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Effects of weight and syntactic priming on the production of Cantonese verb-doubling

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Abstract

Verb-doubling, where a copy of the main verb occurs both before and after the direct object, is a structure commonly used in Chinese in sentences containing a frequency or duration phrase. In Cantonese, verb-doubling is highly optional and therefore problematic for existing syntactic, semantic, and pragmatic accounts of its distribution in Mandarin. The current study investigates the role of grammatical weight and syntactic priming in the choice of verb-doubling in Cantonese. Following Hawkins' (2004) theory of efficiency and complexity in grammars, we hypothesized that speakers would choose verb-doubling over the canonical structure more often when the object NP was heavy, in order to minimize processing domains. In addition, we expected an effect of syntactic priming whereby the choice of structure is influenced by a previously encountered structure. The results of two elicited production experiments revealed no weight-based preference for verb-doubling, and only minor effects of grammatical weight, but clear effects of syntactic priming: (1) for both canonical primes and verb-doubling primes, speakers tended to repeat previously heard structures; (2) the priming effect was just as strong in the heavy NP condition, where speakers made more errors recalling the semantic content of the sentence, suggesting that semantic information is represented separately from syntactic information; (3) the priming effect was stronger for informationally accurate responses, suggesting that recently activated structures are easier to produce than other structures under conditions of increased cognitive load. We conclude that the choice between verb-doubling and canonical structure in Cantonese is easily influenced by the structure of recently encountered sentences, with weight effects, if any, being more difficult to detect.

Key Words

Chinese, verb-doubling, sentence production, grammatical weight, syntactic priming

1. Introduction

Several constructions in Chinese exhibit 'verb-doubling' (or 'verb copying'), where a copy of the main verb occurs both before and after the direct object, as in the Cantonese sentence in (1).[1]

(1) keoi5 tai2 din6si6 tai2zo2 saam1 go3 zung1.
3sg watch television watch-ASP three CL hour
"She watched television for three hours."

The current study examines the verb-doubling construction in Cantonese from the perspective of sentence processing. Specifically, we examine the effects of grammatical weight (length and/or complexity of a phrase) and syntactic priming in the production of Cantonese verb-doubling and related structures. First, however, we will briefly review existing approaches to verb-doubling in Mandarin, which we will argue to be inadequate to account for the highly optional nature of verb-doubling in Cantonese.

In Mandarin, sentences such as (2a), where the direct object is followed by a frequency or duration phrase, require verb-doubling. Therefore, sentences such as (2b) are unacceptable.

(2) a. ta kan dianshi kan-le san-ge xiaoshi
3sg watch television watch-ASP three-CL hour
"She watched television for three hours."

[1] Cantonese examples are given in the *JyutPing* romanization developed by the Linguistic Society of Hong Kong (Fan et al. 1997). The numerals following each syllable indicate tone marks. Abbreviations used for Cantonese examples are as follows: 3sg 'third person singular pronoun', 1sg 'first person singular pronoun', ASP 'aspect marker', CL 'classifier', PRT 'particle', DET 'determiner'.

b. *ta kan-le dianshi san-ge xiaoshi

3sg watch-ASP television three-CL hour

(Paul 2002: 138)

Various grammatical explanations have been proposed to account for obligatory cases of verb-doubling in Mandarin. An influential syntactic account of verb-doubling is Huang's (1982) Phrase Structure Condition, which states essentially that only one complement is allowed following the verb. Because duration and frequency phrases which follow the direct object behave syntactically like complements in Mandarin, a copy of the verb must be inserted following the direct object so that each instance of *kan* 'watch' only takes one complement. A variation on this is Li's (1990) proposal that a transitive verb can only assign one (abstract) Case. Thus, verb-doubling is required to ensure that both the direct object NP and the frequency or duration phrase receive Case. In a more recent Minimalist analysis of this phenomenon, Paul (2002) observes that V2 (the second verb), not V1 (the first verb), exhibits most of the verbal properties (such as aspectual marking and position with respect to VP adverbs) and suggests that V2 is the lexical verb and V1 is actually a functional head occurring outside the verb phrase. Verb-doubling is needed because the verb contains a categorial feature that cannot be checked within the VP and must instead be checked by the insertion of a function word (the copied verb) above VP (2002, p.150).[2]

[2] Similar to Li's (1990) Case account, Paul's Single Checking Hypothesis (SCH) ensures that a head can only be in a checking relation with one lexical element (2002, p. 150). In the case of (2a), this lexical element is the duration phrase *san-ge xiaoshi* 'for three hours', which checks the argument feature of the verb but leaves the categorial feature unchecked.

Syntactic accounts of verb-doubling have paid less attention to cases where there is a choice between constructions with and without verb-doubling, as in the Mandarin sentences in (3a-b), where the direct object is a definite NP:

(3) a. wo kan zhei-bu dianying kan-guo wu-ci le
1sg watch this-CL film watch-ASP five-time PRT
"I have seen this film five times."

b. wo kan-guo zhei-bu dianying wu-ci le
1sg watch-ASP this-CL film five-time PRT
"I have seen this film five times." (Paul 2002, p.142)

Optional cases of verb-doubling such as (3a) are problematic for purely syntactic accounts because they appear to have the same structural properties as obligatory cases like (2a). For example, Huang's (1982) Phrase Structure Condition predicts, contrary to fact, that (3b) should be impossible.

The apparent inadequacy of purely structural accounts has prompted a number of semantic and discourse-pragmatic explanations for the occurrence of verb-doubling in Mandarin (Chang 1991; Hsieh 1992; Liu 1996, 1997; Paris 1988; Tai 1985). In these studies, verb-doubling has been associated with imperfective aspect, discourse backgrounding, and/or thematic structure of individual verbs. For example, Liu (1997) argues that verb-doubling is required for sentences with imperfective (durative) meaning (as in 2a), while optional cases are those for which the sentence can be construed as either perfective or imperfective. Tai (1985, p.59)

suggests an iconic motivation for this association between imperfective aspect and verb-doubling, such that "the repetition of the verb may be said to mirror the dragging [out] of an activity or process associated with the verb". Along similar lines, Liu (1996) argues that verb-doubling is associated with events that are backgrounded in discourse and for this reason tends to be associated with imperfective VPs.

Cantonese has a verb-doubling construction identical in form to the Mandarin verb-doubling construction (Matthews and Yip 1994, p.142). However, the extent to which verb-doubling is optional appears to be greater in Cantonese than in Mandarin. Whereas Mandarin normally requires verb-doubling when the object NP is indefinite, Cantonese does not. As shown in (4a-d), verb-doubling is permitted but not required with both definite and indefinite object NPs followed by a frequency or duration phrase.

(4) a. Indefinite object with verb-doubling

ngo5 tai2 din6si6 tai2zo2 loeng5 go3 zung1.

1sg watch television watch-ASP two CL hour

"I watched television for two hours."

b. Indefinite object without verb-doubling

ngo5 tai2zo2 din6si6 loeng5 go3 zung1

1sg watch-ASP television two CL hour

"I watched television for two hours."

c. Definite object with verb-doubling

ngo5 tai2 go2 tou3 hei3 tai2zo2 loeng5 ci3

1sg watch that CL film watch-ASP two time

"I watched that film twice."

d. Definite object without verb-doubling

ngo5 tai2zo2 go2 tou3 hei3 loeng5 ci3

1sg watch-ASP that CL film two time

"I watched that film twice."

Unlike in Mandarin, where the requirement for verb-doubling in sentences like (2a) can be attributed to imperfective aspect, Cantonese does not appear to impose any strict semantic constraints. Sentences like (4b), which are clearly durative in meaning, are permitted without verb-doubling. Although some speakers do report a preference for verb-doubling in sentences like (4a-b), it is optional to a greater extent than in Mandarin. Thus, the greater optionality of verb-doubling in Cantonese poses problems for both syntactic and semantic accounts of this phenomenon.

Although it is possible that speakers' choice of verb-doubling structure in cases where it is grammatically optional may be influenced by subtle semantic or pragmatic factors even in Cantonese, we explore a different possibility in the present study—the possibility that verb-doubling facilitates sentence planning and production, especially in cases where the direct object NP is long or complex. Specifically, we report on the results of two elicited production experiments which test the hypothesis that choice of verb-doubling vs. canonical sentence

structure in Cantonese depends in part on the 'grammatical weight' (length and/or complexity) of the direct object NP. This hypothesis is based on Hawkins' (2004) principle of Minimize Domains, which predicts that verb-doubling should facilitate the processing of VPs with heavy object NPs by placing a copy of the verb close to the head noun of the direct object NP and by breaking up the VP into two shorter phrases. In addition, our experiments investigate the role of syntactic priming– the tendency for speakers to repeat previously heard or produced structures—with respect to choice of syntactic structure.

Although grammatical weight had robust effects on accuracy of recall, with heavier NPs inducing the most errors, our results showed only minor effects of grammatical weight on structural choice. Specifically, we found an increase in adjunct omission (Experiment 1) and topicalization (Experiment 2) when the object NP was heavy, but no significant weight effects in the production of verb-doubling. However, both experiments showed significant effects of syntactic priming, such that speakers tended to repeat previously heard structures even when the information content of the target sentence was not recalled accurately. This effect held regardless of whether the canonical structure (as in Experiment 1) or the verb-doubling structure (as in Experiment 2) was primed. In addition, the results of both experiments showed an even stronger priming effect for informationally accurate sentences. These results appear to suggest that recently activated structures are easier to produce than other structures under conditions of increased cognitive load.

The paper is structured as follows. Section 2 discusses previous research on grammatical weight and syntactic priming and sets out our hypotheses. Sections 3 and 4 report on two experiments using a type of cued recall task to elicit production of Cantonese verb phrases with

and without verb-doubling. Section 5 discusses general theoretical and methodological implications of the findings, and Section 6 concludes the paper.

2. Background and motivation for the study of weight effects in verb-doubling

This section motivates the present study by reviewing previous work on weight effects in sentence production and discussing the unique properties of verb-doubling which make it an interesting case for the study of grammatical weight. Previous work on syntactic priming in sentence production is also briefly reviewed.

2.1 Weight effects in sentence production

Previous studies of corpus frequency (Arnold et al. 2000; Lohse et al. 2004; Wasow 1997) and online sentence production (Arnold et al. 2000; Arnold et al. 2004; Stallings et al. 1998) in English have shown that choice of syntactic structure can be influenced by the 'grammatical weight' of certain constituents, where weight refers to length and/or syntactic complexity.[3] The main finding of these studies is that longer, more complex phrases tend to occur late in a sentence, leading speakers to choose non-canonical word orders in cases where the canonical word order would require placing a heavy constituent in a non-final position. One example of this phenomenon is Heavy NP Shift (HNPS), a construction in which the direct object of the verb occurs at the end of the sentence following an oblique argument or adjunct (usually a PP), as in (5b), rather than occurring in its canonical position adjacent to the verb, as in (5a).

[3] Wasow (2002: 23-41) shows that length in words is highly correlated with complexity as measured by number of syntactic nodes, and that each factor alone is an excellent predictor of structure choice in corpora. However, he also shows that complexity is a better predictor than length for some of the corpus data involving dative alternations. In the present study, we did not attempt to separate length from complexity. Object NPs get both longer and more complex in the medium and heavy conditions.

(5) a. The waiter brought the wine we had ordered to the table. (Canonical)

b. The waiter brought to the table the wine we had ordered. (HNPS)

(Arnold et al. 2000, p.28)

Arnold et al. (2000) propose that weight effects found in HNPS and other word order alternations in English (e.g., dative shift, particle shift) result at least in part from preferences in production: "When formulation is difficult, choices in constituent ordering allow speakers to postpone the long, difficult constituent while they utter the shorter, easier one." (2000, p.32). They support this proposal with a corpus study showing that choice of syntactic structure varies as a function of grammatical weight independently of discourse factors (new vs. given information) that also affect structural choices.

Although Arnold et al.'s explanation for weight effects works well for understanding several word order alternations in English, Hawkins (1994, 2004) shows that weight effects do not always pattern in terms of heavy constituents moving to the end. One common pattern observed for head-final languages (languages in which the verb typically follows its direct object and more generally head words follow their complements) is that heavy constituents tend to move to the *beginning* rather than the end of the sentence. Hawkins (1994, p.152) reports the results of a corpus analysis of Japanese showing that in cases where the main verb is preceded by both a direct object and a postposition phrase, the heavier of the two constituents occurs first in 72% of the examples collected. Yamashita (2002) reports a similar trend in a corpus analysis of Japanese scrambling. While the canonical word order for Japanese clauses is Subject-Object-Verb (SOV), the language also permits optional 'scrambling' (movement) of the object to a position in front of the subject. Yamashita (2002) found that although the overall incidence of

scrambling was low in the corpus, almost all examples of scrambling involved heavy object NPs, resulting in a long-before-short word order. In a related study, Yamashita and Chang (2001) found a long-before-short preference in a controlled production task: scrambled (object-fronted) word order was produced most often in cases where the object NP was long.

Another weight effect that differs from the short-before-long pattern of Heavy NP Shift is the tendency for grammatically optional function words to occur more often when there is a dependency between non-adjacent constituents, especially in cases where the intervening material is longer than one word. For example, a corpus analysis by Rohdenburg (1999) showed that the optional English complementizer *that* occurs significantly more often when there is an intervening adverbial phrase between the verb and the complement clause, as in (6).

(6) We realized much too late (that) Jill was not coming back.

In this case, the choice between structures with or without *that* does not affect the word order but merely adds an additional word to the beginning of the complement clause. This preference for including optional *that* cannot be explained just in terms of the production preference for delaying the utterance of heavy phrases, since the heaviest phrase comes at the end whether or not *that* is included.

Hawkins' (2004) theory of efficiency and complexity in grammars attempts to explain weight effects using a general principle called Minimize Domains. This principle is more general than Arnold et al.'s (2000) explanation of Heavy NP Shift in two ways. First, the principle is applicable to both production and comprehension, thus accounting for weight effects in comprehension as reported by Uszkoreit et al. (1999), Matthews and Yeung (2001), Cheung

(2006), Ching (2008), and Francis (2010). Secondly, the principle is designed to account for different kinds of weight effects, including the long-before-short preference in head-final languages and the preference for including optional function words with non-local dependencies, among others. We will see that the case of Chinese verb-doubling involves both a head-final NP structure and the optional inclusion of an additional word. Thus, Hawkins' theory makes specific predictions for weight effects with verb-doubling where other explanations of weight effects do not.

Hawkins' principle of Minimize Domains is defined in (7):

(7) Minimize Domains: The human processor prefers to minimize the connected sequences of linguistic forms and their conventionally associated syntactic and semantic properties in which relations of combination and/or dependency are processed. The degree of this preference is proportional to the number of relations whose domains can be minimized in competing sequences or structures, and to the extent of the minimization difference in each domain. (Hawkins 2004, p.104)

Essentially, this principle predicts that speakers should prefer to split up or rearrange heavy constituents to minimize the domains in which relations between linguistic elements are processed. The domains most relevant for the present study are the Phrasal Combination Domain (PCD) and the Lexical Domain (LD). Slightly simplified definitions are given in (8a-b):

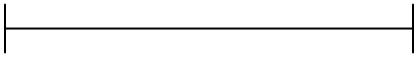
(8) a. Phrasal Combination Domain (PCD): the smallest string of elements required to construct a mother node (e.g., VP) and its immediate constituents (Hawkins 2004, p.107).

b. Lexical Domain (LD): the smallest string of elements required to assign a lexically listed property to a lexical item (Hawkins 2004, p.117)

We will first consider the Phrasal Combination Domain (PCD). In English Heavy NP-Shift, for example, the PCD for the VP includes the verb and head word ('constructing category' in Hawkins' terms) of each of its complements (i.e., the verb, the preposition head of PP, and the determiner or noun introducing the NP). When the NP is heavy, the PCD for VP can be made shorter by moving the NP to the position following the PP, as shown in (9a-b).

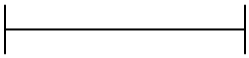
(9) a. PCD for canonical VP

The waiter brought the wine we had ordered to the table.



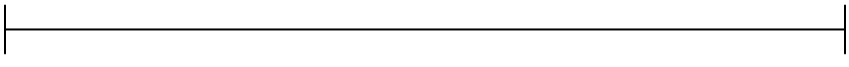
b. PCD for VP with HNPS

The waiter brought to the table the wine we had ordered.



For similar reasons, the PCD for the entire sentence, which includes the verb and the phrase-final head noun of the subject and direct object NPs, can be reduced in Japanese by scrambling (moving) a heavy object NP in front of the subject. Examples (10a-b), from Yamashita and Chang (2001, p.B47), illustrate this contrast:

(10) a. PCD for canonical S (SOV order)

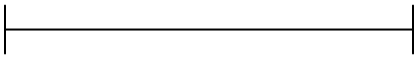


keezi-ga se-ga takakute gassiri sita hannin-o oikaketa.

detective-NOM height-NOM tall and big-boned suspect-ACC chased

"The detective chased the suspect who is tall and big-boned."

b. PCD for S with scrambling (OSV order)



se-ga	takakute gassiri sita	hannin-o	keezi-ga	oikaketa.
height-NOM	tall and big-boned	suspect-ACC	detective-NOM	chased

Lit: "The suspect who is tall and big-boned, the detective chased."

Thus, Hawkins' (2004) principle of Minimize Domains predicts a long-before-short preference for Japanese as attested in corpus analyses (Hawkins 1994; Yamashita 2002) and in a production study (Yamashita and Chang 2001).

The preference for inclusion of optional function words in cases of non-local dependencies is also predicted by Hawkins' theory. For sentences like (6), repeated here in (11), corpus data show that there is a strong preference for including the optional word *that* to introduce the complement clause in cases where an adverbial phrase directly follows the verb (Rohdenburg 1999).

(11) We realized much too late (that) Jill was not coming back.

Both Rohdenburg (1999) and Hawkins (2001, 2004) attribute this effect to a need for increased grammatical explicitness when there is a dependency between non-local constituents. In (11), the relation between the verb *realized* and its non-adjacent clausal complement can be made more explicit by the inclusion of the word *that*. This increased explictness can help avoid ambiguity for the listener because it marks the following material as a subordinate clause (as opposed to another main clause) and more specifically as a complement to the verb. Inclusion of *that* is also predicted by Minimize Domains because the intervening adverbial phrase increases

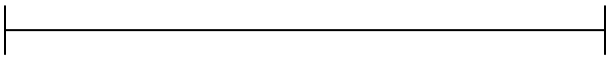
the PCD for the VP, and at the same time, the addition of a complementizer shortens the PCD for VP (Hawkins 2004, p.154). This is because the complementizer *that* is a head (a constructing category) for the clause, but the subject NP *Jill* is not. Without the complementizer, the clause is not constructed until reaching the finite verb *was.* For similar reasons, the Lexical Domain (see 8b above) is also made shorter when there is an explicit complementizer (2004, p.154). It is predicted, therefore, that as the intervening adverbial phrase becomes longer, the tendency to include the word *that* should become greater.

2.2 Predictions for weight effects with Cantonese verb-doubling

Cantonese verb-doubling is an interesting case for testing Hawkins' predictions because it involves both a head-final NP structure (similar to Japanese) and an optional word (the doubled verb) marking a non-local dependency (similar to English *that*). In this section, we lay out the predictions of Hawkins' theory for weight effects in the choice of canonical vs. verb-doubling structure.

Although Cantonese, like English, has Subject-Verb-Object (SVO) word order and head-initial VPs, Cantonese NPs are consistently head-final. In a study of weight-based effects in comprehension, Matthews and Yeung (2001) showed that similar to Japanese, canonical SVO word order in a Cantonese transitive sentence results in a long PCD for the VP when the object NP is heavy. Thus, moving a heavy object NP in front of the subject (topicalization) shortens the PCD in a similar manner to Japanese scrambling. This is shown in the Cantonese examples in (12a-b) (Matthews and Yeung 2001, p.90):

(12) a. PCD for VP in canonical sentence (SVO order)

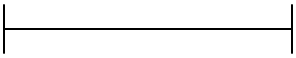


lei5 zeon2bei6 hou2 ting1jat6 gong2 go2 di1 je5 mei6 aa3

you prepare finish tomorrow talk that CL stuff not PRT

"Have you finished preparing the stuff you're talking about tomorrow?"

b. PCD for VP with topicalized object (OSV order)



ting1jat6 gong2 go2 di1 je5 lei5 zeon2bei6 hou2 mei6 aa3

tomorrow talk that CL stuff you prepare finish not PRT

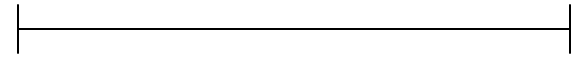
Lit: "The stuff you're talking about tomorrow, have you finished preparing it?"

As predicted by Hawkins' theory, the results of Matthews and Yeung's (2001) reading time study show a processing advantage for topicalization when the object NP is heavy but no difference between topicalized and canonical sentences when then object NP is light.

Hawkins' theory is further supported in a related study of Cantonese dative constructions. Using a dual task comprehension-production experiment, Cheung (2006) investigated the difference in reading time and accuracy of imitation for the double-object construction of the form [Verb Theme Recipient] as in (13a), and for the *zoeng* construction of the form [*zoeng1* Theme Verb Recipient], as in (13b).[4]

[4] The Cantonese *zoeng* construction is similar to the Mandarin BA construction in structure and function.

(13) a. LD for double-object VP

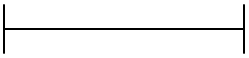


bei2 nei5 ze3 go2 bun2 syu1 ngo5

give you borrow DET CL book me

"Give me the book that you borrowed"

b. LD for VP with *zoeng* construction



zoeng1 nei5 ze3 go2 bun2 syu1 bei2 ngo5

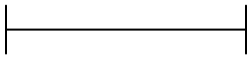
PRT you borrow DET CL book give me

"Give me the book that you borrowed" (Cheung 2006, p.55)

Unlike in the case of topicalization, there is no change in the order of the two NPs. Instead, the *zoeng* construction adds a function word *zoeng1* to the beginning of the VP and moves the verb *bei2* 'give' to a position between the Theme and Recipient NPs. The *zoeng* construction is predicted to be preferred in processing, especially when the Theme NP is heavy, because the Lexical Domain (see 8b above) of the verb is made shorter, as illustrated in (13a-b above). This is because the main verb occurs in a position directly following the head noun of the Theme NP (since NPs are head-final) and directly preceding the Recipient NP. Cheung (2006) found that, as predicted, double-object sentences were read slower and imitated less accurately than *zoeng* sentences. There was, in addition, an interesting weight-based effect in the production results: when participants failed to accurately imitate the double-object construction, they tended to replace it with either the *zoeng*-construction or another construction called the double-*bei*

construction, and did so more often for both constructions when the Theme NP was heavy (Cheung 2006, p.70). As shown in (14), the double-*bei* construction, which involves adding a copy of the verb *bei2* 'give' between the Theme and Recipient NPs, has the same effect as the *zoeng* construction in that the Lexical Domain is made shorter when the Theme NP is heavy.

(14) LD for VP with double-*bei* construction



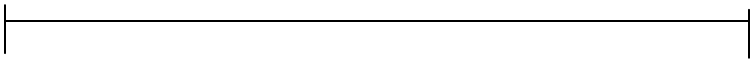
bei2	nei5 ze3	go2 bun2 syu1	bei2 ngo5
give	you borrow	DET CL book	give me

"Give me the book that you borrowed"

We can see in example (14) that the double-*bei* construction is similar in form to the verb-doubling construction as discussed in Section 1 above in that a copy of the verb occurs both before and after the first object. Thus, Hawkins' theory predicts that the verb-doubling construction should also confer a processing advantage over canonical word order when the object NP is heavy. As in the case of the *zoeng* construction and double-*bei* construction, the Lexical Domain of the verb is made shorter with verb-doubling when the object NP is heavy. This is because V2 can show the dependency between the verb and its subcategorized object in a position directly adjacent to the head noun of the object NP, whereas in a canonical VP the Lexical Domain must reach from the verb on the left edge of the VP to the head noun at the right edge of the object NP.[5] This contrast is shown in (15a-b):

[5] We are assuming that the head noun, not just the determiner, is needed to fulfill the lexical requirements of the verb because the noun carries the thematic role and semantic content of the NP (Hawkins 2004: 117). We also

(15) a. LD for verb in canonical VP



ngo5 go4go1 tai2zo2 baa4baa1 teoi1gaai3 go2 tou3 sau6 fun1jing4 ge3 hei3 saam1ci3

1sg elder-brother watch-ASP father recommend that CL popular PRT film three time

"My elder brother watched that popular film that Father recommended three times."

b. LD for verb with verb-doubling

ngo5 go4go1 tai2 baa4baa1 teoi1gaai3 go2 tou3 sau6 fun1jing4 ge3 hei3 tai2zo2 saam1ci3

1sg elder-brother watch father recommend that CL popular PRT film watch-ASP three time

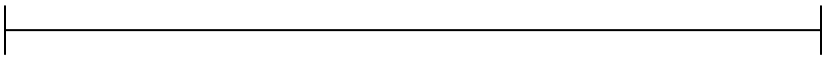
"My elder brother watched that popular film that Father recommended three times."

Another possible advantage of the verb-doubling structure (which also holds for the double-*bei* construction) is that the addition of a verb copy after the direct object splits the VP into two smaller VPs, thus reducing the PCD for each phrase, as shown in (16a-b).[6]

assume here that the frequency or duration phrase, which is optional, is not lexically required by the verb so not part of the LD.

[6] This analysis assumes that, at least for purposes of processing, there is no need to construct a VP node dominating the two smaller VPs in (16b). We also assume here that both the demonstrative determiner *go2* and the noun *hei3* 'film' are constructing categories for NP, with *go2* being the closest to V1.

(16) a. PCD for canonical VP



ngo5 go4go1 tai2zo2 baa4baa1 teoi1gaai3 go2 tou3 sau6 fun1jing4 ge3 hei3 saam1ci3

1sg elder-brother watch-ASP father recommend that CL popular PRT film three time

"My elder brother watched that popular film that Father recommended three times."

b. PCDs for VP1 and VP2 with verb-doubling

ngo5 go4go1 tai2 baa4baa1 teoi1gaai3 go2 tou3 sau6 fun1jing4 ge3 hei3 tai2zo2 saam1ci3

1sg elder-brother watch father recommend that CL popular PRT film watch-ASP three time

"My elder brother watched that popular film that Father recommended three times."

Finally, the verb-doubling construction shares some properties with cases such as English optional *that*. The verb copy (V2) makes explicit the non-local relationship between the first verb (V1) and the frequency or duration phrase without adding additional semantic content to the sentence, just as the insertion of optional *that* in English makes explicit the connection between the verb and its clausal complement. When the object NP is heavy, the distance between V1 and the modifying phrase becomes greater, possibly increasing the preference for a more explicit connection between them, which the verb-doubling construction provides.

2.3 Syntactic priming in sentence production

In addition to factors such as discourse information structure and grammatical weight, the choice of syntactic structure in sentence production is also influenced by structures that have been recently perceived and/or produced in previous utterances. In an effect known as syntactic

priming, or structural priming, the syntactic constituent structure (surface structure) of a recently encountered sentence tends to be repeated in subsequent utterances, even if those subsequent utterances are unrelated to the previous utterance in lexical content and have no apparent semantic or pragmatic relation to the previous utterance (e.g., Bock 1986, Bock and Loebell 1990, Pickering and Branigan 1998, Bock and Griffin 2000). Priming effects are generally interpreted as the result of increased activation of an abstract syntactic structure, which facilitates production of that structure in subsequent utterances.

For example, in her foundational study of syntactic priming, Bock (1986) conducted three experiments showing a priming effect for speakers' choice between active vs. passive structure and prepositional dative vs. double-object structure in English. On each trial, participants imitated a sentence spoken by the experimenter. They then viewed an unrelated event in a picture and described it in one sentence. The results of these experiments showed that participants were much more likely to produce a particular structure (e.g. double-object construction) in their picture descriptions when it occurred in the priming sentence than when the alternative structure was primed. For example, one experiment showed that when the priming sentence used the double-object structure, 53% of picture descriptions also used the double-object structure, whereas only 31% of picture descriptions used the double-object structure when the priming sentence used a prepositional dative structure (1986, p.364). Such priming effects were shown to occur independently of other factors such as lexical content, semantic content, or pragmatic context. In more recent studies, similar priming effects have been shown using prime sentences that were read or heard but not previously produced by the participants (Bock et al. 2007; Potter and Lombardi 1998).

The current study examines the effects of both grammatical weight and syntactic priming on the choice between canonical and verb-doubling structures in Cantonese using an elicited production task in which the prime sentences are heard but not produced by the participants. In Experiment 1, the grammatical weight of the direct object NP is manipulated and the canonical sentence structure [S V O Adjunct] is primed. In Experiment 2, the grammatical weight of the direct object NP is manipulated in the same way as in Experiment 1, but the verb-doubling structure [S V O V Adjunct] is primed. We predict that both grammatical weight and syntactic priming should significantly influence speakers' sentence production. Specific predictions are given in the following sections, which describe the two experiments.

3.0 Experiment 1: Elicited production using canonical sentence structure

The goal of Experiment 1 was to test whether the weight of the direct object NP in Cantonese sentences with canonical [S V O Adjunct] order would induce speakers to shift to alternative syntactic structures when recalling the meaning of a sentence in an elicited production task. The task was similar to a cued repetition task (e.g., Ferreira and Dell 2000), but modified to avoid exact repetition and encourage more structure shifting. Spoken sentences with canonical [S V O Adjunct] order were presented to native Cantonese listeners. An oral response was then solicited using a probe question following the stimulus sentence: *X zou6 me1je5 le1?* 'What did X do?' (where X= subject NP). Participants were instructed to answer the question accurately and completely in terms of meaning, but told that they did not need to repeat the information exactly as they heard it. See Appendix A for the exact instructions. Sample test stimuli with light, medium, and heavy object NPs are given in Table 1 below. See Appendix B for a list of all the experimental sentences.

Table 1: For Experiment 1, stimulus set with light, medium, and heavy object NPs

Light object NP (no modifiers)

Ngo5 go4go1 zaa1zo2 go2 gaa3 ce1 jat1 nin6.
1sg elder-brother drive-ASP that CL car one year
"My elder brother drove that car for one year."

Medium object NP (adjective)

Ngo5 go4go1 zaa1zo2 go2 gaa3 hak1sik1 ge3 ce1 jat1 nin6.
1sg elder-brother drive-ASP that CL black PRT car one year
"My elder brother drove that black car for one year."

Heavy object NP (object relative clause + adjective)

Ngo5 go4go1 zaa1zo2 baa4baa1 maai5 go2 gaa3 hak1sik1 ge3 ce1 jat1 nin6.
1sg elder-brother drive-ASP father buy that CL black PRT car one year
"My elder brother drove that black car that father bought for one year."

Following Hawkins (2004), Matthews and Yeung (2001), and Cheung (2006), we predicted that canonical sentences with heavy object NPs should be particularly inefficient for speakers and listeners to process because of the phrase-initial position of the verb in combination with the phrase-final position of the head noun in Cantonese. Although we expected an overall advantage for the canonical structure due to syntactic priming effects, we hypothesized that speakers would sometimes shift to using alternative syntactic structures in order to minimize the processing domains for the VP. Shifting was predicted to occur most often when the object NP was heavy. Based on pilot results, we predicted that the verb-doubling construction would commonly be used as an alternative to canonical order in VPs containing a frequency or duration phrase, and that the incidence of verb-doubling would increase when the object NP was heavy. Because the verb-doubling construction decreases the distance between the verb and its

arguments (shortening the Lexical Domain) and splits the VP into two separate VPs (shortening the Phrasal Combination Domains), it offers a useful option for minimizing the VP domain while expressing the same semantic content as the corresponding canonical sentence (see discussion in Section 2.2 above). Because of the greater information content associated with heavy NPs, we also hypothesized that speakers would make more errors in recalling the meaning of the sentence when the object NP was heavy.

3.1 Methods

Participants. Twenty-five student volunteers from the University of Hong Kong were paid for their participation. All were native speakers of Cantonese with high proficiency also in English. Participants ranged in age from 19 to 24, with an average age of 21. There were 17 women and 8 men. Data from 4 participants were excluded from the analysis because those participants failed to correctly follow the instructions. Data from 21 participants were included in the analysis.

Materials and procedure. The experimental stimuli consisted of 12 sets of three sentences each. An example of one set is given in Table 1 above. All experimental sentences had the canonical word order pattern of [S V O Adjunct], and all subject and object NPs were definite. Weight of the object NP (light, medium, heavy) was the only factor that was manipulated. Light NPs had three words and consisted of determiner, classifier, and noun. Medium NPs had five words and consisted of determiner, classifier, adjective, modification marker *ge3,* and noun. Heavy NPs had seven words and were identical to the medium NPs except for the addition of a two-word object relative clause at the beginning of the phrase. Subject NPs were always two words, and adjunct phrases were always two or three word NPs expressing either duration (e.g. *jat1 nin6* 'for one year') or frequency (e.g., *saam1 ci3* 'three times'). A different transitive, two-argument verb was used for each set of sentences. See

Appendix B for a list of all the experimental sentences. The stimuli also included 72 filler sentences which varied in syntactic structure, lexical content, and complexity.

Stimuli were recorded by a female native speaker of Cantonese, edited into individual sound files, and presented aurally to participants. Aural presentation was chosen to ensure that participants would process the sentences according to the structure of spoken Cantonese while avoiding influence from the structure of written Chinese, which resembles Mandarin more than Cantonese. A repeated measures design was used, such that each participant heard all of the same sentences. In each session, stimuli were presented in three blocks of 36 sentences each, with each block consisting of 12 experimental sentences and 24 fillers. The experimental sentences in each block were assigned such that one member of each of the 12 sentence sets (as in Table 1 above) was assigned to a block, with an equal number of light, medium, and heavy sentences in each block. An E-Prime program was used to randomize both the order of presentation of sentences within each block and the order of blocks so that each participant heard a different random ordering of sentences. Participants were given a short break following each block of 36 sentences, and the entire session took about 30 minutes.

The presentation of each stimulus sentence was followed by a three-second pause to give participants time to understand the sentence, and then a probe question soliciting an oral response. For experimental sentences, the probe question was always *X zou6 me1je5 le1?* 'What did X do?' (X= subject NP). For example, the participant might hear the following:

> Ngo5 go4go1 zaa1zo2 go2 gaa3 ce1 jat1 nin6. ('My elder brother drove that car for one year')
>
> [3-second pause]
>
> Ngo5 go4go1 zou6 me1je5 le1? ('What did my elder brother do?')

For filler sentences, probe questions were always *wh*-questions, but varied as to whether the question was asking who, where, how long, which one, or what. Participants were instructed to answer each question as accurately as possible in terms of meaning, but told that they did not need to repeat the information exactly as they heard it in the original sentence (see Appendix A for exact instructions). These instructions were designed to encourage structure shifting and avoid exact repetition of the stimulus sentence.

Responses were digitally recorded during the experimental session and later transcribed and coded following a scheme similar to that of Cheung (2006). Sentences were coded for both accuracy of information content and type of sentence structure produced. An informationally inaccurate response was defined as omitting or changing any information described by the verb, the direct object, or the adjunct. For example, omitting the adjunct phrase, replacing any content word (noun, verb, or adjective) with a different word, or omitting the adjective or relative clause describing the direct object were counted as errors. Changing only the word order or structure of the sentence was not counted as an error in information accuracy unless the propositional meaning of the sentence was changed (e.g., reversing subject and direct object NPs). Since the subject NP was mentioned in the probe question, omitting the subject NP from the response was not counted as an error. Sentence type was coded from a list of possible constructions identified in pilot testing, including canonical order, verb-doubling, topicalization, light verb, and other. Responses coded as 'other' were later analyzed, and two new categories of 'adjunct omission' and 'Verb-Adjunct-Object order' were created to describe subsets of the 'other' responses (see section 3.2 below). A portion of responses (20%) was re-coded by a second rater, and there was found to be 96% agreement between the two raters for sentence type and 94% agreement for information accuracy.

3.2 Results

Information accuracy. As shown in Figure 1, accuracy in information content of responses decreased with increased object weight, with 91% accuracy for light NPs as compared with 85% accuracy for medium NPs and 50% accuracy for heavy NPs.[7] A one-way repeated measures ANOVA confirmed that the effect of object weight was significant both by participants and by items: $F_1(2, 19) = 35.46$, $p < 0.01$; $F_2(2, 10) = 22.94$, $p < 0.01$. Pairwise comparisons showed that the significant effect of object weight was due to the large difference in accuracy between the heavy condition and the other two conditions. There was a significant difference between light and heavy conditions ($t = 7.45$, $p < 0.01$) and medium and heavy conditions ($t = 8.49$, $p < 0.01$), but the difference between light and medium conditions did not reach significance ($t = 1.77$, $p = 0.09$).

[Figure 1 here]

Structure repetition. Overall, 86% of responses maintained the canonical word order heard in the stimulus sentences. Contrary to our prediction, the incidence of canonical word order did not significantly decrease when the object NP was heavy. As shown in Figure 2, production of canonical word order decreased slightly in the heavy condition (86% for light objects vs. 84% for heavy objects), but the effect of object weight was not significant: $F_1 (2, 19) = 1.2$, $p = 0.35$; $F_2 (2, 10) = 0.9$, $p = 0.44$. Pairwise comparisons confirmed that no two conditions showed any

[7] Errors bars in all figures indicate Standard Error of the mean.

significant difference: light vs. medium ($t = 0.87$, $p = 0.40$), medium vs. heavy ($t = 1.53$, $p = 0.14$), light vs. heavy ($t = 0.90$, $p = 0.38$).

[Figure 2 here]

Interestingly, when informationally inaccurate responses were excluded from the analysis, a greater proportion of responses showed the canonical structure. Overall, 94% of accurate responses used canonical structure compared with 86% of all responses. As shown in Figure 3 below, proportion of canonical responses increased from 91% for light objects to 98% for heavy objects.

[Figure 3 here]

Structure shifting. As noted above, 86% of all productions were of the canonical sentence type, repeating the structure heard in the stimulus sentences. Other structures produced included verb-doubling (5%), adjunct-object order (2%), adjunct omission (1.5%), and 'other' (5%). Figure 4 shows the number of productions of each sentence type (maximum of 12 for each condition), averaged across all the participants. Canonical responses, which were much higher, are omitted for clarity of presentation of the non-canonical responses. Both accurate and inaccurate responses were included in the analysis.

[Figure 4 here]

Frequency of verb-doubling was lower than expected based on pilot results, at only 5% of all responses. Contrary to our prediction, incidence of verb-doubling did not increase in proportion to the weight of the object NP. In the light condition, 5% of responses (average of 0.62 out of 12 responses per participant) used verb-doubling, while in the heavy condition, 4% of responses (average of 0.52 out of 12 responses per participant) used verb-doubling. This difference was not significant: $F_1(2,19) = 0.29$, $p = 0.75$. Also contrary to expectation, there were no instances of topicalization (object-fronting) or light verb constructions in participants' responses.

Two unanticipated structures showed up in a number of the participants' responses. The first involved simply omitting the adjunct, and the second involved reversing the usual order of object before adjunct. Frequency of structures in which the adjunct phrase was omitted showed a significant effect of object weight: $F_1 (2,19)= 4.75$, $p = 0.02$. In the light condition, 1% of responses (average of 0.14 responses out of 12 per participant) used adjunct omission, while 3% of responses (average of 0.33 responses out of 12 per participant) used adjunct omission in the heavy condition. Note that this effect is consistent with Hawkins' (2004) theory, since omission of the adjunct is one strategy for reducing the PCD of the VP when the object NP is heavy. A similar trend in the opposite direction was found for the production of Verb-Adjunct-Object (VAO) order, in which adjunct phrase and object NP are reversed from the canonical position: an average of 3% of responses (average of 0.38 responses per participant) used VAO order when the object NP was light, while only 1% of responses (average of 0.1 responses per participant)

used VAO order with heavy NPs. Again, this trend is consistent with Hawkins' theory, since VAO order increases the LD of the verb by placing an additional constituent in between the verb and its subcategorized object. Because the object NP is head final, VAO order should be dispreferred especially when the object NP is heavy. However, this trend did not reach significance in our data: F_1 (2,19) = 2.60, p = 0.1.

3.3 Discussion

As expected, participants made more errors in information content as the weight of the object NP increased. It is interesting that the decrease in accuracy from medium to heavy conditions (85% to 50%) was much greater than the decrease in accuracy from light to medium conditions (91% to 85%), with only the former being a statistically significant difference. This result suggests that the heavy object condition, which included both an adjective and an object relative clause modifying the object, greatly taxed the participants' working memory, leading them to change or omit words in the elicited production task. However, the medium condition, which only included an adjective modifying the object, apparently caused little difficulty. The greater decrease in accuracy from medium to heavy conditions could be due to a greater increase in length when adding an object relative clause as opposed to adding an adjective. The adjective adds only one content word to the NP, while the object relative adds two content words, thus increasing the probability for an error on one of the content words.[8] Syntactic complexity could also be a factor. At least under standard assumptions, an object relative clause consists of more phrasal nodes than an adjective does as well as a dependency involving an empty category (gap)

[8] Recall that errors involving function words (e.g., the modification marker *ge3*) were not included in the calculation of information accuracy.

within the relative clause VP. It is therefore possible that both length and complexity contributed to the higher error rate for heavy object sentences.

Contrary to expectation, object weight did not significantly affect the frequency with which the canonical structure was used in responses. Approximately 86% of responses used the canonical structure in all three conditions. In other words, about 14% of responses used alternative sentence structures regardless of object weight. Also contrary to our prediction, incidence of verb-doubling was quite low overall (at 5%), and did not increase in the heavy object condition. However, these results do provide strong evidence for our claim that verb-doubling is optional in Cantonese and not required by the grammar. Only one effect of weight on choice of structure reached significance: the tendency for adjunct omission when then object NP was heavy. Consistent with Hawkins' (2004) theory, adjunct omission reduces the PCD for the VP by removing one of the VP's constituents.

These results appear to show a strong effect of syntactic priming, where the syntactic structure of the stimulus sentence primed participants' responses regardless of the weight and information content of the object NP. These results are consistent with research on structural priming (as discussed in Section 2.3 above) showing that that the syntactic structure of a recently encountered sentence tends to be repeated in subsequent utterances (e.g., Bock 1986, Bock and Loebell 1990, Pickering and Branigan 1998, Bock and Griffin 2000). This sort of priming effect has been shown not only for previously produced structures but also for structures that were read or heard but not previously produced, as in the present experiments (Bock et al. 2007, Potter and Lombardi 1998). For example, Bock et al. (2007) found that listeners tend to repeat the syntactic structure of a sentence just heard (but not previously produced) when describing a picture depicting an unrelated event rather than using an alternative structure to express the same

meaning. The effect was similar to that found in previous studies (e.g., Bock 1986) in which speakers tended to repeat the structure of a previously produced sentence. Similarly, Potter and Lombardi (1998) found that when participants silently read a prime sentence followed by an unrelated target sentence and were then asked to recall the target sentence, they generally repeated the target sentence accurately. However, when the prime sentence mismatched the target sentence in such a way that it suggested an alternative structure to express the meaning of the target sentence (as in dative prime with double-object target), the alternative structure was more frequently produced in recall.

Potter and Lombardi (1998) propose that, after reading or hearing a sentence, people have both explicit (conscious) memory for its meaning and implicit memory for its syntactic structure: "Thus, when there are two equivalent syntactic structures to express the same meaning (as in the case of dative sentences), syntactic priming from the to-be-recalled sentence will make it likely that the participant will generate the same structure processed at input" (1998, p.267). This seems to be a plausible account of what happened in our Experiment 1. Even in the heavy object condition in which participants made a lot of errors in recalling the content of the stimulus sentence, participants repeated the canonical structure just as often as in the light object condition. Interestingly, this priming effect was even stronger for informationally accurate responses, for which 94% of responses used the canonical structure. A plausible interpretation of this result is that structure repetition is generally easier than structure shifting, especially under increased cognitive load. In conditions where participants produced accurate responses to heavy NP sentences, they may have used more cognitive resources to get the information content right, thus falling back more often on the less cognitively demanding strategy of repeating the primed

structure. We discuss this interpretation further with respect to previous literature on syntactic priming in Section 5 below.

4.0 Experiment 2: Elicited production using verb-doubling structure

Because participants in Experiment 1 shifted to the verb-doubling structure infrequently (only 5% of the time), we decided to use a different set of stimuli to test whether there might be a processing advantage for verb-doubling over the canonical structure in the heavy object condition. Experiment 2 used the same elicited production task as Experiment 1, with the same stimulus materials modified slightly to use the verb-doubling structure [S V O V Adjunct] rather than canonical structure [S V O Adjunct]. A sample stimulus set with light, medium, and heavy object NPs are given in Table 2 below (identical to the stimuli in Table 1 except for the verb-doubling).

Just as there was an overall advantage for canonical structure in Experiment 1, we expected an overall advantage for verb-doubling structure in Experiment 2 due to the effects of syntactic priming. Again following the approach of Hawkins (2004), we expected an advantage of verb-doubling over canonical structure when the object NP was heavy. Thus, we predicted that speakers would shift from the verb-doubling structure to the canonical structure *less often* when the object NP was heavy. Thus, rate of canonical structure should decrease in the heavy object condition while rate of verb-doubling structure should increase. Because of the greater information content associated with heavy NPs, we also hypothesized that speakers would make more errors in recalling the meaning of the sentence when the object NP was heavy.

Table 2: For Experiment 2, verb-doubling stimuli with light, medium, and heavy object NPs

Light object NP (no modifiers)
Ngo5 go4go1 zaa1 go2 gaa3 ce1 zaa1zo2 jat1nin6. 1sg elder-brother drive that CL car drive-ASP one year "My elder brother drove that car for one year."
Medium object NP (adjective)
Ngo5 go4go1 zaa1 go2 gaa3 hak1sik1 ge3 ce1 zaa1zo2 jat1 nin6. 1sg elder-brother drive that CL black PRT car drive-ASP one year "My elder brother drove that black car for one year."
Heavy object NP (object relative clause + adjective)
Ngo5 go4go1 zaa1 baa4baa1 maai5 go2 gaa3 hak1sik1 ge3 ce1 zaa1zo2 jat1 nin6. 1sg elder-brother drive father buy that CL black PRT car drive-ASP one year "My elder brother drove that black car that father bought for one year."

4.1 Methods

Participants. Twenty-four student volunteers from the University of Hong Kong were paid for their participation. These participants had not taken part in Experiment 1. All were native speakers of Cantonese with high proficiency also in English. There were 17 women and 7 men, and the average age of participants was 22 years. Data from all 24 participants were included in the analysis.

Materials and procedure. Materials were identical to Experiment 1, except that experimental sentences had the verb-doubling structure of [S V O V Adjunct], as shown in Table 2 above, rather than the canonical structure [S V O Adjunct], as in Table 1 in Section 3. Lexical content of the test sentences was the same as for Experiment 1, and the same female speaker made the recordings that were presented to participants. Filler sentences and probe questions

were exactly the same as in Experiment 1. The procedure for conducting the experiment and coding the data was also the same as in Experiment 1. A portion of responses (20%) was re-coded by a second rater, and there was found to be 97% agreement between the two raters for sentence type and 96% agreement for information accuracy.

4.2 Results

Information accuracy. As shown in Figure 5, accuracy in information content of responses decreased with greater object weight, with 89% accuracy for light NPs, 78% accuracy for medium NPs, and 42% accuracy for heavy NPs. A one-way repeated measures ANOVA confirmed that the effect of object weight was significant both by participants and by items: F_1 (2,22) = 45.29, $p < 0.01$; F_2 (2, 10) = 72.12, $p < 0.01$. Similar to Experiment 1, there was a large difference between the medium and heavy conditions and a smaller difference between the light and medium conditions. However, in this case, differences among all pairs of conditions were significant: light vs. medium ($t = 5.99$, $p < 0.01$), medium vs. heavy ($t = 9.73$, $p < 0.01$), light vs. heavy ($t = 9.37$, $p < 0.01$).

[Figure 5 here]

Structure repetition. Overall, 77% of responses maintained the verb-doubling heard in the stimulus sentences. Contrary to our prediction, incidence of verb-doubling did not increase in the heavy object condition. As shown in Figure 6, production of verb-doubling decreased slightly in the heavy condition (78% for light objects vs. 74% for heavy objects). However, this difference was not significant: F_1 (2,22) = 1.19, $p = 0.32$; F_2 (2, 10) = 0.82, $p = 0.47$. Pairwise

comparisons confirmed that no two conditions showed any significant difference: light vs. medium ($t = 0.43$, $p = 0.68$), medium vs. heavy ($t = 0.9$, $p = 0.38$), light vs. heavy ($t = 1.54$, $p = 0.14$).

[Figure 6 here]

When inaccurate responses were excluded from the analysis, a greater proportion of responses used the verb-doubling structure, as shown in Figure 7.

[Figure 7 here]

Overall, 85% of accurate responses used canonical structure compared with 76% of all responses. This is similar to the result for repetition of canonical structure in Experiment 1. Incidence of verb-doubling structure for accurate responses showed little change with respect to object weight (86% for light objects vs. 87% for heavy objects).

Structure shifting. As noted above, 77% of all productions were of the verb-doubling sentence type, repeating the structure heard in the stimulus sentences. Other structures produced were canonical word order (11%), adjunct omission (3%), topicalization (1%), Verb-Adjunct-Object order (3%) and "other" (5%). Figure 8 below shows the mean number of productions of each sentence type, averaged across all the participants. Verb-doubling responses, which were much higher, were omitted for a clearer view of the other types of responses. Both accurate and inaccurate responses were included in this analysis.

We had predicted that the use of the canonical sentence type should decrease with heaviness of the object NP. As shown in Figure 8 below, the trend was in the predicted direction, with use of canonical structure decreasing from 13% (average of 1.5 responses per participant) in the light NP condition to 10% (average of 1.17 responses per participant) in the heavy NP condition. However, due to high variability across participants, the effect of object weight on production of canonical sentences was not significant: F_1 (2,22) = 0.77, p= 0.47.

[Figure 8 here]

An interesting trend in the data was that participants produced more topicalization structures (sentences in which the object NP is moved in front of the subject) when the object was heavy. This result is consistent with Hawkins' (2004) theory, since topicalizing a heavy object decreases the PCD for the VP, and with Matthews and Yeung's (2001) study showing that reading time is faster for Cantonese sentences with heavy objects when the object is topicalized. However, this trend did not reach significance in our data: F_1 (2,22) = 2.89, p= 0.08. There was also no significant effect of object weight for the production of Verb-Adjunct-Object word order: F_1 (2,22) = 1.57, p=0.23.

4.3 Discussion

As predicted, participants made many more errors in information content when the object NP was heavy. Largely replicating the results of Experiment 1, the decrease in accuracy from medium to heavy conditions (78% to 42%) was again much greater than the decrease in accuracy from light to medium conditions (89% to 78%), although in this case both differences were

significant. The greater difference between medium and heavy conditions can again be attributed to the fact that the object relative clause (which occurred only in heavy NPs) was both longer and syntactically more complex than the adjective (which occurred in both medium and heavy NPs).

Contrary to our predictions for structure accuracy, neither rate of canonical structure, which we had predicted to *decrease* as a function of object weight, nor rate of verb-doubling, which we had predicted to *increase* as a function of object weight, significantly changed. As in Experiment 1, the major finding was that speakers tended to repeat the structure they had just heard. Verb-doubling structure was repeated in about 77% of all responses, regardless of object weight, even though responses were much less accurate in the heavy object condition. These findings are again consistent with previous research showing robust syntactic priming effects for structures that were read or heard but not previously produced (Bock et al. 2007; Potter and Lombardi 1998). Also as in Experiment 1, the apparent priming effect was stronger when looking only at accurate responses, for which 85% used the verb-doubling structure. Again, this suggests that structure repetition is generally easier than structure shifting, and thus will occur more often for accurate responses, for which presumably a greater proportion of cognitive resources are devoted to the task of correctly recalling the information content of the stimulus sentence. We return to this point in Section 5 below.

5. General Discussion

Verb-doubling is a structure commonly used in Chinese when the VP contains a transitive verb, a direct object, and a frequency or duration phrase. In Cantonese, the distribution of verb-doubling is grammatically optional and not clearly linked to particular semantic or pragmatic contexts. The current study set out to discover whether processing factors could help explain the choice of

verb-doubling vs. canonical VP structure, in particular with regard to grammatical weight and syntactic priming.

We correctly predicted that information accuracy should decrease as object weight increases, as confirmed by the results of both experiments. Interestingly, both experiments also showed a greater decrease in accuracy from medium to heavy conditions than from light to medium conditions, an effect which can be attributed to the greater length and complexity of the object relative clause as compared with the adjective. However, these experiments showed little support for our other weight-based predictions based on Hawkins' (2004) theory. First, our hypothesis that canonical sentence structure should be produced less often with heavy objects was not supported. Nor did our results support the prediction that verb-doubling structure should be preferred in proportion to the weight of the object NP. Thus, these results did not replicate results from a pilot study (Liu 2006), which found clear effects of object weight on the incidence of canonical vs. verb-doubling structure, for a smaller population of participants.[9] There were, however, some identifiable effects of weight in both experiments. In Experiment 1, adjunct omission occurred significantly more often in the heavy NP condition. This is consistent with Hawkins' (2004) principle of Minimize Domains, since omitting the adjunct reduces the PCD for the VP by removing one of its constituents. In Experiment 2, there was a similar trend with respect to topicalization. Topicalization of the object occurred more often in the heavy NP condition, again consistent with Hawkins' theory, since the PCD for VP is reduced when the object is topicalized (see Section 2.2, example 12). This trend also concurs with Matthews and

[9] Liu's task was also slightly different, in that stimulus sentences and probe questions were read aloud by the experimenter in a more conversation-like setting, rather than being presented on a computer. Thus, our modification of the task may have discouraged structure shifting.

Yeung's (2001) study showing a reading-time advantage for topicalization with heavy object NPs. However the trend did not quite reach significance in our data, possibly because there were too few instances of topicalization overall.

The main finding of these experiments was a strong effect of syntactic priming. In both experiments, participants tended to repeat the structure heard in the stimulus sentence. When the canonical structure was heard, canonical structure was repeated, and when verb-doubling structure was heard, verb-doubling was repeated. Even though participants were specifically instructed that they should pay attention to the meaning, not the structure, of the stimulus sentences, they repeated the structure much more accurately than the meaning when the object NP was heavy. We interpret this to mean that in general, producing the primed structure may be easier than producing the correct information content when the object NP is heavy. This result is consistent with Potter and Lombardi's (1990, 1998) studies which suggest that, in immediate recall of sentences, speakers regenerate sentences based on a meaning representation that is explicitly encoded in memory and independent of syntax. However, speakers also tend to repeat the syntactic structure of the recalled sentence based on a separate, implicit memory for structure. They argue that both factors independently contribute to the tendency for verbatim immediate recall of sentences. Because structure was repeated much more accurately than meaning, the results of our experiments appear to support Potter and Lombardi's idea that syntactic and semantic representations are independently encoded.

Another interesting finding in both experiments was that priming effects were stronger for informationally accurate responses. In Experiment 1, the canonical structure was repeated in 86% of all responses, but in 94% of accurate responses. Similarly, in Experiment 2, the verb-doubling structure was repeated in 76% of all responses, but in 85% of accurate responses. One

plausible explanation for this is that in conditions where participants produced accurate responses to heavy NP sentences, they may have used more cognitive resources to get the information content right, thus falling back more often on the less cognitively demanding strategy of repeating the primed structure. This interpretation is consistent with studies showing that syntactic priming facilitates processing, possibly by reducing the cognitive resources needed in planning and production. For example, separate studies by Smith and Wheeldon (2001) and Corley and Scheepers (2002) found that speakers began to produce target sentences significantly faster when they had previously produced a sentence of the same structure than when they had previously produced a sentence with a different structure. In addition, our idea that priming was stronger for accurate responses because of more limited cognitive resources receives some support from a study of syntactic priming and Broca's aphasia. Hartsuiker and Kolk (1998) found that syntactic priming effects were stronger in individuals with Broca's aphasia than in normal adults. The authors suggest that a possible explanation for these results might be the limited cognitive capacity of these individuals. Because of limited cognitive resources, Broca's aphasics are unable to maintain competing syntactic structures in working memory. Thus, the less activated (unprimed) structure drops out, resulting in a greater syntactic priming effect (Hartsuiker and Kolk 1998, p.247). Although the studies described here did not systematically manipulate cognitive load, they at least suggest that the increased priming effect for accurately remembered sentences in our study can plausibly be attributed to capacity demands. An interesting direction for future research would be to manipulate cognitive load with a syntactic priming task to test whether increased load results in a stronger priming effect. As far as we can tell, no study has yet directly tested this hypothesis.

Comparing Experiments 1 and 2, another interesting outcome was that the proportion of canonical responses in Experiment 1, for which canonical structure was primed, was greater than the proportion of verb-doubling responses for Experiment 2, for which verb-doubling structure was primed (86% vs. 77%). Conversely, the proportion of verb-doubling responses in Experiment 1 was lower than the proportion of canonical responses in Experiment 2 (5% vs. 11%). This suggests a general preference for canonical word order over verb-doubling, such that canonical order is in some sense the default pattern. This default pattern is reinforced when canonical structure is primed, but still has some effect even when the verb-doubling structure is primed. Similar (though much greater) differences have been shown in priming studies examining active vs. passive sentences in English. For example, Bock (1986) found in one experiment that when an active sentence served as the prime, 73% of picture descriptions used the active structure and 12% used the passive structure. However, when a passive sentence was used as the prime, only 20% of picture descriptions used the passive structure while 65% of picture descriptions used the active structure (1986, p.364). Although there was a significant priming effect for passive sentences (20% passive responses with passive primes vs. 12% passive responses with active primes), there was also a general bias for using the active sentence structure to describe events involving two participants. This general bias is most likely related to the much greater frequency of active vs. passive sentences in English. The bias we found for canonical structure vs. verb-doubling in Cantonese may be similarly related to greater frequency of the canonical structure, though we are unable to verify this due to the unavailability of relevant discourse studies or syntactically tagged corpora of Cantonese.

One implication of these results for the grammar of Cantonese is that there is no case for an obligatory, syntactically or semantically conditioned rule of verb doubling, as has been

proposed in research on Mandarin verb-doubling (see Section 1 above). For each stimulus with doubling (Experiment 2), there were a substantial number of responses without doubling; conversely, for stimuli without doubling (Experiment 1), the rate of doubling in the responses was far lower than would be expected if such a rule were operating. Overall, 86% of responses in Experiment 1 maintained the canonical word order—an ordering that would be ungrammatical if a constraint such as Huang's (1982) Phrase Structure Condition were applicable here.

Although the results of Experiments 1 and 2 provide little direct support for Hawkins' (2004) theory, we believe that these results are still compatible with the theory. Because the particular task that we used produced strong priming effects, the incidence of structure shifting was quite low overall. Therefore, our task may not have been sensitive enough to adequately test the effects of constituent weight on choice of structure. Future research on this topic should use different tasks that avoid or minimize priming effects, allowing a more sensitive test of the effects of constituent weight. However, this is challenging because standard production tasks either involve priming (e.g., cued sentence recall, picture description with priming) or make it difficult to control for NP weight (e.g. picture description without priming). Alternative tasks have been used in previous research on grammatical weight effects in production. For example, Stallings et al. (1998) and Yamashita and Chang (2001) presented written phrases at different locations on a computer screen and asked participants to form a sentence out of those phrases. This kind of task allowed them to investigate choice of word order while manipulating phrase length and avoiding priming effects.[10] However, such a method would have to be modified for our sentence materials, since the word order of canonical and verb-doubling sentences is the

[10] In both studies, priming effects were minimized by counterbalancing the location of different kinds of phrases on the screen across trials.

same while the composition of the phrases is slightly different. In addition to the presence vs. absence of a verb copy, the position of aspect marking is different for the two constructions. One possibility, however, might be to display a direct object, adjunct, and verb with no aspect marking and ask participants to form a sentence using those cues. Although not a measure of online production, a forced choice task such as used by Liu (1996) and Bresnan (2006), in which participants must choose between two alternative sentences for completing a paragraph, could be used to show weight effects independently of other factors. In addition, a corpus-based study examining the frequency of verb-doubling with light vs. heavy object NPs has the potential to reveal grammatical weight effects in a naturalistic context. Finally, a reading time study, such as that used by Matthews and Yeung (2001), or other comprehension task, would provide a useful test of Hawkins' theory, since weight effects are predicted for comprehension as well as production. Some combination of these alternative tasks may well reveal interesting weight-based effects in future research.

6. Conclusion

Because verb-doubling is grammatically optional and has no obvious semantic or pragmatic function in Cantonese, the distribution of Cantonese verb-doubling is not readily explained in terms of existing formal and functional approaches to verb-doubling in Mandarin. Based on Hawkins' (2004) principle of Minimize Domains and on previous research on grammatical weight effects in Cantonese (Matthews and Yeung 2001; Cheung 2006), we hypothesized that speakers would choose verb-doubling to a greater extent when the object NP was heavy. However, the results of two elicited production experiments revealed no weight-based preference for verb-doubling and showed only minor effects of grammatical weight. Rather, our major

findings were related to syntactic priming: (1) for both canonical primes (Experiment 1) and verb-doubling primes (Experiment 2), speakers tended to repeat previously heard structures; (2) the priming effect was just as strong in the heavy NP condition, where speakers made many more errors recalling the semantic content of the sentence, as in the light condition, suggesting that semantic information is represented separately from syntactic information; (3) the priming effect was stronger for accurately recalled sentences in both experiments, suggesting that recently activated structures are easier to produce than other structures under conditions of increased cognitive load; (4) there was a general bias in favor of canonical structure such that the priming effect was stronger for canonical primes than for verb-doubling primes, and the incidence of canonical responses with verb-doubling primes was higher than the incidence of verb-doubling responses with canonical primes. Taken together, these results suggest that the choice between canonical structure and verb-doubling in Cantonese is easily influenced by the immediately preceding syntactic context, with weight effects, if any, being more difficult to detect. Further studies are needed to investigate possible syntactic, semantic, pragmatic, prosodic, and weight-based factors influencing the distribution of verb-doubling in Cantonese and other Sinitic languages.

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Appendix A: Instructions to Participants

[English translation of instructions given in Cantonese]

In a moment, you will hear a series of Cantonese sentences and you will be asked to respond to them by speaking in Cantonese. For each trial, you will hear a sentence followed by a question about that sentence. Please speak your answer to the question, and then press the space bar when you are ready to hear the next sentence. You should answer each question as accurately as possible. However, you do not need to repeat the information exactly as you heard it in the sentence. Just try to convey the meaning accurately to answer the question. Each sentence will be presented only once. If you are unable to answer at all, just say 'I can't answer' and press the space bar to move on to the next sentence.

After each set of sentences is done, the computer will prompt you to take a short break. When you feel ready to continue, you will press the spacebar to begin the next set of sentences. When all three sets are done, a thank-you screen will show up and ask you to inform me that you are finished. The whole experiment will be recorded. Do you have any questions? Please press the space bar when you are ready to begin.

Appendix B: Stimulus Items (Canonical Version) and English Translations

1a. Ngo5 go4go1 tai2zo2 go2 tou3 hei3 saam1ci3

"My elder brother watched that film three times."

1b. Ngo5 go4go1 tai2zo2 go2 tou3 sau6fun1jing4 ge3 hei3 saam1ci3

"My elder brother watched that popular film three times."

1c. Ngo5 go4go1 tai2zo2 baa4baa1 teoi1gaai3 go2 tou3 sau6 fun1jing4 ge3 hei3 saam1ci3

"My elder brother watched that popular film recommended by Father three times."

2a. Ngo5 lou5si1 goi2zo2 go2 pai1 si5gyun2 loeng5ci3

"My teacher marked that batch of test papers twice."

2b. Ngo5 lou5si1 goi2zo2 go2 pai1 sam1 ge3 si5gyun2 loeng5ci3

"My teacher marked that batch of difficult test papers twice."

2c. Ngo5 lou5si1 goi2zo2 hok6saang1 zou6 go2 pai1 sam1 ge3 si5gyun2 loeng5ci3

"My teacher marked that batch of difficult test papers which were done by the students twice."

3a. Ngo5 mui4mui2 coeng3zo2 go2 sau2 go1 ng5ci3

"My little sister sang that song five times."

3b. Ngo5 mui4mui2 coeng3zo2 go2 sau2 dak1ji3 ge3 go1 ng5ci3

"My little sister sang that funny song five times."

3c. Ngo5 mui4mui2 coeng3zo2 lou5si1 gaau3 go2 sau2 dak1ji3 ge3 go1 ng5ci3

"My little sister sang that funny song which was taught by the teacher five times."

4a. Ngo5 go4go1 maat3zo2 go2 zoeng1 toi2 saam1ci3

"My elder brother wiped that table three times."

4b. Ngo5 go4go1 maat3zo2 go2 zoeng1 wu1zou1 ge3 toi2 saam1ci3

"My elder brother wiped that dirty table three times."

4c. Ngo5 go4go1 maat3zo2 mui4mui2 jung6hoi1 go2 zoeng1 wu1zou1 ge3 toi2 saam1ci3

"My elder brother wiped that dirty table used by my little sister three times."

5a. Ngo5 pang4jau5 zou6zo2 go2fan6 gong1fo3 loeng5ci3

"My friend did that homework assignment twice."

5b. Ngo5 pang4jau5 zou6zo2 go2fan6 fuk1zaap6 ge3 gong1fo3 loeng5ci3

"My friend did that complicated homework assignment twice."

5c. Ngo5 pang4jau5 zou6zo2 lou5si1 paai3 go2fan6 fuk1zaap6 ge3 gong1fo3 loeng5ci3

"My friend did that complicated homework assignment distributed by the teacher twice."

6a. Ngo5 maa1mi4 sai2zo2 go2 sek3 wun2 sei3ci3

"My mother washed that bowl four times."

6b. Ngo5 maa1mi4 sai2zo2 go2 sek3 fei4nei6 ge3 wun2 sei3ci3

"My mother washed that oily bowl four times."

6c. Ngo5 maa1mi4 sai2zo2 go4go1 jung6jyun4 go2 sek3 fei4nei6 ge3 wun2 sei3ci3

"My mother washed that oily bowl used by my elder brother four times."

7a. Ngo5 go4go1 caai2zo2 go2 gaa3 daan1ce1 saam1sap6 fan1zung1

"My elder brother has ridden that bicycle for thirty minutes."

7b. Ngo5 go4go1 caai2zo2 go2 gaa3 ji6sau2 ge3 daan1ce1 saam1sap6 fan1zung1

"My elder brother has ridden that second-hand bicycle for thirty minutes."

7c. Ngo5 go4go1 caai2zo2 pang4jau5 sung3 go2 gaa3 ji6sau2 ge3 daan1ce1

saam1sap6 fan1zung1

"My elder brother has ridden that second-hand bicycle given by a friend for thirty minutes."

8a. Ngo5 gaa1ze1 jung6zo2 go2zek3 bui1 loeng5nin4

"My elder sister has used that cup for two years."

8b. Ngo5 gaa1ze1 jung6zo2 go2zek3 luk6sik6 ge3 bui1 loeng5nin4

"My elder sister has used that green cup for two years."

8c. Ngo5 gaa1ze1 jung6zo2 maa1mi4 sung3 go2zek3 luk6sik6 ge3 bui1 loeng5nin4

"My elder sister has used that green cup given by Mother for two years."

9a. Ngo5 gaa1ze1 zaa1zo2 go2 gaa3 ce1 jat1nin6.

"My elder sister has driven that car for one year."

9b. Ngo5 gaa1ze1 zaa1zo2 go2 gaa3 hak1sik1 ge3 ce1 jat1nin6.

"My elder sister has driven that black car for one year."

9c. Ngo5 gaa1ze1 zaa1zo2 baa4baa1 maai5 go2 gaa3 hak1sik1 ge3 ce1 jat1nin6.

"My elder sister has driven that black car bought by Father for one year."

10a. Ngo5 go4go1 cai3zo2 go2 go3 mou4jing4 sei3 go3 zung1

"My elder brother assembled that model for four hours."

10b. Ngo5 go4go1 cai3zo2 go2 go3 san1 ge3 mou4jing4 sei3 go3 zung1

"My elder brother assembled that new model for four hours."

10c. Ngo5 go4go1 cai3zo2 baa4baa1 maai5 go2 go3 san1 ge3 mou4jing4 sei3 go3 zung1

"My elder brother assembled that new model bought by father for four hours."

11a. Ngo5 sai3lou2 wan2zo2 go2 gau6 caak3gaau1 bun3 go3 zung1

“My little brother searched for that eraser for half an hour.”

11b. Ngo5 sai3lou2 wan2zo2 go2 gau6 saam1gok3jing4 ge3 caak3gaau1 bun3 go3 zung1

“My little brother searched for that triangular eraser for half an hour.”

11c. Ngo5 sai3lou2 wan2zo2 maa1mi4 maai5 go2 gau6 saam1gok3jing4 ge3 caak3gaau1 bun3 go3 zung1

“My little brother searched for that triangular eraser bought by Mother for half an hour.”

12a. Ngo5 maa1mi4 guk6zo2 go2 go3 daan6gou1 sei3sap6 fan1zung1

“My mother baked that cake for forty minutes.”

12b. Ngo5 maa1mi4 guk6zo2 go2 go3 wong4sik1 ge3 daan6gou1 sei3sap6 fan1zung1

“My mother baked that yellow cake for forty minutes.”

12c. Ngo5 maa1mi4 guk6zo2 lei5 sik6gan2 go2 go3 wong4sik1 ge3 daan6gou1 sei3sap6 fan1zung1

“My mother baked that yellow cake that you are eating for forty minutes.”

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Table 1: For Experiment 1, stimulus set with light, medium, and heavy object NPs

Light object NP (no modifiers)

Ngo5 go4go1 zaa1zo2 go2 gaa3 ce1 jat1 nin6.
1sg elder-brother drive-ASP that CL car one year
"My elder brother drove that car for one year."

Medium object NP (adjective)

Ngo5 go4go1 zaa1zo2 go2 gaa3 hak1sik1 ge3 ce1 jat1 nin6.
1sg elder-brother drive-ASP that CL black PRT car one year
"My elder brother drove that black car for one year."

Heavy object NP (object relative clause + adjective)

Ngo5 go4go1 zaa1zo2 baa4baa1 maai5 go2 gaa3 hak1sik1 ge3 ce1 jat1 nin6.
1sg elder-brother drive-ASP father buy that CL black PRT car one year
"My elder brother drove that black car that father bought for one year."

Table 2: For Experiment 2, verb-doubling stimuli with light, medium, and heavy object NPs

Light object NP (no modifiers)

Ngo5 go4go1 zaa1 go2 gaa3 ce1 zaa1zo2 jat1nin6.
1sg elder-brother drive that CL car drive-ASP one year
"My elder brother drove that car for one year."

Medium object NP (adjective)

Ngo5 go4go1 zaa1 go2 gaa3 hak1sik1 ge3 ce1 zaa1zo2 jat1 nin6.
1sg elder-brother drive that CL black PRT car drive-ASP one year
"My elder brother drove that black car for one year."

Heavy object NP (object relative clause + adjective)

Ngo5 go4go1 zaa1 baa4baa1 maai5 go2 gaa3 hak1sik1 ge3 ce1 zaa1zo2 jat1 nin6.
1sg elder-brother drive father buy that CL black PRT car drive-ASP one year
"My elder brother drove that black car that father bought for one year."

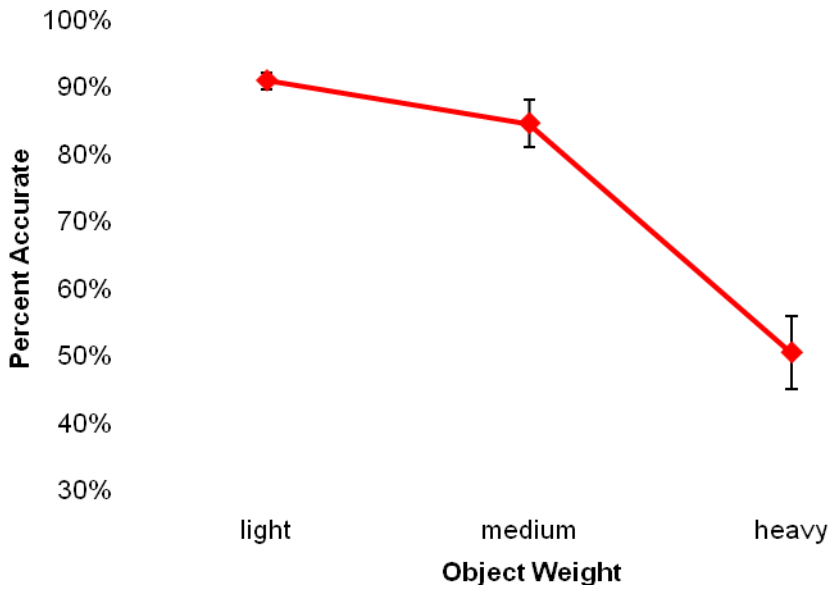

Figure 1: For Experiment 1, percent responses with accurate information content; errors bars represent standard error.

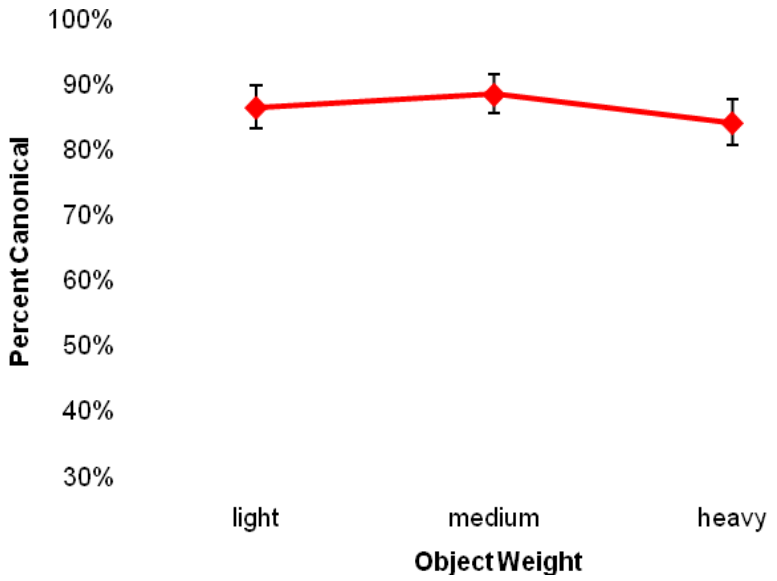

Figure 2: For Experiment 1, percent responses for which canonical structure was repeated, error bars represent standard error.

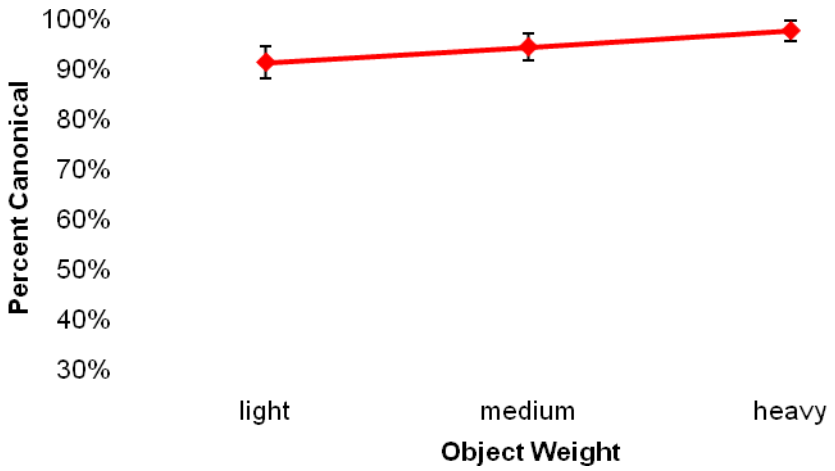

Figure 3: For Experiment 1, percent accurate responses for which canonical structure was repeated; error bars represent standard error.

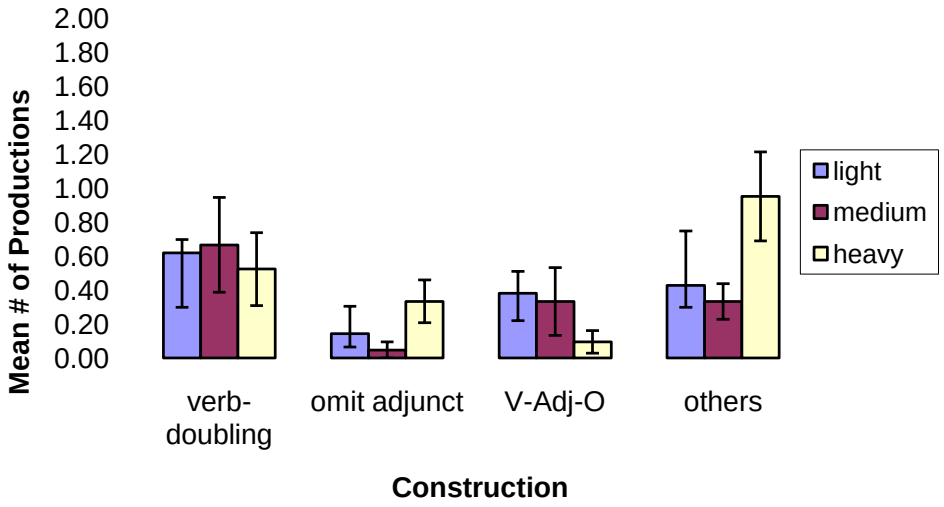

Figure 4: For Experiment 1, mean number of productions for non-canonical sentence structures; error bars represent standard error.

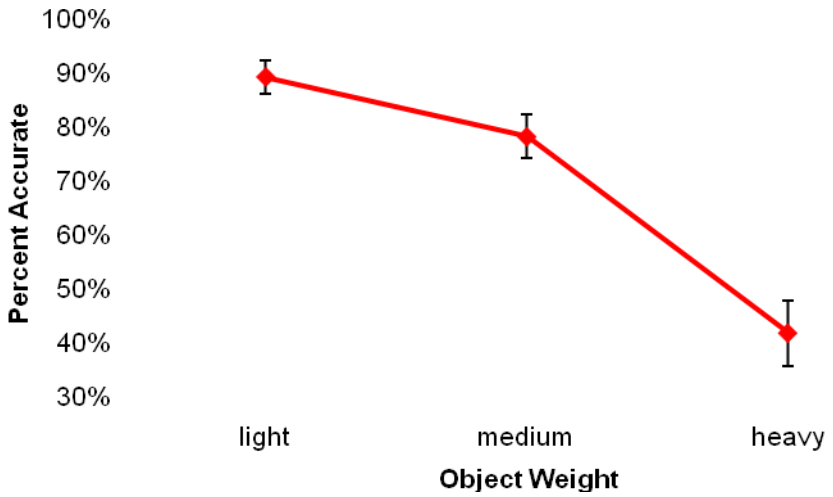

Figure 5: For Experiment 2, percent responses with accurate information content; error bars represent standard error.

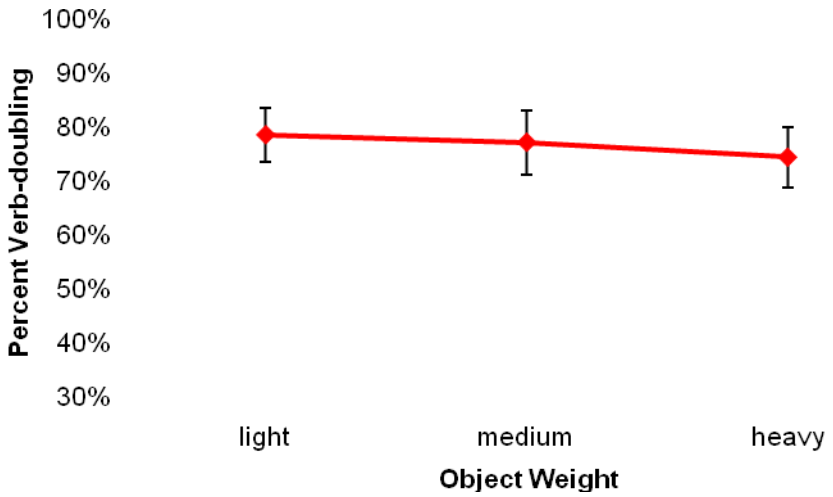

Figure 6: For Experiment 2, percent responses for which verb-doubling structure was repeated; error bars represent standard error.

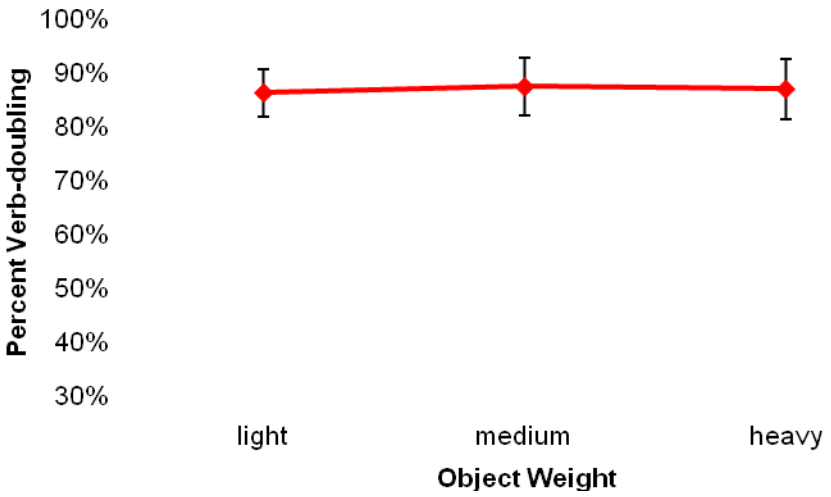

Figure 7: For Experiment 2, percent accurate responses for which verb-doubling was repeated; error bars represent standard error.

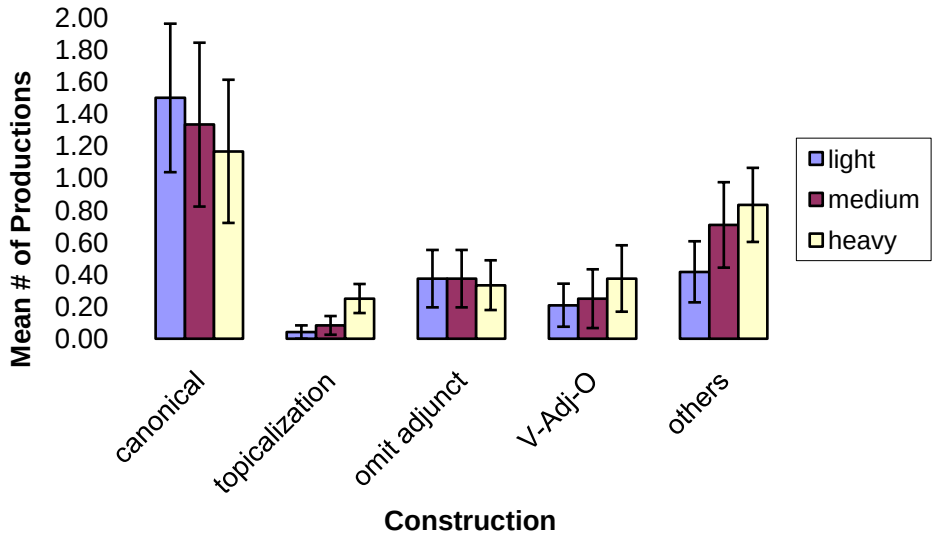

Figure 8: For Experiment 2, mean number of productions for all sentence structures except verb-doubling; error bars represent standard error.

Figure Captions

Figure 1: For Experiment 1, percent responses with accurate information content; error bars represent standard error.

Figure 2: For Experiment 1, percent responses for which canonical structure was repeated; error bars represent standard error.

Figure 3: For Experiment 1, percent accurate responses for which canonical structure was repeated; error bars represent standard error.

Figure 4: For Experiment 1, mean number of productions for non-canonical sentence structures; error bars represent standard error.

Figure 5: For Experiment 2, percent responses with accurate information content; error bars represent standard error.

Figure 6: For Experiment 2, percent responses for which verb-doubling structure was repeated; error bars represent standard error.

Figure 7: For Experiment 2, percent accurate responses for which verb-doubling was repeated; error bars represent standard error.

Figure 8: For Experiment 2, mean number of productions for all sentence structures except verb-doubling; error bars represent standard error.