demonstrated the scrambling effect on the processing of Japanese sentences. Wolff, Schlesewsky, Hirotani, and Schlesewsky (2008) observed ERP data from an auditory presented sentence comprehension task. They found that object-initial sentences had longer reaction times and higher error rates, though this processing disadvantage was mitigated in the presence of a prosodic boundary, implying that object-initial sentences were more difficult to process than subject-initial sentences. Additionally, they found a scrambling negativity for object-initial sentences when the initial object was followed by a prosodic boundary, which they hypothesize reflects

the prediction of upcoming arguments. Otsuki, Morifuji, Ogawa, and Inui (2007) investigated the neural base of case processing by a phrase-by-phrase reading task with fMRI. The left superior frontal gyrus (BA6/8) which associated with image construction and working memory, along with the left inferior frontal gyrus (BA44/45) which associated with syntactic processing were found to be more activated when encountering the OSV sequence, indicating a greater difficulty on construction parsing for scrambled sentences. Kim et al. (2009) used a whole-sentence presentation reading task and discovered that comprehension of scrambled sentences led to greater activation at the left inferior frontal gyrus and the left dorsal prefrontal cortex than that of canonical sentences. These findings indicate that the parsing for scrambled sentences is more challenging.

In addition to the research of native speakers, a small number of studies have examined how L2 JFL learners process Japanese sentences. Tamaoka (2005) found a significant difference in response times and error rates between canonical and scrambled simple active transitive sentences using a visually presented reading task combined with a grammaticality judgement task. Kim (2005) found that the response times and error rates of JFL learners followed a similar pattern with Japanese native speakers. Additionally, the fMRI data revealed a predominant activity in left inferior frontal gyrus which associates with more complex syntactic processing in Chinese and Korean JFL learners compared to native speakers. Thus, the higher processing cost associated with scrambled OSV sentences was demonstrated in L2 learners' comprehension. Ma (2018) examined the comprehension of simple active sentences with transitive verbs, and found that scrambled sentences resulted in increased response times and error rates. However, this effect was not observed in active sentences with three arguments, indicating that the processing cost of complex sentences may outweigh the influence of word order. Regarding the relationship between scrambling effect and proficiency, Tamaoka et al. (2010) used ditransitive sentences in an auditory presented sentence-comprehension task. The results indicated that, regardless of proficiency in Japanese comprehension, there was a significant difference of accuracy between canonical and scrambled sentences; however, comprehension of scrambled sentences could be improved as proficiency enhanced.

As above, the scrambling effect has been found to be inconsistent in previous studies. Hence, it is necessary to examine how difficult it is for participants in the present study to process sentences with scrambled word order.

4.2 Goal

To summarize experiment 1, we observed tendencies in Japanese sentence production using a sentence-recall task and compared the production mechanisms of Chinese JFL learners and Japanese native speakers. As a result, we found that the influence of animacy varies significantly between the production of two groups. However, since sentence comprehension occurred when participants listened to experimental stimuli during this task, we believe it is necessary to examine the relationship between the construction of conceptual representations during sentence comprehension and the construction of syntactic representations during sentence production in future research.

The purpose of this experiment is to explore the relationship between the comprehension ability and the recall situation of Chinese JFL learners. Hence, in addition to the sentence recall task in experiment 1, we administered a sentence comprehension task referring to Tamaoka (2005).

4.3 Participants

Ten Chinese JFL learners from experiment 1 participated in experiment 2 again, and eighteen additional Chinese JFL learners participated with payment (19 female and 8 males in total), with an average age of 26.4 years old. All of these participants are native Chinese speakers who earned the N1 level certification on the Japanese-Language Proficiency Test (JLPT), with an average score of 138 over a range of 104–180. Participants have an average of 7 years of Japanese learning experience.

4.4 Stimuli

For sentence-recall task, we reused the stimuli from experiment 1. To assess participants' comprehension of stimuli in experiment 1, we used the same experimental items to create stimuli for sentence-comprehension task. Thus, we created four lists with 80 sentences in each, with 42 stimuli that elicited a 'Yes' response, 22 stimuli that elicited a 'No' response, and 16 filler sentences among each list. We altered the word order for all stimuli used in experiment 2 in order to examine the effect of different word orders (canonical or scrambled) on sentence comprehension, as well as the voice of stimuli with 'Yes' and 'No' responses.

To be more specific, stimuli that elicit a 'Yes' response are transitive sentences that are both semantically and syntactically correct, have a plausible meaning and contain an appropriate collocation of case-markers and verb phrase forms (active or passive), e.g., *ningen-ga kankyou-o*

hakaishita 'Human ruined the environment'. The 42 experimental items of experiment 1 were used to construct 42 sentences divided equally in SOV order and OSV order for stimuli with a 'Yes' response. Sentence voice was also manipulated in each list, with half the stimuli being active and the other half being passive. The word order and sentence voice of each item were counterbalanced across the four lists; additionally, as mentioned in experiment 1, each item had 4 sentence versions and the same version of an item does not repeat across lists.

To increase the diversity of grammaticality judgements and to keep participants centered, we combined stimuli that required a negative response with stimuli that required a 'Yes' response. Sentences with a 'No' response are both semantically and syntactically incorrect, containing an implausible meaning and an incorrect collocation of case-markers and the verb form (e.g., *obaasan-ga takushi-o hihansareta* 'The old lady was critized the taxi'). We chose words from the 42 items at random and combined them in an unusual way. Additionally, the word order and voice of verb phrases are balanced across lists, and each list contains half SOV and half OSV stimuli with a 'No' response.

Ditransitive sentences and potential sentences were used as fillers, and the same fillers are used in all lists. In addition, we monitored the sequence of presented sentences to ensure that no particular structure (SOV active, SOV passive, OSV active or OSV passive) was immediately followed by another of the same type.

4.5 Procedure

In experiment 2, both the sentence-recall and sentence-comprehension tasks were conducted online using Zoom and Google Forms. Participants from experiment 1 received only the sentence-comprehension task online, whereas newly recruited participants received both tasks, with the sentence-recall task preceding the sentence-comprehension task. The sentence-recall task in this experiment was identical to that used in experiment 1. The entire sentence-comprehension task consisted of a complete reading of the presented sentence and a grammaticality judgement.

We divided the four sentence-comprehension stimuli lists into four questionnaires and distributed them randomly to participants. Prior to the experiment, the questionnaire instructions were presented. Participants were instructed to carefully read the instruction and respond to several questions to ensure they comprehended the content completely. To help participants adjust to the procedure, they received 12 practice trials following the instruction and prior to the experimental trials.

Each participant received a total of 80 experimental trials. Each trial began with an independent presentation of a full sentence. Participants were instructed to silently read the sentence in order to avoid any disfluency in their reading aloud, which could affect the reading time. While there was no time limit on how long participants could read the sentence, once they finished reading and moved on to the next page, they were not permitted to return and read the sentence again. Then, on the following page, a question about whether the previous sentence was correct or not was presented with two options: 'Yes' or 'No'. Due to the existence of semantically implausible sentences and to avoid unnecessary consideration of the plausibility of the event reflected in a sentence, participants were asked to judge the sentence on the basis of its grammatical structure rather than its semantic content (sentence meaning). Additionally, they were instructed to reach a decision as quickly and accurately as possible. Participants proceeded to the next trial by clicking the 'Next page' button.

After all the experimental trials, a questionnaire was administered to ascertain the participants' age, history of Japanese language study, and JLPT certification status.

4.6 Scoring

The scoring for inversions in sentence-recall task was consistent with that of experiment 1. As in experiment 1, we excluded participants who recalled less than a third of experimental sentences (10 out of 30). As a consequence, 17 newly the recruited Chinese JFL learners and 10 from experiment 1 (a total of 27) had their data analyzed. The mean rate of efficient production (proportion of responses not classified as *Other*) was 78.6%.

For the sentence-comprehension task, we recorded reading times during fully presented sentence and also calculated questionnaire scores as a measure of sentence-comprehension accuracy. Reading time was calculated from the time a sentence appeared on the screen until a participant clicked the button to move on to the next page. In terms of sentence-comprehension accuracy, we calculated and analyzed the accuracy separately for stimuli that elicit 'Yes' and 'No' responses. We believed that the grammaticality judgement score reflects the ability to comprehend sentences, and thus concentrated on the score for stimuli with a 'Yes' response in order to categorize participants according to their comprehension ability.

4.7 Results

Here is our prediction based on previous studies and experiment 1. Combining the scrambling effect on sentence comprehension with OSV order suggested in Tamaoka (2005) with the fact that Chinese JFL learners produced more inversions when recalling OSV transitive sentences in experiment 1, it is possible that the same scrambling effect on reading sentences with scrambled word order will emerge in experiment 2. Specifically, OSV sentences should have a lower accuracy and a longer reading time than SOV sentences. In terms of sentence recall, if the comprehension ability had an effect on subsequent sentence production, the pattern of sentence-recall might differ between groups with varying levels of comprehension ability. Moreover, since animacy information has been shown to affect the Chinese production of native Chinese speakers, even though its effect appears to be limited in a specific structure (NP conjunction structure, as we know), and because the general influence of animacy as conceptual information has been suggested by studies on multiple languages, we assume that animacy also affects the Japanese sentence production of Chinese JFL learners. However, the effect may be compromised by the participants' proficiency. Thus, we predict that the animacy effect will be observed in the sentence-recall of participants with higher proficiency, as they are more capable of processing both the conceptual and syntactic information concurrently. By contrast, we predict that no animacy effect emerge in the production of participants with lower proficiency, as observed in experiment 1, since it seems to be difficult for those learners to assemble structures in a flexible manner.

4.7.1 Results of Sentence-comprehension task

As mentioned previously, we are only interested in the grammaticality judgement score for stimuli with a 'Yes' response. The mean score of 27 participants was 37.6 (SD = 4.71) ranging from 25 to 42. Given that 4 questionnaires corresponding to the 4 lists were randomly distributed to participants in the sentence-comprehension task, we used a one-way ANOVA to compare the scores between lists. The result indicated that there was no significant difference in the scores for the 4 lists (F (3, 23) = 1.096, *n.s.*), allowing us to rule out the possibility of influence from different lists encountered by participants.

It is necessary to investigate the scrambling effect on sentence comprehension whether the words are in their canonical or scrambled order. We conducted a one-way ANOVA with repeated

measures on both reading times (milliseconds) and accuracy rate (percent) for stimuli with 'Yes' and 'No' responses separately, with subject (F_1) and item (F_2) as variables. Especially, we excluded reading times longer than 15000ms for each participant to account for the effect of distraction. Table 5 shows the average reading time and accuracy rate.

Table 5

Overall Accuracy Rates and Reading Times by Response type

Response type	Sentence type	Reading time (ms)		Accuracy rate (%)	
		M	*SD*	*M*	*SD*
'Yes' Response	SOV	4477	1013	95.59	4.36
	OSV	5209	1214	83.42	21.24
	OSV-SOV	Δ732		12.17	
'No' Response	SOV	6108	1667	81.81	18.87
	OSV	6123	1349	83.16	18.64
	OSV-SOV	Δ16		Δ1.35	

First of all, reading times for stimuli with a 'Yes' response were significantly longer for sentences with scrambled order than for sentences with canonical order (F_1 (1, 26) = 25.115, $p < .001$; F_2 (1, 41) = 27.270, $p < .001$). Similarly, the accuracy rates for sentences with scrambled order were significantly lower than the accuracy rates for sentences with canonical order (F_1 (1, 26) = 10.076, $p < .01$; F_2 (1, 41) = 38.784, $p < .001$). In contrast, reading times for sentences with scrambled order were found to be shorter than reading times for sentences with canonical order, but this difference was not statistically significant (F_1 (1, 26) = .170, *n.s.*; F_2 (1, 10) = .593, *n.s.*). The accuracy rates for sentences in scrambled order were also higher than that for sentences in canonical order without reaching significant (F_1 (1, 26) = .006, *n.s.*; F_2 (1, 10) = .181, *n.s.*).

We replicated Tamaoka's (2005) finding that the scrambling effect was observed in the sentence comprehension of Chinese JFL learners, but only in stimuli with a 'Yes' response. The difficulty of comprehending sentences with a scrambled order was confirmed once again in the case of Chinese JFL learners.

Regarding grouping, we divided all participants into 2 groups based on the mean score 37.6: scores greater than 38 were considered 'High', while scores less than or equal to 38 were considered 'Low'. 27 participants were thus divided into group High (13 participants) and group Low (14 participants). A *t*-test with *Group* as the independent variable and *Score* on the comprehension task as the dependent variable revealed a significant difference in the average score between the two groups (t (25) = 5.560, $p < .001$): participants in group High scored significantly higher than those in group Low. Thus, the validity of our grouping was established.

Table 6

Accuracy Rates and Reading Times for stimuli with a 'Yes' response by group

		Group High		Group Low	
	Word order	*Mean*	*SD*	*Mean*	*SD*
Accuracy Rates (%)	SOV	98.5	.023	92.9	.041
	OSV	97.8	.037	70.1	.221
Rts (ms)	SOV	4350	1267.196	4595	734.562
	OSV	4799	1269.298	5589	1066.852

Note. There were 13 participants in group High, and 14 in group Low.

To examine whether the accuracy of comprehension task differed between two groups and sentences with canonical and scrambled order, we conducted a two-way ANOVA with *Group* and *Word order* as independent variables (2 [High, Low] × 2 [SOV, OSV]), and the *Accuracy rate* of comprehension for stimuli with a 'Yes' response as dependent variable. As a result, both the main effect of *Word order* and the interaction between *Group* and *Word order* are found to be significant (F (1, 25) = 13.262, $p < .01$; F (1, 25) = 11.661, $p < .01$, in order). Additionally, we tested the simple main effect of *Word order* in each group, and found it was significant in group Low (F (1, 25) = 25.85, $p < .001$), but not in group High (F (1, 25) = .02, *n.s.*). Thus, for participants in group Low, the comprehension of sentences in canonical order was significantly more accurate than sentences in scrambled order. However, since there is no difference in accuracy between canonical and scrambled sentences for participants in group High, we conclude that word order does not affect their

comprehension, at least in terms of grammaticality judgement. The simple main effect of *Group* was found to be significant across all levels of word order (F (1, 25) = 19.53, $p < .001$); F (1, 25) = 19.84, $p < .001$, respectively for SOV and OSV order), implying that participants in group High gained significantly greater accuracy on sentence comprehension than participants in group Low, regardless of the word order of sentences. As a result, participants in group High are assumed to have a greater ability to comprehend sentences than participants in group Low.

Again, in the case of group Low, we found a significant difference of grammatical judgment accuracy between canonical and scrambled sentences. However, since our stimuli for comprehension stimuli were equally divided into active and passive sentences, it is necessary to demonstrate whether the main effect of *Word order* is due to the differences in sentence voice. We conducted an additional repeated-measures two-way ANOVA with *Word order* and *Voice* as independent variables (2 [SOV, OSV] × 2 [active, passive]), and the number of errors made by group Low for stimuli with a 'Yes' response as dependent variable: the main effect of *Word order* was found to be significant (F (1, 13) = 13.878, $p < .01$), while the main effect of *Voice* was not (F (1, 13) = .245, *n.s.*). This result confirmed the influence of word order on sentence comprehension rather than the voice, implying that the scrambled word order interfered with the grammatical judgement of a sentence, which was visible in the comprehension of participants in group Low.

Regarding reading times, we conducted a similar two-way ANOVA with *Group* and *Word order* as independent variables (2 [High, Low] × 2 [SOV, OSV]), and the reading times of stimuli with a 'Yes' response as dependent variable, to investigate whether the word order has an effect on reading time. The main effect of *Word order* was found to be significant (F (1, 25) = 27.102, $p < .001$), and in both groups, the reading time for OSV sentences was significantly longer than that for SOV sentences. The interaction of *Group* and *Word order* was found not significant (F (1, 25) = 3.889, *n.s.*), and the simple main effect of *Group* was also not significant in either the SOV or OSV conditions (F (1, 25) = 1.673, *n.s.*). In general, it took longer to read sentences with scrambled order for all participants, and participants in group High seemed to took less time than participants in group Low. More specifically, there was a small difference in the reading time between two groups for sentences with canonical order, yet the difference was larger for sentences with scrambled order, though it was not statistically significant.

4.7.2 Results of Sentence-recall task

As in experiment 1, we analyzed and reported the inversions in recall of transitive and NP conjunction conditions separately. Moreover, since we divided all Chinese JFL learners analyzed in this study into two groups based on their comprehension ability (particularly on word order), we reported the results individually for each group, and then compared the pattern reflected in their recall.

Table 7

Responses by Chinese JFL learners in Experiment 2 (27 participants)

Condition		Recalled responses				
Voice	Word Order	Same	Vi	Wi	Wi+Vi	Other
Active	SOV	110	2	1	1	14
	OSV	22	35	42	2	28
Passive	SOV	61	6	9	27	19
	OSV	39	53	24	0	16
NP-conj.	An-In	86		10		28
	In-An	66		28		38

Note. An = animate noun, In = inanimate noun; 'An-In' means that the animate noun precedes the inanimate noun.

4.7.2.1 Recall of the group High

To begin, we examine the recall of participants in group High. As mentioned previously, they showed a relatively higher level of proficiency in comprehension of our stimuli that elicit a 'Yes' response. As a result, we believe that they also achieved a greater level of comprehension when listening to recordings in our sentence-recall task.

We carried out a one-way ANOVA with *Condition* as the independent variable to determine the differences in inversions between conditions. In addition, we conducted a repeated-measures two-way ANOVA with *voice* (active or passive) and *word order* (SOV or OSV) as independent variables and the amount of *Voice*, *Word-order, Word-order + Voice inversion* as the dependent variable to figure out the difference in the frequency of inversions and whether the difference was caused by sentences with

different voices or sentences with different word orders. The percentage of each inversion type in transitive conditions is shown in Figure 8.

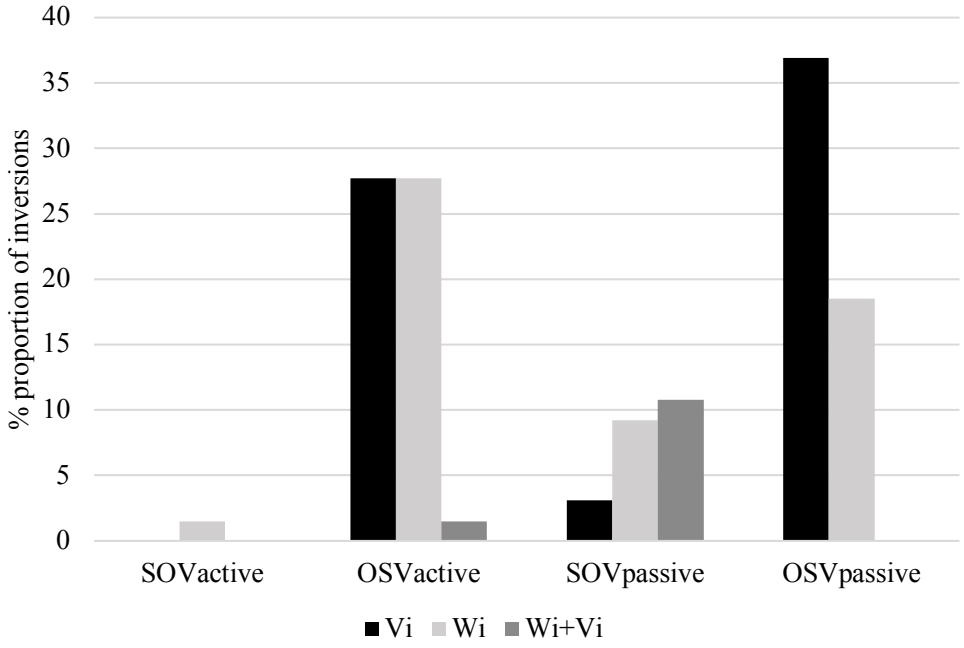

Figure 8. Proportions of inversions recalled in transitive conditions of group High (%).

The results indicated a significant difference in the frequency of *Voice inversion* between conditions (F (3, 36) = 13.752, $p < .001$). To be more specific, we found that more voice inversions were produced significantly in OSV active and passive conditions than in SOV active and passive conditions. The main effect of *word order* was found to be significant (F (1, 12) = 42.291, $p < .001$), but neither the main effect of *voice* nor the interaction between *voice* and *word order* were significant (F (1, 12) = 1.593, *n.s.*; F (1, 12) = .362, *n.s.*). Likewise, as was the case in experiment 1, a significant difference in *Word-order inversion* was observed between conditions (F (3, 36) = 7.247, $p < .01$): more word-order inversions were produced in the OSV active and passive conditions than in the SOV active condition. According to the two-way ANOVA, the main effect of *word order* was again significant (F (1, 12) = 14.233, $p < .01$), while neither the main effect of *voice* nor the interaction reached significance (F (1, 12) = .049, *n.s.*; F (1, 12) = 3.762, $p = .076$). These findings are somewhat consistent with those of experiment 1, which indicated that participants inverted the sentence voice or word order more frequently when recalling sentences in scrambled order (OSV) than recalling sentences in canonical

order (SOV). There was still no significant difference in terms of *Word-order + Voice inversion* (F (3, 36) = 2.641, *n.s.*), and neither the main effect of sentence voice and word order, as participants produced relatively few instances of this type of inversion.

Furthermore, we analyzed the variation of recall within each condition using a repeated-measures one-way ANOVA with *Inversion Type* as the independent variable. The result indicated that there was no significant difference between the three types of inversion in SOV active condition (F (2, 24) = 1.000, *n.s.*) or in SOV passive condition (F (2, 24) = .829, *n.s.*). Conversely, we found a significant effect of in both OSV active and passive conditions (F (2, 24) = 10.770, $p < .001$; F (2, 24) = 10.558, $p < .01$, in order): in OSV active condition, the frequency of both *Voice inversion* and *Word-order inversion* was greater than the frequency of *Word-order + Voice inversion*, while the former two types of inversion did not differ. The same result was also observed in OSV passive condition. Since the *Word-order + Voice inversion* was limited in the production of participants in group High, we can still rule out the effect of bias on sentence recall for any specific sentence type.

To summarize, when recalling sentences in a scrambled order, participants inverted the sentence voice or linear sequence of noun phrases to produce sentences in canonical order, e.g., recalled *kankyou-o ningen-ga hakaishita* as *kankyou-ga ningen-niyotte hakaisareta* or *ningen-ga kankyou-o hakaishita*, or recalled *ningen-niyotte kankyou-ga hakaisareta* as *ningen-ga kankyou-o hakaishita* or *kankyou-ga ningen-niyotte hakaisareta*. Furthermore, since the first nouns were inanimate in OSV active condition and animate in OSV passive condition, we consider that the preference for SOV word order in sentence production was unaffected by the animacy information contained in noun phrases.

The recall of NP conjunctions revealed a significant tendency for participants to invert the linear sequence of noun phrases in order to have the animate noun preceding the inanimate noun when recalling NP conjunctions with Inanimate-Animate sequence (t (12) = −2.920, $p < .05$), rather than those with Animate-Inanimate sequence.

4.7.2.2 Recall of the group Low

We now turn to the recall of participants in group Low. According to the sentence comprehension task, they appeared to have an overall lower proficiency with the stimuli with a 'Yes' response. Thus, we consider that they also struggled more when listening to sentences with a

scrambled order in our sentence-recall task. The identical statistical analyses were performed. The percentage of each inversion type in transitive conditions is shown in Figure 9.

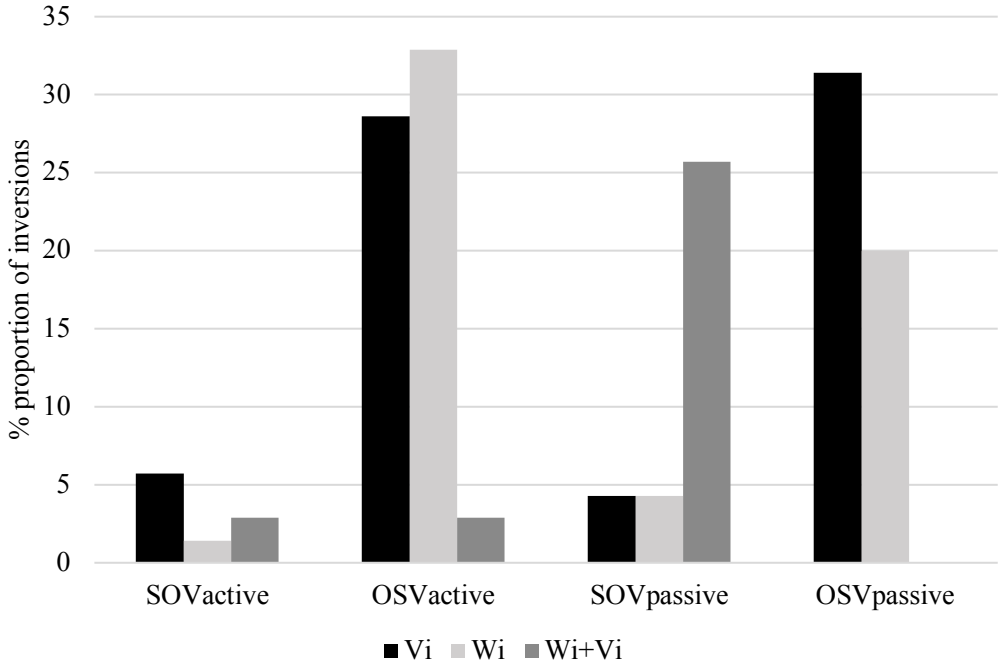

Figure 9. Proportions of inversions recalled in transitive conditions of group Low (%).

The repeated-measures one-way ANOVA with *Condition* as the independent variable revealed a significant difference in the frequency of *Voice inversion* between conditions (F (3, 39) = 9.654, p < .001). Multiple comparisons showed that there were significantly more voice inversions in OSV conditions than in SOV conditions. The repeated-measures two-way ANOVA revealed a significant main effect of *word order* (F (1, 13) = 52.907, p < .001), but not a main effect of *voice* (F (1, 13) = .014, *n.s.*) or the interaction between *voice* and *word order* (F (1, 13) = .258, *n.s.*). In terms of *Word-order inversion*, there was a significant difference between conditions (F (3, 39) = 11.342, p < .001). Multiple comparisons revealed that the more word-order inversions were produced in OSV active condition than in SOV active and passive conditions, while there were only marginally significant more inversions in OSV passive condition compared to SOV active condition. Only the main effect of *word order* was found significant (F (1, 13) = 40.105, p < .001), but neither the main effect of *voice* nor the interaction of the two factors (F (1, 13) = 1.046, *n.s.*; F (1, 13) = 3.270, *n.s.*, in order). In respect of *Word-order + Voice inversion*, there was also a significant difference between conditions

(F (3, 39) = 10.928, p < .001): more specifically, the pairwise comparisons revealed that this type of inversion occurred significantly more frequently in SOV passive condition than in any other condition; the two-way ANOVA also revealed the interaction of *voice* and *word order* (F (1, 13) = 14.425, p < .01).

By analyzing the variation of recall within each condition through a repeated-measures one-way ANOVA with *Inversion Type* as the independent variable, we found significant difference between the three type of inversions in conditions except SOV active condition (F (2, 26) = .765, *n.s.*). The results for the 3 conditions were as follows: there was a significant difference between three inversions (F (2, 26) = 8.904, p < .01) in OSV active condition, and both *Voice* and *Word-order inversion* were found to be significantly more frequent than *Word-order + Voice inversion* but did not differ from one other; likewise, a similar result was obtained in OSV passive condition (F (2, 26) = 10.033, p < .01); moreover, there was also a significant difference in SOV passive condition (F (2, 26) = 8.731, p < .01), with *Word-order + Voice inversion* being significantly more frequent than *Voice* and *Word-order inversion*.

Participants in group Low demonstrated a tendency to invert the sentence voice or linear sequence of noun phrases in order to produce sentences in canonical order when recalling sentences in scrambled order, for example, recalled *kankyou-o ningen-ga hakaishita* as *kankyou-ga ningen-niyotte hakaisareta* or *ningen-ga kankyou-o hakaishita*. Unlike group High, they, on the other hand, tended to only invert the voice of OSV passive sentences: for example, they recalled *ningen-niyotte kankyou-ga hakaisareta* as *ningen-ga kankyou-o hakaishita*. Moreover, when recalling an SOV passive sentence, participants in group Low tended to invert the both the grammatical function and linear sequence of noun phrases, resulting in the production of an SOV active sentence: for example, they were more likely to recall *kankyou-ga ningen-niyotte hakaisareta* as *ningen-ga kankyou-o hakaishita*. In light of the fact that first nouns of sentences were inanimate in OSV active condition and that there was no significant difference in the frequency of *Voice* and *Word-order inversion* among this condition, the preference for SOV order in sentence production of group Low appeared to be unaffected by the animacy information contained in noun phrases. However, the recall in SOV and OSV passive conditions appeared to reveal a strong preference for an animate noun as the sentence subject, as well as a bias for canonical order.

The recall of NP conjunctions revealed a significant tendency for participants to invert the linear sequence of noun phrases in order to have the animate noun preceding the inanimate noun when recalling NP conjunctions with Inanimate-Animate sequence (t (13) = −3.484, p < .01), as what found in group High.

4.8 Discussion

4.8.1 Scrambling effect on transitive sentence comprehension

Taking a look at the results of sentence-comprehension task, it can be seen that both the reading times and the accuracy rates for stimuli with a 'Yes' response demonstrated a scrambling effect for sentences in scrambled order. Our findings were somewhat similar to those of Tamaoka (2005), who found that participants with a high score on the grammar test had longer reading times when reading sentences with scrambled word order, as well as lower accuracy rates in the correctness judgement than when reading sentences with canonical order. Furthermore, this scrambling effect was observed in the same way that native Japanese speakers experienced difficulty comprehending sentences (Tamaoka, 2005).

Despite the similar results to those of Tamaoka (2005), there are some differences between our findings and previous studies. While participants in group High possess higher grammar proficiency in Japanese as those in Tamaoka (2005), no scrambling effect was observed in their grammaticality judgement. This result indicated that word order has no effect on sentence comprehension for L2 learners with a relatively high level of proficiency, which should be the result of increased knowledge of the language. Tamaoka et al. (2010) also demonstrated this phenomenon: they discovered a main effect of *Group* (High, Mid, and Low) in addition to the scrambling effect of different word order, that is, participants with high proficiency performed better than participants with relatively lower proficiency in the comprehension of ditransitive sentences with canonical and scrambled orders. This tendency was also replicated in our experiment 2 (though the stimuli were different), as we observed significantly higher scores in group High for both canonical and scrambled sentences than in group Low. Furthermore, Tamaoka et al. (2010) found no difference in the comprehension of both types of sentences between JFL learners who contained intermediate and low proficiency. The distinction between intermediate and low proficiency appears to be ambiguous, which is why we chose to divide participants into two groups rather than three in experiment 2. Notably, the proficiency we defined in

this experiment is restricted to the perception of different word orders in Japanese sentences (especially the scrambled order), and the distinction between 'High' and 'Low' does not correspond to our participants' overall Japanese language proficiency.

Interestingly, JFL learners in group Low made more errors with regard to word order judgements than with regard to the grammatical function of noun phrases. This also demonstrated their command of grammar. They may, however, lack knowledge or familiarity with scrambled word order and thus regard the scrambled order as incorrect, despite the fact that word order should have no effect in the absence of contexts. Tamaoka (2005) asserted that filling-gap parsing contributed to the difficulty of comprehending scrambled order, and Tamaoka et al. (2010) added that filler-gap parsing in ineffective until L2 learners achieve a high proficiency level. If filler-gap parsing did play a role in sentence comprehension, its effect could be limited because participants did not have a time limit for reading sentences and their judgement was completely constrained by the functional assignment. Thus, we believe that the reason for the low accuracy in comprehending sentences with scrambled order belonging to group Low is primarily due to the unfamiliarity of such word order.

With regard to stimuli with a 'No' response, despite the fact that stimuli with a 'No' response with scrambled word order required a longer reading time and higher accuracy, the scrambling effect was not significant as in previous study (Tamaoka, 2005). Tamaoka (2005) claimed that when reading sentences that are both semantically and syntactically incorrect, the semantic information contained in the sentences has an effect on sentence processing in addition to the effect of syntactic information. This effect appears to be stronger than when correct sentences are comprehended, since both syntactic and semantic information must be processed concurrently when reading a sentence; however, when the sentence's meaning is incorrect, more attention is drawn to semantic processing. As a result, the heavier burden that emerges during semantic processing is assumed to have a significant impact on syntactical processing. Even though we instructed participants to make judgement based on grammatical information, participants inevitably focus on the sentence meaning and process semantic information unconsciously.

Previously, our findings on sentence comprehension were based on a visually presented task to maintain participants' attention on the syntactic information contained in sentences and to observe the influence of scrambled word order on the processing of syntactic information. Additionally, we presume that if participants demonstrated difficulty with syntactic processing in the visual-presented

condition, this difficulty may become more pronounced in the auditorily presented condition. Due to the limited time available to participants to process information in an auditorily presented sentence, if a problem arises during sentence processing, subsequent processing or comprehension of sentence information will be hampered. Finally, this will have an impact on the syntactic choice made during sentence recall, as the choice was made using syntactic information gleaned during sentence-comprehension.

4.8.2 Animacy effect on recall of groups with different comprehension abilities

On the basis of the findings from experiment 1, we discussed the animacy effect on sentence production. We confirmed the preference for canonical SOV word order in the recall of Chinese JFL learners in experiment 1, but did not demonstrate the influence of animacy on their production: participants tended to invert the word-order (linear sequence of noun phrases) or voice of a sentence with scrambled order, preferentially reconstructing a sentence with canonical order. Additionally, it appeared as though this tendency was unaffected by the animacy of the noun phrase serving as the subject. While we observed a tendency toward simultaneously inverting the functional assignment and linear sequence of noun phrases in an SOV passive sentence in order to produce an SOV active sentence with animate subject, this tendency is not be worthy of mention given the rarity of *Word-order + Voice inversion*.

We now turn our attention to the observations made in experiment 2. Additionally, we used a repeated-measures two-way ANOVA taking *Group* and *Inversion Type* (*Voice, Word-order, and Word-order + Voice inversion*) as independent variables, and the number of each inversion as dependent variable to compare the frequency of three different types of inversion produced by groups High and Low within each condition. As a result, the main effect of *Group* was not significant at all levels of inversion in SOV active condition (F (1, 25) = 2.83, *n.s.*; F (1, 25) = .00, *n.s.*; F (1, 25) = 2.01, *n.s.*, in order), owing to the extremely low frequency of recalled inversions in this condition. In other three conditions, the main effect of *Group* was also not found to be significant (F (1, 25) =.634, *n.s.*; F (1, 25) = 1.244, *n.s.*; F (1, 25) =.138, *n.s.*, in order). These results imply that the ability of inversion may be consistent, at least in our sentence-recall task, for participants with varying degrees of sentence-comprehension proficiency.

By combining the analyses in chapter 4.7.2, we sought to discuss the difference in recall between

group High and Low. To begin, we found that participants in group High tended to invert the grammatical function of noun phrases in a sentence with scrambled order, preferring instead to produce a sentence with canonical order. Additionally, they were found to preferentially invert the linear sequence of a scrambled sentence into canonical word order while maintaining the grammatical function of noun phrases. These tendencies were observed in both OSV active and passive conditions, with no distinction between the two. Furthermore, there was no difference in the tendency to invert the voice or word-order between the active and passive OSV conditions. Thus, we can assert that the animacy information contained in noun phrases appeared to have no effect on the determination of sentence structure for Chinese JFL learners in group High, as they prefer to produce a sentence-first subject noun regardless of its animacy; additionally, neither the sentence voice nor the thematic role considered to influence syntactic choice, whereas word order did. The lack of animacy effect was more pronounced than in experiment 1. This result contradicts our prediction that participants with higher sentence-comprehension proficiency should be more sensitive to conceptual information and more adaptable to processing it alongside syntactic information, i.e., an animacy effect should emerge from the recall of participants in group High.

Regarding the recall of group Low, we found a similar tendency for them to invert the grammatical function or the linear sequence of noun phrases in an OSV active sentence, preferring canonical order; likewise, since these inversions were not significantly different in frequency, we concluded that neither the sentence voice nor the animacy information of noun phrases influenced the syntactic choice of participants. In comparison, we discovered that participants had a strong tendency to invert the grammatical function of noun phrases in an OSV passive sentence in order to produce an active sentence in canonical order. Though the quantity variance between *Word-order inversion* and *Voice inversion* was not statistically significant within the OSV passive condition, six participants of group Low (14 participants in total) produced no *Word-order inversion*, while only one produced no *Voice inversion*. Hence, we hypothesize that participants in group Low exhibited a different tendency from those in group High. These findings contradicted the absence of animacy effect observed in group High.

Moreover, an obviously different pattern of inversion was observed in the SOV passive condition: participants in group Low tended to invert both the grammatical function and the linear sequence of noun phrases in an SOV passive sentence in order to finally produce an SOV active

sentence with an animate noun as the sentence subject. This phenomenon is termed as the animacy effect on grammatical encoding: more precisely, we regard it as a consequence of animacy effect on functional processing rather than positional processing. According to Bock and Levelt (1994), functional processing should precede positional processing, thus speakers should determine the grammatical function of arguments first, followed by the linear sequence of constituents. Given the recall of group Low revealed an extremely strong preference for SOV order, it is reasonable to assume that Chinese JFL learners conduct subject function assignment first, and given that they produced more animate subjects, it is reasonable to assume the subject function was assigned preferentially to animate nouns. Due to the preference for animate nouns to undergo formulation first, we believe that animate nouns were activated earlier than inanimate nouns during conceptualization, and the animacy information was also confirmed to affect the accessibility of concepts. However, in positional processing, it is assumed that speakers assign the subject to the first position of a sentence based on their preference for SOV order. An alternative interpretation could be the lower familiarity of passive structures. However, participants in group Low produced nearly identical inversions for OSV sentences, both groups should be equally adept at using passive structures.

Herein lies the rub: how do native Japanese speakers and Chinese JFL learners differ in their production mechanisms? Native speakers demonstrated a strong preference for the animate subject during functional processing; this preference for the animate subject during functional processing was also observed in the processing of JFL learners, though to a lesser extent. Considering the difference at this level, JFL learners may preferentially process the subject assignment (whether the argument is animate or not), whereas native speakers place a higher premium on the functional assignment of animate nouns (whether they are subject or not), as they have greater freedom in structuring sentences and subject determination is not always primary. We consider that animacy also influenced the choice of constituent sequence during positional processing (particularly in the production of NP conjunction structures), even though we did not observe an animate-preceding-inanimate tendency directly in transitive sentences. Although the canonical word order is assumed to be more general in Japanese, the scrambled order is still highly available for native speakers. Nonetheless, native speakers showed a strong preference for SOV order with the animate noun in the first position, which may imply a tendency for animate nouns preceding their inanimate counterparts. However, in previous processing, animate nouns are always assigned as sentence subjects, resulting in an coincide between the

preference for animate subject and animate-inanimate sequence. For JFL learners, positional processing may be based on the consequence of functional processing: they prefer SOV order and only place animate nouns in the sentence-first position if they are sentence subjects.

4.8.3 The relationship between sentence comprehension and production

We then discuss the relationship between the ability of sentence-comprehension and the performance in sentence-recall. Through a visually-presented reading task, we assessed the comprehension ability of Chinese JFL learners and divided them into two groups: the High group performed better than the Low group on the grammaticality judgment task in both canonical and scrambled sentences. The scrambling effect was observed only in the grammaticality judgment of participants in group Low for sentences with scrambled order (lower accuracy and longer reading times). Additionally, it was established that this effect is caused by word order rather than sentence voice (only the main effect of *Word order* was found to be significant). Their performance in sentence-comprehension task may be indicative of their ability to process syntactic information during listening-comprehension.

Moreover, when OSV sentences were recalled, the two groups produced a similar pattern of inversions: participants in both groups tended to invert the linear sequence or grammatical function of noun phrases to produce an SOV sentence with a comparable animate or inanimate subject. Thus, it is significant that, despite participants' disparate abilities in comprehending sentences, the sentence-recall task sometimes masked this disparity: when participants listened to an OSV sentence, word order may have had an effect on their processing of sentence information; nevertheless, even if there was a scrambling effect, it would be minimal given that participants listened to a series of sentences all at once. However, when comparing the recall of Chinese JFL learners, the question of why the animacy effect was observed in production of group Low rather than group High was raised.

Zhao (2019) analyzed the fNIRS data collected from Japanese native speakers and Chinese JFL learners through a silent reading task for Japanese sentences. As a result, the precedence of syntactic processing was discovered in sentence-comprehension of native Japanese speakers. In contrast, it was found that Chinese JFL learners prioritized semantic processing during sentence comprehension, even when the syntactic structure was deviant, implying that semantic processing takes precedence regardless of whether the syntactic processing succeeded or failed. The priority placed on semantic

processing in the processing of Japanese sentences may obstruct the influence of sentence comprehension on the production of Chinese JFL learners in the present study.

To be more specific, participants with a lower ability on grammaticality judgement are also assumed to have a lower ability on processing syntactic information during sentence comprehension. However, even with impaired syntactic processing, they were still able to complete semantic processing via individual words and construct a conceptual representation corresponding to the original message (such as 'who did what'). This is why they are capable of completing the sentence recall. As a result of their difficulty with syntactic processing during listening comprehension, participants in group Low may have difficulty reserving syntactic information of original OSV sentences in memory. Therefore, when they recall OSV sentences, they are unable to rely on any syntactic information and must recreate a syntactic representation for the message. At this point, a more natural processing of concepts manifests itself in their sentence production, which refers to as the animacy effect on functional assignment. Additionally, such processing may be facilitated by the restriction on animate agents in our stimuli: since the agents of events were constrained by our stimuli to be animate, they can only process the animate concepts first, based on the conceptual representation.

In contrast, it is assumed that participants in group High perform better in listening comprehension regardless of different word order. Additionally, they are assumed to be capable of performing both syntactic and semantic processing, implying that some syntactic information from the original sentences may be stored in memory. As a consequence, when they recall or embody the messages, they will be influenced to some extent by the reserved syntactic information, which may obscure a natural conceptual processing. The relatively few inversions for SOV sentences revealed something about their memory of syntactic information. Thus, participants occasionally remembered the information about function assignment and occasionally information about constituent sequence, leading them to begin with memorized information and then complete a sentence accordingly. Certainly, it is possible that participants in group High now and then forgot original syntactic information and thus processed concepts more naturally. However, based on their overall production of inversions, we continue to believe that their production is largely influenced by the reserved information.

To summarize, we observed a distinct pattern of animacy effect in the production of participants with varying capabilities for sentence-comprehension. Additionally, we discussed the relationship

between sentence comprehension (especially for sentences in scrambled order) and sentence production, assuming that the grammaticality judgment revealed the difficulty with syntactic processing. This degree of difficulty (or ease) influenced the syntactic choice made during the structural reconstruction of a specified message. Moreover, we suggested that the use of restored information in memory may have obscured natural conceptual processing, particularly among participants with better comprehension performance. Thus, it may be necessary to employ a task that encourages more natural utterances and allows for the elimination of memory influence.

5. EXPERIMENT 3

5.1 Goal

As a consequence of the sentence-recall task in experiments 1 and 2, the animacy effect in Chinse JFL learners' production was shown to be limited, and the preference for SOV order remained stronger than the preference for animate nouns. We hypothesized that the restricted animacy effect observed in previous experiments could be modified by the task. The sentence-recall task is a memory-related task. Therefore, participants may rely on some type of memory strategy in order to memorize sentences, interfering with the natural processing of animacy information. This possibility was also mentioned during the investigation on production for native Chinese speakers (Yan and Dong, 2011). Take note that our interpretation of sentence-recall task results is predicated on the assumption that animacy effect is functional in the sentence production of Chinese speakers. Alternatively, there is the possibility that there was no animacy effect on the production of Chinese speakers, in contrast to the production of native Japanese speakers.

In a word, Experiment 1 and 2 left several questions unanswered: how exactly does animacy information affect the sentence production of Chinese JFL learners? If an animacy effect existed, how might we extract it in the production of Chinese JFL learners? Additionally, how can Chinese JFL learners acquire the animacy processing present in native Japanese speakers? In previous experiments, there were constraints on exploring the mechanism of production under the sentence-recall task, since it is difficult to disentangle the variables of sentence comprehension and memory.

Experiment 3 aims to validate the animacy effect observed in previous experiments on sentence production by Chinese JFL learners. Moreover, we sought to observe implicit learning of animacy processing through the use of structural priming.

As a result, we decided to repeat our observation of Chinese JFL learners' animacy processing using the picture-description task. Since the influence of memory, word familiarity, and sentence comprehension is less pronounced in this task than in the sentence-recall task, it is widely used in research on sentence production. We anticipated investigating spontaneous processing of conceptual information, as this task allows for relatively natural and spontaneous utterance and is therefore more conductive to studying production tendencies (Morishita et al., 2011). Given the animacy effect

observed in the NP conjunction structures production by all Chinese JFL learners and in the transitive sentences production by participants in group Low in experiment 2, we hypothesize that animacy information will have an effect on participants' production in an environment that allows more natural utterances.

We consider the method of structural priming to investigate he implicit learning of animacy processing. Structural priming is a phenomenon in which the same structure is reused as a result of encountering a particular structure. By manipulating the similarities and differences between experimental stimuli in a systematic manner, we were able to observe the occurrence of structural priming and thus identify the processing of various types of information. Additionally, we could compare the learning effect of specific information processing under conditions of varying experience frequency.

5.2 Structural Priming

Structural priming is the phenomenon in which speakers are more likely to repeat the structure of a sentence or utterance that they have previously heard or read. As an example, Levelt and Kelter (1982) discovered that shop assistants were more likely to respond to the questions `What time do you close?' and `At what time do you close?' (in Dutch) with a syntactically congruent answer (e.g. `Five o'clock' or `At five o'clock').

Bock (1986) investigated the phenomenon of syntactic persistence when there was no regular relationship between the messages or likely communicative intentions expressed in consecutive sentences. In the presence of primes, they found an increase in the frequency of utterances with the same structure, and the findings revealed that syntactic repetition occurred even when significant differences in word order and grammatical roles distinguish the forms used to express semantically comparable messages. Furthermore, they discovered that subjects appeared to be unaware of the similarities between the form of priming sentences and the form of their own descriptions, indicating that the repetition was not done consciously or strategically. Bock and Loebell (1990) also revealed priming in both dative-to-dative and passive or locative-to-passive constructions, demonstrating that structural features, particularly constituent structures, are more responsible for the observed priming patterns than semantic features (such as event roles). Consequently, it is possible to construct sentence constituent structures without having direct access to the conceptual structures that underpin them.

Bock, Loebell, and Morey (1992) discovered that speakers tended to produce sentences in structural forms that were similar to those used in previously spoken, topically unrelated sentence when they were prompted to do so. It is important to note that this tendency was unaffected by the structure of the priming sentences: inanimate subject-arguments in passive primes were as likely as the inanimate subject-arguments in active primes to predispose inanimate subject-arguments in subsequent active targets.

Structural priming has also been observed in studies employing a variety of experimental methods. Pickering and Branigan (1998) demonstrated syntactic priming in the context of written language production using a sentence-completion task. Furthermore, the tendency to repeat structure between sentences was greater when the verbs in the two sentences were identical than when the verbs were different. Potter and Lombardi (1998) also demonstrated that syntactic priming from an unrelated sentence influences immediate recall of the following sentence via a sentence-recall task, indicating that priming occurs even when subjects do not recall the prime but only perceive it. Branigan, Pickering, and Cleland (2000) investigated whether speakers also co-ordinate syntactic structure in dialogue using a novel confederate-scripting technique. They found that the syntactic structure of the confederate's description had an effect on the subsequent description of the subjects. Additionally, their findings established the existence of shared syntactic representations underlying comprehension and production, as well as the activation of these representations during spontaneous dialogue.

Structural priming was confirmed not only in English, but also in a variety of other languages (in the case of L1). For example, Köhne, Pickering, and Branigan (2014) found that when constituent structure remained constant, German speakers repeated the order of constituents as well as the order of thematic roles; Kantola and Gompel (2011) also found a structural priming effect in Swedish dative constructions. Moreover, Huang, Pickering, Yang, Wang, and Branigan (2016) observed a structural priming effect for dative constructions in Chinese, a highly isolating language, despite the fact that verbs are repeated. Similar findings have been made for agglutinative languages such as Japanese (Deng, Ono, & Sakai, 2012).

Structural priming occurs both between and within languages. Hartsuiker, Pickering, and Veltkamp (2004) demonstrated that when Spanish-English bilinguals were exposed to a passive sentence in Spanish immediately before, they described a picture more frequently with a passive

sentence in English (“the church is hit by lightning”). Bernolet, Hartsuiker, and Pickering (2007) discovered that word order priming occurred between Dutch and German relative clauses that have the same verb-final order. Furthermore, structural priming has been observed in some constructions that had a different constituent sequence between languages, such as Dutch and English (Bernolet, Hartsuiker, & Pickering, 2009, 2013), Chinese and English (Chen, Jia, Wang, Dunlap, & Shin, 2013; Hwang & Shin, 2019), Korean and English (Shin & Christianson, 2009, 2011; Song & Do, 2018); structural priming was also observed in some constructions that shared the same constituent sequence between languages, such as German and English though only in dative constructions with identical word order (Loebell & Bock, 2003), Swedish and English (Kantola & Gompel, 2011), even between artificial language and natural language (Muylle, Bernolet, & Hartsuiker, 2021).

5.2.1 Structural priming research on Japanese

In comparison to head-initial languages, structural priming was studied less in hand-final languages. However, the priming effect was found to be comparable in head-final and head-initial languages. Santesteban, Pickering, Laka, and Branigan (2015) investigated the structural selection in Basque, a head-final (OV) language, and confirmed the structural priming effect in native Basque speakers’ event description: more intransitive descriptions were produced following intransitive primes than following transitive primes.

Does structural priming, on the other hand, occur in Japanese? Numerous studies have been conducted on the issue. Deng (2009) demonstrated the structural priming effect on active and passive sentences using a sentence-completion task in Japanese: native Japanese speakers were more likely to construct a passive sentence following a passive prime (the same for active sentences). Moreover, this structural priming occurred irrespective of the different word order (the sequence of thematic roles under their definition) between primes and targets. Similarly, Tanaka, Pickering, and Branigan (2009) investigated the structural priming in Japanese using a picture-description task and found that Japanese native speakers produced more passive sentences following passive primes rather than active primes; additionally, they reused the SOV order following the SOV primes more frequently than after the OSV primes. In consequence, in Japanese, both the priming effect of grammatical function assignment and word order was confirmed. Deng et al. (2012) conducted additional research on structural priming in Japanese, focusing on the independence of the functional assignment and constituent assembly. As a

result, the priming effect of passive sentences was discovered, as well as the priming effect of word order. Notably, it was found that the priming of passive voice and word order are independent of one another: participants produced more passive sentences following passive primes regardless of the word order, and scrambled sentences following OSV primes regardless of the voice. Thus, their findings indicated that the function assignment stage and the constituent assembly stage are computed independently in Japanese production process.

5.2.2 Structural priming and Animacy

While structural priming has been extensively demonstrated, research incorporating animacy information into the priming paradigm is still relatively scarce. Surprisingly, Tanaka et al. (2009) found no animacy effect in the picture-description of native Japanese speakers (there was no particular tendency to assign animate entities to a particular grammatical or linear position, in contrast to the tendency observed in the sentence-recall task (Tanaka et al., 2011). Rather than that, Gamez and Vasilyeva (2015) observed a combination of the animacy effect and priming effect in the production of English native children. They combined thematic roles (agent or patient) and animacy (animate or inanimate noun) in their observation, and found that English native children tend to produce more passives for events involving animate patients and inanimate agents, indicating the animacy effect on structural choice, in which animate nouns are preferentially assigned as the subject. In comparison to Gamez and Vasilyeva (2015), the thematic roles of animate nouns in Tanaka et al. (2009) remained the same as agent. Thus, the absence of animacy effect in Tanaka et al. (2009) can be attributed to the priming of thematic roles. Moreover, such a possibility should be explained by the mapping between thematic role and grammatical function, rather than by the mapping between thematic role and linear sequence, since the incongruent order of thematic roles between prime and target was found to have no influence on the structural priming effect (Deng, 2009).

Buckle, Theakston, and Lieven (2017) investigated the structural priming of ditransitive sentences in 3 and 5 years-old children and adults who are native English speakers. The results indicated that regardless of the syntactic structures, children can be primed to reuse noun animacy order. However, it was discovered that this priming effect is also dependent on the matching animacy-semantic role mappings between prime and target; this result indicated that animacy cues do not function independently of semantic roles to achieve priming effects. Their findings are considered to

contradict the conceptual accessibility theory of Bock and Warren (1985), which proposed that a general preference for animate nouns trumps a preference for specific semantic roles. In addition, they found no effect of animacy noun priming on target noun orders in adults, suggesting that sensitivity to semantic content may decline with age. Particularly, their findings supported the independent effects of syntax and semantics on priming. Similar independence of animate noun priming from semantic roles was observed in Chinese native speakers in using ditransitive sentences (Huang et al., 2016).

Nonetheless, the absence of animate noun priming in these studies may be a result of the constraint from ditransitive sentences. Though they altered the animacy of the theme and patient arguments in ditransitive sentences, both arguments are objects of the action (direct and indirect objects, respectively) and have little grammatical distinction. Thus, in ditransitive structures, the animacy effect is relatively constrained. In comparison to ditransitive sentences, where nouns in two-argument transitive sentences are highly dissimilar in terms of grammatical functions, we expect to see different results in transitive sentences. As previously stated, the animacy effect on grammatical encoding can be observed using the structural priming method, with the caveat that semantic roles must be considered in the interim.

5.2.3 Structural priming and Implicit learning

It was confirmed that structural priming persists even when placeholders and time intervals are inserted between prime and target. Bock and Griffin (2000) found that when 10 sentences were interspersed between the prime and target, the priming effect was comparable to when 2 sentences were interspersed. A similar effect was observed when participants simply heard the primes and did not repeat them (Bock, Dell, Chang, & Onishi, 2007). Chang, Dell, Bock, and Griffin (2000) proposed that structural priming is a form of implicit learning, which is conducted unconsciously. Seger (1994) asserts that incidental learning of complex, abstract relations occurs while performing a task and results in knowledge that is inaccessible to consciousness.

Structural priming is based on encounters with specific syntactic structures, and its effect can be influenced by their frequency of occurrence. Kaschak, Loney, and Borreggine (2006) investigated the cumulative effect in structural priming by manipulating the frequency with which the double-object (DO) and prepositional-object (PO) constructions were encountered. The results indicated that the frequency of previous encounters had an effect on the priming effect: when participants

encountered more DO structures previously, the priming effect on DO structure was enhanced, whereas the priming effect on PO structure was weakened (also see Kaan & Chun, 2018). Segaert, Wheeldon, and Hagoort (2016) discovered a similar long-term cumulative effect, in which participants produced more passives when the proportion of passive primes was higher. Additionally, the 3 primes condition had a stronger priming effect than the single prime condition, implying the immediate effect of cumulativity. These studies established that cumulative encounters can amplify the activation of a particular structure, increasing the likelihood that the same structure will be chosen in subsequent production. Hwang and Shin (2019) also found that when native Chinese speakers were biased toward producing corresponding primes, they were more likely to produce passive and DO structures.

Apart from native speakers, some structural priming research has concentrated on second language learners. McDonough (2006) that structural priming facilitated the use of structures with a higher degree of familiarity (e.g., PO structure), but had no effect on structure with a lower degree of familiarity (e.g., DO structure). By contrast, the fact of facilitation was demonstrated in the production of DO structures by Korean EFL learners. Kim and McDonough (2008) demonstrated the structural priming effect in L2 learning by proving that Korean EFL learners produced more passive sentences after passive primes, which was prompted by the same verbs that appeared in preceding primes. Shin and Christianson (2011) also investigated the effect of structural priming on the L2 production of Korean EFL learners, and found that structural priming resulted in an overall improvement in the target structure production. Notably, such implicit learning was beneficial in the long run for structurally complex double-object datives. Thus, they hypothesized that structural priming could serve as a source of L2 development through structural learning. Hwang and Shin (2019) demonstrated the structural priming effect in conjunction with a cumulative effect from L1 (Chinese) to L2 (English) production: Chinese speakers tended to produce more passive structures when primed and biased with passives. A similar priming effect and cumulative effect was observed in the written production of Korean EFL learners (Kaan & Chun, 2018).

Regardless, structural priming has been shown to improve the sentence production of L2 learners and facilitate their acquisition of specific structures. However, can priming effects that act on specific syntactic structures have an effect on the processing of a more abstract encoding? Cai et al. (2012) discovered both conceptual-to-function mapping and conceptual-to-linear mapping between various dative constructions and DO/PO target responses, demonstrating the existence of an abstract

mapping between levels (or a more abstract syntactic processing) in addition to the mapping of specific syntactic structure. Likewise, Bock et al. (1992) demonstrated that participants were more likely to produce targets with the same noun animacy order as primes, with animate subjects preceding inanimate objects, rather than an inanimate subject-animate object order, irrespective of the thematic roles of sentence subject, or structures. Additionally, Buckle, Lieven, and Theakston (2017) demonstrated that animacy cues can influence the word order in children's (native English) production regardless of whether they repeat prime syntactic structures.

Thus, we hypothesize that Chinese JFL learners are able to reuse the processing of animacy information via structural priming. In addition, we expect to determine whether animacy processing (as observed in native Japanese speakers) can be learned through repeated exposure and contribute to grammatical encoding (syntactic choice) in the production of Chinese JFL learners, specifically the influence of frequency (cumulative effect).

5.3 Materials

We created two distinct types of events, with animate and inanimate nouns acting as agents respectively. Thus, eight different sentence types can be constructed in a 2 (Word Order: canonical vs. scrambled order) × 2 (Voice: active vs. passive) × 2 (Thematic role of animate noun: agent vs. patient) way (see Table 8).

Table 8

Example of experimental sentences

Voice	Animate agent		Inanimate agent	
	SOV	OSV	SOV	OSV
Active	An-*ga* In-*o* V-ta	In-*o* An-*ga* V-ta	In-*ga* An-*o* V-ta	An-*o* In-*ga* V-ta
Passive	In-*ga* An-*ni* V-rareta	An-*ni* In-*ga* V-rareta	An-*ga* In-*ni* V-rareta	In-*ni* An-*ga* V-rareta

Note. An = animate noun, In = inanimate noun.

5.3.1 Stimuli

To observe implicit learning in animacy processing, it is necessary to define the animacy processing first. According to Tanaka et al. (2011), the animacy processing of native Japanese speakers involves 1) preferentially assigning an animate noun as the subject of a sentence and 2) preferentially placing an animate noun in an earlier sentence position. Thus, two conditions of experimental sentences were created to correspond to distinct animacy processing: the Animate-subject prime condition and the Animate-Inanimate prime condition. By dividing these two conditions of primes, we could further observe which processing is more likely to be learned, which reveals the difference in the Chinese JFL learners' sensitivity to different animacy processing. To avoid the influence of the same presentation order, two additional lists with different presentation order of target images were created in each condition. Each list contained 30 pairs of experimental sentences and their corresponding target images, as well as 60 pairs of filler sentences (ditransitive and intransitive sentences) and their corresponding images. All lists used the same filler pairs.

Among the eight types of sentence displayed in Table 8, two with inanimate subject and inanimate nouns preceding animate nouns (In-*ga* An-*o* V-ta, In-*ga* An-*ni* V-rareta) were designed as baseline primes, as they cannot prime any processing on animate nouns. These baseline prime sentences were included in both conditions for us to observe unguided animacy processing.

Additionally, the Animate-subject prime condition contained 4 distinct types of sentences with animate subjects (An-*ga* In-*o* V-ta, In-*o* An-*ga* V-ta, An-*ga* In-*ni* V-rareta, In-*ni* An-*ga* V-rareta). The Animate-Inanimate prime condition contained 4 distinct types of sentences, each of which began with an animate noun preceding an inanimate noun (An-*ga* In-*o* V-ta, An-*ni* In-*ga* V-rareta, An-*ga* In-*ni* V-rareta, An-*o* In-*ga* V-ta). Each condition consisted of 20 pairs of prime-targets and 10 pairs of baseline-targets. It's worth noting that [An-*ga* In-*o* V-ta] and [An-*ga* In-*ni* V-rareta] sentences both contained an animate subject and an animate-inanimate linear sequence, and thus met both conditions. Due to the ambiguity of the animacy processing in these cases, we combined these two types of sentences in a 1:4 ratio with other sentences. Each pair of prime-target contained 3 target prime sentences, whereas each pair of baseline-target contained only one baseline prime. Thus, we examined whether there was a cumulative effect associated with repeatedly encountering 3 target prime sentences, as opposed to the baseline sentences, which cannot prime any processing on animate nouns. Moreover, we could

determine whether encountering multiple prime sentences at the same time enhanced L2 learners' implicit learning of animacy processing.

As previously stated, both the experimental sentences and target images contained 2 distinct types of events: [animate agent–inanimate patient] and [inanimate agent–animate patient]. It is simpler to create events using an animate agent, as animate entities are easily regarded as the doer, and our stimuli involved both human and animal animate nouns. However, creating plausible events with inanimate agents is relatively difficult. We began by considering the choice of inanimate subjects.

Kakuda (1991) utilized Silverstein's referential hierarchies, which originally implicated the degree of the feasibility for noun phrases to become the agent, to discuss the acceptability of inanimate-subject sentences in Japanese (Xiong, 2014). According to Kakuda, inanimate nouns that are higher in the hierarchy, are more plausible as sentence subjects (see Table 9). Therefore, it has been widely discussed that nouns referring to natural forces are more acceptable as sentence subjects.

Table 9

The Referential Hierarchies (Xiong, 2014)

Pronoun	Noun			
	Proper nouns	Human common	Animate common	Inanimate common
First person	proper names		non-human	the elements
Second person	kin terms			abstract nouns
Third person				toponym

Note. Combined the Referential Hierarchies of Silverstein (1976) and the version of Kakuda (1991).

Ohso and Takizawa (2001) classified transitive sentences into ten categories in Japanese, five of which contained inanimate subjects. Among the five types of inanimate subject transitive sentences, we concentrated on the transitive sentence of instrument (a white cloth covered the desk), and the transitive sentence of natural phenomena (tsunami attacked the tribe by the sea), the transitive sentence of cause (the excessive ambition shortened his lifetime). To begin, a transitive sentence of instrument is generally composed of instrumental case nouns. The subject of such sentences is always endowed with semantic properties such as [+controllable] and [+power] (Kanno, 1996). In other words, the inanimate subject, as entities under human control, must be capable of acting autonomously (Xiong,

2009). Machinery nouns are a classic example of an inanimate subject in this type of sentence. In transitive sentences of natural phenomena, nouns referring to natural phenomena serve as the subject. Natural phenomena, by definition, have the ability to automatically carry out events, making them more acceptable as the agent or sentence subject (Xiong, 2009). Che (2018) also proposed two subcategories of natural phenomena nouns: one for natural phenomena such as the *sun, wind, rain*, and another for natural disasters such as *typhoon, tsunami,* and *earthquake*.

Yamada (2014) identified two types of inanimate nouns as the subjects of inanimate-subject transitive sentences: noun phrases with inherent movement and those that lack inherent movement but have the ability to affect other objects. Che (2018) proposed nouns referring to vehicles and natural phenomena for noun phrases with inherent movement. All of these nouns possess the property of acting on humans and are thus plausible as the subject of transitive sentences of instruments and natural phenomena, respectively. While nouns that lack movement, such as *light, sunlight*, or *tree, branch*, are unlikely to be considered agents acting on any objects, they may exert influence on objects simply by their existence or by possessing certain properties that influence the occurrence of events (Che, 2018, 2020). These nouns are considered to be 'the cause of events' and are thus plausible as the subject for transitive sentences of cause (Che, 2020). Additionally, nouns that depict human behavior, such as those referring to emotion or sensation, as well as those referring to what is controlled by humans such as weapons, may serve as the subject for transitive sentences of cause (Che, 2018).

In summary, we combined the findings above and primarily used 4 types of nouns to construct inanimate subject transitive sentences for the prime and target in the current experiment: nouns referring to natural phenomena such as *wind, thunder, lightning, fire*, nouns referring to natural disasters such as *storm, tsunami, avalanche*, nouns referring to vehicles or machines such as *crane, boat, helicopter*, and nouns referring to those that have no inherent movement but may exert influence on objects, such as *cannon, mud, moon*. In addition, nouns referring to human emotion or sensation were chosen to construct transitive sentences of cause.

Correspondingly, we considered verbs for transitive sentences with inanimate subjects. Xiong (2009) discussed the relationship between an inanimate subject and a verb, concluding that verbs emphasizing the process of actions can more naturally collocate with inanimate subjects than verbs emphasizing the outcome of actions. Thus, durative verbs are considered to be more acceptable in

inanimate subject sentences than momentary verbs; also, transitive sentences of natural phenomena appear more plausible when compound verbs like *fukitobasu* ('blow away') are used. Additionally, Xiong (2014) noted that stative verbs expressing feelings and emotions are appropriate for transitive sentences containing inanimate subjects. Che (2018, 2020) compiled and summarized a list of transitive verbs applicable to a variety of inanimate subjects. To select verbs for our stimuli, we combined the discussions from the previous studies and primarily referred to Che's research and the stimuli used in Tanaka et al. (2011). Additionally, we looked up synonyms for verbs used in those studies. Moreover, due to the fact that our stimuli contain both active and passive sentences, we checked whether the verbs could be used in either active and passive voice in the corpus searching tools NINJAL-LWP for Balanced Corpus of Contemporary Written Japanese (NLB) and NINJAL-LWP for Tsukuba Web Corpus (NLT). As a result, verbs with a passive voice frequency equal to or greater than half of the active voice frequency were chosen.

Ultimately, we selected 19 verbs for inanimate-subject prime sentences (three of which are also used in animate subject sentences), as well as 27 for target pictures (also used in both types of event). In total, we created 70 prime sentences (35 animate subject sentences and 35 inanimate subject sentences) using 32 different verbs (half for animate subject and half for inanimate subject, each accompanies two sentences) and 3 additional verbs used in both types (each accompanies one sentence of each type), as well as 54 target pictures with corresponding sentences (half with animate agent and half with inanimate agent) using the same 27 verbs.

We created two lists of target images for the picture-description task, each containing 27 images with an inanimate or animate agent, corresponding to the 27 target sentences. All images were composited using free materials gathered from 'Minna no Kyozai' website and irasutoya.com. To finalize the selection of 30 target images for our experiment, we designed a questionnaire to evaluate the events and images. Eight Chinese native speakers (5 female and 3 male) ranging in age from 25 to 30 (mean = 28.38, *SD* = 1.69), all of whom are JFL learners, assisted in completing the questionnaire.

Three items comprised the questionnaire. First, participants were asked to evaluate whether or not the event depicted in each image was logically plausible. Second, participants were required to evaluate whether or not the content of the presented sentence (always in the active voice) and the accompanying image corresponded. Third, participants were asked to evaluate the intelligibility of the image by indicating whether or not the content of the image was easy to understand. All items were

rated on a 1-7 scale, with 1 indicating 'completely implausible/incongruent/unintelligible' and 7 representing 'completely plausible/congruent/intelligible'. Meanwhile, few notices exist to ensure that participants conduct appropriate evaluations: there is no need to consider any sentence-level grammatical factors such as case-markers, tense, or verb inflection; when assessing the congruence between the picture and sentence, only those characters (in each picture) mentioned in the sentence are considered; last, for the composition of the images, certain referents were exaggerated.

We averaged the three evaluation items separately for the two picture lists, but focused primarily on the congruence between pictures and sentences to ensure that participants could accurately describe the images. Finally, 30 images were chosen (all scored higher than the mean), 15 from the list of inanimate agents (mean = 5.87) and 15 from the list of animate agents (mean = 6.57). The average values for 15 pictures with inanimate agents were 6.37 for event plausibility, 6.24 for picture-sentence congruence, and 6.44 for picture intelligibility. The average values for 15 pictures with animate agents were 6.82 for event plausibility, 6.90 for picture-sentence congruence, and 6.81 for picture intelligibility. Eight of the fifteen images in each list contained the same verbs, while seven contained verbs unique to the other list. The repeated verbs were inserted with the same number of intervals between their initial and subsequent appearances.

5.3.2 Considerations regarding the design of experiment

To observe the processing of animacy information in its entirely, we manipulated the design in three ways. First of all, we considered the influence of overlapping thematic roles. The priming effect was found to be enhanced when the prime and target shared consistent animacy information and thematic roles (Gamez & Vasilyeva, 2015). More precisely, when animate and inanimate nouns in the target shared thematic roles with those in the prime sentence, the same structure was frequently reused in target production. Bock (1986) discovered an increase in the number of nonhuman agent passive priming, though the priming effect was relatively weaker when events involving human agents were described. As a result, Bock believed that both the syntax and conceptual content of a priming sentence could influence the form of subsequent production. Chang, Bock, and Goldberg (2003) also found that role information has an effect on the positioning of phrases, implying that thematic roles contribute in the mapping of messages to sentence structures. Additionally, Cai et al. (2012) confirmed that repetition of thematic roles resulted in conceptual-to-structural priming in Chinese dative structures,

including priming of function assignment and positional assignment. Furthermore, Pappert and Pechmann (2014) asserted that the priming of word order observed in their experiments is contingent on the structural outline of thematic roles. Ziegler and Snedeker (2018) established that the priming of thematic roles is unrelated to syntactic structure, lexical content, or animacy. Therefore, if the same animate noun was the agent in both prime and target, it is difficult to determine whether the priming of animacy processing was caused by the same animacy information or the same thematic role. To avoid this ambiguity, the prime and target events must always have a distinct combination of animacy and thematic role: if the animate noun was the agent in the prime sentence, it must be the patient in the target event.

Second, we considered the lexical boost effect. Though lexical repetition is not a necessary component of priming effect (Bock, 1986, etc.), it has been widely demonstrated that when the verbs between primes and targets remained the same, the priming effect was stronger than when the verbs were different (Branigan et al., 2000; Pickering & Branigan, 1998; Santesteban et al., 2015; Segaert et al., 2016, etc.), even in the production of L2 (Kim & McDonough, 2008). A similar effect occurs with overlapping noun phrases, which can be viewed as a result of semantic boost. For example, Cleland and Pickering (2003) found that when semantically related nouns are placed between primes and targets (e.g., sheep vs. goat), syntactic priming of noun-phrase structures can be strengthened. Thus, if the verb overlapped between a pair of prime and target, structural priming could occur by reusing the structure of the same verb; the same verb form could also be primed, thereby influencing the syntactic choice (verb in active voice leads to the active sentence, while verb in passive voice leads to the passive sentence). In such circumstances, priming of animacy processing may not occur at all. If the noun phrases overlapped between the prime and target, the grammatical function assignment or linear position of the same nouns may be primed, masking the priming of animacy processing. To avoid priming due to lexical overlap, the words in our targets (including nouns and verbs) always differ from those in the prime sentences.

Thirdly, we considered the influence of lexical familiarity. Given that the two noun phrases are always dissimilar in terms of familiarity, it is possible that when participants describe a picture, they preferentially produce the one with the greater familiarity. Thus, we provided participants with the required words (including nouns and verbs accompanied by Hiragana and their Chinese equivalents) prior to viewing the target images. Allowing participants to learn the required words in advance is

thought to mitigate the discrepancy in lexical accessibility between noun phrases and the influence of lexical familiarity. Moreover, if unfamiliar words are used to describe a picture, it is difficult for L2 learners to produce correct and complete sentences. As a result, we displayed the required words alongside the target images. This manipulation could help L2 learners overcome their individual differences in vocabulary and facilitate their sentence production.

5.4 Participants

Twenty-nine Chinese JFL learners participated with payment, but one was excluded from analysis due to misunderstanding the instructions. Each of the 28 participants is a native Chinese speaker and a graduate or undergraduate who has earned the N1 certification on the Japanese Language Proficiency Test (JLPT). The average score is 125 over a range of 101-176 (*SD* = 21.54). As a result, data from twenty-eight participants (24 female and 4 male) were analyzed. Participants' ages ranged from 22 to 29 (mean = 24.96, *SD* = 1.99) and their average learning history of Japanese is 4 years and 8 months (*SD* = 1.77).

5.5 Procedure

Participants were assigned to one of four lists at random. They were given instructions for the experiment, which stated that it would examine the relationship between short-term memory and distraction frequency. Most participants did not doubt the real target of this experiment. The experiment was divided into two phases.

During the word-studying phase, participants were instructed to memorize a series of verbs (4 in practice, 30 in experiment) that would reappear in the subsequent phase. Each trial began with a 500ms cross mark, followed by a 2000ms slide containing a verb. Before the next trial, a 500ms blank appeared. Each verb was presented with Hiragana above it and Chinese equivalent below it, in order to aid Chinese JFL learners in understanding all of the words. We asked participants to pronounce each verb and then check the meaning. All of the words appeared only once. This phase was conducted to create the disguise of a word-memory task.

In the test phase, participants were instructed to indicate whether or not the words presented had been encountered during the word-studying phase. The test phase was divided into three sections: sentence reading, picture description, and yes-or-no recognition. In the sentence-reading section, each

filler trial contained a single filler sentence, whereas each priming trial contained one or three prime sentences (when there were 3 primes, sentences showed up one-by-one). Participants were instructed to read the sentences aloud correctly while also comprehending the gist. If participants made reading errors (such as misreading the case-marker), they were required to repeat the sentence. There was no time limit on how long a sentence could be read. To ensure that participants could read all of the words and comprehend the sentences completely, each word was accompanied by its Hiragana and Chinese translations.

The picture-description section required participants to produce a complete sentence describing the image they were shown. To mitigate the effect of lexical familiarity, required words were presented prior to the picture, along with their Hiragana and Chinese translations. Participants are not permitted to pronounce the words here in order to avoid activating the phonological loop, i.e., to prevent participants from preferentially using the last word they pronounced immediately before the picture description. Following that, a picture was presented and participants were asked to describe it using only the words presented.

There were some limitations since picture-description is relatively unrestricted. First, participants were only permitted to use three distinct case-markers (*-ga/-o/-ni*). Second, they were limited to three types of sentences: ditransitive, transitive and intransitive sentences. They were instructed to create ditransitive sentences using all three case-markers when presented with four words in advance, to create transitive sentences (active or passive) using two case-markers (*-ga* must be included) when presented with three words in advance, and to create intransitive sentences using only the *-ga* case-marker when presented with no words in advance. Similarly, ditransitive and transitive target images were presented with nouns adjacent to the corresponding characters and a verb beneath the picture (transitive targets together with the preamble). While all verbs were presented in their dictionary forms, participants were allowed to change the verb form on demand (base on the sentence they made, or their instinctive reaction). Additionally, participants were permitted to use scrambled word order, and were encouraged to continue with their original utterances while attempting to maintain the integrity of what they had said.

The final section is the yes-or-no recognition. Participants were asked to indicate whether they had encountered the verb depicted in the preceding picture slide during the word-studying phase. They were only required to respond verbally with a yes or no. We emphasized the significance of the

outcome of this section, and thus instructed participants to disregard the grammatical correctness or validity of the sentences they read and to proceed without hesitation with the picture-description.

Each target trial of the test phase began with a 500ms appearance of a cross mark. Following that, the prime sentence (sentences) appeared on the screen, followed by a 500ms blank. After the blank, the words required for description were presented for 4000ms; a target picture was then presented with required nouns, a verb, and the preamble. The yes-or-no recognition appeared 3000ms after participants completed their description. The next trial began after another 500ms blank. Filler trials used the same produce, but the images were only accompanied by nouns and verbs. Except for the slides that were exchanged automatically, the experimenter was in control of the experiment progress. Participants received 30 experiment trials and 60 filler trials during the test phase. Each target trial was separated by two filler trials (a ditransitive and an intransitive). The entire experiment lasted approximately one hour, and the test phase were recorded. Prior to the experiment, participants practiced ten trials.

5.6 Coding

Our purpose was to observe the sentence production of Chinese JFL learners. We considered four factors when coding participants' descriptions of target images.

First, there is the issue of voice or whether a sentence is active or passive. Chinese JFL learners, on the other hand, do not always produce completely correct sentences in the same way that native speakers do. Thus, we classified a sentence as active if the agent was marked with *-ga* and the verb was in active voice, regardless of whether the other case-marker was *-o* or not; sentences as passive if the patient was marked with *-ga* and the verb was in passive voice, regardless of whether the other case-marker was *-ni* or not; and sentences as passive if the patient was marked with *-ga* and the agent was marked with *-ni*, regardless of whether the verb was in passive voice or not. Second, the word order of a sentence, specifically whether it is canonical (SOV) or scrambled (OSV). Third, the sentence subject: the sentence subject was coded as agent-subject if the agent was assigned as subject, animate-subject if the animate patient was assigned as subject, and inanimate-subject if the inanimate patient was assigned as subject. Forth, the linear sequence of noun phrases: responses were coded as Animate-Inanimate if the animate noun preceded the inanimate noun within a sentence, and vice versa.

5.7 Results

We reported the results of this experiment in multiple ways. To begin, we divided participants into groups to assess whether there were differences in the learning of animacy processing between JFL learners of varying proficiency levels. The sentences produced by participants during the test phase were then analyzed. Specifically, we examined whether syntactic structures (including the syntactic form and the word order of sentences) and animacy processing (including the functional and positional assignment, respectively) are primed during their production.

5.7.1 Grouping

Participants were divided into two groups (High and Low) according to their proficiency with Japanese language. As previously stated, all participants achieved the JLPT N1 level. To further differentiate their proficiency, the grouping was based on three criteria.

First, the total score of N1 certification: though the average score is 124.89, the histogram revealed that the distribution of N1 scores between 100 and 120 is extremely concentrated, whereas the distribution above 120 is relatively scattered. Thus, we classified scores equal to or greater than 120 points as ‘high’ and those less than 120 as ‘low’. Second, even though the total score is the same, participants may perform differently in separate sections. For example, some participants may have better grammar and vocabulary knowledge, while others may have superior scores in reading and listening comprehension abilities. Hence, we further focused on the individual score for Language Knowledge section (60-point equals a full mark), which is more pertinent to our experiment: the average score is 40.71, and the histogram revealed a fairly uniform distribution within the left and right interval of the 40-point. Thus, we defined scores equal to or greater than 40 points as ‘high’, and those less than 40 points as ‘low’. Thirdly, we considered the percentage of verbs used in their dictionary form during picture-description. Given the possibility that participants with lower proficiency (particularly in speaking) may struggle with verb conjugation, we defined a person as having low proficiency if more than half of his target output contained verbs in dictionary form.

Taking the above three criteria into consideration, we divided those who met the definition of 'high' in two or more dimensions out of three dimensions into group High, and those who met the definition of 'low' in two or more dimensions into group Low. Finally, 14 participants were assigned to group High, with an average total score of 140 (SD = 19.84), an average Language Knowledge

section score of 48 (*SD* = 8.48), and an average proportion of using dictionary verb form of 20.05% (*SD* = 24.15). The remaining 14 participants were assigned to group Low, with an average total score of 109 (*SD* = 5.13), an average Language Knowledge section score of 33 (*SD* = 3.95), and an average proportion of 54.1% (*SD* = 33.17) in using dictionary verb form. Moreover, group High had significantly higher scores on both the N1 and Language Knowledge section (t (26) = 5.81, $p < .001$; t (26) = 6.34, $p < .001$, in order), and participants in group High performed significantly better than participants in group Low on the flexibly of verb conjugation (t (26) = -3.11, $p < .01$).

Participants were randomly assigned to one of the prime conditions. Finally, six members of group High and eight members of group Low received Animate-subject primes, and the remaining eight members of group High and six members of group Low received Animate-Inanimate primes.

5.7.2 Sentence production in Picture-description task

We first examined whether the production of Chinese JFL learner revealed a syntactic priming by analyzing their production of sentence voice and word order. Then, we examined how animacy processing is primed. Since the grammatical functions and linear sequence of noun phrases in Japanese are independent of each other, we can observe distinct animacy processing separately. Thus, we analyzed Chinese JFL learners' sentence production from the perspective of functional and positional assignment, respectively.

5.7.2.1 Syntactic priming of syntactic structures

Syntactic priming is considered to be a subset of structural priming that is primarily concerned with syntactic structure. While our primary objective is to observe the structural priming of animacy processing, it is also necessary to determine whether syntactic priming of surface structure occurs in the L2 production of Chinese JFL learners. To ascertain whether the production of L2 learners can be influenced by previously encountered syntactic structures, it is necessary to examine the syntactic priming of sentence voice and word order.

5.7.2.1.1 Priming of voice

We begin by observing the syntactic priming following baseline primes, which we refer to as baseline of prime numbers because each baseline-target pair contained only one prime sentence. We

used a three-way ANOVA with *Response type* (active vs. passive), *Group* (High vs Low) and *Prime type* (active vs. passive) as independent variables, and the proportion of active and passive responses as the dependent variable.

As a result, the main effect of *Response type* (F (1, 52) = 109.43, $p < .001$) was found to be significant, as well as the interaction between *Prime type* and *Response type* (F (1, 52) = 145.25, $p < .001$). There was no significant main effect of *Prime type* or *Group*, nor was there a significant interaction between *Prime type* and *Group* or between *Group* and *Response typ*. There was also no three-way interaction between the independent variables. The simple main effect test revealed a significant difference in each target response following the two different prime types: participants produced more active sentences following active primes (F (1, 54) = 73.37, $p < .001$) than after passive primes, also produced more passive sentences following passive primes (F (1, 54) = 73.37, $p < .001$) than after active primes. Additionally, there were significantly more active sentences than passive sentences following active primes (mostly actives and very few passives) (F (1, 54) = 1005.07, $p < .001$), but no significant difference in the production of active and passive sentences following passive primes (F (1, 54) = .57, *n.s.*), indicating that significantly more active responses were produced after active primes than passive responses produced after passive primes. There was no significant difference between group High and group Low.

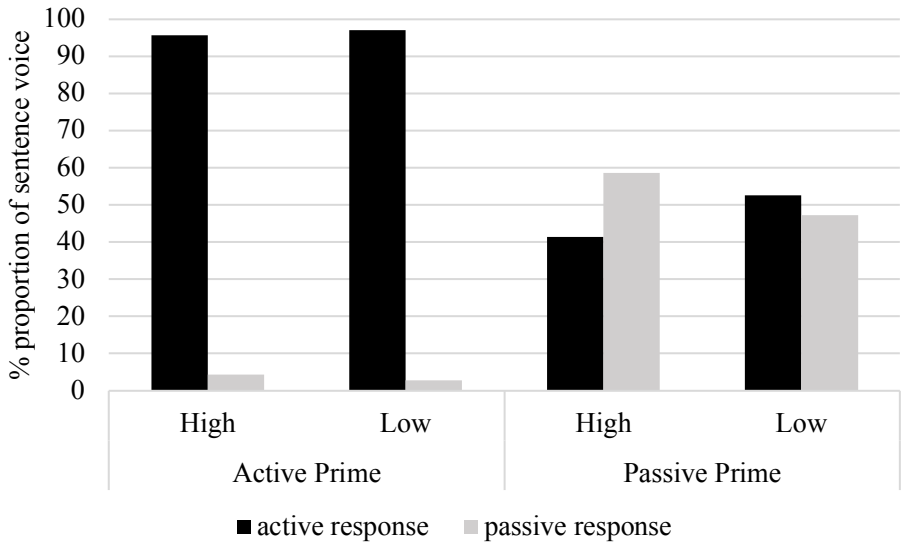

Figure 10. Proportions of active and passive sentences produced in baseline (%).

We next observe the syntactic priming following target primes, which contained three sentences in each prime-target pair. Notably, each triplet of prime sentences always contains two sentences with the same structure and one sentence with a different structure. Moreover, the final sentence in a triplet is sometimes not the repeated structure. Thus, we examined whether the target responses were related to the structure of the final sentence or related to the repeated structure in a triplet.

We used a three-way ANOVA with *Prime type* (active vs. passive), *Structure type* (structure of the final sentence vs. the repeated structure), and *Group* (High vs. Low) as independent variables (only *Group* as between-subject variable). The dependent variable was the proportion of target responses shared the same structure as prime sentences. The results indicated the main effect of *Prime type* (F (1, 26) = 95.44, $p < .001$) and *Structure type* (F (1, 26) = 14.53, $p < .01$), but no significant interaction between them, or the respective interaction with *Group*. There was no significant main effect of *Group*, nor was there any three-way interaction between the independent variables. The pairwise comparison showed that there were significantly more active responses following active primes than passive responses following passive primes. Additionally, regardless of whether the prime is active or passive there were significantly more target responses associated with the structure of the final sentence than with the repeated structure.

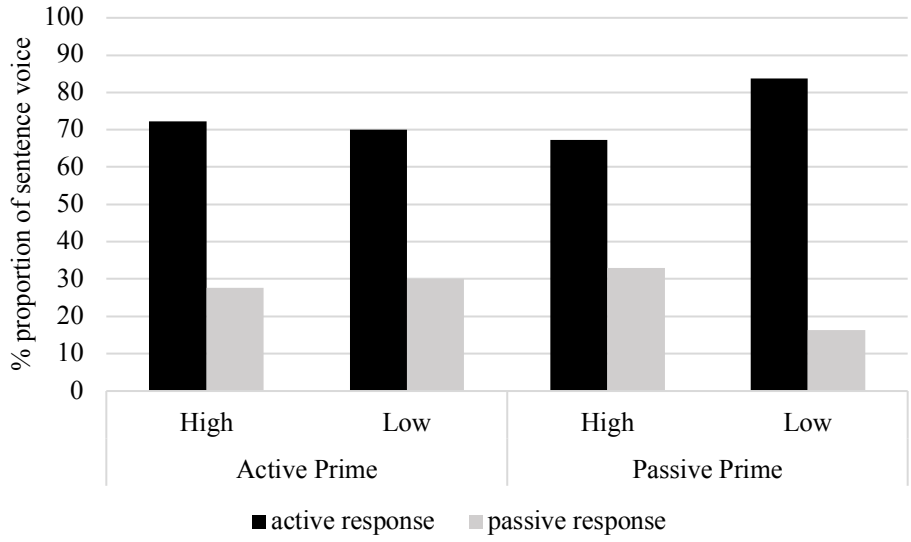

Figure 11. Proportions of active and passive sentences produced in target conditions (%).

The preceding results indicated that participants were more likely to reuse the structure of the previous sentence they read prior to beginning the picture description, rather than the most frequently repeated structure. Hence, we conducted a secondary analysis of voice priming by group, based on the target responses correlating with the previous prime sentence (see Figure 11). The analysis was conducted in the same manner as in baseline. The analysis revealed a single main effect of *Response type* (F (1, 52) = 152.74, $p < .001$), but no main effects of *Prime type* or *Group*, nor did it reveal any interactions between independent variables. A simple main effect test revealed a significant difference between active and passive responses following both active primes (F (1, 54) = 24.95, $p < .001$) and passive primes (F (1, 54) = 52.75, $p < .001$), indicating that more active sentences were produced than passive sentences irrespective of the prime type. The absence of an effect of *Prime type* also indicated that the production of each response did not differ significantly between active and passive primes, and that participants preferred active sentences even when they had previously encountered passive sentences. There was no significant difference between the High and Low groups.

5.7.2.1.2 Priming of word order

Following that, we examined the production of word order. Notably, all baseline primes are in canonical SOV order, whereas each triplet of prime-target pairs always contains two or three primes in scrambled OSV order. More importantly, the final sentence in each triplet is always a scrambled sentence. Thus, we defined the baseline and target primes as the SOV and OSV primes respectively.

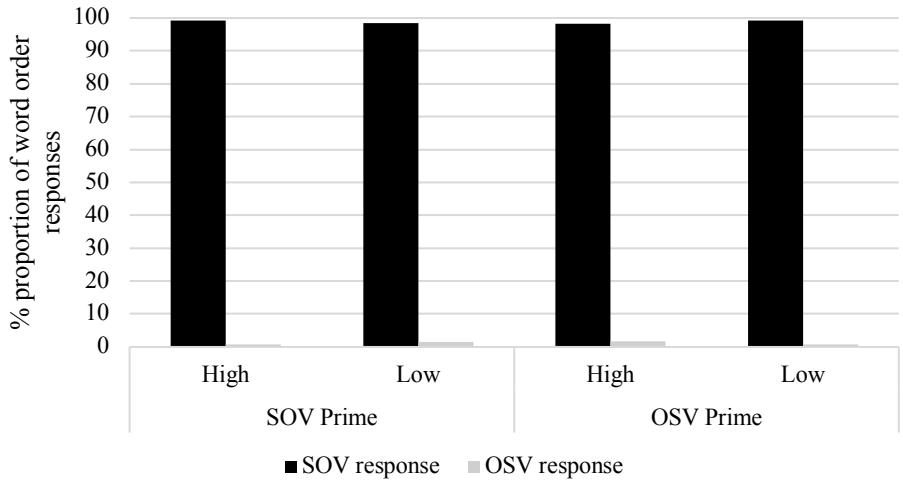

Figure 12. Proportions of SOV and OSV sentences produced in different word order conditions (%).

To examine the syntactic priming of word order, we conducted a two-way ANOVA with *Prime type* (SOV vs. OSV) and *Group* (High vs. Low) as independent variables, and the proportion of target responses matching SOV and OSV order as the dependent variable. The results indicated a significant main effect of *Prime type* (F (1, 26) = 6147.41, $p < .001$), and a simple main effect test revealed the effect of *Prime type* at both *Group* levels: significantly more SOV responses observed in group High (F (1, 26) = 3064.26, $p < .001$), as well as in group Low (F (1, 26) = 3083.17, $p < .001$). The main effect of *Group* was not significant.

Overall, canonical sentences were produced significantly more frequently following SOV primes than scrambled sentences following OSV primes, irrespective of proficiency. As illustrated in Figure 12, there were only a few OSV responses following OSV primes. This finding indicated that Chinese JFL learners have a strong preference for canonical order in their production, even when they have previously encountered a series of sentences with a scrambled order.

5.7.2.2 Structural priming of animacy processing

Apart from syntactic priming at the sentence-level, we also observed the structural priming of animacy processing. Since the grammatical encoding process involved both functional processing (which corresponds to the assignment of grammatical function) and positional processing (which corresponds to the determination of constituent sequence), it is necessary to conduct the observation from two perspectives: the selection of sentence subject and the linear sequence.

5.7.2.2.1 Priming of animate subject

Due to the fact that baseline prime sentences contained an inanimate subject and an inanimate-animate sequence, they are regarded as the baseline for processing animate nouns. Therefore, we began by examining the production of animate subjects under baseline, which reflects the natural selection of sentence subjects.

We conducted a three-way ANOVA with *Event type* (animate agent vs. inanimate agent), *Response type* (animate subject vs. inanimate subject) and *Group* (High vs. Low) as independent variables, and proportion of the two types of responses as dependent variable. The analysis revealed a significant main effect of *Response type* (F (1, 52) = 145.25, $p < .001$), as well as an interaction of

Event type and *Response type* (F (1, 52) = 109.43, $p < .001$); however, there was no significant main effect of *Event type* or *Group*, nor an interaction between *Event type* and *Group* or between *Group* and *Response type*, or the three-way interaction of the independent variables. Through a simple main effect test, it was found that there was significant difference in each target response between event types: participants produced more animate subjects in animate agent events (F (1, 54) = 54.37, $p < .001$) than in inanimate agent events, and also produced more inanimate subjects in inanimate agent events (F (1, 54) = 54.37, $p < .001$) than in their counterparts. In addition, there was significant difference in the responses of animate and inanimate subjects in animate agent events: participants produced primarily animate subjects and very few inanimate subjects in animate agent events (F (1, 54) = 1005.07, $p < .001$); however, there was no significant difference in the production of animate subjects and inanimate subjects in inanimate agent events (F (1, 54) = .57, *n.s.*). There was no significant difference between group High and Low.

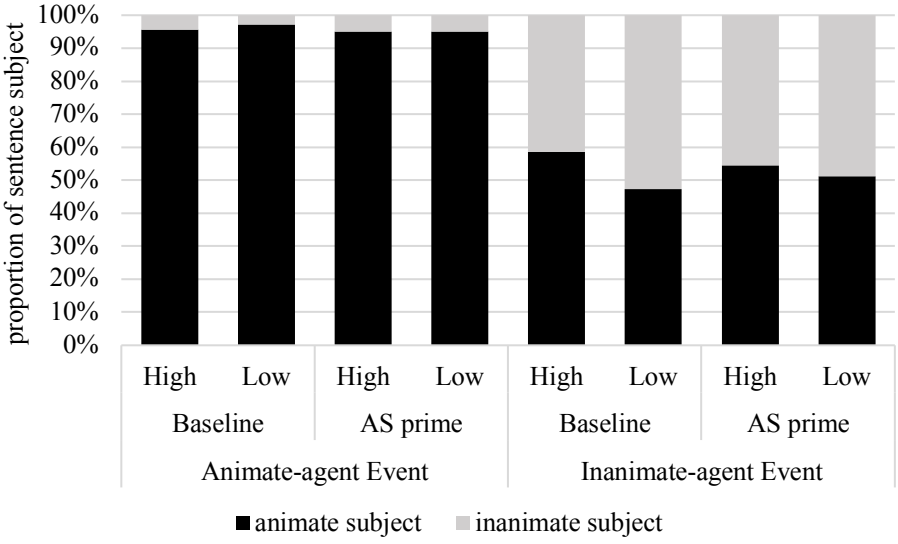

Figure 13. Proportions (%) of animate and inanimate subjects by *Prime type* (Baseline vs. Animate-subject prime) and *Group* (High vs. Low).

The following section discusses the production of animate subjects following target primes. Since only a subset of the participants received Animate-subject primes, we compared their production of animate subjects following baseline primes and that following Animate-subject primes. A three-way ANOVA was performed with *Event type* (animate agent vs. inanimate agent), *Frequency* (0 prime

vs. 3 primes) and *Group* (High vs. Low) as independent variables, and the proportion of animate subjects as dependent variable. The results indicated only a main effect of *Event type* (F (1, 12) = 30.00, $p < .001$), with no other main effects or interactions of independent variables. Pairwise comparison revealed that there were significantly more animate subjects produced in animate agent events than in inanimate agent events, regardless of the proficiency of participants or the frequency of primes. Prime sentences did not appear to facilitate the production of animate subjects, particularly in inanimate agent events, as there was no difference in production following baseline and Animate-subject primes. Additionally, the choice of sentence subject appeared to unaffected by participants' proficiency, as there was no significant difference between groups.

5.7.2.2.2 Priming of animate-inanimate sequence

As shown in the observation on word order, participants (regardless of proficiency) tended to produced sentences mainly in SOV order with only a few in OSV order, resulting in a fact that the linear sequence of noun phrases is strongly associated with the voice and word order of target production. Even so, subtle differences remained, and it is necessary to analyze the priming of linear sequence separately.

Similarly, we began by examining the production of linear sequences in baseline. We conducted a three-way ANOVA with *Event type* (animate agent vs. inanimate agent), *Response type* (animate-inanimate vs. inanimate-animate) and *Group* (High vs. Low) as independent variables, and proportion of the two responses as dependent variable. The analysis revealed a main effect of *Response type* (F (1, 52) = 126.40, $p < .001$) and an interaction between *Event type* and *Response type* (F (1, 52) = 112.82, $p < .001$); there was no significant main effect of *Event type* or *Group*, nor an interaction between *Event type* and *Group* or between *Group* and *Response type*, or the three-way interaction of the independent variables. The simple main effect test revealed a significant difference in each target response between different events: participants produced more animate-inanimate responses in animate agent events (F (1, 54) = 54.63, $p < .001$) than in inanimate agent events, and more inanimate-animate responses in inanimate agent events (F (1, 54) = 54.63, $p < .001$) than in animate agent events. In addition, there was a significant difference between animate-inanimate and inanimate-animate responses in animate agent events: participants primarily produced animate-inanimate responses and very few inanimate-animate responses in animate agent events (F (1, 54) = 906.49, $p < .001$); however,

there was no significant difference in the production of animate-inanimate and inanimate-animate responses in inanimate agent events (F (1, 54) = .27, *n.s.*). There was no significant difference between groups.

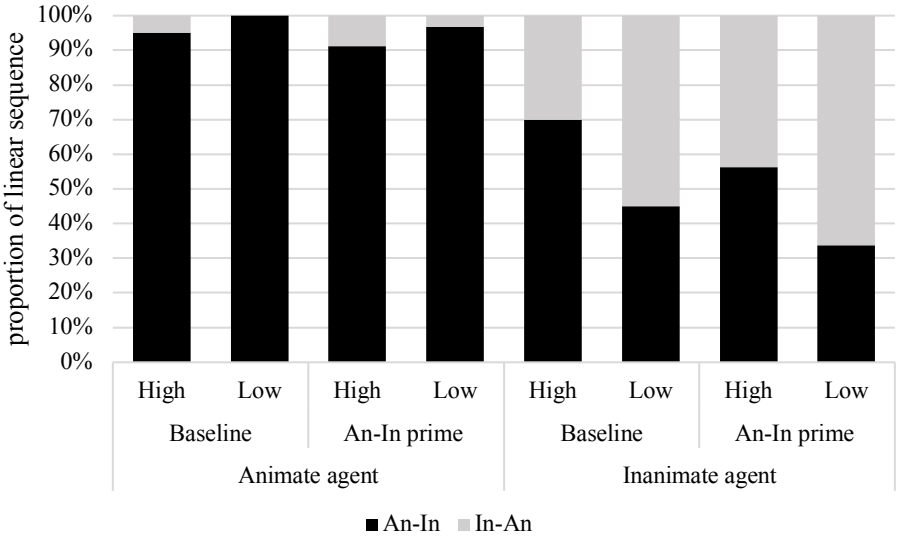

Figure 14. Proportions (%) of linear sequences (An = animate, In = inanimate) by *Prime type* (Baseline vs. Animate-Inanimate prime) and *Group* (High vs. Low).

We also analyzed and compared the production of animate-inanimate sequences for participants who received the animate-inanimate primes to their production in baseline. A similar three-way ANOVA was conducted with *Event type* (animate agent vs. inanimate agent), *Frequency* (0 prime vs. 3 primes) and *Group* (High vs. Low) as independent variables, and the percentage of animate-inanimate sequence s as dependent variable. The results showed a main effect of *Event type* (F (1, 12) = 63.47, $p < .001$) and a main effect of *Frequency* (F (1, 12) = 10.32, $p < .01$), but not the main effect of *Group*. The interaction between *Group* and *Event type* (F (1, 12) = 6.70, $p < .05$) was also found significant, but not the interaction between *Group* and *Frequency* or *Event type* and *Frequency*, nor the three-way interaction between the independent variables. Pairwise comparisons revealed that significantly more animate-inanimate sequences were produced in animate agent events than inanimate agent events, irrespective of participants' proficiency or the frequency of primes. There was no difference in animate-inanimate responses following baseline primes and following Animate-Inanimate primes in animate agent events, nor was there a difference between groups. However, there

were significantly more animate-inanimate responses following baseline primes than following Animate-Inanimate primes in inanimate agent events.

Since we discovered an interaction between *Group* and *Event type*, and confirmed that there was no difference in animate-inanimate responses between groups in animate agent events, we conducted an additional two-way ANOVA on proportion of target responses in inanimate agent events with *Frequency* and *Group* as independent variables. The results were consistent with the three-way ANOVA, with the main effect of *Frequency* being significant (F (1, 12) = 5.86, $p < .05$), and the main effect of *Group* being marginally significant (F (1, 12) = 4.32, $p = .06$): the simple main effect test revealed that there were marginally more animate-inanimate responses following baseline primes than following Animate-Inanimate primes in group High (F (1, 12) = 4.17, $p = .06$), but no difference in group Low (F (1, 12) = 2.05, *n.s.*). Additionally, there was no significant difference in animate-inanimate responses between the two groups following baseline primes (F (1, 12) = 2.99, *n.s.*), whereas following Animate-Inanimate primes, group High produced significantly more animate-inanimate responses than group Low (F (1, 12) = 4.81, $p < .05$).

5.7.2.2.3 Comparing the priming of different animacy processing

Furthermore, we considered the sensitivity of Chinese JFL learners to different animacy processing: in other words, whether there is a difference between the structural priming effect of the two animacy processing. Thus, it is necessary to compare the production of target responses corresponding to the two prime conditions. However, since the difference in production for animate agent events was highly limited, we focused on the production in inanimate agent events.

To determine whether there is a difference in the results of Animate-subject and Animate-Inanimate priming, for example, we compared the animate-subject responses of participants who received either Animate-subject or Animate-Inanimate priming. If participants exposed to different primes produced the same number of animate-subject responses (more precisely, with no statistically significant difference), then Animate-subject priming could be considered to have no effect. The same holds true for animate-inanimate responses.

We conducted a three-way ANOVA with *Prime type* (animate subject vs. animate-inanimate sequence), *Experience* (without prime vs. with prime), and *Group* (High vs. Low) as independent variables, and the proportion of target responses corresponding to the two prime types as the dependent

variable. The analysis revealed no significant main effects for *Group* (F (1, 48) = 3.54, *n.s.*), *Prime type* (F (1, 48) = .03, *n.s.*), or *Experience* (F (1, 48) = .03, *n.s.*); the two-way and three-way interactions between the three independent variables were also not significant. These results indicated that there was no difference in the priming of animate-subjects and animate-inanimate sequences, and that neither animacy processing appeared to have a priming effect.

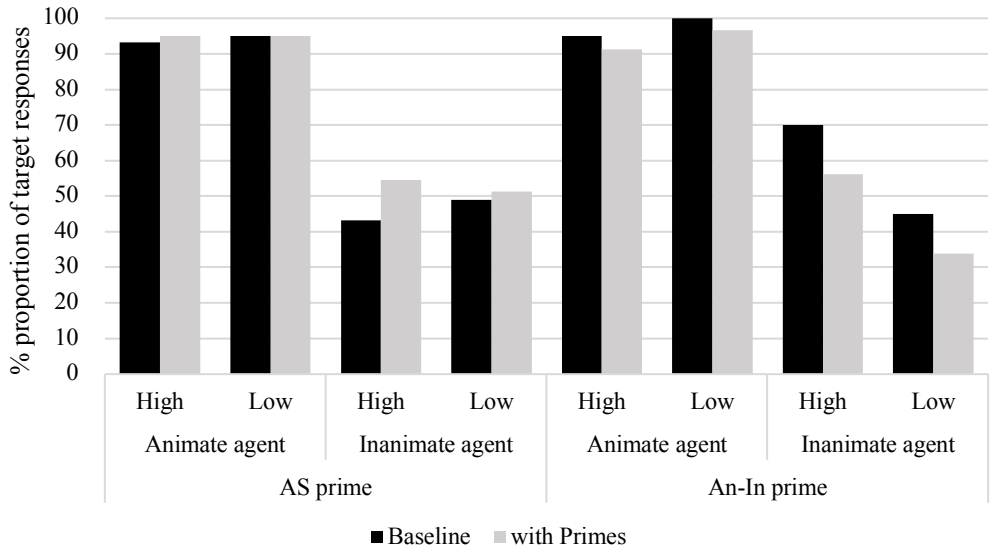

Figure 15. Proportions (%) of target responses produced without and with prime by *Prime type* (Animate-subject vs. Animate-Inanimate), *Event type*, and *Group*.

5.8 Discussion

5.8.1 Syntactic priming of sentence voice and word order

First of all, we discuss syntactic priming in the production of Chinese JFL learners. Concerning the priming of sentence voice, we discovered that it had an effect on both active and passive sentences, with the effect of active structures being greater than the effect of passive structures. This could be related to the frequency of syntactic structure: Chinese JFL learners favored active structures, as evidenced by the high proportion of active sentences, which reflects the higher frequency of active structure in the production of native Chinese speakers. Moreover, they produced active responses that statistically equivalent to passive responses, even when passive primes were encountered. Passive structures require verb conjugation in Japanese, which is relatively difficult for speakers whose first language is an isolated language with no changes in verb form. As a result of this property of Japanese

language, passive usage is less frequent in the production of JFL learners. Despite this, the existence of the priming effect of passive structures demonstrated that syntactic priming could facilitate the use of passives in situations where actives are strongly preferred. Hwang and Shin (2019) revealed a stronger cumulative priming effect for less frequent structures (passive and DO structures) both between Chinese and English and within Chinese. Unlike in the previous study, there was no inverse frequency effect for Chinese JFL learners, implying a higher frequency may be required to achieve a greater priming effect for less familiar structures.

In addition, based on the difference in voice priming between baseline and target primes, it was hypothesized that animacy effect interfered with syntactic priming: the priming effect on passive responses vanished following target primes. To emphasize, due to our experimental design, baseline active primes always correspond to animate agent events description, whereas baseline passive primes always correspond to inanimate agent events description; however, when target primes are present, both active and passive primes correspond to the description both types of events. Thus, animacy information of event agents influenced structural choice: participants produced more active sentences and few passives in animate agent events, despite prior exposure to passive primes. We further conducted two-way ANOVA with *Event type* (animate agent vs. inanimate agent) and *Response type* (active vs. passive) as independent variables and the proportion of active and passive responses as the dependent variable, respectively for group High and Low. The results revealed a main effect of *Response type* (F (1, 26) = 59.48, $p < .001$; F (1, 26) = 112.85, $p < .001$, in order), and the interaction between *Response type* and *Event type* (both $p < .001$) in both groups: there were significantly more active responses produced in animate agent events than passive responses, whereas there was no difference between the proportion of active and passive responses in inanimate agent events.

Interestingly, participants appeared to reuse the structure of the most recently encountered sentence, i.e., the final sentence in a triplet of primes, rather than the structure that appeared twice in a triplet of primes. This may due to the way sentences are distributed within each triplet. Because our primary objective was to observe the priming of animacy processing, we designed the triplets to avoid the impact of entirely identical structures: for example, if all three sentences contained OSV active structure, it would be difficult to discern whether the impact of syntactic structure or animacy processing occurred in the priming effect. As a consequence, each triplet contains one sentence with a structure that is distinct from the other two sentences. In contrast to previous research, which

demonstrated the immediate effect of cumulativity by presenting the same structure in series, the primes preceding each picture-description in the present experiment varied in syntactic structure, which may result in the activation of multiple structures and create confusion regarding the reference structure for subsequent production. Finally, participants frequently referred to the most recent prime encountered immediately prior to their production.

What's interesting is that word order priming had a negligible effect: Chinese JFL learners almost always produced sentences with canonical SOV order, irrespective of whether they encountered multiple primes with scrambled OSV order prior to the production. As in experiment 1 and 2, the strong preference for canonical order in Japanese sentence production by Chinese JFL learners was confirmed once more: syntactic priming had little effect on the production of scrambled order. The result of word order priming on Chinese JFL learners were inconsistent with those of Japanese native speakers: Tanaka et al. (2009) and Deng et al. (2012) both found a priming effect of scrambled order, and native Japanese speakers produced more OSV sentences following scrambled order primes. Such a difference could result from the effect of L1. Mandarin Chinese is an SVO language with a highly restricted word order. As an outcome, Chinese speakers appear to have a low level of familiarity with OSV word order. Additionally, the burden of information processing is relatively high in real-time oral production of L2, which leads to a strong tendency for Chinese JFL learners to begin utterances with the subject, even in simple sentences. This result also confirmed that the less familiar structure has a weaker priming effect, in contrast to the inverse frequency effect. Thus, in order to determine whether the use of scrambled order can be improved for Chinese JFL learners, it is necessary to establish conditions that elicit the production of scrambled order in future research, also to find out whether increasing the priming frequency contributes to such learning.

5.8.2 Structural priming of animacy processing

In baseline, there was a tendency to preferentially assign the event agent as sentence subject. However, it is discovered that this preference is influenced by animacy: when the animate noun served as agent, participants almost always assigned it as sentence subject; even when the animate noun did not serve as the agent, participants produced animate subjects statistically equal to inanimate subjects (agent subjects). If participants preferred agent subjects over animate subjects in inanimate agent events, they should have produced significantly more agent subjects than animate subjects. Thus, we

hypothesized that, while though Chinese JFL learners preferentially assign the agent as subjects, the animacy information appeared to exert an effect concurrently and could influence the final determination of sentence subject. A similar pattern was observed following exposure to animate subject primes. Notably, no priming effect of animate subject was observed, as there was no significant increase in the number of animate subjects exposed to inanimate agent events compared to that in baseline. Similar results were obtained when an animate-inanimate sequence was primed. Indeed, the proportion of animate-inanimate sequences produced in baseline was numerically comparable to the proportion of animate subjects; thus, the production of animate-inanimate sequences reflected the influence of animacy on subject determination as well. After target primes, production of animate-inanimate sequences remained unchanged and even decreased, indicating that there was no priming effect of animate-inanimate sequence either.

Furthermore, the non-significant difference in priming between the two types of animacy processing may reflect the fact that linear sequence is heavily involved in the determination of sentence subject in the production of Chinese speakers. The proportion of sentences with OSV order, which can independently inflect the priming of animate-inanimate sequences, was found to be rare in their Japanese sentence production. Thus, it is reasonable to regard the production of animate-inanimate sequences as a byproduct of the production of animate subjects.

We next considered the distinction between groups in terms of the production of animate-inanimate sequences following target primes. As previously stated, the animate-inanimate sequences reflect the choice of animate subjects. Though not statistically significant, the difference in target responses following Animate-subject primes and Animate-Inanimate primes is small for participants in group High (54.6% vs. 56.2%), but numerically greater for participants in group Low (51.3% vs. 33.8%). That is, it is possible that encountering animate subject primes facilitated the determination of animate subject, particularly for participants in group Low. Notably, the proportion of animate-inanimate sequences produced by group High in response to target primes was significantly greater than that produced by group Low. However, this difference cannot be attributed to structural priming, as the production is marginally less than that of baseline.

The purpose of this study was to examine the mapping between conceptual and syntactic information. However, we observed no such mapping in Chinese JFL learners' structural priming. Thematic roles and conceptual properties such as animacy are frequently used to perform message-

syntax binding. Previous research examined the conceptual-to-function or conceptual-to-linear mappings associated with thematic roles, whereas we attempted to isolate conceptual information such as animacy from semantic information such as thematic roles. Thus, in experiment3, the thematic roles of animate and inanimate nouns remained distinct between each pair of prime sentence and target event. This manipulation may obstruct the mapping between conceptual and syntactic representations. In addition, to eliminate the effect of lexical repetition, we varied the words used in our stimuli, which could divert participants' attention away from the inherent conceptual information. Thus, it is necessary to maintain control over the lexical variety of experimental stimuli in future research.

6. GENERAL DISCUSSION

6.1 Review on Animacy Effect in Japanese Sentence Production

We begin by reviewing the animacy effect in the production of Japanese sentences by both native speakers and Chinese JFL learners, combining the results of experiment 1-3. We found the animacy effect in the production of native Japanese speakers when it came to transitive sentences: they tended to recall sentences in canonical order with animate nouns being preferentially assigned as sentence subjects. However, the animacy effect did not appear to affect their decision of linear sequences in the case of NP conjunction structures. In the production of Chinese JFL learners, the animacy effect was found to be different between participants with advanced and inferior comprehension abilities: participants with advanced comprehension abilities demonstrated no preference for animate subjects or animate-preceding sequences, whereas participants with lower comprehension abilities demonstrated a tendency to assign animate nouns as sentence subjects. We attributed this difference to the possibility that comprehension ability had an effect on the strategy used to complete the sentence-recall task. However, this between-group difference vanished in the picture-description task, where both groups illustrated a proclivity to assign animate nouns as sentence subjects. Overall, three experiments confirmed the preference for active sentences and a strong preference for canonical word order (SOV), as well as the animacy effect on functional assignment. When it came to NP conjunction sentences, there was a clear preference for producing animate nouns first.

As previously stated, the majority of research on Chinese sentence production and comprehension has concentrated on the relative clauses (Kwon et al., 2019; Hsiao & McDonald, 2016, etc.). Nonetheless, these studies were believed to be capable of demonstrating the animacy effect on function assignment: native Chinese speakers tend to assign an animate noun as the sentence subject and an inanimate noun as the object when an animacy contrast exists. Likewise, the preference of native Chinese speakers for NP-conjunction with the animate noun preceding the inanimate noun (Yan & Dong, 2011), as well as their preference for subject assignment (Do & Kaiser, 2019), were demonstrated in their sentence production. However, evidence for an animacy effect on grammatical encoding was rarely observed in simple sentences containing transitive verbs. Our experiments

confirmed the animacy effect in the production of simple transitive sentences, though it was not as strong as it is for native Japanese speakers.

Though there was scant direct evidence of an animacy effect on production, there have been conflicting reports of animacy effect on Chinese sentence comprehension. Su (2001) asked participants to choose the agent (the entity who performed the action) from a sequence of two nouns followed by a verb phrase. Chinese monolingual speakers demonstrated a particular fondness for the animacy cue over the word order cue during the selection; additionally, they preferred the animacy cue over the word order cue when reading various sequences (e.g., the first noun was selected 98% of the time in AI item with canonical NVN order, which is significantly higher than the rate in IA item). Cai and Dong (2007) investigated the comprehension of a word sequence that contained nonsense verbs. In comparison to native English speakers, they discovered that native Chinese speakers made more use of animacy as a cue than word order. Furthermore, native Chinese speakers tended to prioritize the animacy cue over word order when determining thematic roles (Li, Bates, & MacWhinney, 1993). In determining the topic-worthiness, it was found that animacy outweighs givenness (Hung & Schumacher, 2014). However, Chen, Chen, and He (2012) found that when Chinese native speakers made given/new interpretation, they tended to rely on word order cues rather than animacy cues, implying a hierarchy of cue strength in Chinese, with word order surpassing animacy.

No effect of animacy was observed in the first position on comprehension of active and passive sentences, but an N400 effect (generally considered to reflect semantic processing) was observed in the second position when an inanimate argument bearing the actor role was used (Philipp et al., 2008). These findings implicitly reflected a preference for canonical order and a lack of sensitivity to the animacy information of the first noun, as Chinese native speakers may normally regard the first noun as subject in prior, irrespective of its animacy feature. On the contrary, Hung and Schumacher (2014) observed that animacy imposed processing demands only on the sentence-initial position but not elsewhere, implying that a sentence-initial animate entity was more easily integrated, regardless of its givenness. Similarly, an eye-tracking experiment conducted by Li, Zhao, Zheng, and Yang (2015) unearthed that the first-fixation time for inanimate nouns was longer than that for animate nouns in the sentence-initial position. They interpreted this animacy effect at the initial argument as a result of salience or conceptual accessibility, as inanimate nouns are less accessible and retrievable. While they

did not consider the possibility of processors indicating the initial argument as an actor, it is doubtful that conceptual accessibility has an effect on sentence comprehension. We hypothesize that this animacy effect was attributed to an innate preference for animate subjects.

As with sentence comprehension, the animacy effect in sentence production remained ambiguous. Through a structural priming paradigm, Huang et al. (2016) found that priming occurred regardless of whether semantic features (animacy) were repeated across the prime and target sentences. However, they only manipulated the animacy of recipient arguments in ditransitive sentences, which may obscure the animacy effect. Verhoeven (2014), on the other hand, posited an animate-first effect in the oral construction that applied to all languages including Chinese, German, Greek and Turkish. This suggested that animacy information may have an effect on the word order choice in experiencer-object verb structures, which is not unique to NP conjunction structures.

We found that animacy information had a limited effect on both the production by Chinese JFL learners in sentence-recall and picture-description task. Notably, in the picture-description task (experiment 3), where more natural utterances were permitted, the animacy effect became stronger on functional assignment: participants produced animate subjects statistically equivalent to inanimate subjects in inanimate agent events. This result, however, can also be explained by an agent-subject bias: participants assigned the agents as sentence subjects preferentially despite their inanimate nature. If the influence of animacy overweighs that of agent, there should have been more animate subjects in inanimate agent events, whereas if the influence of agent overweighs that of animacy, there should have been more inanimate subjects. Accordingly, we argue that while Chinese speakers are sensitive to animacy information, such effect does not outweigh their preference for agents, as the priority of agent role has been previously demonstrated: for example, Ferreira (1994) found that speakers are more likely to assign the more prominent thematic roles (agent, experiencer) to the subject position, and Hwang (2017) further demonstrated that speakers prefer to place agent arguments in higher functional and linear positions.

While our finding of animacy effect corroborates the findings of several psycholinguistic studies, it contradicts the prediction of Zhang (2001) that Chinese contains not a referential hierarchy. We believe it is a function of the production environment. While we may be able to eliminate some redundant influences in an experimental setting, the real-world speech environment is much more complex. Whereas it may appear that treating inanimate nouns as subjects contradicts their inherent

animacy processing, this error could be due to a variety of factors such as context, purpose, or demand for utterances, and cannot be attributed to the absence of an animacy effect in their language processing. Likewise, the animacy effect observed in experiments is unlikely to be universally consistent across languages and constructions (Verhoeven, 2014). Further studies are required to examine the animacy effect in different constructions and contexts, as well as in different production modalities.

6.2 The Sentence Production Mechanism of Chinese JFL Learners

In addition, we sought to summarize the process by which Chinese JFL learners produce Japanese sentences, with an emphasis on the animacy effect on grammatical encoding processing. We began by considering the accounts suggested by previous research. Two stages are generally assumed to occur during the grammatical encoding process (as discussed in literature review): functional processing, which is concerned with grammatical function, and positional processing, which is concerned with determining constituent sequence. Numerous accounts have been advanced by various studies of different languages, focusing on the relative importance of two stages of grammatical encoding processing and their relationship. Cai et al. (2012) proposed a one-stage model in which speakers employ conceptual information to concurrently construct functional and constituent-structure representations, implying parallel functional and positional processing. Cai et al. (2012) made this claim by observing the priming on grammatical function and linear sequence of noun phrases that shared the same thematic roles in ditransitive sentences. However, since we failed to properly observe structural priming of nouns phrases containing the same conceptual information, we are unable to discuss the grammatical encoding process in terms of the occurrence of priming effect.

Conversely, the two-stage model denotes the separate manipulation of functional processing and positional processing. As previously stated, the interpretation of two-stage model varied by language in terms of the influence of conceptual accessibility. According to Bock and Warren (1985), conceptual accessibility has a direct effect on functional assignment but has an indirect effect on positional processing. For instance, when an English sentence is generated, the animacy information should have a direct impact on the functional assignment, and an animate noun is thus assumed to be assigned a grammatical function earlier than an inanimate noun. In contrast, in languages with a relatively free word order, such as Japanese, conceptual accessibility is assumed to have a direct effect on both functional and positional processing: animate entities are more likely than inanimate entities

to appear in sentence-initial positions (regardless of their grammatical functions) and are also more likely to be assigned as sentence subjects irrespective of their linear position (Branigan, Pickering, & Tanaka, 2008; Tanaka et al., 2011). Despite this, these studies are compatible in terms of the incrementality of grammatical encoding, in which the processor maps concepts to grammatical functions prior to mapping them to specific word orders: since conceptual information, grammatical functions, and word order all have varying degrees of accessibility during language production, conceptual accessibility directly affects the order in which concepts become available for assignment to grammatical functions. This impact is associated with subjecthood, as subject functions are typically assigned first; the concept assigned first with grammatical function typically undergoes positional processing first, and is associated with the earliest word order position, as early positions are typically activated first. Deng et al. (2012) also provided a support for two-stage model with two distinct stages within the grammatical encoding process via the structural priming method, which corroborated Tanaka et al. (2011)' account but excluding the influence of conceptual accessibility.

Chinese and Japanese are typologically distinct languages. Cai et al. (2012) demonstrated that during the language process of native Chinese speakers, the processor converts a conceptual representation containing thematic role information into a single syntactic representation that incorporates both linear order and grammatical functions. They contended that the findings are consistent with an account in which speakers construct functional and constituent-structure representations in parallel. This appears reasonable, given that function assignment in Chinese is highly constrained by constituent sequence. However, observing Japanese sentence production permits us to distinguish between functional and positional processing, as participants could choose a constituent sequence independent of the grammatical function.

The findings of the current study indicate that animacy and thematic role have an independent effect, particularly in experiment 3. The combination of animacy effect and agent preference boosted the production of active sentences with an animate subject; however, in inanimate agent events, participants appeared to prefer both an animate-patient subject and an inanimate-agent subject equally. What's more, both animacy and thematic roles emerged to be highly correlated with functional assignment, owing to the extremely low production of scrambled OSV sentences. We cannot tell with certainty whether Chinese JFL learners are unable or unwilling to use scrambled order. We have emphasized that they are allowed to use a flexible word order, and it is difficult to believe they were

unaware. Additionally, based on the performance in the sentence-recall task, where participants achieved N1 levels and scored similarly to participants in experiment 3, Chinese JFL learners appeared to be capable of producing sentences in a scrambled order, albeit in a small proportion compared to SOV responses. Thus, rather than assuming that participants are incapable of using scrambled order, it is more reasonable to assume that, despite having the option of producing canonical orders, they did so instinctively. This implied a high accessibility of SOV order and a low accessibility (or familiarity) of OSV order, as well as a lower processing load when speaking in SOV order. It is also possible that participants say a word first and then consider its grammatical function. We take issue with this possibility for several reasons. First, there is no time limit for description in experiment 3, which means that participants have sufficient time to construct a corresponding representation (at least a part) prior to beginning the utterance. Additionally, participants silently checked all required words prior to the images; during this time period (4000ms), they may have made a prediction about the upcoming event. And participants essentially speak out a noun phrase along with its case-marker, particularly they occasionally make mistakes in the second argument, resulting in mismatched case-marking between the two arguments or with the verb form.

In addition, there was a general preference for active structure: even when participants were primed with passive structures, they produced comparable active sentences in inanimate agent events. This provided evidence for a more accessible active structure. Hence, we continue to believe that animacy and thematic roles have a direct correlation with functional assignment, rather than positional assignment. Given the general preference for active sentences, they should have produced active sentences with non-subject animate nouns first in inanimate agent events if animacy interfered directly with constituent sequence construction and positional processing is performed first.

Thus, we hypothesis that findings of the present study support a two-stage model for the grammatical encoding process in Japanese sentence production by Chinese JFL learners. To begin, when speakers hear a sentence/see an image, they construct a conceptual representation containing the semantic relations between the concepts involved in the event; however, it is difficult to specify the accessibility of conceptual information since speakers in our experiments did not plan a message on themselves. Grammatical encoding then begins to embody this conceptual representation: the processor maps concepts to grammatical functions, and animacy information or thematic information that affects conceptual accessibility, as well as the accessibility of grammatical functions, exerts an

influence during this functional processing, resulting in an animate concept or an agent assigned with subject function (or nominative case in case-languages). The processor then converts these case-marked concepts to a surface structure specified by a constituent sequence: within a sentence, each position has its own accessibility, with the sentence-initial position being the most accessible; concepts assigned to a more accessible function (subject or nominative) are thus combined with the sentence-initial position preferentially, resulting in an SOV order. Notably, there appears to be a priority of functional processing over positional processing, as well as a direct relationship between conceptual accessibility and functional processing: whereas a direct animacy effect on linear sequence was not confirmed in transitive construction, it was confirmed in NP conjunction structures, where the burden of grammatical processing on concepts is largely reduced. Given the close connection between functional and positional assignment revealed in the production of Chinese JFL learners, for future research, it is important to isolate positional processing to further confirm the animacy effect on the constituent structure assembly.

This assumption is similar to that made in native Japanese speakers (Tanaka et al., 2011), except that it excludes the effect of conceptual accessibility on positional processing; this assumption contrasts with Deng et al. (2012) in terms of the independence between functional and positional processing, as the positional processing appeared to be highly correlated with the outcome of functional processing in Chinese JFL learners' production. Regarding the information that represents conceptual accessibility, our findings indicated that the influence of animacy information reflected a general referential hierarchy similar to that found in other languages, namely that animate nouns are more accessible than inanimate nouns. However, we did not demonstrate that animacy effect outperforms other aspects during the sentence production process.

Apart from discussing the processing mechanism at different levels of sentence production, we could also evaluate how speakers select structural alternatives. Ferreira (1996) discussed two possible mechanisms by which the grammatical encoding system could choose between syntactic alternatives. First, the Competitive Model asserts that alternative syntactic plans actively compete for control of the generated syntactic structure, and that syntactic flexibility should result in more difficult language production. Second, the Incremental Model proposes that the language production system may exploit the sequential nature of language production to resolve structural choices, and thus syntactic flexibility and lexical accessibility interact to determine the form of utterances. Ferreira (1996) found that native

English speakers produced sentences more easily when given syntactic flexibility, implying that flexibility does not complicate language production and thus supporting the incremental model. However, Hwang and Kaiser (2014) revealed that native Korean speakers produced utterances more slowly under the flexible condition, indicating that, unlike in English, the competitive model exists in Korean. Hwang and Kaiser (2014) suggested that this distinction between English and Korean could be a consequence of typological language properties. They argued that in English, word order is relatively fixed and grammatical functions are defined in terms of word order, whereas in Korean, grammatical functions are indicated by case-markers and word order is relative loose. Thus, syntactic flexibility enables the assignment of more accessible words to specific grammatical functions and sentence positions earlier in the sentence, while in Korean, a more accessible word must be assigned to the appropriate grammatical function and word order, resulting a greater burden.

Though Japanese language is typologically similar to Korean, the competitive model does not appear to be compatible with the production of Chinese JFL learners in the present study: first, participants produced sentences with almost canonical SOV order, indicating a close correlation between the assignment of grammatical functions and the determination of word order; second, the priming effect of passives disappeared when the influence of event type was activated: participants produced more actives in animate agent events even when primed with passive sentences. Further research is necessary to confirm whether the structural choice is competitive or not in the absence of animacy effect. Moreover, it appeared that the conjugation of verbs was determined at the end of utterances: participants made conjugation errors despite the correct functional assignment (e.g., *onnanoko-ga funsui-ni nurashita* 'the woman got wet by the fountain', where the verb should be *nurasareta*). This seems to be consistent with the incremental process of grammatical encoding as suggested by Bock and Warren (1994), that speakers complete function assignment first, followed by constituent sequence determination, and finally the inflection. The spoken errors in Chinese JFL learners' production also appear to support an incremental processing. For example, in a sentence like *taihou-ni kaizoku-o taoshita* (the cannon felled the pirate), participant initially assigned the agent *taihou* (cannon) as an oblique-object; however, they preferred an active sentence and later assigned the second noun *kaizoku* (pirate) as object with the verb *taosu* (fell) in an active voice. Additionally, in a sentence such as *tsuukounin-ga akasingou-o tomarareta* (the passenger was stopped by the red light), participants appeared to initially assign the animate patient *tsuukounin* (passenger) as subject;

however, when they moved to the latter part, they misappropriated the case-marker for the second argument, but eventually produced an appropriate voice to match the case-marking of the first noun.

Two additional accounts of incrementality in sentence production take divergent views on how message-level and sentence-level increments are generated. According to the linear incrementality account (Gleitman, January, Nappa, & Trueswell, 2007), speakers can construct a sequence of conceptual and linguistic increments independently of a higher-level framework referring to complete scene apprehension (Konopka & Meyer, 2014). In contrast, the hierarchical incrementality presupposes that formulation begins with the encoding of scene apprehension that guides subsequent linguistic encoding (Konopka & Meyer, 2014). Diverse evidence was gathered during language research.

Contradictory findings were presented in languages with relatively flexible word order. According to Hartsuiker, Kolk, and Huiskamp (1999), the effects of conceptual accessibility on word order in Dutch revealed a tendency for sentences to begin with more conceptually accessible elements. They explained that the earlier retrieval of lemmas associated with conceptually more accessible elements results in a temporal advantage for assigning grammatical functions to these lemmas. Thus, the linearization process began with these elements and advanced them in earlier sentence positions, demonstrating the possibility of linear incrementality in Dutch production. Christianson and Ferreira (2005), on the other hand, examined the Odawa language, which contains a free word order but no overt case markings, and found that more accessible concepts tend to be preferentially assigned as syntactic subjects by the production system, rather than simply being placed in sentence-initial position. A hierarchical incrementality was revealed in the data of Odawa language. Do and Kaiser (2019) used the visual-world eye-tracking paradigm to investigate the real-time production of object *wh*-questions in English (e.g., 'Which chefs did the nurses tickle?'): in spite of the linear order of object *wh*-questions requiring English speakers to say the object first, speakers nevertheless take a glance to the subject during the encoding window prior to looking to the object. These findings showed that English processing has the potential for hierarchical incrementality. Santesteban et al. (2015) investigated the constituent structure selection in Basque, an ergative OV language: according to the lexical boost effect in structural priming, the verb (head) is selected before the constituent structure in OV language production, indicating that the sentence construction in both VO and OV language is verb-based; additionally, the absence of case-marker repetition effect suggested that case-markers are

processed after the constituent structure is chosen. All of these findings implicated that OV languages exhibit hierarchical incrementality. Arai (2012) reviewed the research on syntactic priming in head-final languages, concluding that Yamashita, Chang, and Hirose (2005) demonstrated a boosted priming effect in as a result of the repetition of case-markers, implying that case-markers in Japanese are associated with argument structures; moreover, they observed enhanced priming with verb repetition between the prime and target, similar to Santesteban et al. (2015), corroborating the association of argument structures and the verb in head-final languages. These findings may implicate that hierarchical and linear incrementality coexist in Japanese sentence production.

While we observed a syntactic priming of passive sentences to describe inanimate agent events, this effect could also be interpreted as an inherent animacy effect on sentence construction. In addition, we found that animacy effect and agent preference appeared to have the same magnitude when describing inanimate agent events. Thus, in accordance with previous studies, we assume that our findings reflect both hierarchical and linear incrementality: speakers occasionally begin sentences with the agent, guided by an agent-patient conceptual framework; at other times, they begin sentences with a more accessible concept, even if it is less prominent in a thematic relationship. As Konopka and Meyer (2014) suggested, formulation is flexible and speakers may employ a variety of planning strategies depending on the context.

7. CONCLUSION

Three experiments were conducted to study the animacy effect on the sentence production by Chinese JFL learners using transitive and NP conjunction structures. The influence of conceptual accessibility varied between L1 and L2 Japanese sentence production and also between specific syntactic structures in a sentence-recall task. Chinese JFL learners demonstrated no animacy effect in their production of transitive sentences when compared to native Japanese speakers. However, results ranged between participants with different comprehension abilities, most notably in terms of word order. Surprisingly, participants with lower comprehension capacity tended to prefer animate nouns as sentence subjects. To eliminate the effect of experimental task, another picture-description task was conducted to elicit more natural utterances. The results indicated that Chinese JFL learners have an overall preference for animate subjects, in addition to the preference for agent subjects, active structure and canonical SOV order.

Taken together, the current study established that animacy information contained in noun phrases has an effect on how Chinese JFL learners construct Japanese sentences. Additionally, animacy information was confirmed to exert a direct effect on function assignment and an indirect effect on positional assignment. Further research is needed to determine whether animacy effect occurs across constructions and whether the mapping of conceptual information to syntactic representation can be learned via structural priming; and if so, whether such learning facilitates L2 acquisition for Chinese JFL learners.

REFERENCES

Arai, M. (2012). What can Head-Final Languages Tell us about Syntactic Priming (and vice versa)? *Language and Linguistic Compass, 6/9,* 545-559.

Bernolet, S., Hartsuiker, R. J., & Pickering, M. J. (2007). Shared Syntactic Representations in Bilinguals: Evidence for the Role of Word-Order Repetition. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 33*, 931-949.

Bernolet, S., Hartsuiker, R. J., & Pickering, M. J. (2009). Persistence of emphasis in language production: A cross-linguistic approach. *Cognition, 112,* 300-317.

Bernolet, S., Hartsuiker, R. J., & Pickering, M. J. (2013). From language-specific to shared syntactic representations: The influence of second language proficiency on syntactic sharing in bilinguals. *Cognition, 127,* 287-306.

Bock, J. K. (1986). Syntactic Persistence in Language Production. *Cognitive Psychology, 18,* 355-387.

Bock, J. K., Dell, G. S., Chang, F., & Onishi, K. H. (2007). Persistent structural priming from language comprehension to language production. *Cognition, 104,* 437-458.

Bock, J. K., & Griffin, Z. M. (2000). The persistence of structural priming: transient activation or implicit learning. *Journal of Experimental Psychology: General, 129,* 177–192.

Bock, J. K., & Irwin, D. E. (1980). Syntactic effects of information availability in sentence production. *Journal of Verbal Learning and Verbal Behavior, 19*, 467–484.

Bock, J. K., & Loebell, H. (1990). Framing sentences. *Cognition, 35*, 1-39.

Bock, J. K., Loebell, H., & Morey, R. (1992). From conceptual roles to structural relations: Bridging the syntactic cleft. *Psychological Review, 99*, 150–171.

Bock, J. K., & Levelt, W. (1994). Language production: Grammatical encoding. In M. A. Gernsbacher (Ed.), *Handbook of psycholinguistics,* (pp. 945-984). San Diego: Academic Press.

Bock, J. K., & Warren, R. K. (1985). Conceptual accessibility and syntactic structure in sentence formulation. *Cognition, 21,* 47–67.

Branigan, H. P., & Feleki, E. (1999). Conceptual accessibility and serial order in Greek language production. In M. Hahn & S. C. Stoness (Eds), *Proceedings of the 21st Conference of the Cognitive Science Society,* (pp. 96–101). Mahwah: Erlbaum.

Branigan, H. P., Pickering, M. J., & Cleland, A. A. (2000). Syntactic co-ordination in dialogue.

Cognition, 75, B13-25.

Branigan, H. P., Pickering, M. J., & Tanaka, M. (2008). Contributions of animacy to grammatical function assignment and word order during production. *Lingua, 118*, 172-189.

Buckle, L., Lieven, E., & Theakston, A. L. (2017). The Effects of Animacy and Syntax on Priming: A Developmental Study. *Frontiers in Psychology, 8:2246*, 1-19.

Buckle, L., Theakston, A., & Lieven, E. (2017). Is Structural Priming in Children Facilitated by Interactions between Animacy and Syntax? *Proceedings of the Annual Meeting of the Cognitive Science Society, 39,* 1691-1696.

Cai, Z. G., & Dong, Y. P. (2007). Transfer of sentence processing strategies for Chinese-English bilinguals. *Modern Foreign Languages, 3*, 251-261.

Cai, Z. G., Pickering, M. J., & Branigan, H. P. (2012). Mapping concepts to syntax: Evidence from structural priming in Mandarin Chinese. *Journal of Memory and Language, 66,* 833-849.

Chang, F. (2009). Learning to order words: A connectionist model of heavy NP shift and accessibility in Japanese and English. *Journal of Memory and Language, 61*, 374-397.

Chang, F., Bock, K., & Goldberg, A. E. (2003). Can thematic roles leave traces of their places? *Cognition, 90,* 29-49.

Chang, F., Dell, G. S., Bock, K., & Griffin, Z. M. (2000). Structural Priming as Implicit Learning: A Comparison of Models of Sentence Production. *Journal of Psycholinguistic Research, 29,* 217-229.

Che, L. (2018). On Transitive Sentences with Inanimate Subjects in Japanese Written Language. *Japanese Studies: Research and Education, 22,* 17-34.

車魯明 (2020).「日本語における無生物主語他動詞文について―主語が事態発生の原因となる場合―」『言語・地域文化研究』26, 1-15.

Chen, B., Jia, Y., Wang, Z., Dunlap, S., & Shin, J. (2013). Is word-order similarity necessary for cross-linguistic structural priming? *Second Language Research, 29*(*4*)*,* 375–389.

Chen, S. H., Chen, S. C., & He, T. H. (2012). Surface cues and pragmatic interpretation of given/new in Mandarin Chinese and English: A comparative study. *Journal of Pragmatics, 44,* 490-507.

Christianson, K., & Ferreira, F. (2005). Conceptual accessibility and sentence production in a free word order language (Odawa). *Cognition, 98,* 105-135.

Cleland, A. A., & Pickering, M. J. (2003). The use of lexical and syntactic information in language production: Evidence from the priming of noun-phrase structure. *Journal of Memory and*

Language, 49, 214-230.

De Smedt. (1990). IPF: An incremental parallel formulator. In R. Dale, C. Mellish, & M. Zock (Eds.), *Current research in natural language generation*, (pp. 167–192). London: Academic Press.

De Smedt. (1994). Parallelism in incremental sentence generation. In: Adriaens, G., Hahn, U. (Eds.) *Parallel Natural Language Processing,* (pp. 421-447). Ablex: Norwood.

鄧瑩 (2009).「主要部後置型言語の動作産出における構造的プライミング効果―日本語の能動・受動文を用いた検討―」『広島大学大学院教育学研究科紀要』58, 235-244.

Deng, Y., Ono, H., & Sakai, H. (2012). How Function Assignment and Word Order are Determined: Evidence from Structural Priming Effects in Japanese Sentence Production. *Proceedings of the Annual Meeting of the Cognitive Science Society, 34*, 1488-1493.

Do, M. L., & Kaiser, E. (2019). Subjecthood and linear order in linguistic encoding: Evidence from the real-time production of *wh*-questions in English and Mandarin Chinese. *Journal of memory and language, 105*, 60-75.

Feng, F. R. (1993). On influences of the mother tongue Chinese language on the learning processes of Japanese passive voice. *Journal of Educational Psychology, 41,* 388–398.

Ferreira, F. (1994). Choice of Passive Voice is Affected by Verb Type and Animacy. *Journal of Memory and Language, 33,* 715-736.

Ferreira, V. S. (1996). Is it Better to Give Than to Donate? Syntactic Flexibility in Language Production. *Journal of Memory and Language, 35,* 724-755.

Ferreira, V. S., & Yoshita, H. (2003). Given-New Ordering Effects on the Production of Scrambled Sentences in Japanese. *Journal of Psycholinguistic Research, 32,* 669-692.

Gamez, P. B., & Vasilyeva, M. (2015). Exploring interactions between semantic and syntactic processes: The role of animacy in syntactic priming. *Journal of Experimental Child Psychology, 138*, 15-30.

Gleitman, L., January, D., Nappa, R., & Trueswell, J. C. (2007). On the give and take between event apprehension and utterance formulation. *Journal of Memory and Language, 57,* 544–569.

顧海根・徐昌華 (1980).「中国人学習者によく見られる誤用例―疑問詞用法と受身文を中心に―」『日本語教育』41, 47-60.

Hartsuiker, R. J., Kolk, H. H. J., & Huiskamp, P. (1999). Priming Word Order in Sentence Production. *The Quarterly Journal of Experimental Psychology, 52A*, 129-147.

Hartsuiker, R. J., Pickering, M. J., & Veltkamp, E. (2004). Is syntax separate or shared between

languages? Cross-linguistic syntactic priming in Spanish-English bilinguals. *Psychological Science, 15,* 409–414.

Huang, J., Pickering, M. J., Yang, J., Wang, S., & Branigan, H. P. (2016). The independence of syntactic processing in Mandarin: Evidence from structural priming. *Journal of Memory and Language, 91,* 81-98.

Hung, Y. C., & Schumacher, P. B. (2014). Animacy matters: ERP evidence for the multi-dimensionality of topic-worthiness in Chinese. *Brain Research, 1555,* 36-47.

Hsiao, Y., & McDonald, M. C. (2013). Experience and generalization in a connectionist model of Mandarin Chinese relative clause processing. *Frontiers in Psychology, 4 (767),* 1-19.

Hsiao, Y., & McDonald, M. C. (2016). Production predicts comprehension: Animacy effects in Mandarin relative clause processing. *Journal of Memory and Language, 89,* 87-109.

Hwang, H. (2017). The role of thematic role accessibility in production: evidence from Korean. *Language, Cognition and Neuroscience, 32*, 117–128.

Hwang, H., & Kaiser, E. (2014). Having a syntactic choice is not always better: the effects of syntactic flexibility on Korean production. *Language, Cognition and Neuroscience, 29*, 1115–1131.

Hwang, H., & Shin, J. (2019). Cumulative effects of syntactic experience in a between- and within-language context: Evidence for implicit learning. *Journal of Memory and Language, 109,* 1-14.

Kaan, E., & Chun, E. (2018). Priming and adaptation in native speakers and second-language learners. *Bilingualism: Language and Cognition, 21*, 228-242.

角田太作 (1991).『世界の言語と日本語』くろしお出版

神野雅代 (1996).「日英語間の無生物主語の扱いについて」『自然言語処理』115, 15-20.

Kantola, L., & Gompel, R. P. G. (2011). Between- and within-language priming is the same: Evidence for shared bilingual syntactic representations. *Memory and Cognition, 39,* 276-290.

Kaschak, M. P., Loney, R. A., & Borreggine, K. L. (2006). Recent experience affects the strength of structural priming. *Cognition, 99,* B73-B82.

Keenan, E. L., & Comrie, B. (1977). Noun phrase accessibility and universal grammar. *Linguistic Inquiry, 8,* 33–99.

Kelly, M. H., Bock, J. K., & Keil, F. C. (1986). Prototypicality in a Linguistic context: Effects on sentence structure. *Journal of Memory and Language, 25*, 59–74.

金情浩 (2005).「日本語他動詞文の文処理に関する研究―L1・L2 話者を対象として―」東北大学大学院文学研究科博士論文

Kim, J., Koizumi, M., Ikuta, N., Fukumitsu, Y., Kimura, N., Iwata, K., Watanabe, J., Yokoyama, S., Sato, S., Horie, K., & Kawashima, R. (2009). Scrambling effects on the processing of Japanese sentences: An fMRI study. *Journal of Neurolinguistics, 22*, 151-166.

Kim, Y., & McDonough, K. (2008). Learners' Production of Passive during Syntactic Priming Activities. *Applied Linguistics, 29*, 149-154.

小林 由紀 (2007). 「日本語かき混ぜ文の理解におけるもっともらしさの効果」『日本認知心理学会発表論文集』0, 78-78.

Köhne, J., Pickering, M. J., & Branigan, H. P. (2014). The relationship between sentence meaning and word order: Evidence from structural priming in German. *The Quarterly Journal of Experimental Psychology, 67,* 304-318.

Konopka, A. E., & Meyer, A. S. (2014). Priming sentence planning. *Cognitive Psychology, 73,* 1-40.

Kwon, N., Ong, D., Chen, H., & Zhang, A. (2019). The role of animacy and structural information in relative clause attachment: Evidence from Chinese. *Frontiers in Psychology, 10*, 1-12.

Levelt, W. J. M. (1989). Speaking: From intention to articulation. Cambridge: MIT Press.

Levelt, W. J. M., & Kelter, S. (1982). Surface form and memory in question answering. *Cognitive Psychology, 14*, 78-106.

Li, P., Bates, E., & MacWhinney, B. (1993). Processing a Language without Inflections: A Reaction Time Study of Sentence Interpretation in Chinese. *Journal of Memory and Language, 32,* 169-192.

Li, X. Q., Zhao, H. Y., Zheng, Y. Y., & Yang, Y. F. (2015). Two-stage interaction between word order and noun animacy during online thematic processing of sentences in Mandarin Chinese. *Language, Cognition and Neuroscience, 30 (5),* 555-573.

Liu, X. J. (2007). A Reconsideration of the Translation of the Chinese Passive Sentences into Japanese. *Journal of Zhejiang University of Technology, 6 (4),* 436-440.

Loebell, H., & Bock, K. (2003). Structural priming across languages. *Linguistics and Philosophy, 5*, 791–824.

Ma, J. (2018). Simple-sentence Processing of Japanese Native Speakers and Chinese Learners of Japanese: Focus on Active Sentences with Two-place Verbs and Three-place Verbs. 國立政治大學日本語文學系修士論文

Mazuka, R., Itoh, K., & Kondo, T. (2002). Cost of scrambling in Japanese sentence processing. In M. Nakayama (Ed.), Sentence Processing in East Asian Languages (pp. 131-166). Stanford, CA:

CSLI Publications.

McDonough, K. (2006). Interaction and syntactic priming: English L2 speakers' production of dative constructions. S*tudies in Second Language Acquisition 28*, 179–207.

森下美和・中野陽子・門田修平・磯辺ゆかり・斎藤倫子・平井愛 (2011).「授与動詞構文の産出における日本人英語学習者の統語計画：絵描写課題に基づく検討」*JACET Kansai Journal, 13,* 50-61.

村岡諭・玉岡賀津雄・宮岡弥生 (2004).「かき混ぜ文の処理における格助詞の影響」『電子情報通信学会思考と言語研究会』104, 37‐47.

Muylle, M., Bernolet, S., & Hartsuiker, R. J. (2021). The development of shared syntactic representations in late L2-learners: Evidence from structural priming in an artificial language. *Journal of Memory and Language, 119*, 1-23.

大曾美恵子・滝沢直宏 (2001).「日本語における他動詞文の主語の有生・無生」『日本語電子化資料作成―コーパスに基づく日本語研究と日本語教育の応用を目指して― （平成12 年度名古屋大学教育研究改革プロジェクト報告書)』

大槻 亮・森藤 大地・小川 健二・乾 敏郎 (2007).「基本語順文とかき混ぜ文の比較による格処理の神経基盤の検討」『日本認知心理学会発表論文集』0, 17-17.

Pappert, S., & Pechmann, T. (2014). Priming word order by thematic roles: No evidence for an additional involvement of phrase structure. *The Quarterly Journal of Experimental Psychology, 67,* 2260-2278.

Philipp, M., Schlesewsky, I. B., Bisang, W., & Schlesewsky, M. (2008). The role of animacy in the real time comprehension of Mandarin Chinese: Evidence from auditory event-related brain potentials. *Brain and Language, 105,* 112-133.

Pickering, M. J., & Branigan, H. P. (1998). The representation of verbs: Evidence from syntactic priming in Language production. *Journal of Memory and Language, 39,* 633–651.

Potter, M. C., & Lombardi, L. (1990). Regeneration in the short-term recall of sentences. *Journal of Memory and Language, 29,* 633–654.

Potter, M. C., & Lombardi, L. (1998). Syntactic Priming in Immediate Recall of Sentences. *Journal of Memory and Language, 38*, 265-282.

Prat-Sala, M., & Branigan, H. P. (2000). Discourse constraints on syntactic processing in language production: A cross-linguistic study in English and Spanish. *Journal of Memory and Language, 42,* 168–182.

Santesteban, M., Pickering, M. J., Laka, I., & Branigan, H. P. (2015). Effects of case-marking and head position on language production? Evidence from an ergative OV language. *Language, Cognition and Neuroscience, 30*, 1175-1186.

Seger, C. A. (1994). Implicit learning. *Psychological Bulletin, 115,* 163–196.

Segaert, K., Wheeldon, L., & Hagoort, P. (2016). Unifying structural priming effects on syntactic choices and timing of sentence generation. *Journal of Memory and Language, 91*, 59–80.

Shin, J., & Christianson, K. (2009). Syntactic processing in Korean-English bilingual production: Evidence from cross-linguistic structural priming. *Cognition, 112*, 175-180.

Shin, J., & Christianson, K. (2011). Structural Priming and Second Language Learning. *Language Learning, 62,* 931-964.

Shioiri, S. (2017). Japanese transitive and intransitive verbs corresponding to Chinese BEI passives. *KGU Journal of Language and Literature, 24,* 1-23.

Silverstein, M. (1976). Hierarchy of features and ergativity. In R. M. W. Dixon (ed.), Grammatical categories in Australian languages, 112-71. Canberra: Australian Institute of Aboriginal Studies, and New Jersey: Humanities Press.

Song, Y., & Do, Y. (2018). Cross-linguistic structural priming in bilinguals: priming of the subject-to-object raising construction between English and Korean. *Bilingualism: Language and Cognition, 21,* 47-62.

Sugimura, Y. (2010). A corpus-based analysis of case particle issues with Chinese Japanese Language learners. *Language and Culture Research Series, 9,* 137–152.

Su, I. R. (2001). Transfer of sentence processing strategies: A comparison of L2 learners of Chinese and English. *Applied Psycholinguistics, 22,* 83-112.

Tamaoka, K. (2005). Comprehension of Japanese Active and Potential Sentences with Canonical and Scrambled Word Orders by Native Chinese Speakers Learning the Japanese language. *Journal of Japanese grammar, 5*, 92–109.

Tamaoka, K., Chiu, H., Miyaoka, Y., & Kiyama, S. (2010). Understanding of Sentences with Scrambled Word Order by Native Chinese Speakers Learning Japanese: Comparisons of high-, mid-, and low-level Listening Comprehension Groups. *Journal of Japanese grammar, 10*, 54–70.

Tamaoka, K., & Mansbrige, M. P. (2019). An Eye-tracking Investigation of Pre-head and Head-driven Processing for Scrambled Japanese Sentences. *Gengo Kenkyu, 155,* 35-63.

Tamaoka, K., Sakai, H., Kawahara, J., & Miyaoka, Y. (2003). The effects of phrase-length order and scrambling in the processing of visually-presented Japanese sentences. *Journal of Psycholinguistic Research, 32,* 431–454.

Tamaoka K., Sakai H., Kawahara J., Miyaoka Y., Lim H., & Koizumi M. (2005). Priority Information Used for the Processing of Japanese Sentences: Thematic Roles, Case Particles or Grammatical Functions? *Journal of Psycholinguistic Research, 34,* 281-332.

玉岡賀津雄・張婧禕・牧岡省吾 (2019).「日本語は無生名詞主語の自動詞文が好まれる言語か？―日本語文の主語となる有生・無生名詞の頻度比較―」『日中言語対照研究論集』21, 124-141.

Tanaka, M. N., Pickering, M. J., & Branigan, H. P. (2009). *Structural priming of word order and voice in Japanese and English*. Unpublished manuscript.

Tanaka, M. N., Branigan, H. P., McLean, J. F., & Pickering, M. J. (2011). Conceptual influences on word order and voice in sentence production: Evidence from Japanese. *Journal of Memory and Language, 65*, 318–330.

Tanaka, J., Tamaoka, K., & Sakai, H. (2007). Syntactic Priming Effects on the Processing of Japanese Sentences with Canonical and Scrambled word orders. *Cognitive Studies, 14 (2)*, 173-191.

Verhoeven, E. (2014). Thematic prominence and animacy asymmetries: Evidence from a cross-linguistic production study. *Lingua, 143,* 129-161.

王忻 (2008).『中国日语学习者偏误分析(新版)』, 外语教学与研究出版社.

Witzel, J., & Witzel, N. (2016). Incremental Sentence Processing in Japanese: A Maze Investigation into Scrambled and Control Sentences. *Journal of Psycholinguistic Research, 45,* 475-505.

Wolff, S., Schlesewsky, M., Hirotani, M., & Schlesewsky, I. B. (2008). The neural mechanisms of word order processing revisited: Electrophysiological evidence from Japanese. *Brain & Language, 107,* 133-157.

Wu, F., Kaiser, E., & Andersen, E. (2012). Animacy effects in Chinese relative clause processing. *Language and Cognitive Processes, 27 (10),* 1489-1524.

熊鶯 (2009).「自然現象名詞主語の他動詞文について」『学習院大学人文科学論集』18, 125-146.

熊鶯 (2014).「日本語無生物主語他動詞文の許容に影響を与える要因とその関係」『日本語日本文学』10, 94-110.

Yamashita, H. (1997). The Effects of Word-Order and Case Marking Information on the Processing

of Japanese. *Journal of Psycholinguistic Research, 26 (2),* 163-188.

Yamashita, H., Chang, F., & Hirose, Y. (2005). Producers build structures only with overt arguments. Poster presented at the annual CUNY conference on Human Sentence Processing. Tucson, U.S.A.

Yamada, H. (2014). A study on animacy of transitive sentences with inanimate subjects. *CAJLE Annual Conference Proceedings 2014,* 210-219.

Yan, H., & Dong, Y. P. (2011). The effect of conceptual accessibility on positional processing during language production: Evidence from Chinese NP conjunctions. *Foreign Language Teaching and Research, 43*, 239–250.

張麟声 (2001).『日本語教育のための誤用分析―中国語話者の母語干渉 20 例―』スリーエーネットワーク

張蘇 (2014).「中国人学習者の日本語受動文の習得研究」東北大学国際文化研究科博士論文

趙立翠 (2019).「中国語母語話者と日本語母語話者の日本語処理に関する言語認知脳科学的研究」金沢大学大学院人間社会環境研究科博士論文

Zhou, X., Ye, Z., Cheung, H., & Chen H. (2009). Processing the Chinese language: An introduction. *Language and cognitive processes, 24*, 929-946.

Ziegler, J., & Snedeker, J. (2018). How broad are thematic roles? Evidence from structural priming. *Cognition, 179,* 221-240.

APPENDICIES

APPENDIX A

Experimental stimuli used for the sentence-recall task in Experiment 1 and 2.

All the noun phrases were used to create transitive sentences and NP conjunction structures, respectively with transitive verbs and intransitive verbs.

1. According to the report, the human/the environment (ruined/were deeply concerned).

［報告によると、人間/環境（破壊した/深く関わっていた）］

2. At the toy store, the girl/the doll (chose/were sitting on the cart).

［おもちゃ屋で、女の子/人形（選んだ/カートに乗っている）］

3. Against the flood, the farmer/the big tree (protected/were safe).

［洪水のとき、村民/大きな木　（守った/無事だった）］

4. In a steep hill, the climber/the bike (pushed/were stopped)

［急な坂で、登山者/自転車　（押した/止まっていた）］

5. In the middle of the road, the officer/the jeep (stopped/remained still)

［町の真ん中で、警察官/ジープ　（止めた/動けずにいた）］

6. In the construction area, the factory worker/the heavy stone (crushed/bumped together)

［建設現場で、作業員/重い石　（砕いた/ぶつかった）］

7. In the harbor, the fisherman/the boat (carried/were pulled in to shore)

［港で、漁師/ボート　（運んだ/乗り上げた）］

8. In the botanic garden, the attendant/ branch of the tree (cut down/were exposed to the wind)

［植物園で、職員/木の枝（切った/風にさらされた）］

9. In the kitchen, the cook/the plates (burnished/are important)

［調理場で、料理人/包丁（磨いた/重要である）］

10. In the conference room, the office worker/the bookshelf (pushed/ fell over.)

［オフィスで、社員/本棚　（押し出した/倒れた）］

11. In the Jungle, the gorilla/the tree (flattened/fell on the ground)

［ジャングルで、ゴリラ/木　（踏んだ/倒れていた）］

12. In the factory, the worker/the white clothes (dyed/were colored in dark blue)

［工場で、作業員/白い布（染めた／藍色に染まった）］

13. In the fairy story, the magician/the castle (removed/disappeared)

［おとぎ話の中で、魔法使い/お城　（消した/消えた）］

14. Near the field, the bull/the cart (pulled/were moving)

［畑の近くで、オス牛/荷車　（引っ張った/進んでいた）］

15. In a theme park, the stuff/the costume (carried/lined up)

［遊園地で、スタッフ/ぬいぐるみ　（運んだ/一列に並んでいた）］

16. After the club activity, the club members/the tools (returned/were back to their position)

［部活の後、部員/道具　（戻した/元の位置に戻った）］

17. After the bath, the old lady/the towel (dried/were both soaking wet)

［お風呂の後、おばあさん/タオル（乾かした/びしょびしょだった）］

18. In the department store's playground, the baby/the building block (rolled over/were in the same box)

［デパートの遊び場で、赤ちゃん/積み木　（転がした/同じ箱に入っていた）］

19. In the apartment, the deliverer/the cardboard box (lifted/arrived late)

［マンションで、配達員/ダンボール（持ち上げた/遅れて到着した）］

20. At the Olympics, the athlete/the world (inspired/were excited)

［オリンピック大会で、選手/世界　（励ました/興奮した）］

21. During the experiment, the teacher/the chemicals (burned/contacted)

［実験中、先生/薬品（燃やした/接触した）］

22. In the café, the waitress/the coffee (made warm/made the atmosphere relaxed)

［喫茶店で、店員/コーヒー　（温めた/リラックスした雰囲気を作った）］

23. When there was a bush fire, the fire-fighters/the World heritage (protected/were in danger)

［山火事の時、消防士/世界遺産　（救った/危機にさらされた）］

24. From the sky, the pilot/the bomb (dropped/fell down at the same time)

［空から、パイロット/爆弾　（落とした/同時に落ちた）］

25. In order to pull the ship, the captain/the rope (tied up/ were dragged)

［船を引き戻すため、船長/ロープ　（結んだ/引っ張られた）

26. At the start of the game, the referee/the ball (kicked out/were watched by everyone)

［試合の最初、審判/ボール　（蹴った/全員に見つめられた）］

27. In front of the station, the tourists /the taxi (hailed/were waiting)

［駅前で、旅行者/タクシー　（呼び止めた/待っていた）］

28. In the middle of the river, the sailor/the submarine (submerged/sank)

［川の真ん中で、軍人/潜水艦 （沈めた/沈んだ）］

29. In front of the hospital, the doctors/the ambulance (picked up/left)

［病院の前で、医師たち/救急車（迎えた/出発した）］

30. In the long-term research, the scientist/this discovery (found/became famous)

[長年の研究を経て、科学者/その治療法 （見つけた/有名となった）]

31. During the war, the soldier/the building (damaged/were ragged)

［戦争中に、兵士/建物 （爆破した/ ボロボロになった）］

32. In the interview, the applicant/the require of the company (refused/were in conflict)

［面接の中で、応募者/会社の要求 （拒絶した/対立した）］

33. In this accident, the suspect/the investigation (disturbed/drew people's attention)

［今回の事件で、犯人/捜査 （妨げた/国民に注目された）］

34. In the company, the engineer/the development project (carried out/were introduced to the public)

［会社で、技術者/プロジェクト （実施した/披露された）］

35. In front of the newspaper company, the journalists/the campaign van (surrounded/blocked the queue)

［新聞社の前で、記者たち/選挙カー（囲んだ/人々の列を止めた）］

36. When there was a fire, the security guard/the fire extinguisher (used/prevented danger)

［火災の際、警備員/消火器 （使った/救出に役立った）］

37. In the museum, the artist/the statue (held/were in the picture)

［美術館で、芸術家/銅像（抱えた/写真に写っている）］

38. During the election campaign, the member of parliament/the newspaper (criticized/argued with each other)

［今回の選挙運動で、議員/新聞（批判した/喧嘩した）］

39. In the work section, the carpenter/the machine (broke/were scratched)

［作業場で、工員/機械（壊した/傷を負った）］

40. On the internet, the principal/the school building (introduced/were introduced to the public)

［学校のホームページで、校長/新校舎（紹介した/公開されている）］

41. In the council, the king/the law (supported/were determined)

［議会で、国王/法案（支持した/確定した）］

42. In the main street, the pedestrian/the minibus (chased/were running)

［大通りで、歩行者/バス（追いかけた/走っていた）］

APPENDIX B

Experimental stimuli used for the picture-description task in Experiment 3.

1. Stimuli used for target pictures

No.	Verb	Inanimate agent event	Verb	Animate agent event
1	濡らす	噴水／女の人	止める	警察／トラック
2	止める	赤信号／通行人	埋める	泥棒／大金
3	傷つける	爆竹／野良犬	燃やす	キャンパー／薪の山
4	引っ張る	ヘリコプター／遭難者	傷つける	猫／ソファ
5	照らす	明るい月／恋人たち	引っ張る	雄牛／荷車
6	持ち上げる	クレーン／作業員	照らす	警備員／階段
7	吹き飛ばす	暴風／カラス	持ち上げる	乗客／カバン
8	打つ	落雷／男の人	吹き飛ばす	女の子／木の葉
9	運ぶ	ボート／漁師	揺らす	看護師／注射器
10	倒す	大砲／海賊	守る	兵士／お城
11	汚す	泥はね／歩行者	打つ	選手／ボール
12	吊り上げる	漁船／サメ	運ぶ	小さなロバ／大きな箱
13	追い詰める	掃除機／ウサギ	起こす	学生／椅子
14	挟む	自動ドア／小さい子	操る	傀儡師／人形
15	追い抜く	自動車／ライダー	押し進める	キャスト／フロート

Note. Noun phrases are presented in Agent/Patient order.

2. Items for prime sentences: inanimate agent

No.	Verb	Pair 1	Pair 2
1	覆う	沙石／ラクダ	落葉／小さい虫
2	襲う	寒気／旅人	ひどい嵐／村人たち
3	映す	湖／白鳥	魔法の鏡／白雪姫
4	包む	音楽／聴衆	朝霧／ランナー

5	支える	木の枝／フクロウ	シートベルト／運転手
6	隠す	黒煙／怪我人	水蒸気／入浴者
7	引きつける	血の匂い／ライオン	香水／蜜蜂
8	驚かす	叫び声／寝る人	雷／柴犬
9	追う	津波／泳ぐ人	ほのお／コアラ
10	巻き込む	大きな渦／落水者	雪崩／スキーヤー
11	慰める	金メダル／監督	美味しいケーキ／疲れた女性
12	励ます	良い売り上げ／従業員	勝利／隊員
13	癒す	美しい景色／寂しい病人	アロマ／妊婦
14	滅す	環境汚染／野生動物	大爆発／恐竜たち
15	圧倒する	疲労／部長	不幸／家族
16	苦しめる	貧困／民衆	病気／患者
17	阻む	大きな壁／探検隊員	
18	包み込む	感動／ゲスト	
19	刺す	鋭い雪片／配達員	

Note. Noun phrases are presented in Agent/Patient order.

3. Items for prime sentences: animate agent

No.	Verb	Pair 1	Pair 2
1	切る	秘書／電話	駅員／乗車券
2	壊す	工員／機械	子犬／花瓶
3	蹴る	隣人／扉	幼児／毛布
4	捨てる	大家さん／粗大ゴミ	犯人／拳銃
5	取り換える	父親／電球	修理員／古いタイヤ
6	片付ける	家政婦／クローゼット	部員／部室
7	盗む	盗賊／宝石	ネズミ／チーズ
8	収める	学芸員／標本	母親／段ボール
9	縛る	工人／銅像	集荷員／郵便物
10	乱す	野良猫／庭園	顧客／売り場
11	沈める	容疑者／凶器	軍人／敵艦
12	締める	ガイドさん／安全ベルト	管理人／雨戸

13	転がす	プレイヤー／骰子	作業者／ドラム缶
14	奪う	前妻／遺産	テロリスト／先端武器
15	妨げる	過激ファン／撮影	カメラマン／発表会
16	攻める	山賊／城郭	オオカミ／露営地
17	阻む	島民／工事	
18	包み込む	記者たち／劇場	
19	刺す	宇宙飛行士／アメリカの国旗	

Note. Noun phrases are presented in Agent/Patient order.