The Interactive Serial Processing Model: Evidence from the Processing of the Chinese Ambiguous Construction *V NP1 de NP2*

交互串行加工模型：来自汉语歧义构式*V NP1 de NP2*的加工证据

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前　言

当前句子加工研究领域存在两大对立的理论模型：花园路径模型(the garden-path model)和基于制约的模型(the constraint-based model)。二者就句子加工机制持有不同的观点：前者认为句子加工是模块(modular)、串行(serial)的，句子加工的最初阶段只有句法信息起作用，帮助人们构建一种结构上最简单的分析；后者认为句子加工是交互(interactive)、并行(parallel)的，句子加工中各种信息(如句法、语义、语用等信息)同时发挥作用，帮助人们构建所有可能的结构分析。然而，面对句子加工研究所揭示的复杂现象，两大理论模型均未能作出合理的解释。

本研究指出，句子加工完全可能按一种交互、串行的方式进行：各种信息在句子加工中可以同时发挥作用；当句子存在结构歧义时，人们每次只建构一种分析，而且，该分析是各种信息交互作用的结果。鉴于此，本研究提出了交互串行句子加工模型。

为了检验该模型的可行性，本研究以汉语偏正/述宾歧义构式(如，关心学校的老师)为切入点，集中考察两个问题：(1)语义信息在加工该歧义构式时是否可以立即发挥作用？(2)该歧义构式的两种分析是如何加工的(串行还是并行)？

采用自定步速移动窗口技术(self-paced moving-window paradigm)，实验一发现，当解歧信息与该歧义构式的语义倾向不一致时(如，语义上倾向于述宾的歧义构式按偏正结构解歧)，被试在解歧区上的阅读时间明显延长，表明他们在该区段遇到了加工困难。这一发现说明语义信息在歧义加工中立即发挥了作用。采用同样的技术，实验二考察了均衡型构式(两种分析在语义上同样合理)的在线加工。结果显示，均衡型构式按偏正结构解歧时相对容易加工，而按述宾结构解歧会出现加工困难。这一发现似乎表明人们只建构了一种分析。然而，该发现并不能排除并行加工的可能：假定述宾结构也被激活，但激活的程度相当弱，所以，当

歧义构式最终按述宾结构解歧时，仍会出现加工困难。事实上，仅靠一种方法，很难在串行与并行加工之间做出判断。

为了检验述宾结构是否也被激活，实验三结合结构启动(structural priming)与自定步速移动窗口技术，进一步考察均衡型构式的在线加工。实验发现，只有与偏正结构对应的启动句产生了结构启动效应。基于结构启动的原理(启动句与目标句具有共同的结构表征方可产生启动效应)，该发现表明语义均衡型歧义构式是按偏正结构表征的。由于语言理解需要激活固有的结构表征，因此，在句子加工的最初阶段，只有偏正结构可以被激活。该发现支持串行加工机制。上述三个实验的结果与交互串行句子加工模型的预测一致，为该模型提供了初步的证据。

本研究提出的交互串行句子加工模型符合人类句子加工准确、即时的特点，可以对句子加工研究领域存在的问题和分歧作出更合理的解释。

Abstract

Current sentence processing research has been dominated by two conflicting models: the *garden-path model* (Frazier, 1987a) and the *constraint-based lexicalist model* (MacDonald, Pearlmutter & Seidenberg, 1994). The former holds that the sentence processor draws on syntactic information only to construct a single analysis even when a sentence allows for more than one analysis; by contrast, the latter assumes that the sentence processor makes an immediate use of both syntactic and non-syntactic information to activate all possible analyses in parallel. A critical review of previous studies reveals, however, that neither model can provide a satisfactory account of the processes involved in immediate or "on-line" sentence comprehension.

Rather, the present study points towards an *interactive serial* processing model (ISP) in which both syntactic and non-syntactic information can be used immediately during sentence processing, and that these information sources interact with each other to guide the processor to select a single analysis at a time. This model integrates ideas from previous sentence processing models but differs from them in important respects. On the one hand, it allows different sources of information to interact with each other so that local indeterminacies can be resolved immediately. On the other hand, by pursuing a single analysis at a time, it constrains the processor from being involved in constant (yet unjustified) competition during sentence processing.

To test the soundness of ISP, we conducted three experiments on the Chinese ambiguous construction *V NP1 de NP2*, which can be analyzed as an NP or a VP. Specifically, we investigated two research

questions: (1) How is semantic plausibility information used in processing sentences containing the Chinese ambiguous construction *V NP1 de NP2* (immediately or relatively delayed)? (2) How are the two analyses (i.e., NP and VP) of this ambiguous construction activated in on-line sentence processing (one analysis at a time, or both analyses being activated at the same time)?

Employing the self-paced reading method, Experiment 1 showed that when a semantically biased ambiguous item was disambiguated to the disfavored analysis (e.g., when semantically VP-biased items were disambiguated as NP), processing difficulty occurred immediately in the disambiguation region(s). This finding suggests that semantic plausibility information has an immediate effect on syntactic ambiguity resolution. Using the same method, Experiment 2 found that a semantically equibiased item caused immediate processing difficulty when it was disambiguated as VP but caused no processing difficulty when it was disambiguated as NP. This finding showed that NP is the preferred analysis for the semantically equibiased items, but it failed to show whether the VP analysis was activated or not. In fact, on-line reading methods (such as self-paced reading) alone can hardly detect whether a single analysis is activated or both analyses are activated at the same time.

To determine whether the VP analysis could be activated during the initial stage of sentence processing, we combined the structural priming paradigm with the self-paced reading method in Experiment 3. This experiment showed that semantically equibiased items are typically represented as NP. Given that sentence comprehension requires activation of stored representations, results from Experiment 3 suggest that only the NP analysis can be initially activated during online sentence comprehension, thereby lending support to serial processing.

Taken together, the three experiments showed that semantic plausibility information can be used immediately in processing sentences containing the ambiguous construction *V NP1 de NP2* and that only a single analysis is activated at the initial stage of sentence processing. These results are consistent with the predictions of the interactive serial processing model.

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Chapter 1

Introduction

1.1 Research Orientation

The general goal of this study is to reexamine two major questions concerning human sentence processing. The first question is whether all sources of information can be used immediately during sentence processing, or some sources of information are delayed relative to others. The second question concerns whether all possible analyses of a syntactically ambiguous construction are activated at the same time, or only one analysis is activated at a time. Both questions have been heavily scrutinized over the past few decades, and have given rise to various accounts of human sentence processing.

1.2 Research Background

Sentence processing (or sentence comprehension) is a fundamental issue in psycholinguistics. Over the years, sentence processing has captured psycholinguistic researchers' constant attention because, on the one hand, processing sentences constitutes an essential part of human language use, and much about language use can be gained by studying how sentences are processed. On the other hand, to correctly understand a sentence, we need to draw on various sources of knowledge, ranging from linguistic knowledge such as syntax and semantics to nonlinguistic such as knowledge of the general world. The use of these knowledge sources during sentence processing

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