

### Structural-frequency affects processing cost: Evidence from Chinese relative clauses

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Previous work (e.g., Hsiao and Gibson, 2003) has argued that object relatives (ORs) in Chinese are processed easier than subject relatives (SRs). One explanation is that SRs have a longer distance between the head noun and its corresponding gap than ORs as Chinese relative clauses are prenominal. Another explanation is that the relatively lower structural probability of ORs compared to SRs makes ORs harder to process (Jurafsky, 1996; Hale, 2001; Levy, 2008). Yet when Chinese RCs are presented without syntactically constraining material, temporary ambiguities arise before the head noun is encountered. This makes it difficult to interpret reading times in the region preceding the head noun or at the head noun. Gibson & Wu (2011) addressed this issue using disambiguating context so that the target sentence was guaranteed to be a relative clause from the outset. They found an OR advantage, but restricted to subject-modifying RCs, presumably because of the difficulty to eliminate the temporary ambiguities in object-modifying RCs even with constraining context.

Thus, two problems exist in previous work: we do not know (a) whether the OR advantage exists in out-of-context sentences; and (b) whether the OR advantage is seen in object-modifying RCs as well. In the present self-paced reading study, we look for the OR advantage in both subject-modifying and object-modifying Chinese RCs, using out-of-context relative clauses that are completely unambiguous from the very outset of the sentence. We begin the sentence with a determiner-classifier (det-cl) sequence *na ge* (see (a)) that requires a head noun (here *guke*, 'customer'). However, the det-cl sequence is followed not by the expected noun but an adverbial phrase (e.g., *zuowan*, 'yesterday evening'); it guarantees that the following segment is a relative clause, avoiding the temporary ambiguity preceding the head noun. This manipulation is done for SRs and ORs in subject-modifying RCs as well as in object-modifying RCs (c-d).

Contrary to the predictions of Hsiao & Gibson 2003, Gibson & Wu 2011, we found an SR advantage in the pre-head region (Verb-Noun vs Noun-Verb) in both subject- and object-modifying RCs, and an SR advantage in subject-modifying RCs two words following the head noun. No other effects were found.

The SR advantage in the pre-head region can only be explained in terms of structural-frequency accounts. We cannot hang a major theoretical conclusion on the null result (the absence of any significant effect) at the head noun, but if it is real, then it could be explained by assuming that both locality and expectation-based facilitation canceling each other out (i.e., both factors could play an opposing role). However, if this were the explanation for the null result, we would have difficulty explaining the SR advantage in the post-head noun region. The post-head noun SR advantage is compatible with structural frequency account if it is a spillover effect from previous regions. An interesting question is: why did Hsiao & Gibson 2003 find an OR advantage? We believe this is partly because they used much older participants, mean=45 years (Hsiao 2002, p. 60), than other Chinese RC studies have used, with rather low question-response accuracies even for simple one-embedded relative clauses (76% in ORs, 71% in SRs; cf. 86% and 84% in our expt.). Indeed, a previously reported replication using their items found an SR advantage (Kuo & Vasishth 2006 MS) before and after the head noun. Thus, we believe that the Hsiao and Gibson 2003 results need to be validated via a careful replication (or replications) using the same items and fillers.

- (a) **Na ge** | zuowan | zou le | fuwusheng | yi dun | de | **guke** | jian guo | laoban ... (Subj-modifying SR)  
det cl | yesterday.eve. | hit asp | waiter | one cl | rel | customer | see asp | boss ...  
'That customer who hit the waiter yesterday evening had seen the boss before .....
- (b) **Na ge** | zuowan | fuwusheng | zou le | yi dun | de | **guke** | jian guo | laoban ... (Subj-modifying OR)  
det cl | yesterday.eve. | waiter | hit asp | one cl | rel | customer | see asp | boss ...  
'That customer who the waiter hit yesterday evening had seen the boss before .....
- (c) Laoban | jian guo | **na ge** | zuowan | zou le | fuwusheng | yi dun | de | **guke** ... (Obj-modifying SR)  
boss | see asp | det cl | yesterday.eve. | hit asp | waiter | one cl | rel | customer ...  
'The boss had seen that customer who hit the waiter yesterday evening before .....
- (d) Laoban | jian guo | **na ge** | zuowan | fuwusheng | zou le | yi dun | de | **guke** ... (Obj-modifying OR)  
boss | see asp | det cl | yesterday.eve. | waiter | hit asp | one cl | rel | customer ...  
'The boss had seen that customer who the waiter hit yesterday evening before .....