

Comprehension of Referring Expressions in Chinese

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Studies of English have shown that reduced referential expressions (e.g. pronouns) contribute more to discourse coherence than do unreduced expressions (e.g. proper names). To test the generality of these findings, a series of reading-time studies was conducted to examine the processing of co-reference in Chinese discourse. The results obtained for Chinese were similar to those obtained previously for English. Furthermore, comparisons of the comprehension of overt pronouns and zero pronouns (a phonologically-null form not present in English) showed that the two types of reduced referring expressions contribute equally to discourse coherence for the kinds of passages studied in the experiments. A formal model of the structure and processing of reference in discourse, developed to handle co-reference phenomena in English, is shown to provide an account of these experimental results on the reading of Chinese.

INTRODUCTION

It is generally believed that the use of referring expressions plays a fundamental role in well-formed discourse by providing critical links that integrate successive utterances to form a coherent discourse representation (Grosz, Joshi, & Weinstein, 1995; Halliday & Hassan, 1976; Kintsch & van Dijk, 1978) and that different forms of referring expressions have distinct functions in promoting discourse comprehension (Gordon, Grosz, & Gilliom, 1993). However, most of the research that supports these conclusions has been conducted in English, and there is no certainty that they can be generalised to other languages. The present research extends

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this psycholinguistic investigation of referential expressions to the study of Chinese.

Reduced expressions (e.g. pronominal expressions such as *he* or *she*) appear to contribute more to discourse coherence than do full lexical expressions (e.g. proper names like *John* or definitive descriptions like *the table*). This is illustrated in the following passage.

- (1) a. John went to the grocery store this morning.
 b. *John/He* lost his wallet along the way.

The second sentence (1.b) seems more natural when a pronoun (*he*) is used to refer to a prominent discourse entity (JOHN) than when a repeated name (*John*) is used for the same purpose.

The phenomenon illustrated intuitively in (1) above has been the object of substantial study in psycholinguistics. Demonstrations that discourse coherence is promoted more by co-reference with pronouns than by co-reference with repeated names has been found using a variety of experimental paradigms including: response times to related and unrelated probe words (Cloitre & Bever, 1988), production of coherent speech (Brennan, 1995), judgements of coherence or grammaticality (Gordon & Hendrick, 1997; Hudson, Tanenhaus & Dell, 1986), self-paced reading time (Gordon et al., 1993) and eye-tracking during reading (Kennison & Gordon, 1997). Under specific circumstances, sentences with repeated names are read more slowly than sentences with pronouns, an effect that has been called the repeated-name penalty (Gordon et al., 1993). Other research looking at recognition memory for probe words has been interpreted as indicating that co-reference is achieved more easily with repeated names (or repeated descriptions) than with pronouns (Gernsbacher, 1989; Greene, McKoon, & Ratcliff, 1992), but the methodology used has been criticised because it may tell more about the relation between the repeated name and the probe word than about the repeated name and its referent in the discourse (Gordon et al., 1993; Garrod, Freudenthal, & Boyle, 1994).

The effect of a pronoun on discourse comprehension has been explained in several ways that are broadly similar. Garrod and Sanford (1982, 1988) suggested that the use of a pronoun in a discourse indicated that its referent is in discourse focus whereas the use of a repeated name reintroduced its referent back into the discourse focus. Cloitre and Bever (1988) argued that different forms of referring expressions trigger different levels of representation, with pronouns directly activating semantic information while repeated nouns activate phonological information first. Gordon and Hendrick (1998), drawing on work in model-theoretic semantics (Kamp & Reyle, 1993) and computational linguistics (Grosz et al., 1983, 1995) have presented a model in which reduced expressions (such

as pronouns) are interpreted as referring to entities already represented in a discourse universe while expressions (such as proper names) are interpreted as invoking more general knowledge.

However, since most of the evidence showing differences in the ease of interpreting co-reference with pronouns and names comes from studies of English, the generality across languages of the explanations discussed above is unclear. The current paper addresses this issue by examining the comprehension of co-reference in Chinese, a very different language system from English.

Chinese Anaphora

Chinese has three kinds of anaphoric expressions: zero pronouns, overt pronouns, and referring expressions. The zero pronoun is a non-overt, reduced expression that co-refers with an expression that appears earlier in a discourse (Chen, 1984; Huang, 1984; Li, 1985; Li & Thompson, 1981, 1984; Tai, 1978; Xu, 1986). It is a characteristic of anaphoric reference that distinguishes Chinese and many other East Asian languages from some European languages such as English or French. A sample zero pronoun discourse, taken from Li and Thompson (1981, p.669), is shown below.

(2) a. Speaker A:

他	看見	你	沒有？
ta	kanjian	ni	meiyou?
3sg	see	you	not

“(Did) he see you?”

b. Speaker B:

_____	看見	_____	了。
_____	kanjian	_____	le

(ta) see (wo) ASPECT

“he saw me.”

A Chinese addressee has no difficulty in using discourse context to determine the intended referents in utterance 2.b, even though the expressions that indicate those referents (“*ta*” and “*wo*”) have been omitted. However, if context is removed by eliminating utterance 3.a, then the intended referents in 3.b cannot be determined. Accordingly, it is commonly assumed that Chinese-speakers and listeners have to rely upon contextual and pragmatic knowledge in order to interpret zero pronouns rather than upon syntactic and semantic factors (Chen, 1984; Li & Thompson, 1981, 1984). Some European languages, like Italian or Spanish,

contain zero pronouns. But these languages have morphosyntactic systems that redundantly encode pronominal information in the verbal agreement system. Chinese has an impoverished morphosyntactic system that lacks verb agreement. Elliptical expressions in English might be considered zero pronouns but these are under far greater syntactic control than are zero pronouns in Chinese.¹ The phenomenon of zero pronouns in Chinese raises two theoretical issues that merit examination.

First, do the two kinds of reduced expressions in Chinese (overt and zero pronouns) have different effects on discourse coherence? Generally speaking, linguists studying Chinese believe that zero pronouns in pro-drop languages perform specific roles with respect to meaning that are different from the roles of overt pronouns (Chen, 1984; Givon, 1983, 1992; Huang, 1991; Li, 1985; Li & Thompson, 1981, 1984; Tao, 1996). A traditional view attributes the choice of the form of a referring expression to the degree of familiarity or accessibility of its referent; the more accessible a referent, the more likely speakers are to choose a reduced expression. Building on this view, it has been argued that zero pronouns require referents with a higher degree of accessibility than do overt pronouns (Ariel, 1990, 1991; Halmari, 1996; Givon, 1983). Ariel (1990, 1991) proposed that a zero pronoun is a referential expression that signals the retrieval of the antecedent with highest accessibility from a mental representation of a discourse. Further, Givon (1981, 1983) proposed a cross-linguistic ranking of the impact of topic continuity on the form of referring expressions. According to this ranking, speakers use zero pronouns when the referent is the most accessible topic in discourse context, whereas they tend to use overt pronouns when the referent becomes less accessible.

The second theoretical issue posed by zero pronouns is whether their interpretation depends exclusively on pragmatic factors or whether syntactic factors also help to determine the referent of a zero pronoun. It has been generally believed that the interpretation of omitted referential expressions in a Chinese zero-pronoun discourse heavily depends upon the integrated semantics of a discourse (Chen, 1984; Li, 1985; Li & Thompson, 1981, 1984). However, views differ with regard to the role that syntactic factors play in deciphering omitted referential expressions in a zero-pronoun discourse. Li and Thompson (1981, 1984) contended that the interpretation of omitted referential expressions relies upon context and

¹ The null subjects in English infinitives such as "John wanted to go to school" appear to have different empirical properties than Chinese zero pronouns. For example, they typically have an antecedent within their sentence or when one is not present they are given a generic interpretation (cf. Chomsky, 1986). Gerundives show similar restrictions. The Chinese zero pronoun do not show these characteristics.

pragmatic information only. In contrast, Chen (1984) and Li (1985) both asserted that syntactic structure partially determines the choice between overt pronoun and zero pronoun, but primarily for the special syntactic constructions that involve “coverb” and “pivotal” sentences. Because relatively little psycholinguistic research has been done on anaphoric reference in Chinese discourse, there is no immediate answer to this question with regard to language comprehension. However, the context-and-pragmatics-only approach advocated by Li and Thompson (1984) is not consistent with characterisations of anaphoric reference in other languages, where referential processing is found to be influenced by syntactic factors (Gordon et al., 1993; Gordon & Chan, 1995; Gordon & Scarse, 1995; Kennison & Gordon, 1997; McKoon, Ratcliff, & Ward, 1993; McKoon, Ward, & Ratcliff, 1993).

The experiments reported in this paper use self-paced reading time methodology to address the questions raised above. The first two experiments were conducted using designs that are very similar to those developed by Gordon et al. (1993) to study the comprehension of co-reference in English. Accordingly, comparison of the findings from those experiments with the findings reported by Gordon et al. (1993) provides a basis for cross-linguistic comparison in the comprehension of co-reference. The second two experiments focus specifically on similarities and differences in the comprehension of zero and overt pronouns in Chinese.

EXPERIMENT 1

This experiment examined how the timecourse of reading Chinese sentences was influenced by three types of referring expressions: repeated names, pronouns, and zero pronouns. A self-paced reading task was employed to examine the reading of passages such as the one shown in Table 1. Each passage consisted of three sentences in a semantically coherent discourse. The first sentence introduced two named individuals of different genders using a subject-verb-object word order. Subject-verb-object order was used because it is the most common order in Chinese and does not use the special markings (“把 ‘Ba’” and “被 ‘Bei’”) required by other orders (Chu, 1979; Sun & Givon, 1985). One discourse entity was introduced as a grammatical subject, and the other was introduced as the postverbal object. This assignment of syntactic roles for these two discourse entities was maintained in the second sentence. In the second, critical sentence the form of referring expressions was manipulated. There were six versions constructed by the combinations of assigning different forms of anaphoric expression (repeated name, overt pronoun, and zero pronoun) to different syntactic positions (subject or object). However, zero pronouns were only used for the expression in the position of grammatical

TABLE 1
Sample Stimuli for Experiment 1

Initial Sentence:

小明 告訴 小玲 這一帶 住宅區 不 安全。
Xiaoming gaoshu Xiaolin zheyidai zhuzaiqu bu anquan.
 3rd sing. tell(told) 3rd sing. here community not safe.
 “*Xiaoming told Xiaolin that the community here is not safe*”.

Second Sentence:

小明 / 他 / 警告 小玲 / 她 平常 隨時 提高 警覺。
Xiaoming / Ta / Ø jinggao Xiaolin / Ta pinchang suishi tigao jingjie.
Xiaoming / Ta / Ø warn(ed) Xiaolin / Ta usually always keep alert.
 “*Xiaoming / He / Ø warned Xiaolin / her to keep alert always*”.

Passage-final Sentence:

提高 警覺 是 預防 意外的 不二 法門。
Tigao jingjie shi yufang yiwai de buer famen.
 Keep alert is prevent accident prep. best way.
 “*To keep alert is the best way to prevent an accident*”.

Note: For all the Chinese Sample Stimuli in this paper, we adopted the system of “Hanyupinyin” (Wentzu Kaiko Chupanshe, 1958) for the Pinyin Spellings

subject because the appearance of zero pronouns in object position must meet strict discourse and syntactic constraints such as the absence of any complement or modifier after the object (Huang, 1984; 1991). With the exception of the inclusion of the zero-pronoun condition, the experiment matches the design of reading-time studies that have been done in English by Gordon et al. (1993) and by Kennison and Gordon (1997). This allows a comparison of the current results in Chinese to those previously obtained in English.

The first goal of the experiment was to examine the effect of the form of the referring expression on reading time. As discussed earlier, Gordon et al. (1993) demonstrated a repeated-name penalty in English where sentences with repeated names are read more slowly than matched sentences with pronouns. The various explanations of such differences between names and pronouns all incorporate in some way or another the notion that there are fundamental differences in the way that unreduced expressions (such as names) and reduced expression (such as pronouns) achieve reference (Cloitre & Bever, 1988; Garrod & Sanford, 1982; Gordon et al., 1993; Gordon & Hendrick, 1998). If these accounts are generalised to comprehension in Chinese as well as in English, they predict that a repeated-name penalty should occur in Chinese so that the sentence

in Table 1 with the repeated name (*Xiaoming*) would be read more slowly than the matched sentence with the overt pronoun (*Ta*) or the zero pronoun (1). However, these theoretical explanations make no distinction in how different types of pronouns, as reduced referring expressions, are interpreted. Accordingly, they do not predict a difference in reading time between the reading time of sentences with overt pronouns (*Ta*) and those with zero pronouns (1). This prediction contrasts with the traditional view that the zero pronoun makes the strongest contribution to discourse coherence in Chinese (Chen, 1984; Givon, 1983, 1992; Li, 1985; Li & Thompson, 1981, 1984; Tao, 1996). If the zero pronoun plays a unique role in forging coherence in a Chinese discourse then one might expect that it would also render a discourse easier to understand than would an overt pronoun. It is that expectation that our first experiment evaluates.

The second goal of this experiment was to examine whether the interpretation of referential expressions in Chinese depends on the syntactic role of the expression as it does in other languages. Gordon et al. (1993; Kennison & Gordon, 1997) found that the repeated-name penalty for a referring expression appeared when the expression occupies a syntactically prominent position, such as the position of grammatical subject, but disappeared when it was in a less prominent position, such as the position of grammatical object. If the role of syntactic factors in the interpretation of reference in Chinese is similar to that in English, then we would predict that the repeated-name penalty would only be observed for expressions in subject position. In contrast, the context-and-pragmatics-only approach that has been advanced for the interpretation of reference in Chinese (Li & Thompson, 1981; 1984) would not lead normally to an explanation for why the repeated-name penalty would only be observed in subject position.

Method

Participants. Sixty undergraduate students attending introductory psychology courses at National Taiwan University (NTU) participated in a single session lasting about 40 minutes. They were all native Chinese speakers and received course credit for their participation.

Stimuli. A set of 42 three-sentence passages like the one shown in Table 1 was constructed. There were six alternative versions of the second sentence constructed by varying the forms of the anaphoric expressions in different syntactic positions. The third sentence did not mention either of the two discourse entities. It was included so that the critical sentence did not appear at the end of the passage. Each passage was followed by a true-or-false comprehension question. The names of the two characters in a

passage were conventionally of different genders so that there was no gender ambiguity in interpreting overt pronouns. All named characters were two-character Chinese word with as simple strokes and visual forms as possible, such as “小明”, “大興”, “小美”, and “文英”. For example, in Table 1, the name “Xiaoming” and “Xiaolin” conventionally refer to male and female characters, respectively. Also, in Chinese, there is no phonological differentiation for overt pronouns with different genders. Overt pronouns with different genders have exactly the same pronunciation: “Ta”. However, in written Chinese, gender influences the visual form of overt pronouns. Thus, male pronominal “Ta” in our experimental passages was indicated as “他” and female pronominal “Ta” as “她”. The gender sequence for the two characters in the first sentence of each passage was counterbalanced across passages so that half of the passages were *male-female* and half were *female-male*.

A set of 102 filler passages was constructed. The fillers, like the experimental passages, consisted of three-sentence passages which included named referents. Approximately half of them (48 out of 102) had similar syntactic structures to those of the experimental passages and had roughly equal numbers of the six types of NP sequences in the second sentences. The rest of the filler passages were also semantically coherent discourses, with various syntactic structures that are not relevant to our experimental manipulations. Each filler passage was followed by a comprehension question like those for the experimental passages.

Design. Six sets of materials were constructed by assigning one of the six versions of each experimental passage to each material set. In this design, each experimental passage occurred in all its six versions across six material sets, but within each material set each experimental passage appeared in only one version. Participants read one of the six material sets as well as the 102 filler passages. The stimulus material for each set along with fillers was divided into six blocks of 24 passages each. In each block, there were seven experimental passages as well as 17 filler passages. The order of trials was randomised. An initial practice block consisting of 10 filler passages was used to familiarise participants with the reading task.

Procedure. The experiment was conducted on a personal computer. Participants read the instructions on the computer screen and performed the practice block to become familiar with the self-paced reading task. At the start of each trial, the sentence “請按任意鍵開始” (*Please press any key to begin trial*) was presented in the centre of the screen. Participants initiated a trial by pressing a key and the passage was presented one sentence at a time in the centre of the screen. They pressed the space bar to move on to the next sentence. They were instructed to

read each sentence at a natural pace, neither slowly nor rushed. The reading time for each sentence was calculated from the onset of a sentence to the time the participants pressed the space bar. At the end of each passage, the screen went blank for one second and a true-or-false comprehension question was presented in the centre of the screen. This question assessed knowledge of the event described in the passage but did not require knowledge of the characters names. Participants responded by pressing "T" (true) or "F" (false) keys. Feedback on the accuracy of the response to the true-false question was presented only for incorrect responses. Also, participants received feedback about the percentage of correct responses and incorrect responses after they had finished each block.

Results

Table 2 shows the mean reading time of the critical (second) sentence and the mean accuracy for the comprehension questions for all combinations of the two variables: form and syntactic role of the referring expressions. Outliers were excluded from the data analysis according to the criterion of Gordon et al. (1993, p.326): reading times below 500 ms per sentence or greater than 6000 ms were considered as premature or careless responses and therefore excluded. Excluded observations comprised 2.9% of the data. The same criterion was adopted for the remaining experiments reported in this article.

The reading times of the critical sentences containing repeated-names as grammatical subjects were 156 ms slower than those with overt pronouns as grammatical subjects, an instance of the repeated-name penalty. In contrast, this difference was only 54 ms for referring expressions in the position of grammatical object. Further, the difference in reading times of sentences with overt pronouns compared to those with zero pronouns was just 52 ms. Analysis of variance was conducted both by participants (F_1)

TABLE 2

Mean Reading Times (in ms) with 95% Confidence Interval for the Second Sentence and Mean Accuracy (% in parenthesis) for the Comprehension Questions in each of the Experimental Conditions

<i>Syntactic status</i>		<i>Object</i>		
		<i>Repeated name</i>	<i>Overt pronoun</i>	
<i>Subject</i>	<i>Repeated name</i>	1965 ± 83 (94.4)	1923 ± 89 (94.5)	1944 ± 61 (94.4)
	<i>Overt pronoun</i>	1784 ± 79 (95.3)	1791 ± 82 (94.8)	1788 ± 57 (95.1)
	<i>Zero-pronoun</i>	1798 ± 76 (95.1)	1673 ± 81 (93.7)	1736 ± 56 (94.4)
<i>Average</i>		1849 ± 46 (94.9)	1795 ± 49 (94.3)	

and by items (F_2) to test the generality of these effects. The results indicated that when an anaphoric expression was in the grammatical subject position, the effect of form of expression was significant both by participants; ($F_1(2,118) = 16.39, P < .001$) and by items ($F_2(2,82) = 13.37, P < .001$). In contrast, when the anaphoric expression was in the grammatical object position, the effect of form of expression failed to reach significance by participants; ($F_1(1,59) = 2.93, P = .092$) or by items ($F_2(1,41) = 2.31, P = .136$). The interaction of the effect of form of anaphoric expression and the syntactic status of such anaphoric expression was not significant by participants; ($F_1(2,118) = 1.49, P = .229$) or by items ($F_2(2,82) = 1.69, P = .190$).

Post hoc contrasts for different forms of expression in subject position, adjusted by the Bonferroni method, showed that the reading times for repeated-names were slower than those for overt pronouns by participants ($t_1(59) = 4.11, P < .005$) as well as by items ($t_2(41) = 3.69, P < .005$); however, the difference between the reading times for overt pronouns and those for zero pronouns was not significant by participants ($t_1(59) = 1.396, P > .1$) or by items ($t_2(41) = 1.256, P > .20$). Further analysis illustrated that the reading time of sentences with repeated-name subjects was significantly slower than the pooled reading times for sentences with overt pronoun subjects and zero pronoun subjects both by participants ($t_1(59) = 5.55, P < .005$) and by items ($t_2(41) = 4.99, P < .005$).

Table 3 also shows the mean reading times for the first and third sentences of the passages as a function of the experimental manipulations. The manipulations had no significant effects on these measures of performance. The finding that manipulation of the form of a referring expression has effects confined to the sentence in which it occurs is consistent with previous self-paced reading experiments of this sort (Gordon et al., 1993; Gordon & Chan, 1995; Gordon & Scarce, 1995). The mean accuracy for comprehension questions was 94.6% overall with a

TABLE 3

Mean Reading Times for the Initial and Final Sentence of Experimental Passages in Experiment 1 in each of the Experimental Conditions

Syntactic status	Mean reading times for the initial sentence		Mean reading times for the final sentence	
	Object		Object	
	Repeated name	Overt pronoun	Repeated name	Overt pronoun
Subject	Repeated name 3440 (± 192)	3490 (± 182)	1571 (± 115)	1537 (± 93)
	Overt pronoun 3352 (± 175)	3330 (± 187)	1517 (± 88)	1457 (± 79)
	Zero pronoun 3375 (± 171)	3316 (± 189)	1565 (± 97)	1509 (± 89)

Note: The numbers in parenthesis indicates the 95% confidence interval of the mean

range from 93.7% in the zero pronoun-pronoun condition to 95.3% in the pronoun-name condition. Statistical analysis showed that no significant effects on accuracy were observed for the experimental conditions.

Discussion

The results of the experiment show that the form of a referring expression in Chinese contributes to discourse comprehension in a manner that is similar to that which has previously been observed for English. Sentences containing reduced referential expressions (overt or zero pronouns) in subject position were read more quickly than matched sentences containing repeated names. This repeated name penalty has previously been observed in self-paced reading time experiments in English (Gordon et al., 1993). It suggests that pronouns can facilitate discourse comprehension in Chinese just as they can in English. Further, the experiments showed no significant differences between the reading times of sentences containing overt pronouns and those containing zero pronouns. The absence of a significant difference between these conditions suggests that accounts of referential processing that incorporate a basic distinction between reduced and unreduced forms (Cloitre & Bever, 1988; Garrod & Sanford, 1982; Gordon et al., 1993; Gordon & Hendrick, 1998) are sufficient and that at least for the kinds of passages examined in this experiment there is no need to assign special status to the zero pronoun in Chinese (Chen, 1984; Givon, 1983, 1992; Li, 1985; Li & Thompson, 1981, 1984).

Furthermore, the facilitating effect of pronominal reference on discourse comprehension occurred only for expressions in subject position and not for expressions in object position, again showing a parallel between the effects of form of reference in Chinese and what has previously been shown for English (Gordon et al., 1993). This result suggests that in Chinese syntactic information plays an important role in the processing of co-reference at a local discourse level, a conclusion that is not consistent with the context-and-pragmatics-only approach proposed by Li and Thompson (1981, 1984).

In this experiment, as well as in the subsequent ones, the lengths of the critical sentences varied slightly as a function of the form of the critical referring expression. Sentences with repeated names were one character longer than matched sentences with overt pronouns which were one character longer than matched sentences with zero pronouns. These length differences do not provide a general explanation of the pattern of reading times observed here because the repeated-name penalty was only found for expressions in subject position but not for expressions in object position even though manipulating the form of the expressions in the two positions causes the same differences in length. In a similar way length differences

cannot explain results obtained in English where the magnitude of the repeated-name penalty is determined by syntactic and discourse factors rather than by the greater number of letters in names as compared to pronouns (Gordon et al., 1993; Gordon & Chan, 1995; Gordon & Scarse, 1995). An explanation in terms of length differences is also inconsistent with eye-tracking results that show that repeated names cause elevated durations for fixations after the repeated name and also cause an increase in regressive saccades (Kennison & Gordon, 1997). Subsequent experiments in this paper will further show that the effect of form of referring expression on reading time does not reduce to an effect of length.

EXPERIMENT 2

Experiment 1 demonstrated that the repeated-name penalty in Chinese depends on the syntactic role of the referring expression. As in English, it occurs for expressions in subject position but not for expressions in object position. An additional finding in English is that the repeated-name penalty depends not only on the syntactic role of an expression in an utterance but on the syntactic role of the expression that mentioned the referent in the immediately preceding sentence. Building on centering theory (Grosz et al., 1983; 1995), Gordon et al. (1993) examined how the effect of form of reference on reading time was influenced by whether a sentence *continued* or *shifted* a critical referent from the preceding sentence. The continue and shift conditions are illustrated in Table 4. In the continue condition, the subject of the critical (second) sentence is also the subject of the preceding sentence. In the shift condition, the subject of the critical sentence was an object in the preceding sentence and the subject of the preceding sentence is not mentioned. Gordon et al. (1993) found that the repeated-name penalty occurred in the continue condition but not in the shift condition, thus showing that the facilitating effect of a pronoun on discourse comprehension depends on the structural relation between successive sentences. Centering theory (Grosz et al., 1983, 1995) explains such effects through the theoretical construct of a set of forward-looking centres that are ordered in prominence, and where subsequent pronominal reference to prominent entities is easier than to nonprominent entities. Gordon and Hendrick (1998) have incorporated the notion of forward-looking centres into a model of discourse processing in which syntactic prominence (defined in terms of depth of embeddedness) is a central determinant of prominence in the discourse model. This model provides an account of why the repeated-name penalty is present in the continue condition and absent in the shift condition.

The current experiment examines whether the syntactic relation between successive sentences has the same impact on the ease of

TABLE 4
Sample passage for Experiment 2

Initial Sentence

大明 喜歡 告訴 文瑩 每晚 作的 夢。
Daming xihuan gaoshu Wenying meiwan zuo de meng.
 "Daming likes to tell Wenying the dream he has every night."

Second Sentence

Continue Condition

大明 / 他 描述 夢境 時 興致 盎然。
Daming / Ta miaoshu mengjing shi xingzhi angran
 "Daming / He describes his dreams with great excitement."

Shift Condition

文瑩 / 她 聽了 都 覺得 索然 無味。
Wenying / Ta ting le dou jue de suoran wuwei
 "Wenying / She feels insipid every time she hears those dreams."

Passage-final Sentence.

夢 的 趣味 只有 作夢 的 人 才能 了解。
meng de quwei zhiyou zuomeng de ran cai neng liaojie.
 "Only those who dream can enjoy the fun from their dreams."

comprehending different forms of referring expressions in Chinese as it does in English. It has been argued that the processing of discourse comprehension in Chinese is different from that in English in that the interpretation of referring expressions in Chinese relies primarily upon context and pragmatics and does not involve syntactic structure as in English (Li & Thompson, 1981, 1984). Examining the effect of structure on the repeated-name penalty provides one way of addressing this position. The experiment employs passages like those shown in Table 4.

In these passages, two named individuals of different genders were introduced in the first sentence. One was introduced as the grammatical subject, a syntactically prominent position, while the other was introduced as the postverbal object, a less prominent position. The second sentence was the critical sentence in which two factors were manipulated. One was the continue-shift factor; in the continue condition, the subject of the second sentence (*Daming*) was identical to that of the first sentence, whereas in shift condition the subject of the second sentence (*Wenying*)

differed from that of the first sentence. The second factor was the form (name vs. overt pronoun) of the referring expression in subject position of the second sentence. These Chinese passages closely match those studied in English by Gordon et al. (1993, also Kennison & Gordon, 1997) and therefore provide a test of whether discourse structure has a similar influence on the comprehension of referring expressions in the two languages.

Method

Participants. Sixty new undergraduate students from the same population of Experiment 1 participated in this experiment.

Stimuli, design, and procedure. Forty three-sentence experimental passages were constructed as shown in Table 3. A preliminary questionnaire study was conducted to ensure that the predicate of the second sentence for each experimental passage led naturally to the intended interpretation of reduced expressions for sentences in both the Continue and Shift conditions. Passages were tested, revised, and re-tested until approximately 92% of the participants identified the grammatical subject of the second sentence in the expected way. Two groups of eight participants participated in this preliminary study. Other than the structure of the passages, the experiment was run in the same manner as Experiment 1 except for minor design changes to accommodate the differing number of conditions. In particular, the experimental passages along with fillers were divided into five blocks of 28 passages each. Each block consisted of eight experimental passages as well as 20 filler passages. Participants performed one initial practice block of 16 filler passages at the beginning of the session.

Results

Figure 1 shows the mean reading time for the critical sentence for all combinations of the two factors: form of referring expression (name vs. overt pronoun) and discourse structure (continue vs. shift).

In the Continue condition, the reading times of sentences with repeated-names were 147 ms slower than those of sentences containing overt pronouns, an instance of the repeated-name penalty. In contrast, in the Shift condition, sentences with repeated names were read as fast as those with pronouns. Analysis of variance showed that the main effect of Continue/Shift did not reach significance by participants ($F_1(1,59) = 0.59$, $P = .45$) nor items ($F_2(1,39) = 0.12$, $P = .73$). The main effect of form of

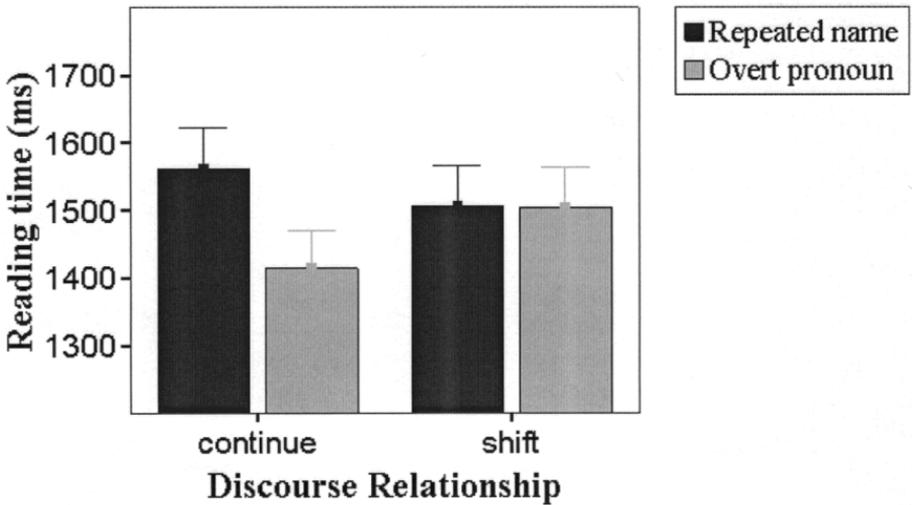


FIG. 1. Mean reading times (ms) of the critical sentences that include the experimental manipulations. Error bars show 95% confidence interval of mean. The mean accuracy rates for comprehension questions in each condition are: Continue-Name: 95%, Continue-Pronoun: 94%, Shift-Name: 95%, and Shift-Pronoun: 92%.

referring expression was significant both by participants ($F_1(1,59) = 6.52, P < .05$) and by items ($F_2(1,39) = 7.75, P < .01$). A significant interaction was observed between forms of referring expression and Continue/Shift by participants ($F_1(1,59) = 6.12, P < .05$), as well as by items ($F_2(1,39) = 4.65, P < .05$). A planned contrast showed that the repeated-name penalty was significant in the continue condition ($t_1(59) = 3.58, P < .01$; $t_2(39) = 3.09, P < .01$) but not in the shift condition ($t_1(59) = 0.024, P > .25$; $t_2(39) = 0.021, P > .25$). A further contrast showed that reading times for sentences containing pronouns were faster in the continue condition than in the shift condition when tested by subjects ($t_1(59) = 2.19, P < .05$) but not when tested by items ($t_2(39) = 1.89, P > .05$). In addition, no significant difference was found for reading times of sentences containing repeated names in different discourse relationship ($t_1(59) = 1.34, P > .10$; $t_2(39) = 1.16, P > .20$).

Table 5 shows the mean reading times for the initial and final sentences of the passages as a function of the experimental manipulations. The manipulations did not significantly influence the reading times of those sentences. The mean accuracy for comprehension questions was 94.6% overall with a range of 92.0% in the *shift-pronoun* condition to 95.9% in the *shift-name* condition. Accuracy was not influenced significantly by experimental condition.

TABLE 5

Mean Reading Times for the Initial and Final Sentence of Experimental Passages in Experiment 2 in each of the Experimental Conditions

		<i>Mean reading times for the initial sentence</i>		<i>Mean reading times for the final sentence</i>	
		<i>Discourse Relations</i>		<i>Discourse Relations</i>	
		<i>Continue</i>	<i>Shift</i>	<i>Continue</i>	<i>Shift</i>
<i>Referring expressions</i>	<i>Repeated name</i>	3255 (\pm 159)	3112 (\pm 140)	1422 (\pm 67)	1353 (\pm 60)
	<i>Overt pronoun</i>	3156 (\pm 145)	3139 (\pm 140)	1389 (\pm 62)	1350 (\pm 60)

Note: The numbers in parenthesis indicates the 95% confidence interval of the mean

Discussion

The results of this experiment show that for the most part local discourse structure has a similar effect in Chinese to that which it has in English. In both English and Chinese, a repeated-name penalty is observed in the continue condition, where the subject of the critical sentence co-referred with the subject of the preceding sentence, while no repeated-name penalty occurred in the shift condition, where the subject of the critical sentence co-referred with object of the preceding sentence. This similarity suggests that discourse structure in the types of passages studied here may be processed in similar ways in Chinese and English despite the many differences between the two languages.

The results of this experiment also provide additional evidence that in Chinese, as in English, differences in the length of different types of referring expressions cannot account for the repeated-name penalty. Length differences between the repeated-name and pronoun versions of the sentences were the same in the continue and shift conditions but a repeated-name penalty was only observed in the continue condition, indicating that the effect depends on the relation between successive sentences.

One difference between the results of this experiment on Chinese and those previously done on English is that there was a marginally significant trend for sentences with pronouns to be read more quickly in the continue condition than in the shift position. Such a difference was originally predicted based on centering theory (Grosz et al., 1983) but was not observed in our reading time studies of English. Experiment 4 of Gordon et al. (1993) found a difference of 53 ms in this direction but the difference was not significant. Experiment 2 of Gordon and Chan (1995) and Experiment 2 of Kennison and Gordon (1997) also failed to find significant

effects. Given that the difference between the continue and shift conditions in the present experiment was only marginally significant it is unclear whether or not the present result points to a real difference between English and Chinese.

EXPERIMENTS 3 AND 4

Experiment 1 indicated that the two types of reduced expressions in Chinese, overt pronouns and zero pronouns, make similar contributions to discourse coherence. This finding does not support the view that a zero pronoun in Chinese has a special role in promoting discourse coherence (Chen, 1984; Givon, 1981, 1983; Li, 1985; Li & Thompson, 1981, 1984). Experiments 3 and 4 provide additional tests of whether zero pronouns promote discourse coherence more than overt pronouns and also examine whether there are situations where overt pronouns are preferred (Chen, 1984; Li, 1985; Li & Thompson, 1981). In the model of discourse processing proposed by Gordon and Hendrick (1998), the occurrence of a pronoun triggers a construction rule by which the entities in the discourse model are searched in order of prominence for a "suitable antecedent". As discussed earlier, the syntactic role of the expression that introduced an entity is a major determinant of prominence. A suitable antecedent is defined as one that matches the pronoun on grammatically encoded semantic features such as gender, number or animacy. This model leads to the prediction that the ease of understanding the two types of pronouns should not differ in cases where they refer to the most prominent entity in the discourse nor in cases where the semantic features encoded in the overt pronoun do not specifically identify a suitable antecedent. However, in cases where the referent of the pronoun is not the most accessible entity and where semantic features do specifically identify an antecedent, the Gordon and Hendrick (1998) model predicts an advantage of overt pronouns, which grammatically encode semantic features, over zero pronouns, which as null expressions convey no semantic information about their referents.

Experiments 3 and 4 examine these predictions measuring the reading time for passages such as those shown in Table 6. The two named characters in the first sentence are the same gender in Experiment 3 and different genders in Experiment 4. Thus, in Experiment 3 the gender of a pronoun in the second sentence cannot unambiguously pick out its referent while in Experiment 4 it can (as was the case in Experiment 2). For both experiments, the second sentence varies two factors: the continue/shift manipulation and whether the referring expression in subject position is an overt pronoun or a zero pronoun.

TABLE 6
Sample passage for Experiment 3 and Experiment 4

Initial Sentence

小美(3) / 大興(4) 告訴 小蓉 花園 裏 應 種 蔬菜 而 不 種 花。
Xiaomei(3)/Daxing(4) gaoshu Xiaorong huayuan li ying zhong sucai er bu zhong hua.
 “*Xiaomei(3)/Daxing(4) told Xiaorong that vegetables, instead of flowers, should be planted in the garden.*”

Second (Critical) Sentence

Continue Condition

她(3) / 他(4) / 認 爲 蔬 菜 比 花 還 要 實 用。
Ta(3)/Ta(4)/Ø renwei sucai bi hua haiyao shiyong.
 “*She(3)/He(4)/Ø thought vegetables are of more utility than flowers.*”

Shift Condition

她(3) / 她(4) / 卻 認 爲 蔬 菜 和 花 都 要 種。
Ta(3)/Ta(4)/Ø que renwei sucai han hua dou yao zhong.
 “*She(3)/She(4)/Ø thought, however, that both vegetables and flowers should be planted.*”

Passage-final Sentence

花 園 的 使 用 及 規 劃 是 很 大 的 學 問。
Huayuan de shiyong ji guihua shi henda de xuewen.
 “*The usage and planning of a garden are worth studying.*”

Note: The numbers in parentheses in the passage indicates the version of different experiments. For instance, in the initial sentence, the grammatical subject in Experiment 3 is *Xiaomei* (a Female name) whereas it is *Daxing* (a Male name) in Experiment 4. Also, both Experiment 3 and 4 use the same postverbal object *Xiaorong* (Female name). This changes in the pronominalisation of the grammatical subjects in different conditions of the second sentence across Experiment 3 and 4. For Experiment 3, the grammatical subject for all conditions are all female pronominal expressions (“她”, *She*); for Experiment 4, the grammatical subjects are pronominal expressions with different genders for different conditions, “他” (*He*) in the continue condition and “她” (*She*) in the shift condition

Method

Participants. Experiment 3 tested 64 new participants while Experiment 4 tested 48 new participants. They were all from the same population as the previous experiments.

Stimuli, design, and procedure. Both Experiment 3 and 4 used 36 experimental passages that were constructed as shown in the sample stimuli above. Most of the passages were adopted from the experimental passages of Experiment 2. Thirty-three of the 36 passages were taken directly from those used in Experiment 2; only the referring expressions in those passages were changed so that they contained the kinds of referential relationships to be investigated in the study. For the remaining three passages, changes in content were necessary so that the passage made

sense when the characters were the same gender (Experiment 3) or were of different gender (Experiment 4). The changes in these three passages were validated with a preliminary study (using five native Chinese speakers who were naïve to the purposes of the study) of plausibility like that conducted for Experiment 2. Within each experiment, appropriate changes were made for the second sentence of each passage in terms of the type of referring expressions used. Across Experiments 3 and 4, appropriate changes were made for the first sentence of each passage in terms of the gender of the two characters. Both experiments were conducted in a similar manner to Experiment 2 in terms of the assignment of experimental passages to conditions, participants, and trial blocks. For Experiment 3, each stimulus material set along with additional 89 fillers were divided into five blocks of 25 passage each, and for Experiment 4, each stimulus material set along with additional 94 fillers were divided into five blocks of 26 passage each. Participants performed one initial practice block of 16 filler passages at the beginning of each experiment.

Results

Experiment 3. Figure 2 shows the mean reading time in Experiment 3 for the critical sentence as a function of the experimental conditions. Analysis of variance indicated that only the main effect of Continue/Shift reached statistical significance both by participants ($F_{1(1,63)} = 33.24$, $P <$

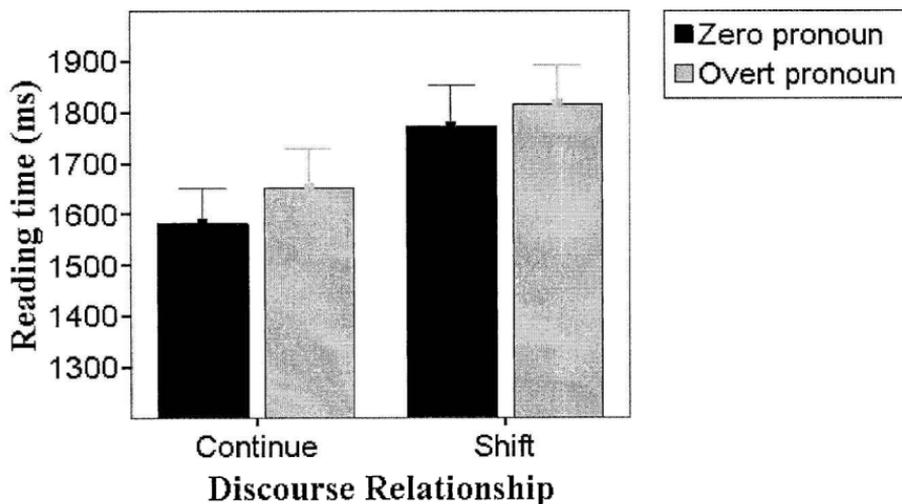


FIG. 2. Mean reading times (ms) of the critical sentences that include the experimental manipulations. Error bars show 95% confidence interval of mean. The accuracy rates for comprehension questions in each condition are: Continue-Zero: 93%, Continue-Pronoun: 93%, Shift-Zero: 91%, and Shift-Pronoun: 87%.

TABLE 7

Mean Reading Times for the Initial and Final Sentence of Experimental Passages in Experiment 3 in each of the Experimental Conditions

		<i>Mean reading times for the initial sentence</i>		<i>Mean reading times for the final sentence</i>	
		<i>Discourse Relations</i>		<i>Discourse Relations</i>	
		<i>Continue</i>	<i>Shift</i>	<i>Continue</i>	<i>Shift</i>
<i>Referring expressions</i>	<i>Overt pronoun</i>	3619 (\pm 165)	3491 (\pm 151)	1382 (\pm 65)	1395 (\pm 66)
	<i>Zero pronoun</i>	3620 (\pm 169)	3613 (\pm 171)	1379 (\pm 64)	1427 (\pm 68)

Note: The numbers in parenthesis indicates the 95% confidence interval of the mean

.001), and by items ($F_2(1,35) = 12.81, P < .001$). Neither the main effect of type of reduced expressions was significant ($F_1(1,63) = 2.34, P = .131$; $F_1(1,35) = 1.59, P = .22$) nor was the interaction between type of reduced expression and continue/shift ($F_1(1,63) = .19, P = .66$; $F_2(1,35) = .10, P = .75$). Table 7 shows the mean reading times for the initial and final sentences of the passages. The experimental manipulations had no significant effects on the reading times of these sentences.

Experiment 4. Figure 3 shows the mean reading time in Experiment 4 for the critical sentence as a function of the experimental conditions.

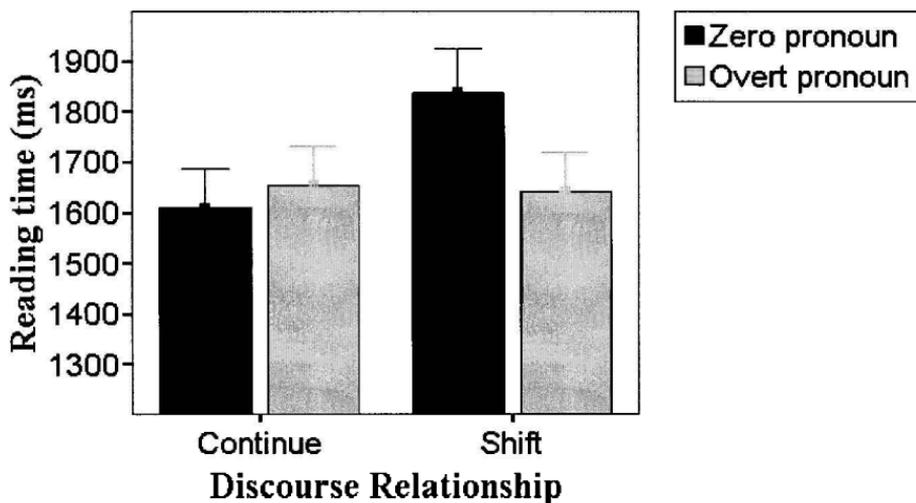


FIG. 3. Mean reading times (ms) of the critical sentences that contain the experimental manipulations. Error bars show 95% confidence interval of mean. The accuracy rates for comprehension questions in each condition are: Continue-Zero: 95%, Continue-Pronoun: 96%, Shift-Zero: 93%, and Shift-Pronoun: 93%.

Analysis of variance showed that the reading times of sentences with zero pronouns were significantly slower than those with overt pronouns ($F_1(1,47) = 4.60, P < .05; F_2(1,35) = 4.88, P < .05$). Also, significantly slower reading times were observed in the Shift condition than in the Continue condition by participants ($F_1(1,47) = 14.14, P < .001$), but not by items ($F_2(1,35) = 4.06, P = .052$). The interaction of type of reduced expressions and Continue/Shift was significant by participant ($F_1(1,47) = 11.48, P < .01$) and by items ($F_2(1,35) = 9.95, P < .01$). Table 8 shows the mean reading times for the initial and final sentences of the passages. The experimental manipulations had no significant effects on the reading times of these sentences. Accuracy on the comprehension questions was marginally higher in the continue condition (95.4%) than in the shift condition (92.9%); $F(1,47) = 3.96, P < .1$.

A planned contrast on the difference between reading times of critical sentences with pronouns in the continue and shift conditions revealed no significant differences ($t_1(47) = 0.24, P > .25; t_2(35) = 0.22, P > .25$).

Discussion

The results of the continue conditions of Experiments 3 and 4 show no significant difference in reading times between sentences with overt pronouns and those with zero pronouns. This finding, consistent with the results of Experiment 1, does not support the notion that the zero pronoun makes a unique contribution to the coherence of Chinese discourse in cases where it refers to a highly accessible entity (Ariel, 1990, 1991; Givon, 1983, 1992). The finding supports models (Cloitre & Beaver, 1988; Garrod & Sanford, 1982; Gordon et al., 1993; Gordon & Hendrick, 1998) in which the same mechanisms underlie the interpretation of different types of reduced referring expressions.

TABLE 8

Mean Reading Times for the Initial and Final Sentence of Experimental Passages in Experiment 4 in each of the Experimental Conditions

		<i>Mean reading times for the initial sentence</i>		<i>Mean reading times for the final sentence</i>	
		<i>Discourse Relations</i>		<i>Discourse Relations</i>	
		<i>Continue</i>	<i>Shift</i>	<i>Continue</i>	<i>Shift</i>
<i>Referring expressions</i>	<i>Overt pronoun</i>	3714 (± 196)	3764 (± 203)	1461 (± 77)	1394 (± 65)
	<i>Zero pronoun</i>	3573 (± 190)	3729 (± 190)	1489 (± 76)	1457 (± 76)

Note: The numbers in parenthesis indicates the 95% confidence interval of the mean

In Experiment 4 the continue/shift factor was manipulated for sentences with overt pronouns, as it was in Experiment 2. While Experiment 2 found a marginally significant effect of this factor, Experiment 4 did not find such an effect. This supports the idea that the continue/shift manipulation does not have a substantial impact on the processing of sentences with overt pronouns where the pronoun can unambiguously indicate its referent because of a gender cue. Thus, the marginal effect observed in Experiment 2 contrasts with the absent effect or small hints of effects that were observed in this experiment and in several experiments on English (Gordon et al., 1993; Gordon & Chan, 1995; Gordon & Scarse, 1995). For both Chinese and English it appears that effects of the form of referring expressions are much more robust than the main effect of continue-shift with unambiguous pronouns.

Again, the results of these experiments show that differences in the length of the different types of referring expressions do not account for differences in reading time. Length differences between the overt-pronoun and zero-pronoun versions of the sentences were the same in the continue and shift conditions and when gender was ambiguous or unambiguous. However, differences in reading time as a function of the type of referring expression depended on these factors rather than reflecting a constant influence of length.

The overall pattern of the continue/shift effects in the two experiments is consistent with the predictions from the Gordon and Hendrick (1998) model. As discussed above, that model predicts that the form of the reduced referring expression should not interact with the continue/shift manipulation in Experiment 3 because the gender of the overt pronoun provides no information about its referent beyond what is conveyed by the zero pronoun (since the two possible referents are the same gender). In contrast, in Experiment 4 the continue/shift manipulation should have a greater impact for sentences with zero pronouns than with overt pronouns because the gender of the overt pronoun can unambiguously pick out its referent. The results of the two experiments show this pattern exactly.

GENERAL DISCUSSION

The goal of the current experimental research was to examine how referring expressions in brief locally coherent discourses contribute to the comprehension of Chinese. The results of a series of experiments showed that the form of referring expressions affects reading time for Chinese text in a manner that is very similar to what has been observed in English (Gordon et al., 1993) despite the different linguistic properties of the two languages. In particular, reduced expressions (both overt and zero pronouns) contribute more to discourse coherence than do full expressions

(repeated names) for the types of passages studied here; this facilitating effect of reduced expressions only occurs when the antecedent expression is syntactically prominent. These results suggest that overt and zero pronouns are for the most part interpreted by the same structure-dependent processes when they refer to an entity introduced into the discourse by a syntactically prominent expression. When these expressions refer to an entity that was introduced by an expression that is not syntactically prominent, the relative ease of understanding the two types of pronouns depends on whether the inherent semantic features of the overt pronoun allow it to unambiguously indicate its referent. When the overt pronoun is ambiguous then no difference is observed in the comprehension of sentences with overt and zero pronouns. When the overt pronoun unambiguously indicates its referent, then sentences with overt pronouns are understood more easily than matched sentences with zero pronouns. This pattern shows a specific situation where overt pronouns are more easily understood than zero pronouns; this advantage is readily understood in terms of the relative ability of the two types of pronouns to convey information about the identity of their referents.

The basic similarity that we have observed in the processing of overt and zero pronouns contributes to the assessment of different approaches to the comprehension of referring expressions. Several approaches that have been developed for the study of English (Cloitre & Bever, 1988; Garrod & Sanford, 1982; Gordon et al., 1993; Gordon & Hendrick, 1998) make a basic distinction between how unreduced and reduced referring expressions contribute to discourse coherence. These approaches do not distinguish among different types of reduced expressions. In contrast, several approaches to the study of Chinese and other languages (Ariel, 1990, 1991; Chen, 1984; Givon, 1983; Li, 1985; Li & Thompson, 1981, 1984) advance the position that under some circumstances zero pronouns contribute more to discourse coherence than do overt pronouns. Our results show that at least for the types of discourses that we examined, there is no need to posit special mechanisms for how zero pronouns contribute to discourse coherence, thereby supporting approaches that do not distinguish among different types of reduced referring expressions.

Our results also show that the ease of interpreting reduced expressions in Chinese depends on the accessibility of the intended referent as determined by the syntactic prominence of the antecedent expression that introduced the referent. This finding is in accordance with what has been observed in English (Gordon et al., 1993; Gordon & Hendrick, 1997) and it is consistent with a number of theories (Ariel, 1991; Gordon & Hendrick, 1998; Halmari, 1996) in which the ease of interpreting reduced expressions depends on the accessibility of their referents. The model developed by

Gordon and Hendrick (1998) provides an explicit account of how differing degrees of accessibility influences referential interpretation and also places substantial emphasis on the contributions of syntax to this process. We review that model here in order to show how it can provide an account of the findings observed in the present work.

The Gordon and Hendrick (1998) model addresses the distribution and comprehension of different forms of referring expressions both within and between sentences. It is developed using the formalism of *Discourse Representation Theory* (Kamp & Reyle, 1993), a framework that applies model-theoretic semantics to natural language. Kamp and Reyle (1993) characterise a discourse model as a semantic representation mediating between linguistic expressions and objects in the world. A set of *Construction Rules* determines the way in which syntactic expressions are mapped onto a *Discourse Representation Structure*. Each construction rule consists of a linguistic triggering condition and a set of instructions for modifying the current model of discourse. In this view, syntactic expressions trigger the building of a discourse representation structure through dynamic interaction with the discourse model. Gordon and Hendrick (1998) modify the construction rules of Kamp and Reyle (1993) so that they can account for how the form of referring expressions influences the ease of establishing co-reference.

Gordon and Hendrick (1998) propose three major construction rules. The construction rule for pronouns is triggered by the occurrence of a pronoun and then searches the current discourse entities in order of their (syntactically-derived) prominence in order to find a "suitable antecedent"—one that matches in terms of gender, number, animacy and reflexivity. Thus, the construction rule for pronouns establishes co-reference directly. The construction rule for names is triggered by the occurrence of a name (or a description) and then posits a new entity into the discourse model with the name predicated on that entity. Thus, the construction rule for names introduces new entities and does not establish co-reference directly. This is done through the construction rule for equivalence which is triggered by the occurrence in the discourse model of the same name predicated on different entities. The construction rule for equivalence operates in the opposite fashion in that it has greater difficulty establishing co-reference when the antecedent is prominent. The differing operations of the construction rules for pronouns and for equivalence account for the patterns of co-reference and disjoint reference that have been observed in reading-time studies and in judgments of co-reference (Gordon et al., 1993; Gordon & Hendrick, 1997).

The results of the current experiments show that the Gordon and Hendrick (1998) model can account for phenomena in the comprehension

of co-reference in Chinese as well as in English. Experiments 1 and 2 both show that the repeated-name penalty (slower reading of sentences with repeated names as compared to matched sentences with pronouns) occurs in Chinese. In the Gordon and Hendrick (1998) model, this effect occurs because co-reference with pronouns is established in one step via the construction rule for pronouns whereas co-reference with repeated names is established in two steps via the construction rules for names and for equivalence. Experiments 1 and 2 also show that the repeated-name penalty occurs for expressions that refer to the entity that was the grammatical subject in the preceding sentence but not the grammatical object. This pattern (which also occurs in English) is explained by the fact that syntactic prominence facilitates operation of the construction rule for pronouns and inhibits operation of the construction rule for names. Experiment 1 shows that the repeated-name penalty occurs for pronouns as a class, but that there is no difference between reading times for overt and zero pronouns. This pattern is explained in the Gordon and Hendrick (1998) model by the fact that pronouns are interpreted directly in relation to the discourse universe while names are interpreted in relation to the world; the model makes no distinction between types of pronouns. Experiments 3 and 4 show that both overt and zero pronouns are processed more easily when they refer to a prominent entity than when they refer to a nonprominent entity in cases where the pronoun could match either of two entities in terms of gender. When the gender of an overt pronoun allows it to refer unambiguously to a nonprominent entity it is processed more easily than a matched zero pronoun which cannot convey gender information. This pattern is easily explained by the construction rule for pronouns which preferentially interprets pronouns as referring to the most prominent entity in the discourse model unless features of the pronoun (gender, number, etc.) mean that the prominent entity is not a suitable antecedent. The operation of the rule causes substantial processing difficulty when subsequent semantic information forces a pronoun to be reinterpreted and this reinterpretation leads to the finding that reading times are elevated (as found in Experiment 3 with ambiguous overt pronouns and Experiment 4 with zero pronouns) when ambiguous pronouns refer to nonprominent entities as compared to when they refer to prominent entities.

The construction rule for pronouns also suggests that an unambiguous pronoun that refers to a nonprominent entity should be less easy to understand than a pronoun that refers to the most prominent entity because the most prominent entity is always evaluated first as a suitable antecedent. However, with a clear gender cue mismatch the most prominent entity is easily rejected as a suitable antecedent and measurable differences in reading time are not consistently found in comparing

unambiguous pronouns in the continue and shift conditions (as seen in Experiments 2, 4 and comparable experiments in English). Similarly, the construction rule for equivalence suggests that repeated-name co-reference should be easier when the repeated name refers to a less prominent entity than when it refers to a prominent entity because the construction rule for equivalence evaluates the entities as suitable antecedents from the least prominent to the most prominent. Once again, however, name mismatches are a clear cue for rejecting an entity as a suitable antecedent and measurable differences in reading time are not found in comparing repeated names in the continue and shift conditions (Experiment 2 and comparable experiments in English). Combined, the greater ease of establishing co-reference with pronouns in continue as compared to shift conditions and with repeated names in shift as compared to continue conditions leads to a significant interaction between continue-shift and pronoun vs. name (as seen in Experiment 2 and comparable experiments in English).

In beginning our research on the comprehension of referring expressions in Chinese we believed that it was important to study passages of a type that were similar to those that we have previously studied in English. Some researchers (e.g., Li & Thompson, 1981) prefer to analyse an unmarked, sentence-initial NP in Chinese as a topic rather than as a grammatical subject. A topic is defined in relation to a discourse rather than in relation to a sentence; it extends through a sequence of sentences in a "topic chain". A topic does not necessarily have any direct semantic relation to the subsequent verb (Li & Thompson, 1981). In contrast, a subject does have a direct semantic relation to the subsequent verb (Li & Thompson, 1981; Tsao, 1977). In more formal terms, the subject is an argument of a semantic function expressed by a predicate. To illustrate, sentence (3) has both a topic (*zhe ke shu*) and a subject (*yezi*) with the sentence-initial NP as a topic whose semantic scope dominates the following predicate. Example (4) shows a "topic chain" because two sentences show the continued prominence of a single topic (*zhe ke shu*). Sentence (5) shows a sentence-initial NP preferentially defined as a subject because of its direct relationship with the following VP.

- (3) 這 棵 樹 葉 子 很 大 。
- zhe ke shu yezi hen da.
- This CL tree leaf very big
- "This tree, (its) leaves are very big."

- (4) 這 棵 樹 葉 子 很 大 花 很 小 。

zhe ke shu yezi hen da hwa hen xiao.

This CL tree leaf very big flower very small

“This tree, (its) leaves are very big (its) flowers are very small.”

- (5) 我 喜 歡 吃 蘋 果 。

wo xihuan chi pinguo.

I like eat apple.

“I like to eat apple.”

The passages in our experiments were designed so that the initial NP of both the first and second sentences had direct semantic relations to the subsequent verb. Using this type of passage minimised possible influences of a topic chain and provides support for our characterisation that the syntactic role of the NPs was the level of language that influenced comprehension processes. According to the Gordon and Hendrick (1998) model, the initial steps in comprehension are driven by syntactic and sequential factors that influence how linguistic expressions are mapped onto discourse expressions. These initial steps in processing can be observed through online measures such as reading time. In the Gordon and Hendrick (1998) model, semantic and pragmatic processing occur subsequently within the discourse model. The distinction between subject and topic in Chinese is based exclusively on linguistic analyses that used off-line data such as classical written Chinese text, or recorded discourse. Those data may reflect later integrative processes that occur after the initial discourse model is created.

As just described, the Gordon and Hendrick (1998) model provides a clear account of the findings reported in this paper. However, this conclusion raises questions about why the zero pronoun is used so extensively in Chinese given that our experiments found no evidence that the zero pronoun plays a special role in making Chinese discourse coherent at least for the types of discourses that we studied. One obvious line of explanation is that zero pronouns involve less articulatory effort than overt pronouns and that some principle of least effort is involved. A second avenue is that the zero pronoun has some specific stylistic value. For example, it might relate to social stratification or be expressive of social attitudes; one might expect that the choice of a zero pronoun is influenced by the same kinds of factors that influence the use of contracted negatives in English. Finally, many interesting questions remain concerning how the

immediate processing of syntactic structure of Chinese interacts with more functionally oriented aspects of the language, such as topic-chain structure, to achieve coreference and discourse coherence in the comprehension of Chinese.

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