

# Pronoun Resolution in Discourse by Chinese Dyslexic Children: A Preliminary Study on Text Integration

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**ABSTRACT**—*Previous psycholinguistic studies on dyslexia mainly emphasize on phonological, lexical, morphological and syntactic levels of language, and the majority of studies works on English language. This study attempts to extend the current trend of investigation to higher-order text integration with coreference in Chinese language by Chinese dyslexic children who suffered from problems with cognitive and language processing abilities. A computerized self-paced reading experiment was conducted with dyslexic and non-dyslexic children who read short discourses containing apronoun and designed according to three types of discourse situation which were referential interference, protagonist continuity and topic prominence. The results indicate that dyslexic children generally performed worse than non-dyslexic counterparts who had comparable age, education level and intelligent quotient level in pronoun resolution, especially when there was an intervening referent. And dyslexic children could not benefit from topic prominence for referents' accessibility in terms of resolution time. However, further detailed analyses would reveal that the dyslexics did not differ that much from their non-dyslexic counterparts. And the study also shows which conditions may be harder for pronoun interpretation for children. The findings provide a preliminary foundation to the research community and to the practitioners working with dyslexic children for a better understanding of dyslexic children's performance in text integration involving coreference. Together with previous findings in literature, a more comprehensive description of dyslexics' language performance may be available for remedial or pedagogical purposes.*

**Keywords**—Chinese dyslexia, Coreference, Pronoun resolution, Chinese discourse

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## 1. INTRODUCTION

Developmental dyslexia is a specific learning disability that originates from neurobiological basis and is related to a number of visual, language-based and cognitive deficits (e.g., Leong, Hau, Tse, & Loh, 2007; Pickering, 2006; Ziegler, Perry, Ma-Wyatt, Ladner, & Schulte-Korne, 2003). Dyslexic people are known to suffer from weaker verbal working memory in cognition and in language processing. And difficulties in language processing are also said to mainly result from a deficit of phonological awareness causing lexical decoding, vocabulary problems and other further comprehension issues (e.g., Hagtvet, 1997; Leong, 2006; Lyon, Shaywitz, & Shaywitz, 2003; Snowling, 2000; Vellutino & Fletcher, 2005). The lack of language experience due to these primary deficits, such as phonological awareness, is partially responsible for the secondary deficits in syntax and other higher-order levels. Therefore, the entire language system of dyslexic people may eventually delay to develop and different parts of the language processing faculty may be affected to cause reading and comprehension problems (e.g., Hagtvet, 1997). Previous studies in literature have showed that dyslexic people performed worse than the non-dyslexics in a number of language phenomena, especially in the lower-order levels of phonology, word recognition, semantics and syntax, in English and Chinese languages (e.g., Chan, 2014; Chik, Ho, Yeung, Chan, et al., 2012; Chik, Ho, Yeung, Wong, et al., 2012; Chung, Ho, Chan, Tsang, & Lee, 2010; Ho, Chan, Tsang, Lee, & Chung, 2006; Ho, Chan, Tsang, & Lee, 2002; Vellutino, Fletcher, Snowling, & Scanlon, 2004). However, very few studies have investigated dyslexics' higher-order comprehension issues like text integration with reference-tracking in discourse. This study attempts to fill this gap by investigating pronoun resolution between dyslexics and non-dyslexics.

In the linguistic scopes of language reading processing by poor or dyslexic readers, there have been a lot of research work ranging from word-level reading skills such as vocabulary and word semantics to sentence-level reading skills such as syntactic skills. In word level, Chinese dyslexic children perform like the dyslexic children of alphabetic languages to have specific difficulties in word learning, especially irregular words (e.g., Ho et al., 2006). Besides, lexical knowledge like morphological awareness and processing, identification of characters and words, and vocabulary skills were shown to be worse to poor readers than to good readers (e.g., Leong & Ho, 2008; Shu, McBride-Chang, Wu, & Liu, 2006; So &

Siegel, 1997). In sentence-level, dyslexic readers seems to lag behind their counterparts in the development of grammatical sensitivity and processing of complex sentence structures, especially the structures that require more use of verbal working memory(e.g., Chan, 2014; Siegel & Ryan, 1988; Snowling, Gallagher, & Frith, 2003).

Pronoun resolution in anaphoric processing is a crucial text-level operation in psycholinguistics concerning how readers resolve anaphoric relations to maintain text coherence and keep reading a rapid coherent process(e.g., Ehrlich & Rayner, 1983; Gordon, Camblin, & Swaab, 2004; Halliday & Hasan, 1976). Anaphora in Chinese generally includes three types, namely zero anaphora, pronominal anaphora and nominal anaphora, with the zero pronoun and the overt third-person singular pronoun *ta* appearing most frequently and widely(e.g., Li & Thompson, 1981; Pu, 1997; Wang, 2004; Xu, 2000). Referential pronouns are said to access the discourse representation in readers' mind through a more direct path to activate deeper conceptual-level information(e.g., Cloitre & Bever, 1988; Garrod, Freudenthal, & Boyle, 1994) and to be interpreted with the dependence on the context or contextual cues to establish the indexical features(e.g., Van Vliet, 2008). Pronoun resolution can be affected by a number of factors that can be explained from the perspectives of linguistics and psycholinguistic processing. The most identified factors include but not limited to (1) referential interference between pronoun and antecedent, (2) protagonist continuity and (3) topic prominence(e.g., Ariel, 1991; Huang, 2000a, 2000b; Pu, 1997; Tao, 1996, 1997). Referential interference has long been recognized as one factor influencing pronoun resolution processing(see Givón, 1983). The number of intervening clauses or intervening referent between the antecedent referent and the pronoun will affect the antecedent-pronoun mapping because increasing the number of clause would weaken the activation of the referent and its accessibility in readers' mental representation whereas having intervening referent would trigger completion or disruption to the antecedent-pronoun mapping process. Protagonist continuity concerns about the information flow of a discourse. A discourse with a consistent focused character or referent has a continuous protagonist while a discourse with an inconsistent or shifted character has a discontinuous protagonist. A text with a continuous protagonist is easier for reading and readers may use this type of discourse cue to resolve pronoun (Fox, 1987). Topic prominence is another factor influencing pronoun assignment. When a referent is prominent pragmatically or syntactically, its representation in the reader's mind will be easier to be accessed and retrieved. If the antecedent of an anaphor is made prominent in a discourse, the anaphoric resolution should be faster and more accurate(e.g., Ariel, 1991; Givón, 1983). This study is an attempt to investigate dyslexic children's performance in processing pronoun resolution in the aforementioned threetypes of discourse situations with the overt pronoun (i.e., *ta* "he/she") in Chinese.

## 2. RESEARCH OBJECTIVE

The current investigation aims at examining whether there are differences of anaphoric resolution in threetypes of discourse situations which are (1) referential interference (i.e., 0, 1 or 2 intervening referents), (2) protagonist continuity (i.e., continuous protagonist or discontinuous protagonist) and (3) topic prominence (i.e., prominent topic or topic not prominent) with the overt pronoun *ta* ("he/she") between two groups of participants (i.e. dyslexic and non-dyslexic Chinese children). Specific research questions are listed below.

- 1) Is there any difference between dyslexics and non-dyslexics in resolving pronoun interpretation in text?
- 2) Is there any difference in resolving pronoun in the three types of discourse situation (i.e., referential interference, protagonist continuity and topic prominence) for the dyslexics and non-dyslexics?
- 3) Is there any difference in resolving pronoun in the conditions of each of the three discoursesituations for the dyslexics and non-dyslexics?

## 3. RESEARCH METHOD

### 3.1 Participants

The experimental group of the study included 12 dyslexic Chinese children from grade 3 to grade 6 from two primary schools in Hong Kong; whereas the control group included 12 non-dyslexic Chinese children who were age-matched, educational-year matched and intelligent-quotient (IQ) matched with the dyslexic counterparts in the experimental group. Participants' information is given in Table 1.

**Table 1:** Participants' information

Year of Study	Age Range (year;month)	Experimental Group (no. of dyslexics)	Control Group (no. of non-dyslexics)
Grade 3 and 4	9;1 - 11;1	6	5
Grade 5 and 6	11;1 - 13;10	6	7
Overall	10;11	12	12

All the participants were assessed for their non-verbal intelligence quotient scores by the use of Raven’s Standard Progressive Matrices individually (Raven, 2006). The test had 60 questions in 5 categories. The children generally took about 30 minutes to finish. The scores were analyzed and the statistics showed that the dyslexic and non-dyslexic children had the same level of IQ level ( $F(1, 22) = 0.247, p > 0.05$ ).

### 3.2 Materials

A total of 42 experimental trials were constructed for the discourse situations (1) Referential interference, (2) Protagonist continuity and (3) Topic prominence. Each trial was a three-sentence or two-sentence short discourse followed by a multiple-choice resolution question for the identity of the pronoun. The sentence before the resolution question was always a pronoun-containing sentence. The number of character and structure of the sentences were controlled in each conditions. 60 fillers were randomly mixed with the experimental trials. The words used in the experiment were ensured to have already been taught at school with accordance to the Hong Kong Chinese Lexical Lists for Primary Learning (Hong Kong Education Bureau, 2007) before the children took the task. Table 2, 3 and 4 showed a sample experimental trial for the three discourse situations respectively.

**Table 2: A sample stimuli of referential interference**

Conditions	Stimulus
0 intervening referent	在夏天，天氣很炎熱。阿美看見小明吃飯後吃雪糕和糖果，然後他就回房間看圖書。 “In summer time, it is hot. A-Mei saw that Xiao-Ming ate some ice-cream and candies, then <b>he</b> went back to his room to read story books.”
1 intervening referent	在夏天，天氣很炎熱。阿美見到小明吃阿天的雪糕和糖果，然後他就回房間看圖書。 “In summer time, it is hot. A-Mei saw that Xiao-Ming ate A-Tin’s ice-cream and candies, then <b>he</b> went back to his room to read story books.”
2 intervening referents	在夏天，天氣很炎熱。阿美見到小明吃阿天的雪糕和大朋的糖果，然後他就回房間看圖書。 “In summer time, it is hot. A-Mei saw that Xiao-Ming ate A-Tian’s ice-cream and Da-Peng’s candies, then <b>he</b> went back to his room to read story books.”

**Table 3: A sample stimuli of protagonist continuity**

Conditions	Stimulus
Continuous protagonist	朱醫生昨天吩咐李登記員查看紀錄。朱醫生經過詢問處時掉下了一枝筆。 他拾起筆，繼續醫治病人。 “Doctor-Zhu instructed Registrar-Li to check some records yesterday. Doctor-Zhu dropped a pen when passing by the information desk. <b>He</b> picked up the pen and continued to heal the sick.”
Discontinuous protagonist	朱醫生昨天吩咐李登記員查看紀錄。李登記員經過詢問處時掉下一枝筆。 他拾起筆，繼續醫治病人。 “Doctor-Zhu instructed Registrar-Li to check some records yesterday. Registrar-Li dropped a pen when passing by the information desk. <b>He</b> picked up the pen and continued to heal the sick.”

**Table 4: A sample stimuli of topic prominence**

Conditions	Stimulus
Topic prominent	小林，這個人在比賽的時候取笑阿天。 現在他在球場上踢足球。 “Xiao-Lin, this guy teased A-Tian in a game. Now <b>he</b> is playing football on the pitch.”
Topic not prominent	小林在昨天的足球比賽中取笑阿天。 現在他在球場上踢足球。 “Xiao-Lin teased A-Tian in a game yesterday. Now <b>he</b> is playing football on the pitch.”

### 3.3 Procedure

For the IQ assessment, the standardized Raven’s Standard Progressive Matrices (Raven, 2006) was implemented to participants with no time frame to assess the children’s non-verbal intelligence. The test included five sets of 12 items adding up to 60 items in total. Each item was a visual matrix with one piece missing and participants had to choose from a choice of 4 to 8 to complete the whole target matrix. This was a paper-pencil test.

Before the computerized self-paced reading task, a pre-experiment naming task was implemented to all participants individually. A vocabulary list which consisted of 90 words in the experimental stimuli was given to all participants. Participants were instructed to mark the words that they were not familiar with in terms of meaning or pronunciation. Participants were taught the words that they previously marked and they were ensured to understand the meaning of the words before the experiment. Participants were then asked to read aloud the words on the list and were asked the meaning of the unfamiliar words that they marked or showed unfamiliar in the pronunciation.

For the computerized self-paced reading experiment, LINGER (version 2.94) which is a computer program for behavioral experiments constructed by Dr. Doug Rohde of the TedLab at MIT (available online at <http://tedlab.mit.edu/~dr/Linger/>) was used to implement the experiment. Children were instructed to read sentence-by-sentence by pressing the spacebar key on the keyboard and to answer comprehension questions by pressing the corresponding keys. Children were given a 5-minute break in the middle of the experiment. The experiment always started with a few practice trials for the children to familiarize with the task.

#### 4. RESULT

The current result session will report the results collected from the computerized self-paced reading experiment. The comprehension accuracy and the resolution time of the pronoun resolution were statistically analyzed. Statistical analyses were done for the comparisons of the dyslexics and non-dyslexics, the three types of discourse situation, and the conditions of each type of discourse situations. Generally speaking, dyslexic children used similar reading time to interpret pronoun ( $F(1, 23) = 2.21, p > 0.05$ ), but dyslexics had worse resolution accuracy than the non-dyslexics ( $F(1, 23) = 4.37, p < 0.05$ ). In the discourse with referential interference, dyslexics and non-dyslexics just performed roughly the same in terms of accuracy ( $F(1, 23) = 2.78, p > 0.05$ ) and resolution time ( $F(1, 23) = 1.27, p > 0.05$ ); and this was also the case in the discourse concerning protagonist continuity in terms of accuracy ( $F(1, 23) = 1.80, p > 0.05$ ) and resolution time ( $F(1, 23) = 0.06, p > 0.05$ ). In the discourse concerning topic prominence, although the two groups of children had roughly the same accuracy ( $F(1, 23) = 1.69, p > 0.05$ ), dyslexics needed significantly longer time for the resolution ( $F(1, 23) = 6.30, p < 0.05$ ).

Concerning the sub-levels of the three discourse situations between the dyslexics and non-dyslexics, the results indicate that dyslexics had worse accuracy than the non-dyslexics when there is one intervening referent between the antecedent and the pronoun ( $F(1, 23) = 4.59, p < 0.05$ ) but the resolution time between the two groups was roughly the same ( $F(1, 23) = 0.83, p > 0.05$ ). When the topic of the discourse was prominent, dyslexics spent much longer time to resolve the pronoun than non-dyslexics ( $F(1, 23) = 7.55, p < 0.05$ ) but the accuracy between them was not significantly different ( $F(1, 23) = 0.83, p > 0.05$ ). A summary of other ANOVA statistics of the conditions in each type of discourse situation was given below in Table 5. Figure 1 and Figure 2 showed the resolution accuracy and resolution time patterns of all conditions respectively.

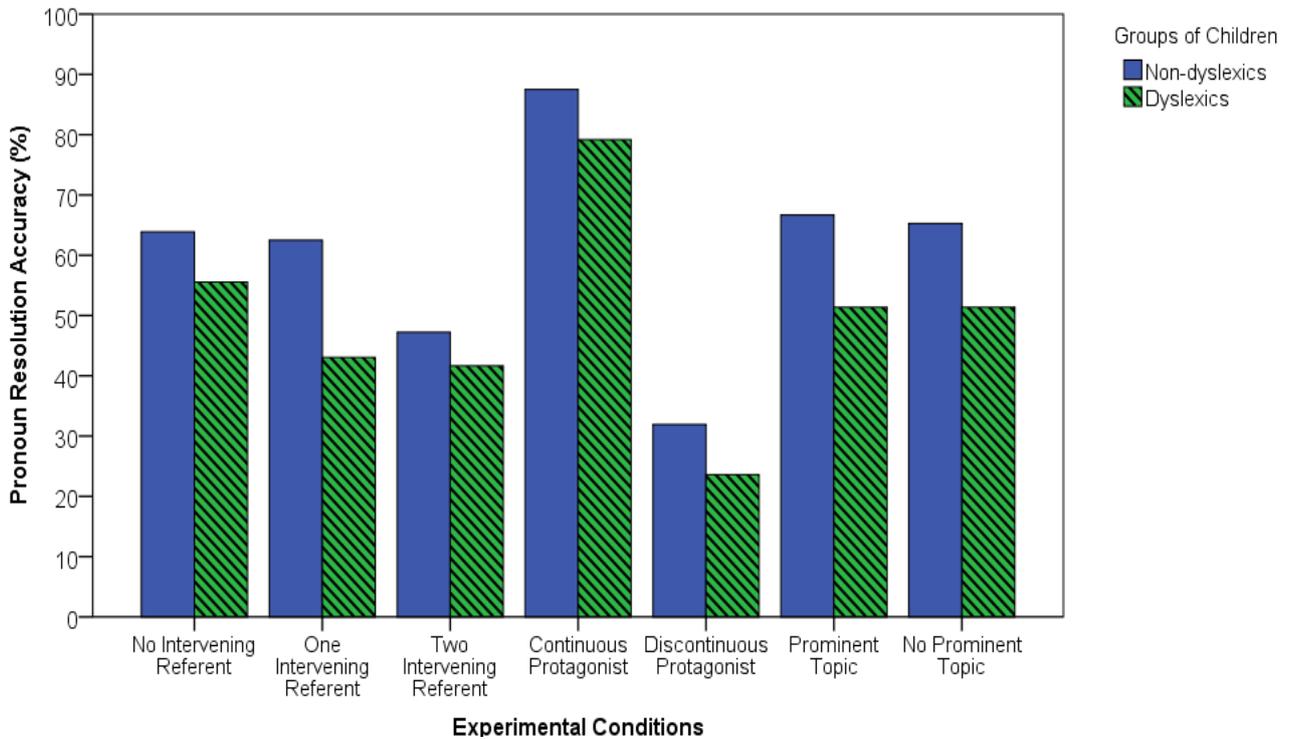
**Table 5:** ANOVA statistics

	Between dyslexics and non-dyslexics			
	Resolution Accuracy		Resolution Time	
	<i>df</i>	<i>F</i>	<i>df</i>	<i>F</i>
0 intervening referent	1, 23	0.86	1, 23	1.67
1 intervening referent	1, 23	4.59*	1, 23	0.83
2 intervening referent	1, 23	0.40	1, 23	0.60
Continuous protagonist	1, 23	0.86	1, 23	0.00
Discontinuous protagonist	1, 23	0.92	1, 23	0.28
Topic prominent	1, 23	1.66	1, 23	7.55*
Topic not prominent	1, 23	1.24	1, 23	3.51

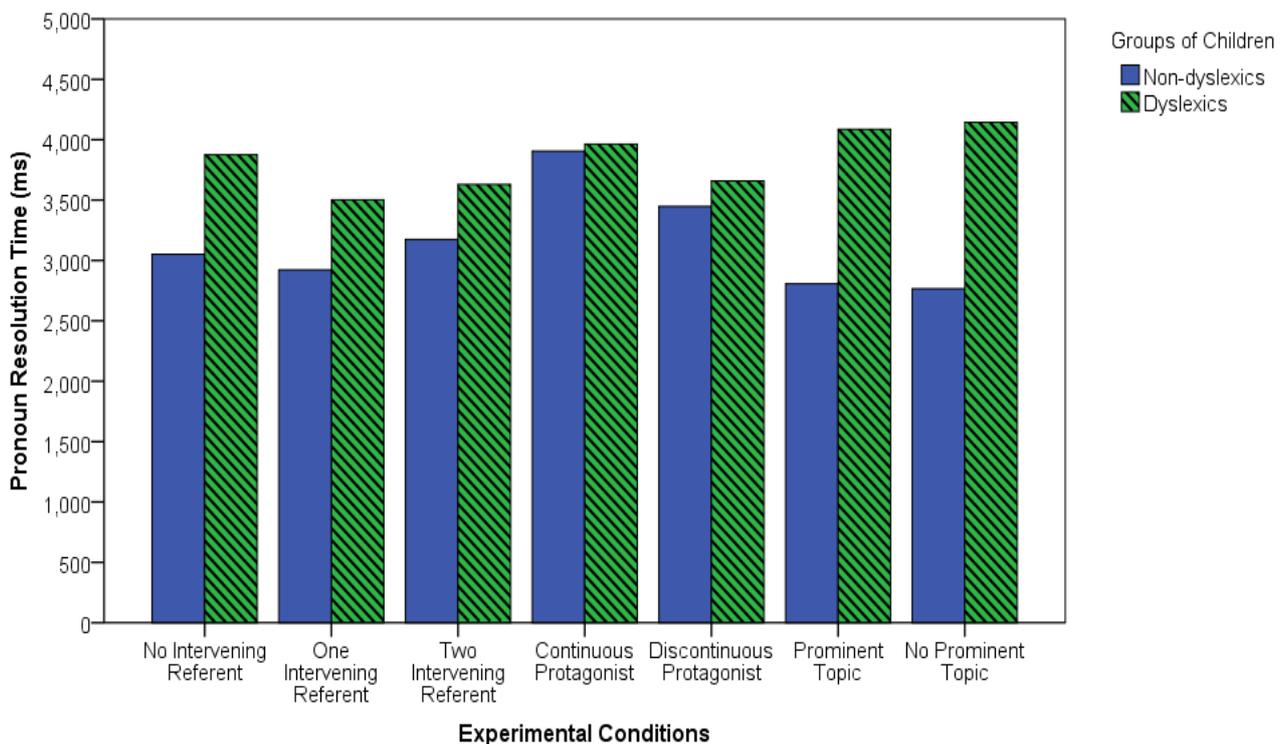
\* $p < 0.05$

Across the two groups of children, the three types of discourse situations were just of similar level of ease in terms of accuracy ( $F(2, 71) = 0.56, p > 0.05$ ) and resolution time ( $F(2, 71) = 0.51, p > 0.05$ ). In the referential interference

situation, the three sub-level conditions, i.e., 0, 1 and 2 intervening referents, did not differ from each other significantly in terms of resolution accuracy ( $F(2, 69) = 2.80, p > 0.05$ ) and in terms of resolution time ( $F(2, 69) = 0.18, p > 0.05$ ). In the discourse situation of protagonist continuity, it was found that the continuous protagonist condition was significant better than the discontinuous protagonist condition in terms of accuracy only ( $F(1, 46) = 79.31, p < 0.001$ ), but not resolution time ( $F(1, 46) = 0.57, p > 0.05$ ). In the discourse situation concerning topic prominence, the two sub-level conditions, i.e., topic prominent and topic not prominent, were the same in terms of both accuracy ( $F(1, 46) = 0.006, p > 0.05$ ) and resolution time ( $F(1, 46) = 0.00, p > 0.05$ ).



**Figure 1:** Pronoun resolution accuracy of dyslexics and non-dyslexics in various conditions



**Figure 2:** Pronoun resolution time of dyslexics and non-dyslexics in various conditions

## 5. DISCUSSION

One observable pattern from the experimental results as reflected by the Figure 1 and 2 is that dyslexic children generally had poorer accuracy and spent longer resolution time than their non-dyslexic counterparts for all conditions of discourse. However, not all of these comparisons between the two groups constituted a statistical significance. Indeed, the fact that dyslexics and non-dyslexics were not different in most of the conditions may suggest that dyslexic children could perform referent tracking in discourse comparably when word-level deficits were excluded in assessments as this study did by trying to minimize the effect of lexical processing using a pre-experiment naming task and by using words that should had been taught before their grade.

Referential interference bears an idea that the antecedent-pronoun assignment is more difficult to achieve when there is a referent intervening between the antecedent referent and the pronoun, especially when the intervening referent is of the same gender as the antecedent. In readers' mental representation of comprehension, an intervening referent may distract the antecedent-pronoun assignment or may play as a competitor and thus indirectly weakens the accessibility of the designated antecedent for the anaphoric relation. The grammatical position that the intervening referent occupies would determine the strength of the referential interference following a grammatical hierarchy like subject > object > others (e.g., Ariel, 1991). In the cases of the current study where the intervening referents occupied a possessive position, the interference effect was not typically big. However, there was a difference between dyslexics and the non-dyslexics when there was one intervening referent. Such a difference disappeared when there were two intervening referents. This may be due to the possibility that the raise of interference effect posed a burden to the processing resources to both the two groups and their difference became insignificant in this case.

Protagonist continuity concerns the flow of the character in a discourse. In the sense of topic continuity (Givón, 1983), the more reduced referring expressions which are seen as of higher accessibility require more stable thematic information of the protagonist. A similar ideology could also be found in the Centering Theory (e.g., Grosz, Weinstein, & Joshi, 1995) that a discourse segment with a *continue* coherence transition is more preferable than a segment with a *shift* transition. The results confirmed that a discourse with a continuous protagonist was easier than a discourse with a discontinuous protagonist for reading and for pronoun resolution. However, there were no differences between dyslexics and non-dyslexics.

Topic prominence suggests that if the topic of a discourse is made prominent through the use of syntactic or pragmatic means, its accessibility will be greater and facilitate the antecedent-pronoun linkage. Although the two groups of children had roughly the same accuracy, non-dyslexics could resolve the pronoun faster than dyslexics did when the topic of a discourse was made prominent. This seems to suggest that dyslexic children could not be as sensitive as the non-dyslexics to benefit from the topic prominence.

## 6. CONCLUSION

This study is a preliminary research to examine the differences between dyslexics and non-dyslexics in interpretation of third person singular pronoun in three different types of discourse situations which are referential interference, protagonist continuity and topic prominence with the use of a computerized self-paced reading paradigm collecting data of resolution accuracy and resolution time for statistical analyses. The study attempts to provide a preliminary understanding of the performance of pronoun interpretation of the dyslexic and the non-dyslexic children.

With the specific data analyses of accuracy and resolution time, the results could briefly answer the research questions stated at the beginning. From a general perspective, dyslexic children had poorer interpretation accuracy of pronoun in reading short discourse although they spent roughly the same amount of time for the resolution process. However, when various fine conditions were concerned and looked into, it was found that the difference between dyslexics and non-dyslexics was indeed not large and in a few conditions only. Dyslexics may be easier to be distracted by an intervening referent, but when there were more distracting referents at secondary positions, dyslexics and non-dyslexics were just the same. And non-dyslexics seemed to be more sensitive to the benefit of topic prominence in speed. The three discourse types were not particularly different in terms of difficulty to the children. And children generally performed better in a discourse structure that had fluent protagonist flow.

The study is an attempt to extend the current trend of dyslexic research from phonological and word level aspects to higher-order level of reading comprehension. The findings provide information about Chinese dyslexic children's performance of reference tracking in discourse. It is hoped that the reading patterns in various discourse situations could serve as cues to practitioners for dyslexics' reading issues.

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