

THESIS



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SOME ISSUES OF AGRAMMATIC COMPREHENSION IN CHINESE

By

MING XIANG

A THESIS

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ABSTRACT

AGRAMMATIC COMPREHENSION OF CHINESE

By

MING XIANG

Much work has been done on agrammatic comprehension in English, and a couple of issues under debate are reviewed in this study. The first question is whether Broca's patients all share a consistent comprehension pattern. The second question, related to the first, is how to choose patients for a comprehension study. Finally, it is asked how best to account for the relatively established pattern that Broca's aphasics perform above chance on the comprehension of active sentences and subject relative clauses, but at chance on passives and object relative clauses.

Few studies have been done on Chinese. This thesis aims at providing an experimental design to test the comprehension pattern of Chinese agrammatic patients. Chinese relative clauses and wh-questions are the structures under discussion. These two structures in Chinese have some interesting characteristics English doesn't have, and they provide very good opportunities for testing the two competing hypotheses: *Trace Deletion Hypothesis* and *Double Dependency Hypothesis*.

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INTRODUCTION

Lesion study has been a very important part of neurolinguistic literature. By studying the language performance of aphasia patients, i.e. people who have lost some or most of their language because of brain damage, current linguistic theories can be tested because aphasia patients deviate in systematic ways from normal speakers. At the same time, lesion study may help us to find out how language is spatially organized in the brain.

Cross-linguistic studies provide an opportunity to study language break-down from all kinds of aspects. Each language has its own unique characteristics that other languages lack, so a cross-linguistic study reveals a more complete picture which describes patients from different languages, and at the same time this helps to avoid restricting a neurolinguistic theory to only one or just a couple of frequently studied languages.

Although Chinese is a language with an enormous number of speakers, few studies have been done on Chinese aphasia patients. The aim of this thesis is to offer a study design regarding the agrammatic comprehension of Chinese Broca's patients. Limited by the subject pool in the area, a real study has not been done yet, but the discussion in this thesis aims to sort out clearly what is the problem and what is the possible solution. Hopefully these will contribute to future research.

This thesis is going to focus only on comprehension. A brief background about lesion study is introduced in section one. In section two, we will look at the comprehension pattern in more detail. The main question is if it is realistic to claim a comprehension pattern applies to every patient diagnosed as Broca's. In section three, a

screening test is argued to be a necessary procedure to select patients, in addition to their being diagnosed as Broca's. Two competing hypotheses (the TDH and DDH) accounting for Broca's comprehension and some criticism of them are introduced in section four. Section five is devoted to two Chinese syntax structures which are relevant to the experiments designed in section six. These experiments are designed to test the predictions of the TDH and DDH.

Chapter 1

Background

This chapter is a brief tour of the main observations with regard to Broca's aphasia. Neurologists have been interested in Broca's aphasia for a long time. Recently the work of linguists in this area has revealed some interesting patterns from the perspective of language structure. This is particularly important if we believe that the final goal of aphasia study is to answer the question as to how language is represented in the brain. Comparing a Broca's patient with a normal person, we will find impaired ability in both production and comprehension for the Broca's aphasic. This section describes the main agrammatic patterns that have been confirmed in literature.

1.1. The production of Broca's aphasia

Broca's aphasia is named after the French surgeon Paul Broca. In 1861 he studied the brain at autopsy of his former patient. This patient had serious speech problems: he could only utter single syllables. Broca found a lesion in the frontal lobe on the posterior surface of the third frontal gyrus on the left side (Broca 1861), and since then this area has been referred to as *Broca's area*.

After many years of study, the production pattern of Broca's aphasia is firmly set: it is characterized by the effortful and fragmentary speech, sometimes called *telegraphic speech*. The speech of Broca's patients heavily depends on nouns, although verbs are present sometimes. Inflectional morphemes and functional words are usually omitted.

1.2. The comprehension of Broca's aphasia

The comprehension of Broca's aphasics was long thought to be intact. For example Paul Broca considered the deficit in his patients to be exclusively in articulation. But further studies revealed that this is clearly not the case. Although Broca's patients generally show little difficulty following conversation, careful studies showed that they do have problems with complicated sentence structures which require relatively sophisticated processing of grammatical rules. For example, Caramazza and Zurif (1976) provided evidence to show that Broca's patients did not retain the full syntactic algorithmic processing. Instead, they were clearly relying on semantic cues for comprehension. The experiment used a picture-sentence matching task. Crucially, nonreversible center-embedded sentences like (1) and reversible center-embedded sentences like (2) were compared. It turned out that patients did much better on (1) than on (2).

(1) The apple that the boy is eating is red.

(2) The cow that the horse is kicking is brown.

In (1), the knowledge of the world tells us that only the boy can eat the apple, not vice versa, and this is a reliable semantic cue to interpret the sentence; whereas in (2), the semantic cue is taken away, since in the real world, the cow can kick the horse, and the horse can kick the cow too, therefore patients can only depend on their knowledge of syntax to interpret the sentence. The conclusion was that although Broca's aphasics are unable to use the syntactic algorithm, their ability to use heuristic strategies is retained to help interpretation.

After this study, many studies were done to test various aspects of Broca's comprehension. It has been claimed that Broca's aphasia has a pretty much intact ability for the comprehension of simple sentence structures, including θ -assignment and case

assignment (see Grodzinsky (1995) for a review). For structures involving movement, they have no problem if the sentence has some pragmatic or semantic cues. The core data reported in the literature are summarized below (data taken from Grodzinsky 1995). The basic pattern is the following: for active sentences and subject-gap sentences, the comprehension is above chance; but for passives and object-gap sentences, the comprehension is at chance.

- (3) Above-chance performance
- a. The girl pushed the boy
- b. The girl who pushed the boy was tall.
- c. It is the girl who pushed the boy.
- (4) Chance performance
- a. The boy was pushed by the girl.
- b. The boy who the girl pushed was tall.
- c. It is the boy who the girl pushed.

In summary, the production of Broca's aphasia is largely impaired. Normally they can only produce telegraphic speech with verbs and functional items omitted. Although their comprehension is relatively spared, they do have serious problems in understanding complicated structures when semantic cues are taken away. It is this highly selective deficit pattern in comprehension that has aroused lots of attention in the literature because it provides a chance to look particularly at a small part of linguistic theory and relate the theory to language behavior.

Chapter 2

The Comprehension of Broca's Aphasics: A Consistent Pattern?

Since Caramazza and Zurif (1976) found that Broca's patients have a selective deficit in comprehension, many comprehension studies have been conducted. Some of the results replicated the core pattern that patients perform above chance on active sentences and subject relative clauses, but perform at chance on passives and object relative clauses, but at the same time, some studies fail to show this pattern (see Berndt 1991, Berndt et al. 1996 for a review). These contradictory results led to a debate as to whether there exists a characteristic comprehension pattern for Broca's patients. This question is important because the initial interest in Broca's patients came from the idea that studying the selective breakdown of the abnormal grammar will shed some light on modeling normal grammar, and the particular pattern of Broca's aphasics will lead to significant generalizations concerning the neurological spatial organization of linguistic capacity. If it turns out that this comprehension breakdown is not necessarily related to Broca's aphasia, the clinical diagnosis of Broca's aphasia is not sufficient any more to select patients in any comprehension study. In this section I will present the two sides of the debate: one side (Grodzinsky et al. 1999, Drai et al. 1999, Zurif et al. 1999) thinks that Broca's aphasia forms a uniform category that can serve as the unit of analysis for comprehension studies, because there exists a comprehension pattern for Broca's aphasics, and group study is the right way to reveal their general comprehension pattern; the other side (Berndt et al 1996, Caramazza 1986, 2001) thinks that group study hides

big individual differences, and a closer look at each patient shows that there is not a general pattern applicable to every Broca's aphasic's comprehension. If this is true, functional lesions cannot be inferred on the basis of clinical category.

2.1. The group study approach

Grodzinsky (1999) examined the comprehension data of Broca's aphasics published between 1980 and 1996. In these studies, subjects are tested on their ability to associate two semantic roles with two syntactic positions: subject and object position. Grodzinsky started with the logic that if patients are confident about their responses, the majority of the patients should differ from chance (whether or not the answer is correct is another issue), i.e. their performance should be above-chance. But if they are not sure of the answer and guess between two possible answers, the outcome should look like the outcome from a coin tossing game. Each subject can be considered as flipping a coin for *n* trials. Obviously it is not possible for every single subject to get exactly n/2 times heads, and n/2 times tails. But if we look at M subjects in a group, given a big enough value of M, statistically we can predict that out of total M n trials, 50% of the time we get heads, and the other 50% of the time we get tails. This is what is meant by "chancelevel". As a result, only the group study, not the individual study will correctly characterize the probability of chance behavior. Based on this logic, if Broca's aphasics understand active sentences, they should have a high correct rate, i.e. above-chance, and if they are not sure about passives, and are guessing at the answer, a group study will show an at-chance performance. Grodzinsky et al. (1999) examined two things. First, the average performance of actives and passives. Statistically significant results showed above-chance performance on actives and at-chance performance on passives.

Second, Grodzinsky compared the distribution of passive performance with a computer stimulated distribution of coin toss, and concluded that "the similarity between the data and the simulation is striking... they are both open to an almost identical extent..."(Grodzinsky et al, 1999, p.141).

According to these results, Grodzinsky claimed that the traditional diagnostic categories can be used in the study of Broca's comprehension, since despite individual variation, a uniform pattern emerged through the group study: patients perform at abovechance level for active sentences and at chance for passives. This is so because the seemingly random individual variation comes from the statistical property of chance performance, and a group study will remove the surface variation and reveal the underlying trend of the comprehension pattern. The existence of such a uniform pattern strongly supports the syndrome approach as a sufficient criterion to select patients for any comprehension study. On the contrary, the diagnostic value of the active-passive comprehension contrast is not strong enough. It can be used for a positive, but not a negative diagnosis of an individual as a Broca's patient. That is to say, if a patient shows the active-passive distinction in their comprehension, he is a Broca's patient, but if he does not show the pattern, he cannot be ruled out as a Broca's patient, because when a series of comprehension scores are analyzed in a group study, this patient could just happen to be the one on the higher end of the distribution.

The overall performance tendency of Broca's was supported by Beretta (2001). He reported data from those patients who were excluded and thus not reported in three studies: Beretta and Munn (1998a, 1998b), Beretta and Campbell (2001). These patients were diagnosed as Broca's patients, but their data were excluded because they did not

show the core pattern in their comprehension, namely, above chance on actives and at chance on passives. But even for these patients, the direction of the difference still favors the active sentences across the board, although the magnitude of the difference is smaller than for the patients who were selected for the study. The best patients can score both active and passives perfectly, but nobody did better on passives then actives.

2. 2. The individual study approach

The individual study approach is not trying to deny that in general, actives are understood better than passives. Even for normal people that would be the case, and Broca's patients simply have even more difficulty with passives. The issue at stake is whether Broca's patients can form a homogeneous group such that each member in the group shows the same comprehension pattern; i.e. understand actives but guess on passives. Berndt et al. (1996) presented an analysis of studies of aphasic comprehension published between 1980 and 1993. Statistics were done on each individual and the results revealed approximately equal distributions of three patterns: both structures comprehended better than chance; both structures comprehended no better than chance; active voice structures comprehended better than chance while passive voice sentences were no better than chance. Only the last pattern (one third of the total data) was usually asserted by other researchers to be the characteristic of the comprehension of Broca's patients and many linguistic accounts were proposed based on the last pattern (see the same paper for a review). The conclusion from this review is that Broca's aphasia is not associated with a single pattern of comprehension performance. Grodzinsky responded to this study by his statistical analysis in Grodzinsky et al. (1999), as reviewed above. In response to this study, Caramazza et al. (2001) criticized the group study method

advanced in Grodzinsky et al. (1999), and claimed again that individual study of each patient is the right way to analyze data and Broca's comprehension doesn't show a uniform pattern. Caramazza's criticism focused on two points: first, the group average performance demonstrated by Grodzinsky possibly hides some patients who didn't show the active-passive dissociation at all. In a hypothetical group of 42 patients, 38 patients had the perfect dissociation (50% on passives, and 100% on actives), only 4 patients didn't have the dissociation (100% on passives, and 100% on passives), and the group average for passive is 54.8%, and 100% for active. Therefore, the group study result is the same as Grodzinsky's study, but the perfect performance of the four patients was hidden and ignored. Second, when there is only a small number of trials, the score of a particular patient may locate at anywhere on a binomial curve with a fairly reasonable probability. But for cases with a large number of trials, the probability of getting a high correct score by chance is very small, and the performances of the patients reported in Berndt et al. (1996) and Grodzinsky et al. (1999) do indicate that some patients with above-chance performance on passive were tested on many trials.

To sum up, Broca's patients do show a tendency to perform above chance on actives and below chance on passives, and this dissociation forms the baseline for researchers to select patients for a comprehension study. At the same time, there exist individual variations among Broca's patients, and how to interpret that variation— group study or individual study—is still hard to decide. However, without completely resolving the debate, we still have reasons to believe that although the clinical category is a good place to start, it is far from sufficient to select patients just on the basis of clinical category alone.

2.3. The disadvantage of clinical category

First, the clinical definition for "Broca's aphasia" is a very fuzzy one. The lesion site is generally taken to be located at the left frontal lobe on the posterior surface of the third frontal gyrus, but most patients who are defined as Broca's have an extensive lesion beyond Broca's area. And some patients with Broca's aphasia don't have lesions in Broca's area (Dronkers et al., 2000). At the same time, although Broca's patients are characterized by their telegraphic speech and omission of functional categories, not all the patients show all the production pattern and not all the patients show the same pattern (e.g. Miceli et al. 1989). It is not uncommon that a patient is defined as "Broca's" not because he behaves like a typical Broca's patient, but just because his behavior fits more into the category of Broca's than any other aphasia category such as Wernicke's. For example, Druks and Marshall (1995) reported a patient who was categorized as Broca's and he did much better on passives (35/48; p < .01) than actives (25/48). But the author admitted that in the BDAE test of this patient, his intonational contour and phrase length are better than the upper limit for Broca's patients, but his overall profile gives a better fit to Broca's aphasia than to any other category recognized by the BDAE. The uncomfortable inclusion of this kind of patient shows that the traditional approach to classification is a very vague one, with fuzzy edges between categories, and this makes patient selection less precise and objective.

Secondly, if the final goal of the study of agrammatic comprehension is to understand more about normal grammar by looking at the opposite side—the broken grammar of aphasic patients. This particular orientation determines that we need a class of patients who show detailed homogeneity in linguistic terms. Suppose Grodzinsky is

right, and there might be other evidence to support the claim that Broca's patients as a whole do show the core asymmetric pattern in their comprehension of actives and passives, when we choose patients for a particular study, it is the individual performance that matters, not the general pattern. For example, suppose a study is conducted to look at the agrammatic comprehension of wh-movement. The basic working hypothesis is that since wh-movement and the movement in passives have something in common, if the source of the poor performance on passives lies in the selective breakdown of a linguistic mechanism, it is interesting to see if the same breakdown will affect the comprehension of wh-movement. Limiting our subject pool to those patients with this particular breakdown in passives becomes important because it is their data that can tell us whether or not this breakdown can disturb the comprehension of another syntactic structure besides passives. Obviously the inclusion of those Broca's patients who don't have this breakdown in passives might dilute the final results. So if the result from the wh-question task don't show any pattern, it is not clear how to interpret that. Is it because the breakdown of passives is irrelevant for wh-questions, or is it because the good performance of some patients in our subjects balance out and hide the pattern that should emerge from the bad performance of other patients? So, to make the final results more linguistically meaningful, it is better to choose a group of patients that have shown a set of common characteristics which are relevant to the processing mechanism under study.

2.4. Conclusion

Broca's patients have been of the interest to research for a long time because of their selective breakdown of grammar. But a closer look at each individual patient reveals that not everybody labeled as Broca's aphasic significantly demonstrates the same

grammar breakdown. So the clinical category *Broca*'s is inadequate to capture the finegrained linguistic properties of each patient in the same group. Only those patients who do show the relevant asymmetric comprehensive pattern fit best for the purpose of studying normal grammar, because their selective breakdown will possibly tell us what linguistic mechanism is broken to cause the problems they have.

Chapter 3

Screening Test

It is argued in this chapter that besides clinical criteria, a linguistic screening task should be used to select patients. A good screening test makes sure that patients selected for the comprehension study have the linguistic characteristics under consideration. For English speaking patients, their performance on active versus passives, subject relative clauses versus object relative clauses has been established as a reliable screening task, but for other languages, little has been done to establish a language specific screening task.

3.1. A screening test as a filler

As shown in chapter two, although Grodzinsky argued that group study of Broca's patients is able to appropriately interpret the agrammatic comprehension pattern, the criticism of this approach mainly came from the observation that the individual comprehension pattern varies a lot from the core pattern , i.e. above-chance on active/subject relative clauses, and at-chance on passives/object relative clauses. If the purpose of a study is claimed to be a linguistic one, it is not very helpful to compare the performance of two patients who have never been tested on any linguistic grounds, and thus possibly have different comprehension patterns. Such a comparison would also raise the serious problem that "any non-replication of results or nonconfirmation of a theory can be dismissed as being due to differences in patient selection and that any apparent replication of results or confirmation of a theory can have occurred in a different patient population than the one originally tested" (Caplan, 1995, p.332). This problem was exemplified by many studies in literature. For example, Zurif et al. (1993) conducted a processing study on Broca's patients, and found Wernicke's patients have roughly normal

lexical activation during online processing, while Broca's patients have much slower lexical activation. Tyler (1985) did a processing study too, and claimed that Broca's patients show normal online processing. Putting aside the different technique they used, the fact that Zurif et al. (1993) used an active-passive screening test to choose subjects while Tyler (1985) did not, makes comparison impossible. Tyler's finding is theoretically less interesting because it is just a single case study, and whenever people attempt to make a generalization by comparing a large number of studies, this one cannot be counted because it is meaningless to compare it with Zurif's study.

A screening test might be a solution for this problem. For example, to explain the observation that Broca aphasics perform above chance on the comprehension of actives and subject relative clauses, but at chance on passives and object relative clauses, Grodzinsky (1984, 1990, 1995) proposed the Trace Deletion Hypothesis (for an introduction of TDH, see Chapter 4). If a study is designed to test the prediction of this hypothesis, the subjects included in the study should at least replicate the performance pattern the Grodzinsky set out to explain. That is to say, a screening test of active-passive or subject-object relative clauses should be administrated and only patients who do above chance on actives/subject relatives, and at chance on passives/object relatives should be included in the target study, because that was the basic pattern TDH tried to account for. The essential principle underlying a screening test is that "no assumptions should be made about how patients would perform on tasks on which they have not been tested. All patients should be tested to establish the integrity of processes that are necessary to accomplish experimental tasks on which they are tested and that are needed to establish the specificity of a deficit in representational and processing terms" (Caplan, 1995)

p.336). But this principle was not well respected in some published studies. For example, as Caplan pointed out, Badecker et al. (1991) attempted to test Grodzinsky's theory on truncated passives, but they failed to select patients who behaved in accord with Grodzinsky's account on full passives.

This principle was not respected even in some studies which did the screening test, because it was not the relevant screening test. Let's take Zurif (1993) again as an example. This study used a lexical priming paradigm to look at whether Broca's and Wernicke's patients have normal ability to link moved constituents to their base position. First, Zurif used an active-passive screening test to screen his Broca's aphasic subjects and Wernicke's aphasic subjects. All four Broca's patients showed active-passive differences (generally good performance on actives and bad on passives), but Wernicke's patients were inconsistent in this respect. The experimental stimuli he used for the priming test were subject-object relative constructions. Subjects were presented with auditory stimuli sentences, and at the gap position of the relative clause, a string of letters would appear on the screen in front of the subjects, and they were instructed to do a lexical decision task. The results showed that for both subject and object relative clauses, Broca's patients were not able to immediately fill gaps, whereas Wernicke's patients appeared normal. Zurif linked this result with previous findings that Broca's patients interpret subject relative clauses at a significantly above chance level (Grodzinsky, 1986, 1989), whereas Wernicke's patients show uncertain comprehension (Grodzinsky, 1984). And his conclusion was that syntactic processing (filling gaps) occurs at a stage prior to thematic assignment, and Wernicke's patients were intact at this respect, whereas Broca's patients can't establish dependency relations normally. Based on this, he further

concluded that Broca's patients have to rely on some abnormal strategy for their seemingly normal comprehension. This is an interesting result, but it overlooks one important thing: Zurif did not test his subjects on subject/object relative clauses at all, and it is possible that his patients did not show the same pattern as previous studies. The claim of this study actually assumed that subjects here are similar on potentially crucial aspects (subject-relative clauses) to those already tested elsewhere. This assumption is essentially no different from the claim that we already challenged earlier: that patients labeled as agrammatic can be directly compared to each other. Second, although a comprehension screening task is relevant to his conclusion, a priming screening test is also necessary to see if subjects showed priming effects for single words in isolation. If not, the absence of priming in the sentence context has no implications for the sentence processing deficits in these patients.

3.2. A screening test for cross-linguistic study

At present, a well-established screening test for English speaking Broca's patients is the comprehension of active versus passive structures or the subject relative clause versus the object relative clause. Many studies revealed a selective comprehension deficit for these structures, i.e. above-chance on active/subject relative clauses, and at-chance on passive/object relative clauses (see Grodzinsky 1999, Zurif 1999). So this kind of screening test is useful to pick out those patients who have a deficit in comprehending sentences involving movement.

But cross-linguistically, it is not clear what test should be used as a screening test. If non-English speaking patients are tested to evaluate some hypotheses proposed before, the ideal situation is that in this language, there are some constructions patterning in the

same way as the English screening test. Then these constructions can be used to reduplicate the performance observed in English patients. Japanese seems to be a case of this sort. Hagiwara (1993) looked at several passive constructions in Japanese. She claimed that in general Japanese has two types of passives, the gapped ones (including direct passives and possessive passives) and gapless ones (indirect passives). The purpose of the experiment was to see if Japanese patients distinguish the gapped and gapless passives. The Japanese indirect passive doesn't have an obvious counterpart structure in English , but the direct passive in Japanese does pattern in the same way as the English passive. Hagiwara used a screening test with active-passive constructions. Only those patients who demonstrated above-chance performance on actives and at-chance level performance on direct passives were included in the study. One of the methodological merits of this study is that by doing this screening test, Hagiwara kept the study within a homogeneous subjects group, and this makes the results more reliable.

Unfortunately, not all languages can use the same structures in a screening test. Lukatela et al (1995) investigated the aphasic comprehension of four types of relative clauses in Serbo-Croatian. This is a language with rich inflectional morphology and in their stimuli, the inflectional morphology can possibly aid in coindexation of the moved constituent and trace. It is a very interesting idea to see what patients will do in a language very different from English, but the study is based on a false premise. All the subjects are only diagnosed as Broca's on clinical bases. No distinction was made on linguistic grounds. As we have argued, this is already a major flaw in the whole experiment design. To make the result reliable, subjects should be selected by a screening test which satisfies two aspects: first, find a pair of sentence constructions in Serbo-

Croatian that have the same relevant syntactic analysis as the English active-passive or subject-object relative clauses pair. Second, the study was intended to look at how Serbo-Croatian Broca's aphasics handle movement in relative clauses, but there was a confound introduced by inflectional morphology, which works together with the thematic grid of the verb to assist in sentence interpretation. So a good screening test should aim at teasing apart subjects' ability to interpret movement and their ability to interpret inflectional morphology.

3.3 Summary

To sum up, in this section it is argued that when confirming or rejecting a theory by comparing some new data with the data from which the theory originated, or comparing the results of two studies, patients should be screened to make sure the comparison is within a homogeneous group as much as possible. For English patients, active-passive or subject-object relative clauses are relatively reliable choices for a screening test, but cross-linguistically, there are no standard tests to follow yet, because each language has some characteristics that another language does not have. In general, a cross-linguistic study should make sure the material used is the same in spirit as those in the original study, and tease apart the question under consideration and those language specific characteristics which might confound the study.

Chapter 4

Two Accounts for the Comprehension of Broca's Patients

If we put asides for the time being the problem of whether Broca's patients share a characteristic comprehension pattern (namely, above chance on actives and at chance on passives), and focus now on those patients who did show this pattern, a question immediately arises as to why there is a pattern and why it is this pattern instead of some other pattern. An explanation from a linguistic point of view would be that something is wrong with the underlying language processing mechanism. There have been many proposals of this sort in literature. They differ from each other in terms of which piece of the language mechanism is broken down underlyingly. In this section I will particularly look at two of them: the Trace Deletion Hypothesis and the Double Dependency Hypothesis. The basic idea of each proposal along with their strengths and weaknesses follows.

4.1.Trace Deletion Hypothesis (TDH)

4.1.1. The proposal

One hypothesis to accommodate these findings is the Trace Deletion Hypothesis (TDH), proposed by Grodzinsky (1984a,b, 1990, 1995). It is stated in two parts:

TDH: (Grodzinsky 1995, p.46)

a. TBA (Trace based account): Traces in θ -positions are deleted from agrammatic representation (or are invisible to θ -assignment).

b. R-strategy: Assign a referential NP a role by its linear position iff it has no θ -role. The theoretical basis for this hypothesis is that in sentences involving movement, the moved element doesn't get its θ -role directly, instead, the θ -role is assigned to the trace left by the moved constituent, then transmitted to the moved constituent through the mediation of the chain formed by the trace and its antecedent constituent. By assuming that trace is impaired in Broca's representation, the TBA explains why the transmission of a θ -role to a moved NP is impossible. At this point, the default strategy kicks in and assigns a role to any referential NP that does not have a θ -role, according to its linear position and the thematic hierarchy. The following example is taken from Grodzinsky (1995, p.35):

Agrammatic representation Normal θ -representation a. The man i is t_i pushing the woman Theme (Agent, Theme) Agent b. The woman *i* is t_i pushed t_i by the man I L (Theme, Agent) Agent Agent c. The man *i* is t_i hated t_i by the woman 1 I Agent Experiencer (Theme, Experiencer) The VP internal subject hypothesis is assumed in all these examples. (a) is an active

sentence. According to the TBA, trace t_i is deleted in agrammatic representation, the patient has no way via structure to assign a θ -role to the subject NP *the man*, and at this point, the default strategy comes in and assigns the *Agent* role to it, because *the man* is the first NP in the sentence, and the first thematic role in the Thematic hierarchy is *Agent*.

It happens to be the correct result, compared to the normal representation. And that, it is argued, is why Broca's patients always get above chance performance on active sentences. (b) is a passive structure, and (c) involves a psych-verb as the predicate. The problem and the strategy are exactly the same for Broca's patients: trace is deleted thus the transmission of the θ -role to the subject NP is impossible, and at this point, the default strategy comes in and assigns the Agent role to the subject NP because it is the sentence initial NP. But at this time the result turns out to be different from the normal representation. (b) will lead to chance-performance because, confronted with two Agents, the patient only has 50% chance of guessing the second NP is the real Agent, which is the correct answer. And they have an equal chance of guessing the first NP is the real Agent and getting the wrong answer. However (c) will lead to below-chance performance because no obvious contradiction exists in the wrong representation itself, so the patient will presumably be happy with this result and have no chance of getting back on the right track.

4.1.2. Some criticism

Both components of the TDH, trace deletion and default strategy, have their limitations. First, trace deletion assumes an incomplete syntactic representation, and this assumption is challenged by the fact that subjects with attested dissociation in comprehension are very sensitive to grammaticality, even for those sentences they have difficulty interpreting (Linebarger et al 1983). Linebarger argued that agrammatic subjects are able to recover syntactic structures based on the result that they generally showed a considerable sensitivity to a wide range of grammatical deformations, and this casts some doubt on any theory based on a partially impaired representation. She also

noticed that those subjects were insensitive to semantic properties such as anaphoric relations, and suggested the impaired comprehension is possibly caused by a failure of further interpretive processing.

The default strategy, defined as an extralinguistic heuristic strategy which is strictly constrained by its modularity of linguistic system, was even more awkward. As Beretta (2001) pointed out, a principle motivation of the TDH is to describe agrammatic patients' data in theoretical terms, with the hope that the agrammatic comprehension will shed some light on how to constrain the grammar of normal representations. The TDH is an interesting proposal because it attempts to reduce the problem to a theoretical linguistic source (i.e. the presence or absence of trace, which is theoretically motivated.). But the use of an extralinguistic strategy deviates from the original motivation. Instead, it severely weakened a linguistic account by implying that the agrammatic comprehension is only partly the result of an incomplete linguistic representation. For every instance of an incomplete representation, the default strategy has to be applied to get the final interpretation, either correctly or incorrectly. Although it can be used to correctly derive most of the comprehension data, the default strategy has little theoretical motivation. That is, there is no theory of strategies. If it is just a stipulation to describe the data, it is not theoretically interesting because it is not too much different from any other proposals which could attribute the agrammatic comprehension to any impaired mechanism other than the linguistic faculty. "But as the expressed intention of the TDH is to use data ordered by linguistic theory to constrain linguistic theory, and not merely to describe aphasic patients' behavior, then a minimum requirement is that data actually be ordered

by linguistic theory and not by an atheoretical strategy. Conceptually, therefore, the TDH is fundamentally flawed (Beretta 2001, p.518)".

The default strategy is flawed empirically too. To defend this strategy, Grodzinsky has explicitly emphasized that "[the default] heuristic is invoked... it is necessary because patients are faced with a task that forces them to map every NP in a given sentence onto a representation of a depiction of a real-world event" (Grodzinsky, 1990, p.136). Traditional sentence-picture matching tasks only give pictures that involve two characters: one Agent and one Theme. But the default strategy proposed a double-Agent representation in cases like passives, object-relatives, etc. Therefore, a mismatch arises between the real world picture tasks and the hypothesized double-Agent representations, and the patients have never been given a picture to match this double-Agent representation. Beretta and Munn (1998) designed a study to match the real world tasks and the double-Agent representation. For all the pictures there were three characters in each action, two Agents and one Theme, and for each trial, there was at least one picture which matched the double-Agent interpretation, i.e., a mistaken interpretation of the sentence. If the double-Agent representation predicted by the default strategy is real, patients should unambiguously choose this picture. But the result turned out to the opposite. Patients unanimously rejected the double – Agent picture. This can only be naturally explained if there has never been a second Agent in the agrammatic representation.

Empirically, the TDH is not able to derive some of the core data either. As observed by Hickok and Avrutin (1995, p.14), the chance performance of object relative clause is hard to derive under the TDH if we assume the VP internal subject hypothesis.

(1) NP[The boy_{i CP}[that $_{IP}$ [the girl_k t_k hit t_i]]] is tall.

Under the TDH, both traces t_k and t_i are deleted. Neither of the two NPs can receive its theta-role through structural means. The default strategy will assign an Agent role to the first NP *the boy*, and a Theme role to the second NP *the girl*, exactly the opposite of the normal assignment. Since there is no ambiguity in the agrammatic's representation here, they have no way of escaping the wrong interpretation. So the TDH would wrongly predict a below-chance performance.

The results from some cross-linguistic studies are also wrongly predicted by the TDH too. The TDH is a linear order based account, so different word order from a language other than English is a potential danger. Beretta, Piñango, Patterson, and Harford (1999) looked at such an example in one kind of passives (V-by phrase-S) in Spanish.

(2) Es mojado por el elefante el monoIs soaked by the elephant the monkey"the monkey is soaked by the elephant"

Following Belletti (1998), (2) was assumed to have a movement structure like (3):

(3) Es mojado t_i por el elefante [el mono]_i

The TDH predicted above-chance performance for (2). Because *the elephant* is the first NP in linear order, the default strategy should assign an Agent role to it, which happens to be the right role. And *the monkey* is the second NP in linear order, so it will get a thematic role lower than Agent. There is no ambiguity in this analysis, so patients should have no problem in choosing the right answer. But the results from Beretta el al. (1999) showed chance performance. To summarize, Grodzinsky's Trace Deletion Hypothesis has been criticized from both conceptual and empirical perspectives. However, as the first proposal that tried to account for the abnormal grammar by applying normal grammar, the TDH encouraged many other ideas along the same lines. It is still an active proposal in literature, so we will consider it as one target of our test in this study.

4.2.Double Dependency Hypothesis (DDH)

The Double Dependency Hypothesis proposed by Mauner et al. (1993) rests on the same assumption that subject's chance performance in comprehension tasks suggests that they are choosing between ambiguous analyses assigned to a sentence. They attribute the problem to some kind of defect in the representation of the syntactic structure. The fact that subjects perform above chance on actives and on subject-relative clauses on the one hand, but at chance on passives and on object-relative clauses on the other corresponds to the syntactic distinction of these two groups of structures. In passives and object-relatives, there exists a dependency relationship between the moved NP and the trace it left, and this dependency is built up through the chain linking the head and the foot NPs. Dependencies are marked by the same indices, and most importantly, θ assignment is a condition on the whole movement chain. For example, in the passive structure (4), the boy_i is related to the trace t_i through the chain, and trace is at the foot of the chain and in a θ position. At the same time, assuming the passive morphology -en assigns a θ -role to the external argument, there is another dependency relation between the passive participial morpheme e_i and the girl *i*. So there are two dependencies in (4):

(4) [*The* boy]_i is chase- $en_j t_i$ by [*the* girl]_j.

However, for actives and subject-relatives, there is only a single dependency relation between the VP-internal subject and the s-structure subject. The analysis of the active is shown in (5):

(5) [the boy]_i is t_i chasing the girl.

Based on this syntactic distinction, Mauner et al. proposed the Double dependency Hypothesis (DDH):

(6) DDH:

(a). the deficit underlying asyntactic comprehension affects the processing of syntactic referential dependencies, and

(b). when there is only one such dependency the output syntactic representation, although abnormal, is not ambiguous, but when there are two such dependencies the output representation is semantically ambiguous. (Mauner et. Al 1993 p.349)

In a normal representation, a passive sentence like (4) has only one possible dependency assignment like (7a), but for agrammatic subjects, since their processing of dependency relations is impaired, (7a) as well as (7b) are both acceptable for them.

(7) (a) <[the boy]_i, t_i >, <[the girl]_j, -en_j>

(b) <[the boy]_i, -en_j >, <[the girl]_j, t_i >

Since the trace t_i and passive morphology $-en_j$ get *patient* and *agent* role respectively, and the head of the chain gets the same role as the foot of the chain, (7a) yields an interpretation like (8a), and (7b) yields an interpretation like (8b):

- (8) (a) x is the girl, and y is the boy, x chased y
 - (b) x is the boy, and y is the girl, x chased y
As a result, agrammatic subjects have to choose between (8a) and (8b), and have a 50% chance of getting the correct answer (8a). As for the active sentence like (5), although the dependency relation is also impaired for the subject, no ambiguity arises because there is only a single dependency. And that is why agrammatic subjects still perform well. Other types of structures, such as subject-relative clauses versus object-relative clauses and subject-clefts versus object-clefts are accounted for along the same lines.

It is should be noted that in order for the DDH to derive the empirical data, it has to assume that the abnormal processing of agrammatics still preserves some intact semantic and syntactic representation. For example, to derive the right interpretation of the subject gap sentence the boy is chasing the girl, the subject has to be able to rule out the coindexation where the VP internal subject trace is linked with the internal argument the girl. Mauner (1993) argued that the structure coming from this coindexation will lead to a deviant interpretation such as "x is the girl and x chases x", where the girl take two theta roles, moreover, "This interpretation is not nonsensical; however, it is problematic because no interpretation is assigned to the orphaned NP the boy. Suppose that declarative clauses denote propositions or closed sentences (formulated with no free variables). ... the boy, ... denotes an individual. There is no way to combine an individual with a closed sentence to yield another closed sentence. Hence, under widely shared assumptions about natural language semantics, [this interpretation] is deviant on semantic grounds." (Mauner 1993 p.360). And as Linebarger (1995) noted "the deviation arises out of a particular meaning with a particular linguistic structure, rather than out of the deviance of the meaning per se" (p.65) because in some cases the utterance of an isolated NP is perfectly fine, such as exclamations, book titles, etc. She concluded that "the

processing operations by which agrammatics reject the deviant indexing must have access both to the semantic representation and the linguistic structure from which this representation is derived." (Linebarger 1995, p.66.).

To sum up, the TDH is a hypothesis based on linear order, so it is vulnerable in the sense that so many languages in the world have different word orders from English. Every one of them could possibly be a case opposite to the prediction the TDH made based on English data. At the same time, the non-linguistic strategy in THE TDH is not satisfactory because if THE TDH is claimed to link the linguistic theory of normal grammar to the broken grammar of Broca's patients, it is necessary to limit its explanatory power within linguistic theories, instead of depending on something that is not linguistic. On the other hand, DDH is a theory purely depending on structural dependencies. We know that the same type of structures might have very different word orders cross-linguistically, but usually keep the same dependency relations. And this makes the DDH a better proposal to face cross-linguistic differences.

Chapter 5

An Introduction to Chinese Linguistics

Chinese has some special characteristics compared with other languages that have been well studied in the aphasia literature. For example, the Chinese relative clause is head final, with the relative clause as a pre-nominal modifier. This provides a very interesting test for the TDH and DDH. The TDH crucially depends on linear order of the language, so it will predict a different comprehension pattern in relative clauses for Chinese Broca's patients, because Chinese has different word order from English relative clause. On the other hand, the DDH will predict no change for Chinese patients as long as the dependency relations involved in Chinese relative clause are the same as English. Wh-questions are another interesting structure in Chinese. Wh-words stay in situ in Chinese, and move at LF, whereas in English wh-words move on the surface. In this chapter, I will lay out the syntactic analyses of a few Chinese structures, including topicalization, relative clause and wh-questions. The syntactic properties of these structures form the basis of the next section in which some experiments are designed to test the TDH and the DDH.

5.1. WH-in-Situ

In languages like English, interrogative wh-elements undergo overt movement to the [Spec, CP] position. An instance is given in (1):

(1) $_{CP}[What_j did_{IP}[he buy t_j]]?$

In (1), *what* moves to the [Spec, CP] position and leaves a trace behind in the object position of *buy*. In cases where the sentence has more than one interrogative whelements, only one moves to [Spec, CP], and the rest stay at their D-structure positions.

We call them wh-in-situ. For example, in (2), what undergoes overt movement, and leaves a trace t_i behind, but whom stays in situ.

(2) $_{CP}$ [What did $_{IP}$ [he buy t_i for whom]]?

In languages like Chinese, every wh-element stays in situ, i.e. there is no overt wh-movement at all. The Chinese counterpart example of (1) is like (3):

(3) Ta mai-le shenme?

He buy-perf. what?

What did he buy?

Since Huang (1982), it has been widely assumed that in Chinese, wh-elements undergo LF movement. That is to say, although Chinese wh-questions look different from English on the surface, the LF form of Chinese is exactly the same as English, with the wh-element moving to the [Spec, CP] position. So, at LF, (3) has the same representation as the English example (1):

However, the LF movement analysis has also been questioned and a nonmovement analysis was offered to interpret wh-in-situ questions. Aoun and Li (1993) argued that wh-in-situ elements, in both English and Chinese, need not raise to [Spec, CP] at LF. Instead, wh-in-situ elements are coindexed to a question operator that is raised to [Spect, CP] position at S-Structure. The major arguments they provided for the nonraising analysis are the interactions between *only* and wh-in-situ elements. As pointed in literature, *only* can be associated with the postverbal object when the object is in the ccommand domain of *only*.

(5) a. He only likes Mary. (he doesn't like Sue.)
b. Ta zhi xihuan Mali.
He only like Mary.
He only likes Mary.

Crucially, *only* must be associated with a lexical constituent in its c-command domain (Tancredi 1990). So in (6), the object cannot undergo any overt movement, such as topicalization.

- (6) a. * Mary_i, he only likes t_i .
 - b. * Mali_i, ta zhi xihuan t_i.
 - Mary, he only like

Moreover, independent arguments show that not only an overt movement like (6) is bad for *only*, but also a covert movement at LF will have the same effect.

- (7) a. Someone loves every boy in the room. (ambiguous)
 - b. Someone only loves every boy in the room. (unambiguous)

After quantifier raising (QR, May 1985), (7a) has two possible readings: either someone takes wide scope over every boy, or the other way around. But the scope ambiguity disappears in (7b), which only has the reading in which someone has wide scope. Aoun and Li argued that this is because at LF, only still needs to c-command the object every boy, and this blocks the QR of the object.

If only needs to c-command the object at both S-Structure and LF, it provides a test to show whether or not wh-in-situ elements have moved at LF. Aoun and Li offered the following data to show the LF movement analysis is not possible.

- (8) a. Who only likes what?
 - b. Ta zhi xihuan shei?
 - He only like whom
 - Who does he only like?

What in (8a) and shei (whom) in (8b) are wh-elements in situ. The fact that both sentences are fine indicate the non-raising of the wh-elements at LF, otherwise one expects these sentences are bad because after LF raising only is not able to c-command the wh-elements anymore.

Alternatively, Aoun and Li proposed that wh-in-situ does not need to raise to the Spec of Comp at LF and that in Chinese the wh-in-situ is coindexed and interpreted with respect to a question operator (Qu-operator). Under this proposal, a Chinese wh-question like (3), repeated as (9), will not have a LF raising representation like (4), repeated as (10), instead, it will have a LF representation like (11), in which a Qu-operator is at [Spec, CP] position and binds the wh-in-situ element.

(9) Ta mai-le shenme?

He buy-perf. what?

What did he buy?

(10) $_{CP}[shenme_{j}]_{IP}[ta mai-le t_{j}]]$ what_j he buy-perf. t_{j} what did he buy?

The LF raising analysis has also been challenged for conceptual reasons. Reinhart (1998) argued that under minimalist program, LF movement of wh-in-situ will possibly violate the economy principle (Chomsky 1995), and as a result, such movement must no exist.

(12) Who knows where to find what?

(12) is ambiguous. The wh-in-situ element *what* can take narrow scope, and the question can have an answer like *Max knows where to find what*. On the other hand, *what* can take scope over the matrix clause, so the question can have a pair list answer like *Max knows where we can find bicycles....* Under a movement analysis, the wide scope reading of *what* is obtained by moving *what* and adjoining it to *who*. Note that another option of the movement of *what* is to adjoin it to *where*, which is a shorter movement, so adjoining *what* to *who* would violate economy. To avoid this, Reinhart suggested abandoning the LF movement analysis, and adopting the unselective binding analysis (Baker 1970, Heim 1982). The basic idea is there is an abstract Q-morpheme at [Spec, CP] position, and it unselectively binds all the unmoved wh-variables. This is very similar to Aoun and Li's analysis.

To summarize, the status of wh-in-situ elements are under debate. One view is that LF raising happens, so at LF level, every wh-element moves. The opposite view is that LF raising does not happen, instead, there exist an null operator binding all the whin-situ elements.

5.2 Relative Clauses

5.2.1Word order

Unlike English, the Chinese NP is strictly head final. All NP modifiers can only show up in the pre-nominal position, including adjectives, possessors, and relative clauses. Between the modifier and the head NP, a morpheme DE is inserted to mark the modification relationship. The relative clause is especially important for our purpose here, and a simple example is given in (13) below (Law 2000):

(13) (a) Subject relative clause:

Chinese:Da nanhaiDE nuhaihensouLiteral translation:Hit boyDE girlvery thinEnglish:The girl who hit the boy is very thin

(b) Object relative clause:

Chinese:	Nanha	ai da	DE nuhai	henshou
Literal translation:	Boy	hit	DE girl	very thin
English:	The g	irl wl	no the boy h	it is very thin

(13a) is a subject relative clause, with a meaning that it is the girl that hit the boy, so girl is the agent, and "boy" is the patient. And (13b) is an object relative clause in Chinese, with an opposite meaning, namely, that it is the boy that hit the girl, so boy is the agent, and girl is the patient. As is shown very clearly, Chinese relative clauses have reversed word orders compared with their English counterparts. For the Chinese subject relative clause, the patient boy precedes the agent girl in its linear order, but for English, it is the opposite way: the agent precedes the patient; and for the Chinese object relative clause, the agent boy precedes the patient girl, while English has the opposite pattern again.

5.2.1.The syntactic structure of Chinese relative clauses

The traditional analysis of relative clause involves operator movement. For instance, example (14 a) would have an analysis like (14b):

(14) a. the story John likes

b. $_{DP}$ [the story_{i CP}[Op_{i IP}[John likes t_i]]

In this analysis, the relative clause CP is adjoined to the head NP as an adjunct. Since Kayne (1994), one consequence of his Linear Correspondence Axiom (LCA) is that there are no right-adjunction structures any more. So the relative clause receives a head movement analysis from Kayne. Example (14a) would have a new analysis like (15):

(15) DP[the CP[story_{i IP}[John likes t_i]

It is beyond the scope of this thesis to decide which analysis is the right one, and fortunately the difference between the two is not crucial for the purpose of this thesis either. So in this section I will provide evidence to show that movement is involved in Chinese relative clauses too, and assume a head movement analysis.

First of all, there is a gap between the argument and its original theta position. In (16a), the structural agent position is presumably before the predicate *hit*, as marked by t, but on the surface order the agent *girl* is showing up after the patient *boy*. And in (16b), the real patient *girl* also stands in a different position from its structural theta position. The intuition is that the argument has be linked to their original theta position through some kind of chain, thus get their theta roles. A simple version of the analysis is that movement links them together.

(16) (a) Subject relative clause:

Da nanhai de nuhai hensou t_i Hit boy de girl_i very thin The girl who hit the boy is very thin (b) Object relative clause: Nanhai da de nuhai henshou Boy hit t_i de girl_i very thin The girl who the boy hit is very thin

Two arguments are given here for the movement analysis. One is the subjacency condition (Chomsky 1986). Subjacency blocks movement that crosses more than one bounding node, where the bounding nodes are IP and NP. As Huang (1982) and Xu (1993) pointed out, the difference between wh-movement and relativization in Chinese is that while the former is not subject to the subjacency condition, the latter is, as shown in the following examples (examples are from Xu (1993)):

- (17) (a) Ni tingshuo Zhangsan mai sheme DE na-jian-shi le ma?
 You hear zhangsan buy what DE that-CL-thing part Q
 What have you heard the story that zhangsan bought?
 - (b) * wo tingshuo zhangsan mai DE na-jian-shi le DE che.
 - I hear zhangsan buy DE that-CL-thing part DE car. the car that I hear the story that zhangsan has bought

(17a) is a wh-question, and (17b) is a case of relativization. The English counterpart of both (a) and (b) are ungrammatical due to a violation of the subjacency condition. The difference between Chinese wh-movement and relativization can be accounted if we

assume subjacency only applies to s-structure movement. In English both wh-movement and relative clause involves s-structure movement, so they are both ruled out in situations like (17a) and (17b). But in Chinese, wh-movement is an LF movement or is not movement at all, (17a) is fine because subjacency doesn't apply at LF (Huang 1982) or does not apply to non-movement structures. The fact that subjacency does apply to the relative clause in (17b) suggests s-structure movement happens in Chinese relative clauses.

The second argument for movement comes from Across-the-Board (ATB) movement facts in coordination structures (Liou, 2002) Again, we find an asymmetry between wh-movement and relative clauses. Compare the wh-question in (18) and the relative clause in (19):

(18) *Ta gaosu wo zhangsan xihuan he Lisi bu xihuan shenme.
 He tell me zhangsan like and Lisi not like what
 He told me what zhangsan does and Lisi does not like.

As one can see in the English translation, which is grammatical, the overt wh-movement in English can bind two gaps left behind, so (18) means that there is one thing that Zhangsan likes, while for the same thing, Lisi does not like it. But the Chinese version of (18) is bad. (18) is in sharp contrast with a relative clause (19), in which the coordination structure is fine.

(19) Ta gaosu wo zhangsan xihuan er Lisi bu xihuan DE dongxi.
He tell me zhangsan like while/and Lisi not like DE thing
He told me about the thing that zhangsan likes and Lisi does not like.

It seems that the Chinese relative clause patterns the same as English wh-movement in terms of coordination, again a S-structure movement analysis like (20) in the Chinese relative clause is able to account for this:

(20) Ta gaosu wo zhangsan xihuan er Lisi bu xihuan DE dongxi. He tell me zhangsan like t_i while/and Lisi not like t_i DE thing i

5.3.Topicalization

Sentences having the form of "topic-comment" are common in Chinese (cf. Li and Thompson 1976). For example, in (21), the topic cannot be considered as derived from the subject predicate form, because there is no gap in the comment sentence.

(21) Shuiguo, wo xihuan juzi.

Fruit, I like orange

As for fruit, I like orange.

On the other hand, some topics can be traced back to a base position, i.e. movement is involved to derive a topicalization structure (Huang 1982), as in (22),

(22) Zhangsan_k DE baba_i, ta_j hen zunzong t_i.
Zhangsan_k 's dad_i, he_j very repect t_i
Zhangsan's dad, he respected a lot.

In (22), Zhangsan and he can't co-refer. This is naturally explained if we assume Zhangsan's dad is moved from the postverbal position. When it is reconstructed back to the trace t_i position, co-reference between Zhangsan and he will lead to a violation of binding Principle C. To summarize, Chinese relative clauses are head-final as opposed to the head-initial order in English, but they both involve movement on the surface. Chinese wh-questions don't involve the S-structure movement, i.e. wh-words stays in situ, but may move at LF. Finally, topicalization comes in two kinds, one involving movement to the topicalized site, the other not. We will see in the next section that it is the former type suits our interest to study agrammatic comprehension.

Chapter 6

A design of an experiment on Chinese Broca's patients

6.1. Previous studies on Chinese patients

Law (2000) reviewed the results of three studies investigating sentence comprehension deficits of Mandarin Chinese and Cantonese aphasics (Su & Law, 1993; Law & Leung, 1998a, 1998b). All these patients were assessed on, among other sentence types, subject-gap and object-gap relatives, and the subject-gap sentences seem to present greater difficulty than the object-gap sentences, contrary to the English cases. Based on this, it was suggested that patients were using the linear order of the lexical NPs to make their judgment instead of structural prominence.

This is a very interesting result for several hypotheses if the result is reliable. The subject selection problem, however, makes the result very suspect. The working hypotheses Law used are the Structural Prominence Hypothesis (SPH) proposed by Friederici & Gorrell (1998), and the linear strategies, as exemplified by the default strategy in Grodzinsky (1990, 1995). Notice that both hypotheses are proposed to account for agrammatic comprehension, not aphasic comprehension in general. Although it was argued earlier in this paper that *agrammatism* alone is not a sufficient category to group patients together for the purpose of neurolinguistic study, the point is to find a better way of grouping patients, not throw away the idea of category. But in the three studies Law reviewed, subject selection was not considered either on the traditional clinical grounds, namely, that they are agrammatic. Nor was subject selection based on a carefully designed comprehension task, which grouped together those patients who had the same performance pattern. The only criterion for these studies is that all subjects are

aphasic patients but this would not tell us too much because those patients started with very different linguistic performance.

6.2. Topicalization--the screening test for Chinese patients

As far as I am aware, no study before with Chinese aphasic patients has thought of a screening test, partly because no study before has established a certain performance pattern of agrammatic comprehension in Chinese. Assuming that the impaired processing mechanism responsible for English patients' comprehension will also influence the Chinese patients' comprehension in the same way, a Chinese version of the English screening test should work too. Under the assumption that the same structure is processed by the same mechanisms cross-linguistically, the question immediately raised is to find a construction in Chinese which has a structure with relevant properties in common, just as English active-passive structures or subject-object relative clauses do. Active and passive structures are not appropriate candidates for Chinese because of the unclear syntactic nature of Chinese passives. But active-topicalization might be the closest structure one can find. Chinese active sentences have the same syntax as English actives. Regarding topicalization, as introduced in 5.3, one type of Chinese topicalization involves the object extraction. Together with the subject extraction (under the VP internal subject hypothesis), this type of topicalization should present the same problem to Chinese patients, just as passives and object relative clauses do to English patients. That is to say, one expects Chinese patients to have only at chance comprehension of topicalization sentences, while they should have above chance comprehension of active sentences.

Although topicalization seems to be a good candidate for a screening test, one needs to be careful when using it, and a control group of normal subjects is recommended. If even normal people have problems processing topicalization structures because of their low frequency, they should not be used to screen Broca's patients, even though it does have the syntactic properties we want. For this reason, a pilot study was conducted on some normal Chinese speakers.

A pilot study

Subjects and material

8 Chinese graduate students at Michigan State University took part in the study. 80 sentences in total were used for each subject. 40 of them are screening test sentences, with 20 normal active sentences and 20 topicalization sentences. The other 40 sentences are fillers for the screening test, with 20 subject relative clauses and 20 object relative clauses (see Appendix A for the material). All the sentences in the test were randomized. Examples of each type of sentence are given below (these are translations from Chinese sentences):

- 1 active-topicalization sentences
- (a) nuren tui-le yi-xia changjinglu
 woman push-perf. once giraffe
 The woman pushed the giraffe.
- (b) changjinglu, nuren tui-le yi-xia giraffe, woman push-perf. once The giraffe, the woman pushed.

- 2 relative clasues
- (a) jingcha kun DE niu policeman bind DE cow

The cow who the policeman is binding.

(b) kun jingcha DE niu

bind policeman DE cow

The cow who is binding the policeman.

Two-actor pictures were used for active-topicalization (the screening test) sentences and relative clauses sentences. For each sentence, two pictures were used. The thematic relations are reversed in the two pictures. The two pictures were presented in a vertical order, and the order for all sentences was randomly arranged to avoid the possible guessing the order pattern. Ten verbs in total were used.

Procedure

Subjects were asked to look at the pictures, and match the picture or the actor they see with the sentence they hear. Instructions were given to the subject before the test, and two practice sentences followed to ensure the subjects understood the test. Sentences could be repeated, if the subjects wished to hear them again.

Results

	relative clauses			act	tive	topicaliz	ation	
subjects	subject-relative		object-relative					
	correct	In-	correct	In-	correct	In-	correct	In-
		correct		correct		correct		correct
A	20	0	20	0	20	0	20	0
В	20	0	20	0	20	0	20	0
С	20	0	20	0	20	0	20	0
D	20	0	20	0	20	0	20	0
E	20	0	20	0	20	0	20	0
F	20	0	20	0	20	0	20	0
G	20	0	20	0	20	0	20	0
Н	20	0	20	0	20	0	20	0

Table 1: The results of the pilot study

Although the pilot study above is a very small one, the consistent results still showed that normal speakers have no problem processing topicalization structures in an off-line study, although this type of structure is relatively infrequent in Chinese. This eliminates the possibility that poor performance of Broca's aphasics on topicalization structures could be due to the infrequency of the structure itself.

6.3. Relative clause--testing the TDH and DDH

6.3.1. The predictions of the TDH and DDH

hypothesis. In this section we will look at how each of them accounts for the English relative clauses, and what predictions they will make for Chinese relative clauses.

6.3.1.1 Predictions for English

Predictions of the TDH

Assuming the VP-internal subject hypothesis, the basic syntactic structure for the English relative clause is given in (3):

- 3 (a) [the boy]_i [Op that t_i is t_i chasing [the girl]] is tall
 - (b) [the boy]_j [Op that [the girl]_i is t_i chasing t_j] is tall

Since the underlying traces are all missing for agrammatic patients, the agrammatic representation, according to the TDH, is like (4) (asterisks represent deletions):

- 4 (a) [the boy] [Op that * is * chasing [the girl]] is tall
 - (b) [the boy] [Op that [the girl] is * chasing *] is tall

For the subject relative clause (4a), *the boy* cannot be traced back to its argument position, because the argument chain is disrupted. But *the boy* is the first NP of the sentence, and the first θ -role on the thematic hierarchy is the agent role, so the default strategy tells the patients to assign an agent role to *the boy*. This happens to be the same role assigned by normal subjects. Thus no misinterpretation occurs. For the object relative (4b), in section 4.1.2, we already saw that the TDH cannot account for the atchance performance under VP internal subject hypothesis. If we put aside the issue of VP internal subject, and just assume one movement -- the object movement, as in (5):

(5) [the boy] [Op that [the girl] is chasing *] is tall

The at-chance performance is derived because "the girl" gets its agent role through the verb "chase", and the trace is deleted, so "the boy" can only get its role from the default

strategy, and it is an agent role. Two contradictory agent roles lead to chance performance.

Predictions of DDH

Example (3) is repeated as (6) to demonstrate how DDH works to get all the results.

- 6 (a) [the boy]_i [Op that t_i ' is t_i chasing [the girl]] is tall
 - (b) [the boy]_j [Op that [the girl]_i is t_i chasing t_j] is tall

for the subject relative (6a), there is only one dependency relation, <the boy, t_i ', t_i >. Even for agrammatic patients, whose dependencies are disrupted, it is impossible to get a dependency relation like < the girl, t_i ', t_i >, because semantically the latter dependency means: *x is a girl, and x is chasing x*. Assuming common knowledge about the world, this interpretation has to be ruled out because it is deviant in nature. So agrammatic subjects will not make mistakes because there are no ambiguous options. On the other hand, for the object relative (6b), there are two dependency relations. The correct dependency relation is <the boy, t_j > and < the girl, t_i >, which means: *x is a girl, y is a boy, and x is chasing y*. If agrammatic patients are not able to form the right dependency relation, they could be distracted by the wrong pair of dependencies: < the boy, t_i > and < the girl, t_j >, which means exactly the opposite to the reading above: *x is a boy, y is a girl, and x is chasing y*. Being unable to distinguish the two, the agrammatic subject has to make a guess and will end up with chance performance.

6.3.1.2.Predictions for Chinese

As already argued in section 5.1, the Chinese relative clause involves the movement of the head NP.

(7) (a) Subject relative clause:

Da nanhai de nuhai hensou t_i Hit boy de girl_i very thin

The girl who hit the boy is very thin

(b) Object relative clause:

Nanhai da de nuhai henshou Boy t_k hit t_i de girl_i very thin The girl who the boy hit is very thin

The predictions of theTDH

According to the TDH, traces t_i in (7a) and t_i , t_k in (7b) are deleted. For the subject relative clause (7a), *boy* is the object of *hit*, so it gets assigned the Theme role via the structure. *Girl* is not assigned any role structurally, because the trace t_i , which can transmit the theta role, is missing. Because *girl* is the second NP in the linear order, so the default strategy will assign a Theme role to it, which is also the lower role in the thematic hierarchy. Confronted with two Theme roles, the agrammatic subject can only guess and should end up with chance performance. But for the object relative clause (7b), although traces t_k and t_i are deleted, because *boy* is the first NP in linear order, it should be assigned the Agent role. And since *girl* is the second NP, it should get a Theme role. This happens to be the same as normal theta role assignment, and the agrammatic subject should display above-chance performance.

The predictions of the DDH

The predictions of the DDH are similar to the English cases. The Subject relative clause only involves one dependency relation $< t_i$ girl >, so no ambiguity arises for

comprehension. But the object relative clause has two dependencies $< t_k$, boy> and $< t_i$, girl >. Ambiguity should arise and the agrammatic subject should exhibit chance performance.

The summary of the predictions is listed below. We can see that two hypotheses give different predictions for Chinese relative clauses. And that is why Chinese data provides a very good chance to evaluate the two competing hypotheses.

	DDH	TDH
Subject	above-chance	at-chance
Relative-clause		
Object	at-chance	above-chance
Relative-clause		

Table 2: Predictions of the DDH and the TDH

6.3.2 A test using relative clauses

This test aims at testing different predictions made by the TDH and DDH. Criteria for subjects are:

(i) Neurological left-frontal CVA involving Broca's area, confirmed by CT scan, at least

three months prior to participation in this study;

(ii) Diagnosed as Broca's aphasic, as confirmed by clinical workup and BDAE test.

(iii) No significant disabilities in vision or hearing.

(iv) In the screening test, above-chance performance on active sentences, and at-chance

performance on topicalization sentences.

Testing materials and procedures are the same as in the screening test (see section 6.2 and Appendix A). Screening sentences and relative clauses are mixed up in one material set, so that active, and topicalization sentences can be viewed as fillers for relative clauses, and vice versa. Two-actor pictures are used and two pictures are presented in a vertical order for each sentence. Subjects are asked to look at the pictures, and match the picture or the actor they see with the sentence they hear.

6.4. The comprehension of wh-movement

6.4.1. The comprehension of English wh-questions

It seems reasonable to assume that the comprehension of wh-questions should reveal the same pattern as active/passives, or relative clauses, because they share some similarity in structure. Subject wh-questions are on a par with actives and subject relative clauses in that each of them only has one movement, the VP internal subject movement, and thus only one dependency relation; and object wh-questions are on a par with passives and object relative clauses in that each has two movements and thus two dependency relations. The TDH would predict that Broca's patients perform above chance on subject wh-questions, and at chance on object wh-questions, and the DDH would predict the same thing but for different reasons. There have been only a few studies of wh-questions as far as I am aware of, and the focus of those studies is not just testing the predicted asymmetry between subject wh-questions and object wh-questions. Hickok and Avrutin (1996) reported the results of an experiment in which two agrammatic aphasic subjects showed an interesting pattern in their comprehension of who questions and which-NP questions. Both subject extraction and object extraction sentences were tested, and only which NP questions showed the expected asymmetry

with subject extracted questions comprehended significantly better than object extracted ones. For *who* questions, performance was above chance for both subject and object extractions. Based on this result, Grodzinsky (1995) revised the Trace Deletion Hypothesis by proposing that the default strategy applies only to referential NPs (*which-*NP questions), not to nonreferential NPs (*who* questions). Thompson et al. (1999) failed to replicate the pattern in Hickok and Avrutin (1996), with only one out of four subjects showing the distinct performance between *which*-NP questions and *who* questions.

6.4.2. A test with Chinese Wh-questions

So, the facts now are unclear. More research needs to be done to see if the asymmetry pattern between subject and object extraction is real for wh-questions, and if there is really a distinction between *who* and *which-NP* questions. This is the first reason why a study on Chinese wh-questions is relevant. More importantly, recall that in section 5.2, a theoretical account for wh-in-situ is still under debate. A successful replication of the asymmetric comprehension pattern in English would provide support for wh-movement at the LF level. That is to say, the existence of a covert LF level movement can be made visible by the agrammatic comprehension pattern.

Subject criteria are the same as for the screening test. 80 sentences are used. 40 of them are wh-questions, with 20 subject wh-questions and 20 object wh-questions, see examples in (8), and 40 of them are filler sentences, and examples are given in (9). Only one picture is presented for each sentence, and there are three actors in each picture. Five verbs are used in total. Procedures are still the same as for the other tests. Subjects are asked to look at the pictures, and match the picture they see with the sentence they hear

- 8 wh-questions
- (a) Who grabs the camel?
- (b) Who does the camel grab?
- 9 filler sentences
- (a) Where is the camel?
- (b) Who is in the middle?

6.4.3. The predictions for wh-questions

If wh-movement at LF level is correct, Chinese wh-questions will essentially have the same structure as English wh-questions. So TDH and DDH would predict the same result for Chinese patients as for English patients, i.e. above-chance performance on subject extraction questions, and at-chance on object extraction questions.

On the other hand, if in Chinese, an abstract Q-morpheme binds wh-in-situ via unselective binding, the TDH and the DDH will make different predictions. Since there is no movement in this analysis for wh-words, there will be only one trace left for all types of wh-questions, the trace for the VP internal subject, the TDH will only operate on this single trace, and should predict above-chance performance for both subject and object extraction questions. By contrast, for the DDH, since binding between the Q-morpheme and the wh-words is still counted as one dependency relation, the prediction should be the same as assuming the LF movement analysis. Predictions are summarized below:

	TDH	DDH
LF movement	Above chance on subject	Above chance on subject
	extractions, and at chance on	extractions, and at chance on
	object extractions	object extractions
Unselective binding	Above chance on both	Above chance on subject
	subject and object	extractions, and at chance on
	extractions.	object extractions

Table 3: The predictions for wh-questions

6.5. Summary

To sum up, in this section three tests are suggested for a Chinese comprehension study. The first is a screening test. Since the contrast between actives and topicalization sentences in Chinese is on a par with the contrast between actives and passives in English, we predict that Chinese Broca's patients should perform above chance on actives and at chance on topicalization sentences. And that can be considered as a base line for the subjects' performance in the experimental tests. A pilot screening test was carried out on normal Chinese speakers just to make sure the topicalization structure itself does not pose significant difficulty for off-line comprehension. The second test is on Chinese relative clauses. Compared with English, the different word order of Chinese relative clauses will lead to different predictions for the TDH and the DDH, and hence possibly distinguish these two proposals. The last test is on Chinese wh-questions. Whwords stay in-situ in Chinese, though their theoretical status is not completely clear yet. As a follow-up test after the relative clauses, patients' performance on wh-questions can tell us whether the breakdown of their comprehension of one type of movement (movements in relative clauses) has some effect on other types of movements. If it does, it also provides some empirical support for the invisible LF movement of wh-words in Chinese.

Chapter 7

Conclusion

The goal of this study is to give an overview to the issues that are important to many researches on agrammatic comprehension. Questions that are frequently asked are whether Broca's patients form a single group that is characterized by a unique comprehension pattern, and if that is the case, how to account for this pattern. Chinese is the target of an experimental design because of its unique syntactic structure which can nicely distinguish the two competing hypotheses, the *Trace Deletion Hypothesis* and the *Double Dependency Hypothesis*. Chinese relative clauses have different word order but similar syntactic structures as English, so the TDH as a linear order based account would predict a different comprehension pattern from English, but the DDH as a structure based account would predict the same result as English. The test of wh-questions is interesting because a significant result from that will provide a strong argument for the existence of LF from the aspect of language processing. Sentence-picture matching tasks are used for this experiment, and a pilot study is done on normal people to establish a baseline for the screening test.

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Actives

1. 女人推了长颈鹿一下 2. 长颈鹿推了女人一下 3. 女人亲了男人一下 4. 男人亲了女人一下 5. 厨师捅了骆驼一刀 6. 骆 驼捅了厨 师一刀 7. 警察踢了长颈鹿一下 8. 长颈鹿踢了警察一下 9. 骆 驼打了医 生一下 10. 医 生打了骆 驼一下 11. 斑 马咬了厨 师一口 12. 厨师咬了斑马一口 13. 斑 马抓了厨 师一下 14. 厨师抓了斑马一下 15. 警察拉了牛一下 16. 牛拉了警 察一下 17. 狗踩了牛一下 18. 牛踩了狗一下 19. 骆 驼撞了警 察一下 20. 警察撞了骆驼一下

Topicalizations

1.	长颈鹿,女人推了一下
2.	女人,长颈鹿推了一下
3.	男人,女人亲了一下
4.	女人,男人亲了一下
5.	骆 驼, 厨 师捅了一刀
6.	厨 师, 骆 驼捅了一刀
7.	长颈鹿,警察踢了一下
8.	警察,长颈鹿踢了一下
9.	医 生, 骆 驼打了一下
10.	骆 驼, 医 生打了一下
11.	厨 师, 斑 马咬了一口
12.	斑马,厨师咬了一口
13.	厨师,斑马抓了一下
14.	斑马,厨师抓了一下
15.	牛, 警 察拉了一下
16.	警察,牛拉了一下
17.	牛,狗踩了一下

The woman pushed giraffe. The giraffe pushed woman. The woman kissed the man. The man kissed the woman. The cook stabbed the camel. The camel stabbed the cook. The policeman kicked the giraffe. The giraffe kicked the policeman. The camel hit the doctor. The doctor hit the camel. The zebra bit the cook. The cook bit the zebra. The zebra grabbed the cook. The cook grabbed the zebra. The policeman pulled the cow. The cow pulled the policeman. The dog stepped on the cow. The cow stepped on the dog. The camel bumped the policeman. The policeman bumped the camel.

The giraffe, the woman pushed. The woman, the giraffe pushed. The man, the woman kissed. The woman, the man kissed. The camel, the cook stabbed. The cook, the camel stabbed. The giraffe, the policeman kicked. The policeman, the giraffe kicked. The doctor, the camel hit. The camel, the doctor hit. The cook, the zebra bit. The zebra, the cook bit. The cook, the zebra grabbed. The zebra, the cook grabbed. The cow, the policeman pulled. The policeman, the cow pulled. The cow, the dog stepped on.

18. 狗, 牛踩了一下 19. 警 察, 骆 驼撞了一下 20. 骆 驼, 警 察撞了一下	The dog, the cow stepped on. The policeman, the camel bumped. The camel, the policeman bumped.
Subject relative clauses	
1. 指出捆牛的警察	Point to the policeman who is binding
2. 指 出捆警 察的牛	Point to the cow who is binding the policeman
3. 指出推女人的长颈鹿	Point to the giraffe who is pushing the woman.
4. 指出推长颈鹿的女人	Point to the woman who is pushing the giraffe.
5. 指出亲男人的女人	Point to the woman who is kissing the man.
6. 指出亲女人的男人	Point to the man who is kissing the woman.
7. 指 出拖着厨 师的骆 驼	Point to the camel who is pulling the cook.
8. 指出拖着骆驼的厨师	Point to the cook who is pulling the camel.
9. 指出打骆驼的医生	Point to the doctor who is hitting the camel.
10. 指 出打医 生的骆 驼	Point to the camel who is hitting the doctor.
11. 指出背着骆驼的医生	Point to the doctor who is carrying the camel.
12. 指 出背着医 生的骆 驼	Point to the camel who is carrying the doctor.
13. 指出跟着斑马的厨师	Point to the cook who is following the zebra.
14. 指出跟着厨师的斑马	Point to the zebra who is following the cook
15. 指 出踢警 察的长颈鹿	Point to the giraffe who is kicking the policeman
16. 指 出踢长颈鹿的警 察	Point to the policeman who is kicking the giraffe
17. 指 出追牛的小狗 18. 指 出追小狗的牛 19. 指 出咬厨 师的斑 马	Point to the dog who is chasing the cow. Point to the cow who is chasing the dog. Point to the zebra who is biting the cook.
20. 指出收斑 马的厨 帅	Point to the cook who is biting the zebra.

Object relative clauses

1. 指 出警 察捆的牛	Point to the cow who the policeman is
2. 指出牛捆的警察	Point to the policeman who the cow is
3. 指出女人推着的长颈鹿	binding. Point to the giraffe who the woman is
	pushing.
4. 指出长颈鹿推着的女人	Point to the woman who the giraffe is pushing.
5. 指出女人亲的男人	Point to the man who the woman is
6 指出黒人辛的ケ人	kissing. Point to the woman who the man is
	kissing.
7. 指 出厨 师拖着的骆 驼	Point to the camel who the cook is
8. 指 出骆 驼拖着的厨 师	Point to the cook who the camel is
	pulling.
9. 指出骆驼打的医生	hitting.
10. 指 出医 生打的骆 驼	Point to the camel who the doctor is
11 指 电医 生背差的路 啶	hitting. Point to the camel who the doctor is
11.11 山区 工具有的研究	carrying.
12. 指 出骆 驼背着的医 生	Point to the doctor who the camel is
13. 指 出斑 马跟着的厨 师	Point to the cook who the zebra is
	following.
14. 指出厨师跟看的斑马	Point to the zebra who the cook is following.
15. 指出警察踢的长颈鹿	Point to the giraffe who the policeman is
16 步山长颈声跟的教家	kicking.
10. 拍 田 民项能竭的 蒼 泵	kicking.
17. 指 出小狗追的牛	Point to the cow who the dog is chasing.
18.指出牛追的小狗 10. 作山斑 马哈的厨 师	Point to the dog who the cow is chasing.
19. 拍 西班 · J·叹的剧 师 20. 指 中厨 师应的斑 马	Point to the zebra who the cook is biting.
	Tome to the Zeola who the cook is oking.
Subject wh-question	
1. 谁抓着猪?	Who is grabbing the pig?
2. 谁推着绵 羊?	Who is pushing the sheep?
3. 谁咬了狗?	Who is biting the dog?
4. 唯打 5 长颈鹿?	Who is hitting the giraffe?
5. 唯抓有羒 兆?	who is grabbing the camel?
0. 唯咬丁午!	who is bitting the cow?

7. 谁推着老 虎?
 8. 谁打了马?
 9. 谁踢了长颈鹿?
 10. 谁踢了马?

Object wh-questions

- 1. 长颈鹿打了谁?
- 2. 绵 羊推了谁?
- 3. 狗咬了谁?
- 4. 长颈鹿踢了谁?
- 5. 马踢了谁?
- 6. 牛咬了谁?
- 7. 猪抓着谁?
- 8. 马打了谁?
- 9. 骆 驼抓着谁?
- 10. 老 虎推着谁?

Who is pushing the tiger? Who is hitting the horse? Who is kicking the giraffe? Who is kicking the horse?

Who is the giraffe hitting? Who is the sheep pushing? Who is the dog biting? Who is the giraffe kicking? Who is the horse kicking? Who is the cow biting? Who is the pig grabbing? Who is the horse hitting? Who is the camel grabbing? Who is the tiger pushing?
Appendix B: Samples of Experimental Pictures

A sample picture for topicalization sentences and relative clauses





A sample picture for wh-questions



