Resolving structural ambiguity using animacy and grammatical cues in Chinese

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Resolving Structural Ambiguity using

Animacy and Grammatical Cues in Chinese

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A Final Year Project submitted to the School of Humanities and Social Sciences, Nanyang Technological University in partial fulfillment
of the requirements for the Degree of Bachelor of Arts in Linguistics & Multilingual Studies

2011

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  The URECA part (comprehension study) had funding from the URECA office and payment to each Singaporean participant was SGD $5 per study and for each Taiwanese participant (study carried out during INSTEP) it was NTD 100 per study. For the FYP part, it was partially supported by my supervisor's grant and partially self supported. For Singaporean participants it was $3 per study and for PRC participants it was $7 per hour.

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List of Abbreviations

ANOVA: Analysis of Variance

L1: First Language

L2: Second Language

M: Mean

Max: Maximum

Min: Minimum

NP: Noun Phrase

NP1: First Noun Phrase

NP2: Second Noun Phrase

PRC: People's Republic of China

SD: Standard Deviation

Abstract

This study investigates how bilinguals resolve structural ambiguity in ambiguous Chinese relative clauses. Previous studies have found cross-linguistic differences in the processing of ambiguous sentences such as "Somebody shot the servant of the actress who was on the balcony" (Cuetos & Mitchell, 1988). Some languages show preference for high attachment (the servant) while other languages such as Chinese have shown a preference for low attachment (the actress) (Shen, 2006). The role of animacy has also been found to be relevant in Chinese, with studies on the Competition Model supporting it as an important cue in agent identification (Li et al., 1992). With two off-line questionnaire studies, this study looks at how the semantic animacy role and grammatical role (low attachment preference) affect ambiguity resolution in Chinese for both comprehension and production. It was found that animacy was a stronger cue for disambiguiting Subject-extracted relative clauses while the grammatical cue was stronger for disambiguiting Object-extracted relative clauses. The ambiguity resolution strategies of early English-Chinese bilinguals and that of first languaage (L1) native Chinese speakers who are late bilinguals are also found to be largely similar.

1 Introduction

Language processing involves the rapid integration of different cues that language users rely upon when assigning meaning to sentences. While there are some universal processing strategies found across languages, there are also language-specific cues for sentence processing. The Competition Model (Li et al., 1982) looks at the varying cues that may be preferred across different languages. In particular, when language users process structurally ambiguous sentences, they need to rely on various cues to disambiguate the structural ambiguity. An example from Cuetos and Mitchell (1988) is shown below:

(1) Somebody shot *the servant of the actress* who was on the balcony.

There is standing ambiguity in (1) as language users have to decide who was on the balcony; the servant or the actress. Users have a choice to attach either of the noun phrases (NPs) (*the servant* or *the actress*) to the relative clause (*who was on the balcony*).

Past research has shown that speakers of various languages have preferences for different interpretations when processing ambiguous relative clauses containing a complex noun phrase (NP1-of-NP2). Users of some languages (such as English and Chinese) have a preference for attaching the lower noun in the tree structure to the relative clause, while others (such as users of Spanish) prefer to attach the higher noun to the relative clause (Fernández, 2003). While studies on ambiguous relative clauses have focused on high or low attachment preference, the effect of noun animacy has yet to be looked at greatly. Animacy has been found to be an important cue in sentence processing for speakers of languages such as Mandarin Chinese (Li et al., 1992).

In this study, we look at how English-Chinese bilinguals process ambiguous Chinese relative clauses. Our goal is to explore the role of animacy and its interaction with the grammatical cue (low attachment preference) in structural disambiguation in Chinese. We also investigate if there is any processing difference in the ambiguity resolution of Chinese Subject-gap (Subject-extracted) relative clauses and Object-gap (Object-extracted) relative clauses. In addition, we also look at the processing strategies of early English-Chinese bilinguals in comparison to their late bilingual counterparts who had acquired Chinese at an early age but learnt English at a relatively later age.

We can summarise our goals and research questions into the following:

- To investigate the roles of the semantic cue (noun animacy) and the grammatical cue (low attachment) in disambiguating structural ambiguity of Chinese relative clauses

- To observe any interaction between the two cues in ambiguity resolution

- To compare and see if there are any differences in the ambiguity resolution of Subject-gap and Object-gap relative clauses in Chinese

- To explore any difference in sentence processing of ambiguous Chinese relative clauses by the two groups of participants; early English-Chinese bilinguals and their late bilingual counterparts

To investigate these research questions, we look at how bilingual speakers resolve ambiguity in Chinese relative clauses involving complex NPs. We observe whether one interpretation is preferred over the other, where they have to choose one noun out of the two in the complex NP to attach to the relative clause, such as in (1). We also observe how speakers utilise the semantic and grammatical cues to disambiguate ambiguity. This study involves two experiments; a comprehension task and a production task. Our hypothesis for the results are further elaborated in the later chapters but can be summarised as the following:

- Both semantic and grammatical cues would be utilised in disambiguating ambiguous Chinese relative clauses

- When the two cues are in agreement, the interpretation supported by both cues would be the strongest. When the two cues are in disagreement, the stronger cue will predict the noun attachment preference to the ambiguous relative clause; the semantic cue will predict animate noun attachment (regardless of low or high attachment) and the grammatical cue will predict low attachment noun attachment (regardless of noun animacy)

- Ambiguous Subject-gap relative clauses will show a preference for animate nouns while ambiguous Object-gap relative clauses will show a preference for inanimate nouns for ambiguity resolution

- If the semantic cue (animacy) is utilised by both groups of bilinguals, it may suggest that early bilinguals are also able to use language-specific cues in ambiguity resolution

This study would have implications on how lexical-semantic cues may have an effect on sentence processing, in particular ambiguity resolution of relative clauses, apart from the syntactic-grammatical cue that has been investigated to a greater extent previously. The study would also have implications on bilingual sentence processing, looking at how early bilinguals utilise language-specific cues.

2 Literature Review

2.1 Relative Clause Attachment

Research has shown that there is cross-linguistic variation in ambiguity resolution of relative clauses. Consider an example of a complex noun phrase ambiguous relative clause (1) and its Chinese equivalent (Shen, 2006).

(1) a. Somebody shot the servant of the actress who was on the balcony.

b. 某人开枪打死了站在阳台上的女演员的仆人。

mouren kaiqiang dasi-le zhanzai yangtaishang-de nüyanyuan-de puren.

Someone   shot   standing-on-balcony -de actress   -de servant.

There is a standing syntactic ambiguity in (1) with two potential sites for relative clause attachment; either of the two nouns (*the servant* and *the actress*) can be attached to the relative clause *who was on the balcony*. This leads to two possible ultimate intepretations and speakers have to decide on one; whether it was *the servant* or *the actress* who was on the balcony. Languages such as English (Cuetos and Mitchell, 1988) and Chinese (Shen, 2006) would prefer the lower attachment noun *actress*, while other languages such as Spanish (Fernández, 2003) and Japanese (Kamide and Mitchell, 1997) would prefer the higher attachment noun *servant* . This cross-linguistic difference in attachment preference allows it to be a grammatical factor influencing the choice speakers have to make between nouns when processing an ambiguous relative clause.

While both English and Chinese prefer a low attachment noun interpretation to resolve ambiguity in a complex noun (NP-of-NP) relative clause, there are a number of differences in the nature of such relative clauses between the two languages that are important to note. Let us now extract the ambiguous relative clause from its main sentence from example (1), a Subject-gap relative clause:

(2) a. the servant of the actress who[_ was on the balcony].

b.[_ 站在阳台上]的女演员的仆人。

[_zhanzai yangtaishang]-de nüyanyuan-de puren.

[_standing-on-balcony] -de actress -de servant.

From (2) we can observe a number of differences between English and Chinese relative clauses. Firstly, relative clauses are marked differently in English and Chinese. English relative clauses are marked by relative pronouns such as *who* and *that* like in (2a). In Chinese, relative clauses always require the use of the postposition *de* that is somewhat equivalent to the Japanese *no* (Shen, 2006). *De* is also used as a general noun phrase marker (Xu, 2009) or to mark a relationship between a possessor and possessee (genitive) in (2b). As a result, we see a " a double *de* construction " in a complex noun phrase in (2b) where the first *de* is a relative clause marker and the second *de* marks the noun phrase. The rough English equivalent of the second *de* in the Chinese clause would be *of* in (2a).

Secondly, the position of the relative clause differs. English relative clauses are postnominal; the modifier (NP in this case) precedes the relative clause it modifies, like in (2a) where *the servant of the actress* appeared before *who was on the balcony*. On the other hand, Chinese relative clauses are prenominal; the relative clause precedes the term it modifies, with *standing-on-balcony* appearing before the complex noun phrase *actress-de servant*. Due to this difference in position of the modified noun (the head), English is a head-initial language and Chinese is a head-final language for relative clauses.

Lastly, English relative clauses that are head-initial are right branching, as in (2a). Readers would have read the two potential nouns (fillers) for attachment at the time where the relative clause is attached at the gap (denoted by _) (Sturt et al, 1999). The reverse is true for Chinese relative clauses that are left-branching and head-final in nature for NPs and postposition phrases (note that Chinese is head-initial for VPs and prepositions) (Shen, 2006). This would mean that the Chinese equivalent of the *servant of the actress* (NP of NP) is *actress-de servant* (NP-de NP). In English, it is the second noun phrase (NP2) that is the low attachment noun to the ambiguous relative clause, whereas for Chinese, it is the first noun phrase (NP1) following the postposition *de* that is the low attachment noun. For the study of Chinese relative clauses disussed in this paper, NP1 would be referred to as the low

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attachment noun and NP2 would be referred to as the high attachment noun. It is interesting to note that despite the difference in distance between the gap and its potential filler nouns (compare (2a) and (2b)), both languages have a low attachment noun preference in relative clause ambiguity resolution. In addition, this preference in the left-branching Chinese relative clauses is in contrast to the high attachment preference of other head-final languages such as Japanese.

Despite these differences of relative clauses in English and Chinese, both languages have shown a preference for lower noun attachment in disambiguiting ambiguous relative clauses. In our study of English-Chinese bilinguals, we would expect a strong reliance on the this grammatical cue of low attachment preference to resolve structural ambiguity in Chinese relative clauses, as it is a common preference in both of the bilinguals' languages.

2.2 The Competition Model

The Competition Model (Li et al., 1992) proposes that sentence processing is dependent on competing factors in a particular language. In languages, there are a finite number of forms (eg. limited number of vowels and consonants in a language) but an infinite number of functions (unlimited number of concepts and semantic properties in our minds). Hence, the same form may be shared by different functions, such as the case of homophones (same phonetic features but representing different meanings). Related to the Connectionist Model, the Competition Model involves the dynamic process of *competition* of the mappings between forms and functions, where the infinite set of functions competes for the limited forms. The relationship between a cue and the function is strengthened when one function wins in competition against other functions mapped on by the same cue, while the connections are weakened between the cue and the other functions that had lost (Year, 2003).

A major predictive construct of the model is cue validity, which is the product of how often a cue is available, when and how often it is reliable and points to the correct answer. Cue validity is also an important determinant for predicting cue strength (Bates and MacWhinney, 1989). Studies examining different cue combinations like animacy, word order and agreement cues have been done. For instance, identifying the agent is a common method for determining the strengths of different cues in a language. Bates et al (1992) found the following cue strength hierarchy for agent assignment in Mandarin Chinese:

(3) Mandarin Chinese: passive marker> animacy > word order > object marker.

As the passive marker was not frequently found in informal speech, animacy was concluded as the most valid cue in Chinese sentence processing. While English speakers rely more on word order to determine the agent (MacWhinney, 1997), Chinese speakers tend to prefer interpreting animate nouns as agents, against less animate or inanimate nouns. During comprehension, different cues may cooperate or compete with each other. Bates et al states that when two or more cues agree with a same interpretation, there will be a greater activation of the interpretation than by a single cue alone. On the other hand, if the cues disagree, then the interpretation activated most strongly will be chosen. A cue high in conflict validity (cue validity when there is a conflict of cues) is usually maximally reliable (McDonald 1987).

In a study on attachment ambiguity in Japanese relative clauses, an effect of animacy was found and was strong enough to alter the attachment bias from high to low, even though the main focus of the study was not on the effects of animacy (Sturt, 1997). In another study on attachment ambiguity in Turkish relative clauses, low attachment preference was only found in the genitive condition when both NPs in the complex noun were non-human. When both NPs were human nouns in the genitive condition, no attachment preference was found (Kırkıcı, 2004).

The Competition Model is a paradigm that emphasises cross-linguistic variation in language processing. By identifying the cues in a language, we are also able to explore if they help in disambiguating ambiguous relative clause. In our study, we explore the use of the semantic cue (animacy) in disambiguating ambiguous Chinese relative clauses, as the animacy cue has been found to be a high validity cue in the processing of Chinese simple sentences. Another cue would be the syntactic cue (preference for low attachment). We will see if there is a greater activation of the interpretation supported by both cues than soley by one. We will also investigate if the language-specific animacy cue is stronger than the syntactic cue in conflict validity when both cues are in disagreement.

2.3 Subject-gap and Object-gap Relative Clauses

Corrigan (1988) has shown that when there is an animate and inanimate contrast in an action, it is usually an animate agent acting on an inanimate noun. In a study of the acquisition of Japanese (Ozeki and Shirai, 2007), it was found that Chinese and English speakers who were beginning learners of Japanese would almost exclusively produce subject relative clauses with animate head nouns and object relative clauses with inanimate head nouns. This strongly suggests that learners associate animacy and grammatical relations when acquiring relative nouns.

In addition, previous studies on relative clauses have shown a difference in the ease of processing Subject-gap (subject-extracted) relative clauses and Object-gap (object-extracted) relative clauses. There seems to be a universal preference for Subject-gap relative clauses, regardless of whether the relative clauses are prenominal or postnominal (Lin and Bever, 2006). However, there appears to be an exception regarding this preference, in the case of Chinese relative clauses. Hsiao and Gibson (2003) found results demonstrating that Object-gap relative clause structures were less complex than their Subject-gap relative clause counterparts. They proposed that this was due to the difference in positions of the head nouns and relative clauses for English and Chinese (which we have discussed in 2.1). This has been disputed by Lin and Bever who found a preference for Subject-gap relative clauses processing in Chinese, which was also found in studies on relative clauses of other prenominal languages such as Korean (Kwon et al., 2004).

In a study on Dutch relative clauses, it was found that animacy influences the processing difficulty of relative clauses (Mak et al., 2002). While previous research had tested relative clauses with only animate protagonists, Mak et al found no difference in reading time between the Subject-gap and Object-gap relative clauses when the object was inanimate. This suggests a preference for animate noun attachment for Subject-gap relative clauses and inanimate noun attachment for Object-gap relative clauses when there is no standing ambiguity.

In our study exploring Subject-gap and Object-gap Chinese relative clauses that involve complex NPs and standing structural ambiguity, we investigate if there are processing differences between the two types of relative clauses, with reference to reliance on cues. While we postulate that both types of relative clauses would show a preference for low attachment, we also predict a difference in the effect of animacy on attachment preference.

Based on the animacy cue, Subject-gap relative clauses would prefer an animate noun attachment and Object-gap relative clauses would prefer an inanimate noun attachment. We investigate if there is a difference between cue validities of the grammatical cue (low preference) and semantic cue (animacy) when participants process these two types of Chinese relative clauses.

2.4 Bilingual Sentence Processing and L1 and L2 Processing Difference

Previous research has shown that children ignore lexical-semantic and contextual cues for ambiguous input, unlike adult native speakers(Clahsen and Felser, 2006). On the other hand, adult second language (L2) learners tended to rely more on non-structural information when processing ambiguous sentences. Differing from children and native speakers, these L2 adult learners do not rely on structure-based parsing strategies when resolving ambiguities in the L2. In the case where lexical cues are absent, even highly proficient speakers may not show a preference for either NP for ambiguous relative clauses, even if both their first language (L1) and L2 utilise the same preferred attachment strategy. It was proposed that when such cues are absent, L2 learners' decision may be made randomly. Clahsen and Felser (2006) had also mentioned a shallow structure hypothesis. L2 learners were found to use lexical, semantic and pragmatic information like native speakers. However, native speakers rely on both lexical cues and phrase structure-based parsing strategies, using the latter when the former is unavailable.

Research on ambiguous relative clause attachment has also shown that bilinguals display the same preference in both their languages. In an off-line research by Dussias (2003), L1 English- L2 Spanish bilinguals showed a low attachment preference for relative clause attachment in both English and Spanish, while L1-Spanish and L2- English bilinguals also exhibited the same low attachment preference in both their languages. This was in the contrast to previous research that had shown a preference of high attachment by monolingual Spanish speakers. Dussias (2003) suggests that living in a predominantly English-speaking environment, language exposure of the bilinguals might have affected the results of the study. In another study on ambiguous relative clause attachment, Fernández (2003) found that English-dominant bilinguals showed an overall preference for lower noun attachment (in both English and Spanish) and that Spanish-dominant bilinguals have an overall preference for higher noun attachment (in both English and Spanish). The bilinguals' attachment preference in both langauges was similar to the preference shown by the monolinguals of the bilinguals' dominant language. She reports that this is evidence for language independent processing, where bilinguals process both their languages using the language-specific strategies of their dominant language, regardless of the input language.

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In our current study, we will explore if English-Chinese bilinguals are able to show an attachment preference similar to that of their L1 Chinese-L2 English bilingual counterparts who are dominant in Chinese.

3 Experiment

Two experiment designs were carried out on four groups of English-Chinese bilinguals to investigate their use of the grammatical cue (low attachment preference) and the noun animacy cue to disambiguate ambiguous Chinese relative clauses. The first was a comprehension study and the second was a production study. The methodology, results and discussions will be detailed in the sections below. Reviewing the aims and hypothesis of this paper, we would expect to see the use of both the grammatical cue (low attachment preference) and the semantic cue (animacy) by the bilinguals. When the two cues are in agreement, there would be a stronger attachment preference. If the two cues are in conflict, the stronger cue (in cue validity) would influence attachment preference more. For the comprehension study, we hypothesise that Subject-gap relative clauses will prefer an animate noun attachment and the Object-gap relative clause will prefer an inanimate noun attachment based on the animacy cue. For the production study, we predict that modifiers in the responses from the participants would also exhibit noun attachment preference for the animate low attachment noun.

3.1 Comprehension Study One: Singaporean English-Chinese bilinguals

3.1.1 Participants

For the first comprehension study, a group of 32 Singaporean participants that include undergraduate and graduate students took an off-line pen-and-paper study on ambiguous Chinese relative clauses. They were compensated SGD$5 each for their participation. All participants were instructed to fill in a language background survey before the experiment was started. They were asked a series of questions about their language acquisition history and rated their own proficiency and language usage in both English and Chinese. Their ratings for the different questions were then compiled to derive an overall rating shown in the table below.

Table 1
Language Background of Singaporean Participants for Comprehension Study One

Self Reported Data	Mean	SD	Min	Max
Age of Participants	22.99	1.07	22	25
Age of first exposure to English	2.69	2.64	0	10
Age of first exposure to Chinese	1.5	1.63	0	7
English Proficiency	4.11	0.66	3	5
English Usage Frequency	3.77	0.75	2	5
Chinese Proficiency	3.94	0.66	2.5	5
Chinese Usage Frequency	3.69	0.74	1.5	5

Notes. The ratings are collated from different questions to form a collated rating. For Language Proficiency, the minimum rating is 1 (very poor) and the maximum rating is 5 (excellent). For Usage Frequency, the minimum rating is 1(never) and the maximum rating is 5 (very frequent). Total number of participants is 32. Figures are rounded off to two decimal places.

The mean age of the Singaporean participants was 22.99 (SD=1.07) years and their mean age of first exposure to English and Chinese was 2.69 (SD=2.64) and 1.5 (SD=1.63) years respectively. They rated their English proficiency at a mean of 4.11 (SD=0.66) and their Chinese proficiency slightly lower at a mean of 3.94 (SD=0.66), out of a maximum possible of 5 (excellent). For frequency of language use, they reported an average of 3.77 (SD=0.75) for English and 3.69(SD=0.74) for Chinese (maximum is 5 for very frequent). This shows a rather balanced frequency of use of both languages by the Singaporean participants.

3.1.2 Experiment Design

The comprehension study had four conditions, with each condition having six test items, making it a total of 24 test items per questionnaire. It was a two by two experimental design: Type of relative clause (Subject-gap/Object-gap) x Animacy order of the two noun phrases (NP1 and NP2). The four conditions are namely: Subject-gap AnimateNP1-InanimateNP2, the Subject-gap InanimateNP1-AnimateNP2, the Object-gap AnimateNP1-InanimateNP2 and the Object-gap InanimateNP1-AnimateNP2. The four conditions are illustrated below, each with a sample clause:

4) Subject-gap AnimateNP1-InanimateNP2 condition:
   [＿＿泄漏机密]的记者的报社
   [__ leak secret]-de reporter -de newspaper agency
   The newspaper agency of the reporter that leaked the secret

5) Subject-gap InanimateNP1-AnimateNP2 condition:
   [＿＿泄漏机密]的报社的记者
   [__ leak secret]-de newspaper agency -de reporter
   The reporter of the newspaper agency that leaked the secret

6) Object-gap AnimateNP1- InanimateNP2 condition:
   [经理看管＿＿]的员工的工厂
   [The manager oversees __]-de workers -de factory
   The factory of the workers that the boss oversees

7) Object-gap Inanimate NP1-AnimateNP2 condition:
   [经理看管＿＿]的工厂的员工
   [The manager oversees __] -de factory-de workers
   The factory of the workers that the boss oversees

Participants were instructed to read the test sentences in which the ambiguous relative clauses were the non-primary clause. Each sentence was followed by two printed interpretations that attach each of the two nouns (NP1 and NP2) to the gap found in the corresponding ambiguous relative clause. This means that the participants were presented with two possibilities (interpretations) of how the ambiguous relative clause could be disambiguated. In one interpretation NP1 would be the filler to the gap, and in the other interpretation NP2 would be the filler instead. Participants were then asked to rate how much they agreed with each interpretation using a seven-point Likert scale after they had read each test sentence. Based on the two ratings for each interpretation of resolving relative clause ambiguity, we can determine if there is an attachment preference for NP1 or NP2, or if there was no

preference for either noun (undecided; no attachment preference). A sample of an ambiguous relative clause (taken out of the main sentence) is shown below, along with the two interpretations following it. In the case below, participants were asked to rate how much they agreed with interpretations i) and ii).

Example of an ambiguous relative clause and its two possible interpretations:

4a) Subject-gap AnimateNP1-InanimateNP2 condition:
　[__ leak secret]-de reporter -de newspaper agency
　The newspapers agency of the reporter that leaked the secret
　The reporter leaked the secret.
　The newspaper agency leaked the secret.

The test was printed in Simplified Chinese and was an untimed task. Each questionnaire comprised of 72 test items (24 test items and 48 fillers). There were four sets of questionnaires. Using a Latin Square design, each set contained 24 target test questions that differed from the other three sets. The questions were pseudo-randomised and no two items of the same condition were adjacent to each other. Each set was given to eight participants.

3.1.3 Results of Comprehension Study One: Singaporean English-Chinese bilinguals

The ratings for each pair of interpretations for every test item were then compared to derive the attachment preference response, which could be either low attachment to NP1, high attachment to NP2 or undecided (when there is no preference for either NP1 or NP2). A raw data distribution test was used to analyse this data on attachment preference. An ANOVA test and a post-hoc student's T-test were also used to analyse the data collected.

3.1.3.1 Distribution Frequency Results
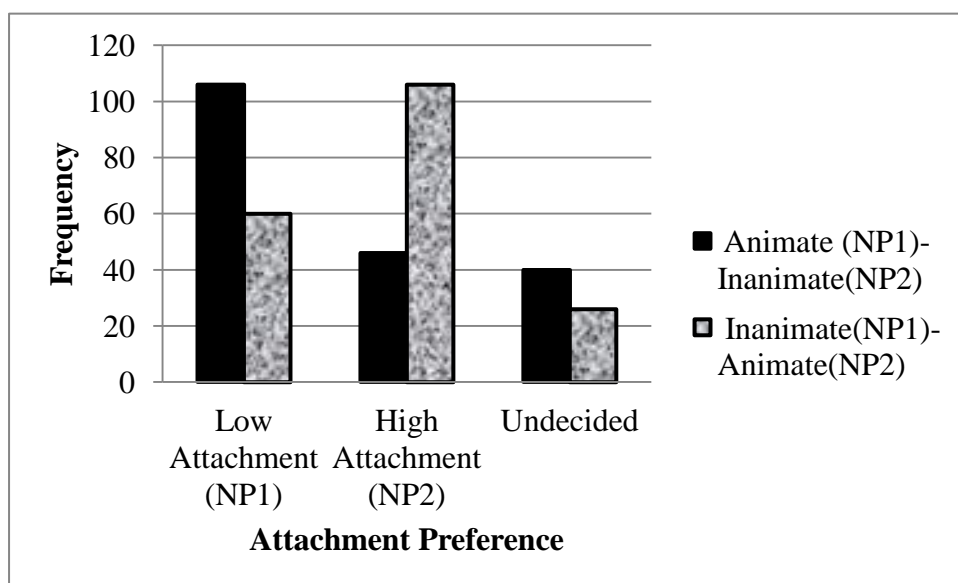
Figure 1. Raw data distribution of the Attachment Preference in ambiguous Chinese Subject-gap Relative Clauses by Singaporean Participants for Comprehension Study One. The total number of responses for each condition is 192.

For the Singaporean group, the raw data distribution test showed a larger preference (55.21%) for low attachment (NP1, animate) than high attachment (NP2, inanimate) (23.96%) for the Subject-gap animateNP1-inanimateNP2 condition. However, when the animacy order is reversed for Subject-gap clauses, there was instead a preference for high attachment (NP2, animate) (55.21%) compared to low attachment (NP1, inanimate) (31.25%), as seen in Figure 1.

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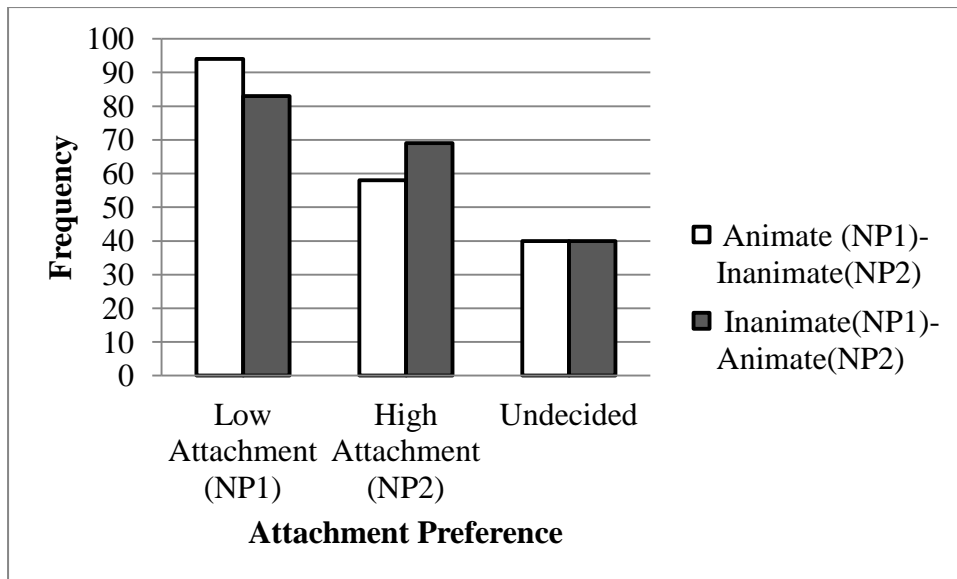
Figure 2. Raw data distribution of the Attachment Preference in ambiguous Chinese Object-Gap Relative Clauses by Singaporean Participants for Comprehension Study One. The total number of responses for each condition is 192.

For the Object-gap relative clauses, there was a preference for low attachment regardless of noun animacy. This means that in the animateNP1-inanimateNP2 condition, the animate noun (48.96%) was preferred while for the inanimateNP1-animateNP2 condition, the inanimate noun (43.23%) was preferred. However, the preference for low attachment (NP1) in the animateNP1-inanimateNP2 condition was more distinctive than when the animacy was reversed. (Figure 2, difference between Low Attachment and High Attachment for the two conditions).
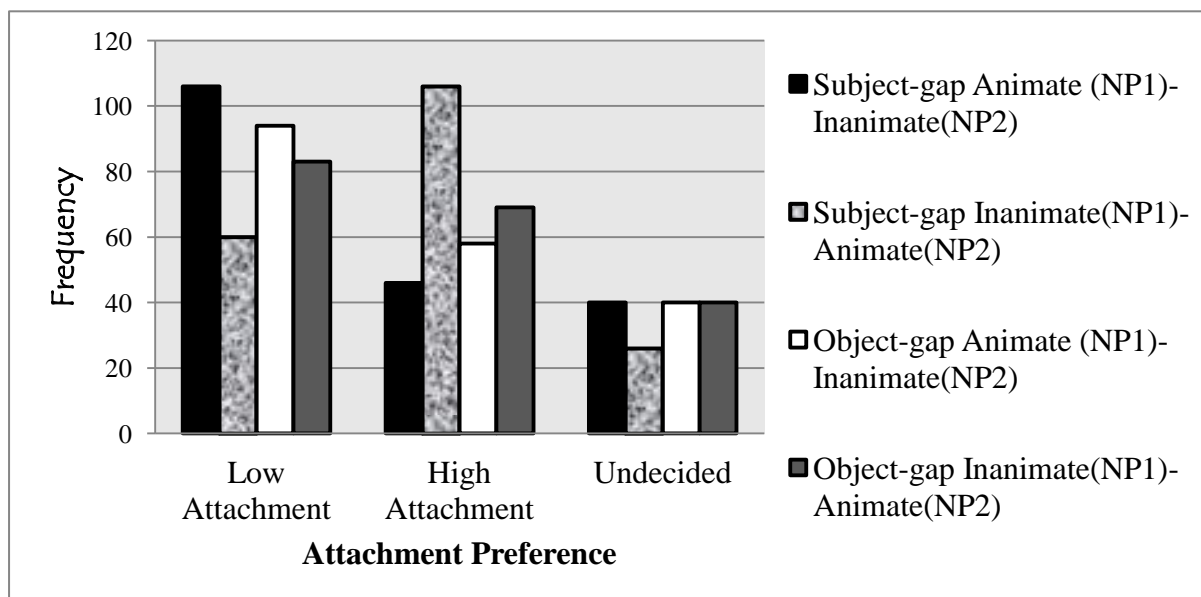
Figure 3. Raw data distribution of the Attachment Preference for all four conditions of ambiguous Chinese Relative Clauses by Singaporean Participants for Comprehension Study One. The total number of responses for each condition is 192.

Comparing the results for Subject-gap and Object-gap relative clauses, the animate nouns are much more strongly preferred in Subject-gap relative clauses when compared to the extent of preference for the low attachment noun in Object-gap relative clauses.

3.1.3.2 ANOVA Analysis

The ANOVA test showed a significant effect of animacy order on attachment preference by both subject analysis, [$F1$ (1, 31) = 22.145, p<0.0001] and item analysis, [$F2$ (1, 23) = 7.839, P<0.0102]. There was no significant effect of relative clause type on attachment by either subject or item analyses. However, there was a significant interaction between relative clause type and animacy order by subject analysis [$F1$ (1, 31) = 20.275, p<0.0001] while item analysis showed marginal interaction [$F2$ (1, 23) = 3.218, p<0.086]. The post-hoc analysis with student's T-test by both subject and item analysis showed that relative clause type had a significant effect (at p<0.05 level) on attachment preference when the inanimate noun precedes the animate noun in the ambiguous clause.

3.1.4 Discussion

From the frequency distribution results, it can be observed that animacy is the stronger cue used by Singaporean bilinguals in determining which NP is to fill the gap in ambiguous Subject-gap relative clauses. Animate nouns were preferred as the subject of ambiguous relative clauses regardless of low or high attachment. When noun animacy was incongruent with low attachment preference, participants still showed a preference for the animate high attachment noun. For the case of Object-gap relative clauses, low attachment nouns were preferred as the object, regardless of the animacy order of the two NPs. Although we had predicted a preference for inanimate nouns for Object-gap relative clauses, this preference was not found. Hence, the low attachment cue was the stronger cue for Object-gap relative clauses. From the ANOVA analysis, it can be seen that it is the animacy of the nouns, rather than the relative clause type, that had an effect on attachment preference. However, post hoc analysis showed that relative clause type had an effect when the inanimate noun preceded the animate noun.

An interesting point to note is that although we had hypothesised that in the case for Object-relative clauses, there would be a stronger preference for nouns when they are both inanimate and in lower attachment (when two cues are in agreement), Singaporean bilinguals showed a stronger preference when the low attachment noun was animate as compared to when it was inanimate. This may suggest that the saliency for subjects to be animate may be stronger than the saliency for objects to be inanimate.

Generally, Singaporean bilinguals rely on both animacy and grammatical cues in deciding which noun is to be modified by an ambiguous relative clause. While the low attachment cue is common to both English and Chinese, we observe through this study that early simultaneous bilingual speakers are also able to utilise a cue that is language-specific to Chinese, as a strategy to resolve ambiguous Chinese relative clauses. Overall, the animacy cue is stronger for ambiguous Subject-gap relative clauses and the grammatical cue is stronger for ambiguous Object-gap clauses. We will see if this is also the case for the group of late L1 Chinese- L2 English bilinguals.

3.2 Comprehension Study Two: Taiwanese Chinese-English bilinguals

3.2.1 Participants

For this comprehension study, a group of 32 Taiwanese participants that include undergraduate and graduate students took a pen-and-paper study on ambiguous Chinese relative clauses, identical to the one in Comprehension Study One. They were compensated NTD$100 each for their participation. All participants were instructed to fill in a language background survey in Chinese before the start of the study. The survey is a Chinese version of the one used in Comprehension Study One. Their ratings for the various language profile questions were then compiled to derive an overall rating shown in the table below.

Table 2

Language Background of Taiwanese Participants for Comprehension Study Two

Self Reported Data	M	SD	Min	Max
Age of Participants	22.53	2.34	20	31
Age of first exposure to English	8.66	2.48	5	15
Age of first exposure to Chinese	1.41	1.04	0	3
English Proficiency	2.78	0.47	1	4
English Usage Frequency	2.56	0.58	1.5	3.5
Chinese Proficiency	4.30	0.66	3	5
Chinese Usage Frequency	3.69	0.74	1.5	5

Notes. For Language Proficiency, the minimum possible rating is 1 (very poor) and the maximum possible rating is 5 (excellent). For Usage Frequency, the minimum possible rating is 1(never) and the possible maximum rating is 5 (always). Total number of participants is 32. Figures are rounded off to two decimal places.

The mean age of the Taiwanese participants was 22.53 (*SD*=2.34) years and their mean age of first exposure to English and Chinese was 8.66 (*SD*=2.48) and 1.41 *(SD*=1.04) years respectively. They rated their English proficiency at a mean of 2.78 (*SD*=0.47) and their Chinese proficiency higher at a mean of 4.30 (*SD*=0.66), out of a maximum possible of 5 (excellent). For frequency of language use, they reported an average of 2.56(*SD*=0.58) for English and 3.69(*SD*=0.74) for Chinese (maximum is 5, for very frequent). This suggests that the Taiwanese participants were sequential bilinguals as compared to their simultaneous bilingual Singaporean counterparts in Comprehension Study One, as they had acquired English at a relatively later age after acquiring Mandarin Chinese. They were also dominant in Chinese for both self-rated proficiency and frequency of language use.

3.2.2 Experiment Design

This study used the same experiment design and materials as Comprehension Study One (see 3.1.2). However, for this study, the questionnaires were printed in Traditional Chinese characters as it was the script used by the Taiwanese participants.

3.2.3 Results of Comprehension Study Two: Taiwanese Chinese-English bilinguals

A raw data distribution test was used to analyse the responses, based on attachment preference. An ANOVA test and a post-hoc student's T-test were also used to analyse the response data.

3.2.3.1 Distribution Frequency Results
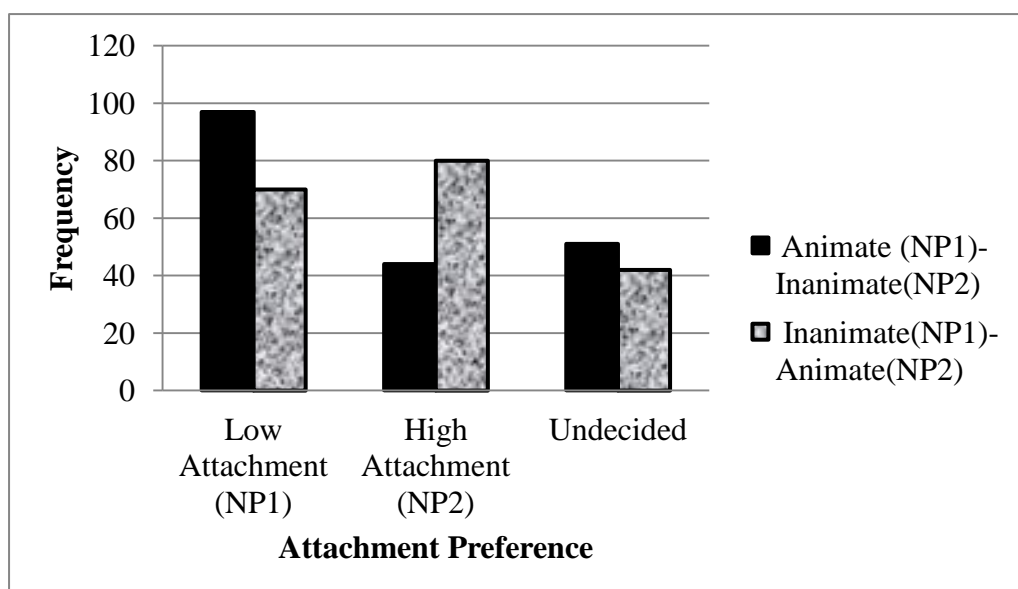
Figure 4. Raw data distribution of the Attachment Preference in Chinese ambiguous Subject-Gap Relative Clauses by Taiwanese Participants for the Comprehension Study Two. The total number of responses for each condition is 192.

For the Taiwanese group, the raw data distribution test of noun attachment preference of Subject-gap relative clauses showed a larger preference for low attachment (NP1, animate) (50.52%) than high attachment (NP2, inanimate) (22.92%) for the animateNP1-inanimateNP2 condition. However, when the animacy order was reversed, there was instead a slight preference for high attachment (NP2, animate) (41.67%) rather than low attachment (NP1, inanimate) (36.46%), as seen in Figure 4.
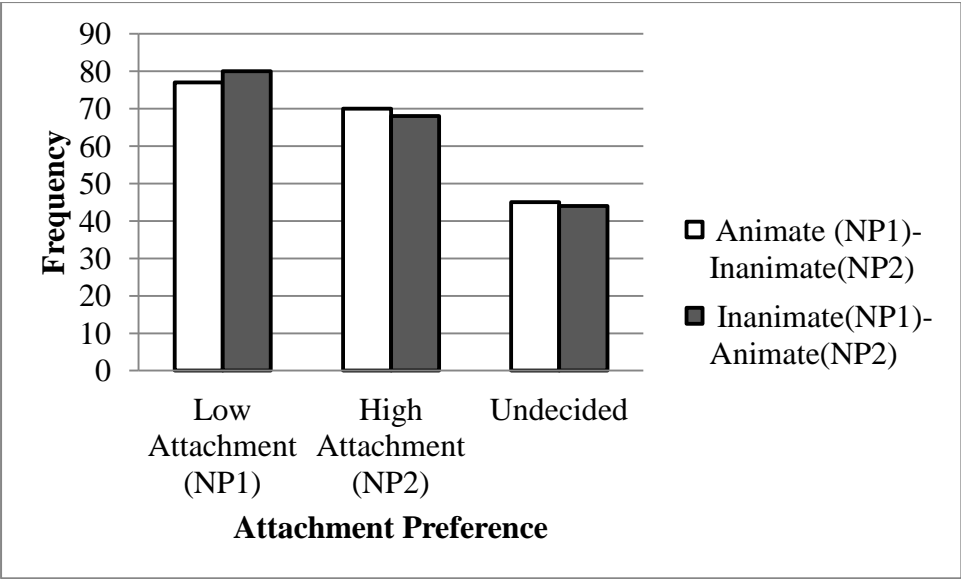
Figure 5. Raw data distribution of the Attachment Preference in Object-Gap Relative Clauses by Taiwanese Participants for the Comprehension Study Two. The total number of responses for each condition is 192.

For the Object-gap relative clauses, there was a slight preference for low attachment regardless of animacy order. This means that in the animateNP1-inanimateNP2 condition, the animate NP1 (40.10%) was preferred while for the inanimateNP1-animateNP2 condition, the inanimate NP1 was preferred (41.67%).
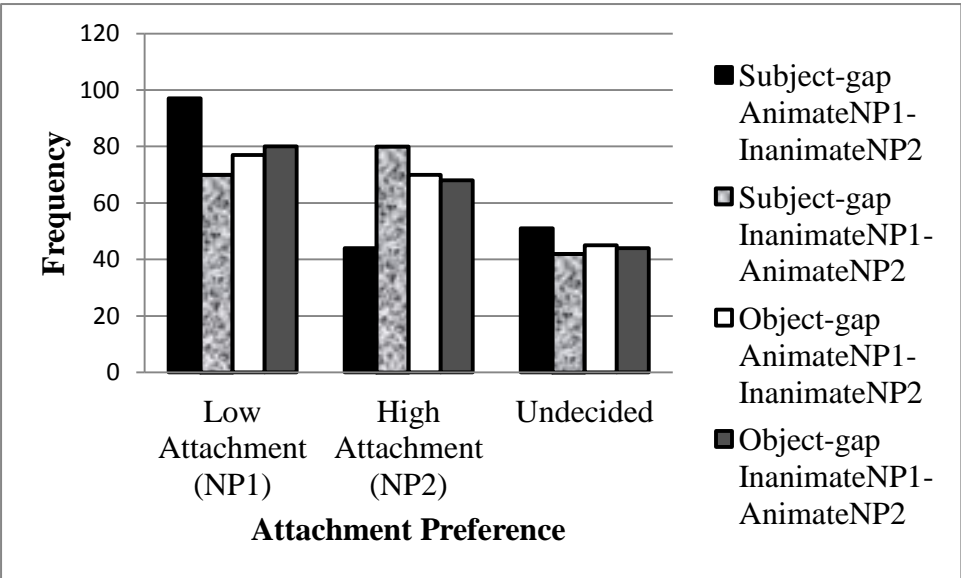

Figure 6. Raw data distribution of the Attachment Preference for all four conditions for ambiguous Chinese Relative Clauses by Taiwanese Participants for the Comprehension Study Two. The total number of responses for each condition is 192.

Comparing the results for Subject-gap and Object-gap relative clauses, the animate noun is much more strongly preferred in Subject-gap relative clauses than the extent of how low attachment noun is preferred in Object-gap relative clauses.

3.2.3.2 ANOVA Analysis

For the Taiwanese group, ANOVA analysis showed a marginal effect of animacy order on attachment preference by subject [F1 $(1, 31) = 3.261$, $p<0.0807$] but no significant effect by item [$F2$ $(1, 23) = 1.777$, $p<0.196$]. ANOVA analysis showed no significant effect of relative clause type on attachment preference by either subject [$F1$ $(1, 31) = 0.973$, $p<0.332$] or by item [$F2$ $(1, 23) = 1.39$, $p<0.251$]. For interaction between relative clause type and animacy order, ANOVA analysis showed a significant effect on attachment preference by subject [$F1$ $(1,31) = 10.581$, $p<0.0027$] and by item [$F2$ $(1,23) = 4.185$, $p<0.0524$].

Post-hoc analysis using Student's T-test showed that relative clause type had a significant effect on attachment preference when the animate noun preceded the inanimate noun for both the subject test and item test. It also showed that animacy order had a significant effect on attachment preference for subject-gap relative clauses.

3.2.4 Discussion

From the distribution frequency, it can be observed that animacy is the main cue used by Taiwanese bilinguals in determining which NP is to fill the gap in the Subject-gap ambiguous relative clauses. Here, animate nouns were preferred as the subject of ambiguous relative clauses regardless of low or high attachment. For the case of Object-gap relative clauses, there was a slight preference of low attachment nouns over high attachment nouns. For the Taiwanese group's ANOVA analysis, there was no significant effect of relative clause type on attachment preference. However the post-hoc analysis showed that relative clause type had a significant effect on attachment preference when the animate noun preceded the inanimate noun. The ANOVA analysis also showed only a marginal effect of animacy order on attachment preference by subject and no significant effect by item. However, ANOVA showed interaction between the animacy order and relative clause type in attachment preference. These results also seem to suggest that the Taiwanese bilinguals tended not to show a strong preference towards either cue for Object-gap relative clauses.

3.3 Overall Discussion for Comprehension Studies One and Two

From the ANOVA analysis, it appears that Singaporean bilinguals were more likely to rely more on the animacy cue for attachment preference in Chinese ambiguous subject-gap relative clauses, as compared to their Chinese dominant Taiwanese counterparts. However, their cue strategies appear largely similar on the whole. Low attachment is a common cue for both English and Chinese speakers, while the animacy cue is only unique to Chinese speakers.

The results of this study could mean that balanced or strong English-Chinese bilinguals might not only utilise similar cue strategies as compared to a Chinese dominant bilingual in processing ambiguous Chinese relative clauses, they rely even more on the cues, such as the animacy cue and low attachment cue in this case. This is interesting as although the Singaporean bilinguals are slightly English dominant, they rely more on the animacy cues than their Chinese dominant counterparts. While the reliance on semantic cues over syntactic cues were found for proficient L2 learners (Clahsen and Felser, 2006), this may suggest that the slightly English dominant Singaporean bilinguals might have a preference for animacy cue over grammatical cue. In contrast, the Chinese dominant Taiwanese bilinguals might have a more balanced reliance on both cues resulting in no clear preference for the Object-gap relative clauses.. In addition, from the raw data distribution, we can see that for Subject-gap relative clauses, the preference is the strongest and most obvious when the low attachment noun is also animate. This is likely so as both cues are in agreement and hence there is a huge motivation for this preference. However, for object-gap relative clauses, the preference between the two nouns was not as pronounced, perhaps due to the fact that low animacy may not be as strong a cue for objects as high animacy may be for subject assignment.

As we have looked at how bilinguals use the two cues to disambiguate complex NP relative clause, we can observe if the same strategies are used to attach nouns in a production study involving complex NPs.

3.4 Production Study One: Singaporean English-Chinese Bilinguals

The production study seeks to explore the noun attachment preference of bilinguals for potentially ambiguous clauses or phrases during production. We will also investigate if the ambiguity resolution in production also utilizes the grammatical and semantic cue. Participants are asked to provide the modifier to a complex noun phrase and their attachment preference will be observed. From this we can further explore how the low attachment cue interacts with the animacy cue in the production of Chinese clauses and phrases with a complex noun phrase. The production study can also help to avoid verb or noun preference bias that we have sought to avoid but might not have done so successfully for the comprehension study.

3.4.1 Participants

A group of Singaporean undergraduate participants took part in an off-line pen-and-paper production study on ambiguous Chinese relative clauses. The participants were either volunteers or were compensated for their time spent participating in the study, at a rate of SGD$7 per hour or SGD$3 per study.

All participants were instructed to fill in a language background survey before the experiment started. They were asked a series of questions about their language acquisition history and rated their own proficiency and language usage in both English and Chinese. Their ratings for the different questions were then compiled to derive an overall rating shown in the table below.

Table 3

Self-Reported Language Background of Singaporean Participants for Production Study One

Self Reported Language History	Mean	SD	Min	Max
Age	20.9	1.68	19	24
Age of First Exposure to English	1.2	1.89	0	5
First Age of Speaking English	1.75	2.29	0	7
Age of First Exposure to Chinese	1	1.69	0	5
First Age of Speaking Chinese	1.6	2.48	0	9
Self Reported Language Proficiency	Mean	SD	Min	Max
English Proficiency (1=very poor, 5= excellent)	4.53	0.40	3.78	5
Chinese Proficiency (1=very poor, 5= excellent)	3.41	0.75	1.67	4.89
Self Reported Frequency of Use	Mean	SD	Min	Max
Language used for mental arithmetic calculation (1=always English, 5= always Chinese)	1.55	0.83	1	4
Language used with family and friends (1=always English, 5-=always Chinese)	3.16	0.97	1.5	5
Language used in daily life (1=always English, 6= half-half, 11= always Chinese)	4.3	1.77	1	8.5

Notes. First age of speaking in each language refers to the age when the participant first started speaking in the language, regardless of age of exposure. Total number of participants is 20. Figures are rounded off to 2 decimal places.

The mean age of the Singaporean participants was 20.9 (SD=1.68) years and their mean age of first exposure to English and Chinese was 1.2 (SD=1.89) and 1 *(SD=1.69)* years respectively. They rated their English proficiency at a mean of 4.53 (SD=0.40) and their Chinese proficiency slightly lower at a mean of 3.41 (SD=0.75), out of a maximum possible of 5 (excellent). Using the scale of 1-5 (1 stood for always English and 5 stood for always Mandarin), participants were asked to rate their own frequency of language use for arithmetic and with family and friends, for which they reported a mean rating of 1.55 (SD=0.83) and 3.16 (SD=0.97) respectively. For overall language use in daily life (where 1 stood for always English, 6 stood for half-half and 11 stood for always Chinese), an average rating of 4.3 (SD=1.77) was reported. This suggests that while the Singaporean participants were largely simultaneous early English-Chinese bilinguals, they were English dominant in proficiency and language use.

3.4.2 Design and Materials

The experiment was a modifier production study, where participants were required to input their production responses in Chinese by modifying complex noun phrases. The complex noun phrases (NP1-de NP2) were presented without any verb or modifier but with the general noun marker *de* preceding each complex noun phrase. This results in a "double de construction" that is similar to the one found in the ambiguous relative clauses of the previous comprehension study. Each test item would consists of pair of nouns; one animate and one inanimate. A blank line was inserted before each item for participants to fill in a modifier. Participants were tasked with the instructions to complete the phrase by filling in the blank. Hence, they were faced with a choice to provide a modifier that shows a clear noun attachment preference or one that has no clear attachment preference. For the former case, participants would produce a modifier that avoids syntactic ambiguity. In the case of the latter, the participant's response would result in standing structural ambiguity.

The following shows an example of an ambiguous relative clause and the subsequently verb-removed test item for this production study.

Ambiguous Relative Clause

8(a)我喜欢的农夫的农场

Wo xihuan-de nongfu-de nongchang

I like -de farmer-de farm

The farm of the farmer that I like.

Complex Noun Phrase of verb-removed clause

Animate-Inanimate condition:

8(b)_____ 的农夫的农场

_____-de nongfu-de nongchang

_____-de farmer-de farm

'farm of the farmer' _____

Inanimate-Animate condition:

8(c)＿＿ 的农场的农夫

　 ＿＿ de nongchang de nongfu

　 ＿＿ de farm de farmer

'farmer of the farm that' ＿＿＿

Items used in the production study were modified from the comprehension study like in (8). Some noun pairs for the complex NP were replaced to suit the production study better. The experiment design includes two conditions based on the animacy of the two nouns. The first condition is the animate-inanimate condition where NP1 is animate and NP2 is inanimate (see (8b) for an example). The second condition is the inanimate-animate condition, where NP1 is inanimate and NP2 is animate like in (8c).What differs between the two conditions is the animacy order of the two nouns in the complex NPs.

There were a total of 24 test items, with two variations for each test item, manipulated according to the two conditions (animate-inanimate and inanimate-animate). There were another 26 filler items, each containing only one noun. 13 of the filler items presented an animate noun, while the remaining 13 filler items presented an inanimate noun. This was to ensure that there would be no potential ambiguity present, as there was only one noun in the filler. There were two lists of questionnaires, each containing 12 test items from each condition and 26 filler items. The test items of each list differed from that of the other set. The test items were pseudo-randomised and no two items of the same condition would be adjacent to each other. Filler items were slotted in between every test item. The first three items of each set were also filler items. No participant saw the same list and each list was given to 10 participants.

Participants were instructed to write whatever came to their mind first and were told that they would not be judged by the length of their response (modifier to the nouns). They were also specifically told before the study that they were allowed to give their response in hanyu pinyin (romanised pronunciation) if they were unable to recall how to write the Chinese characters. This was to ensure that their responses would not be affected by their ability to recall the characters, especially if they have not been writing Chinese characters for a period of years. This is often the case for Singaporean students who mostly do not require Chinese

writing for their tertiary education. The study was printed in Simplified Chinese, the standard Chinese script used in Singapore. The experiment was also an untimed task.

Two raters read every response to assign a rating to each. The responses were judged by the NP they modify (NP1 or NP2) and were each assigned an attachment type by the raters. There were a total of three attachment types: i) Low attachment, when the response was judged to be modifying NP1, ii) High attachment, when the response was judged to be modifying NP2 and lastly iii) Undecided attachment type. The Undecided rating was given in the case where the response was judged to be ambiguous as to which noun it was modifying.

The judgment ratings by both raters were carried out independently. The two sets of ratings were then compared and complied to derive a final rating. In the case of disagreement between the two sets of ratings, the raters carried out a discussion to determine a final rating. The final compiled rating was later used for the statistical analysis of the responses, which is reported in the next section.

3.4.3 Results

The final rating by the two raters was used for a distribution test to analyse the responses based on attachment type. An ANOVA was also used to test for significant effects of condition (animacy order) by subject analysis and item analysis.

3.4.3.1 Distribution Analysis
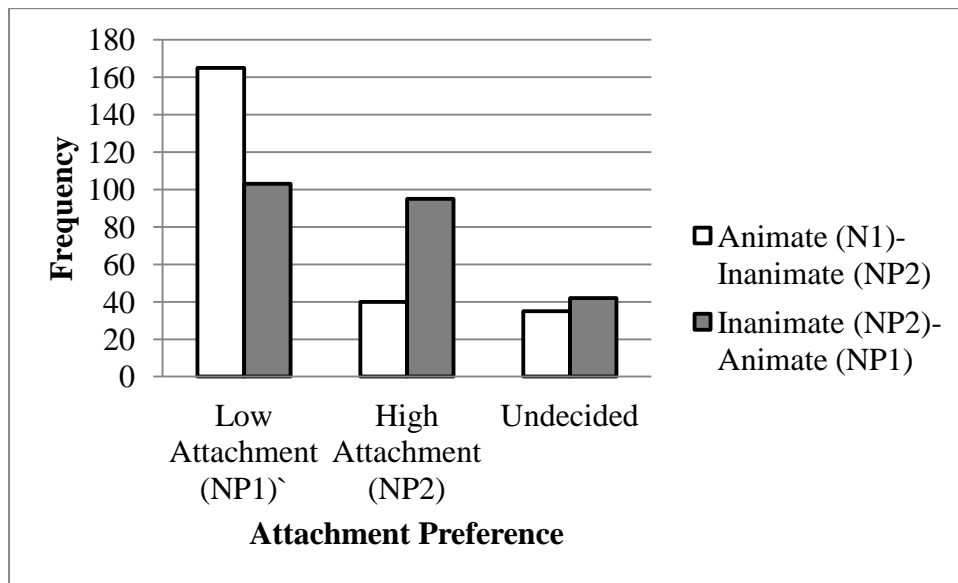
Figure 7. Frequency distribution of the Attachment Preference in responses given by Singaporean participants for Production Study One. The total number of responses for each condition is 240.

For the Singaporean group, the frequency distribution results showed that there was a larger preference for low attachment to NP1 (68.75%) in the Animate-Inanimate condition, where NP1 was the animate noun, rather than high attachment to inanimate NP2 (16.67%) (see Figure 7). In the second condition, where the animacy order was reversed, there was no clear attachment preference for either low attachment (42.92%) or high attachment (39.58%), for the Inanimate-Animate condition.

3.4.3.2 ANOVA Analysis

The ANOVA test showed a significant effect of condition on attachment by both subject analysis [$F1$ (1, 19) = 12.815, p<0.0003] and item analysis [$F2$ (1, 23) = 7.778, p<0.0104]. This means that both analyses show a significant effect of animacy order on attachment preference in the production study by the Singaporean participants.

3.4.4 Discussion

The results of the Production Study One suggest that Singaporean early bilinguals who were English dominant preferred to attach modifiers to the low attachment noun (NP1) when it was animate. When the low attachment noun (NP2) was the animate noun, the participants seem to display no clear preference in noun attachment. This suggests that there is only a clear attachment when both the cues are in agreement. When the cues are in conflict, neither the grammatical cue for low preference nor semantic cue for animacy emerged as a stronger cue, as evident from the lack of clear attachment preference in the Inanimate-Animate condition.

3.5 Production Study Two: PRC Chinese-English Bilinguals

3.5.1 Participants

A group of undergraduate and postgraduate participants from the People's Republic of China (PRC) studying in Singapore took part in an off-line pen-and-paper production study on ambiguous Chinese relative clauses. The participants were compensated for their time spent participating in the study, at a rate of SGD$7 per hour or SGD$3.50 per study. All participants were instructed to fill in a language background survey before the experiment started. They were asked a series of questions about their language acquisition history and rated their own proficiency and language usage in both English and Chinese. Their ratings for the different questions were then compiled to derive an overall rating shown in the table below.

Table 4
Self-Reported Language Background of PRC Participants for Production Study Two

Self Reported Language History	Mean	SD	Min	Max
Age	22.7	2.39	19	27
Age of Arrival to Singapore	21.2	3.32	17	27
Age of First Exposure to English	11.25	4.97	0	22
First Age of Speaking English	17.88	4.66	11	26
Age of First Exposure to Chinese	0.45	1.28	0	5
Self Reported Language Proficiency	Mean	SD	Min	Max
English Proficiency (1=very poor, 5= excellent)	3.46	0.49	2.44	4.33
Chinese Proficiency (1=very poor, 5= excellent)	4.86	0.18	4.44	5
Self Reported Frequency of Use	Mean	SD	Min	Max
Language used for mental arithmetic calculation (1=always English, 5= always Chinese)	4.3	0.66	3	5
Language used with family and friends (1=always English, 5-=always Chinese)	4.68	0.35	3.8	5
Language used in daily life (1=always English, 6= half-half, 11= always Chinese)	8.55	1.96	6	11

Notes. First age of speaking English refers to the age when the participant first started speaking in English, regardless of age of exposure. For this study, all participants reported their age of exposure to Chinese as the same as their first age of speaking in Mandarin Chinese. The total number of participants is 20. Figures are rounded off to 2 decimal places.

The mean age of the PRC participants was 22.7 (*SD*=2.39) years and their mean age of first exposure to English and Chinese was 11.25 (*SD*=4.97) and 0.45 *(SD*=1.28) years respectively. They rated their English proficiency at a mean of 3.46 (*SD*=0.49) and their Chinese proficiency slightly lower at a mean of 4.86 (*SD*=0.18), out of a maximum possible of 5 (excellent). Using the scale of 1-5 (1 stood for always English and 5 stood for always Mandarin), participants were asked to rate their own frequency of language use for arithmetic and with family and friends, for which they reported a mean rating of 4.3 (*SD*=0.66) and 4.68 (*SD*=0.35) respectively. For overall language use in daily life (where 1 stood for always English, 6 stood for half-half and 11 stood for always Chinese), an average rating of 8.55 (*SD*=1.96) was reported. This suggests that the PRC participants were relatively late Chinese-English bilinguals as compared to their Singaporean counterparts in Production Study One. They were Chinese dominant in both proficiency and language use.

3.5.2 Materials and Design

The same materials and experiment design from Production Study One were used in this study on PRC participants.

3.5.3 Results

The two raters rated the responses by the PRC participants using the same protocol from Production Study One. The final compiled rating of the responses was used for a distribution test to analyse the responses based on attachment type. An ANOVA analysis was also used to test for significant effects of condition (*animacy order)* by subject analysis and item analysis.

3.5.3.1 Distribution Analysis
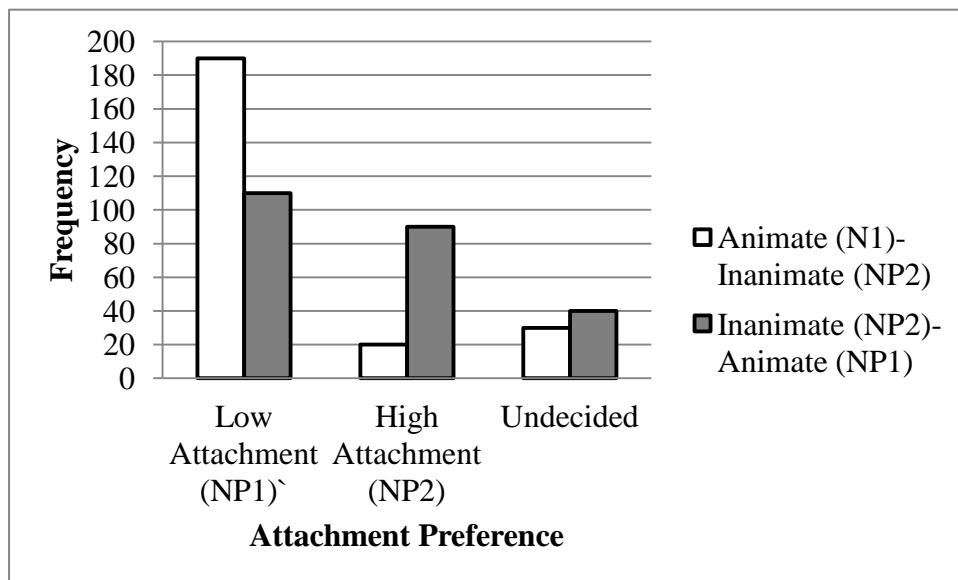
Figure 8. Frequency distribution of the Attachment Preference in responses given by PRC participants for the Production Study Two. The total number of responses for each condition is 240.

For the PRC group, there was a large preference preference for low attachment to NP1 (79.17%) in the Animate-Inanimate condition, where the low attachment noun was also the animate noun (see Figure 8). When, the *animacy order* was reversed in the condition Inanimate-Animate condition, there was no clear attachment preference for either low attachment (45.83%) or high attachment (37.5%).

3.5.3.2 ANOVA analysis

The ANOVA test showed a significant effect of condition on attachment by both subject analysis [$F1$ (1, 19) = 19.286, p<0.002] and item analysis [$F2$ (1, 23) = 15.891, p<0.0006]. Both analyses by subject and item also show a significant effect of *animacy order* on attachment preference in the production study by the PRC group.

3.5.4 Discussion

The results of the Production Study Two suggest that the Chinese dominant sequential bilinguals had preferred to attach modifiers to the low attachment noun (NP1) when it was animate. When the low attachment noun (NP1) was the animate noun, the participants seem to display a very clear preference for which noun to attach to, with very large preference for the animate low attachment noun. When the cues are in conflict, neither the grammatical cue for low preference nor semantic cue for animacy emerged as a stronger cue, as seen from the lack of preference for either noun in the complex NP.

3.6 Overall Discussion for Production Studies One and Two

The results from the Production Study by both the Singaporean bilinguals and PRC bilinguals are largely similar. Both had showed a significant effect of animacy order on attachment preference by ANOVA. Generally, it also seems that animacy cue is only used in production when the animate noun is also the low attachment noun. When the noun immediately following the modifier (low attachment noun) was inanimate, no clear effect of animacy or low attachment preference was found. The low frequency for the undecided attachment type also shows that participants had largely tried to avoid ambiguity when modifying complex NPs. The main strategy used for avoiding any potential ambiguity was also to rely on both the semantic cue and the grammatical cue at the same time. This can be seen by contrasting the results for the two conditions, as clear attachment was only found for the animate low attachment noun. This could be attributed to the fact that it was not possible for both cues to agree in the Inanimate-Animate condition as the low attachment noun was inanimate. This similar results found in both production studies showed that the English dominant Singaporean bilinguals did not exhibit a difference in attachment preference in production when compared to the Chinese dominant PRC bilinguals. This shows evidence that the ambiguity resolution strategies for modifier production involving complex NPs are largely similar for the two groups of bilinguals.

4 General Discussion

With the analysis of the comprehension studies and production studies, we can look at how the overall results had addressed our research questions. Firstly, we had observed the use of the semantic cue of animacy in disambiguating Chinese relative clauses, which had not been explored by previous studies. The comprehension study test results showed that participants preferred to attach the animate noun to Subject-gap relative clauses. On the other hand, influence from the grammatical cue was also found, especially for Object-gap relative clauses, where participants had preferred to attach the lower noun (NP1) to the relative clause regardless of noun animacy. Secondly, an interaction between the two cues was also found in Subject-gap relative clause disambiguation, as the greatest preference was found for the animate low attachment noun when the two cues were in agreement. However, this clear preference was not found for Object-gap relative clause disambiguation, as there was no large preference found for the inanimate low attachment noun. In fact, while we have predicted a preference for inanimate noun interpretation as the filler to the gap in Object-gap relative clauses, the Singaporean bilinguals have a slightly higher response in assigning animate low attachment nouns to the clause rather than preferring inanimate low attachment nouns. This suggests that saliency for inanimate objects may be weaker than for animate subjects. Thirdly, our results are also evident of a processing difference in ambiguous Subject-gap and Object-gap ambiguous Chinese relative clauses. While this study does not explore the ease of processing Subject-gap and Object-gap relative clauses, it has shown that different strategies are used to assign the filler to the gap in the two types of relative clauses. When the cues are in conflict, we are also able to determine which of the two cues are stronger in the processing of each type of ambiguous relative clause. The semantic animacy cue is the stronger cue for Subject-gap relative clauses, while the grammatical cue for low attachment preference is the stronger cue for Object-gap relative clauses. It should be noted that the former cue is a much stronger cue than latter in the comprehension studies. When the animacy cue is preferred, the preference is larger than when the low attachment cue is preferred. If the conclusions from Hsiao and Gibson (2003) stating that Chinese Object-gap relative clauses are easier to process than Subject-gap relative clauses are held true, then this may be one possible explanation for the difference in preference of cues that we have found. Users may have relied on animacy cue more when there is a greater difficulty in the processing of Subject-gap relative clauses.

A set of strategies that differs from the one used in the comprehension studies were found in the production study. Noun attachment preference was only clear when the two cues were in agreement. When in conflict, there was no clear attachment preference for either noun. Both groups of participants showed the same attachment preference trends regardless of language dominance. It should also be noted that when the cues were in agreement, attachment preference for the animate low attachment noun was large and distinct. This suggests that in production, the participants tend to make an attachment choice that avoids structural ambiguity, by choosing to modifier the noun that is preferred by both cues. Hence, the difference between the strength of the two cues can only be teased apart in a comprehension study where the conditions of the complex NPs in ambiguous relative clauses are manipulated according to the conditions.

In comparing the attachment preference of early English-Chinese bilinguals and native Chinese speakers who were relatively later L2 English learners, the participants had exhibited largely the same trends in utilizing the two cues. This shows that early bilinguals are able to utilize language-specific cues in generally the same way as other native L1 speakers. Therefore, from both our comprehension and productions studies, we can conclude that the bilinguals resolve structural ambiguity using both the animacy and grammatical cues in Chinese, in way similar to that of other early L1 Chinese speakers.

5 Conclusion

Looking back at our hypothesis, we found that the animacy cue, which has not been previously looked at, is a valid cue for structural ambiguity resolution in Chinese relative clauses. This preference for the animacy cue is the most distinct for Subject-gap relative clauses. For object-gap relative clauses, the grammatical low attachment cue is the more valid cue. We also found interaction between the two cues. When the two cues, the animacy cue and grammatical cue, had disagreed with each other, the reader is forced to rely more on one of the cues to determine the filler noun in the ambiguous relative clause. Overall, we also found difference in the processing of Subject-gap and Object-gap relative clauses, as the cues have different cue strengths depending on the type of relative clause. For the production study where participants had control in the input of modifier, we find that they have largely avoided ambiguity by showing a greater preference to attach the modifier to the noun that were supported by both cues in agreement. When the cues were in conflict, there was clear no noun attachment preference.

The strategies in ambiguity resolution were also found to be largely the same for both early English-Chinese bilinguals and their L1 native counterparts who have acquired English at a relatively later age. Further studies can seek to explore the structural ambiguity resolution of the early Singaporean bilinguals in English, to see if there is a language dependent or language independent set of strategies in disambiguating ambiguous English relative clauses. Other types of Chinese relative clauses apart from Subject-extracted and Object-extracted relative clauses can also be looked at, to see if the animacy and grammatical cues are used by speakers to disambiguate ambiguity in other types of clauses as well. As this current off-line study had showed that the animacy cue influences the final ultimate interpretations of structural ambiguity resolution, on-line studies in the future can also investigate if the semantic cue affects the initial processing of such ambiguous relative clauses in Chinese as well.

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Appendix A: Test items for Comprehension Study

a) Subject-gap Animate(NP1)- Inanimate(NP2) condition [___ V O]de Sanimate de NPinanimate

b) Subject-gap Inanimate(NP1)- Animate(NP2) condition [___ VO]de Sinanimate de NPanimate

c) Object-gap Animate(NP1)- Inanimate(NP2) condition [SV__]de Oanimate de NPinanimate

d) Object-gap Inanimate(NP1)- Animate(NP2) condition [SV__] de Oinanimate de Npanimate

1a) [负责演员]的老板的经纪公司

the agency of the boss that manages the actor

1b) [负责演员]的经纪公司的老板

the boss of the agency that manages the actor

1c) [老板负责]的演员的经纪公司

the agency of the actor that the boss manages

1d) [老板负责]的经纪公司的演员

the actor of the agency that the boss manages

2a) [泄漏机密]的记者的报社

the newspaper agency of the reporter that leaked the secret out

2b) [泄漏机密]的报社的记者

the reporter of the newspaper agency that leaked the secret out

2c) [我喜爱]的农夫的农场

the farm of the farmer that I like.

2d) [我喜爱]的农场的农夫

the farmer of the farm that I like.

3a) [探讨课题]的作者的专栏

 the column of the author that discussed issues

3b) [探讨课题]的专栏的作者

 the author of the column that discusses issues

3c) [专栏探讨]的作者的课题

the issues of the author discussed by the column

3d) [专栏探讨]的课题的作者

the author of the issues discussed by the column,

4a)[欺负小公司]的大企业的老板

the boss of the big enterprise that bullied small companies

4b)[欺负小公司]的老板的大企业

the big enterprise of the boss that bullied small companies

4c)[大企业欺负]的老板的小公司

the small company of the boss that is bullied by the big enterprise

4d)[大企业欺负]的小公司的老板

the boss of the small company that is bullied by the big enterprise

5a)[获得资助]的小孩的家庭

the family of the child that received financial support

5b) [获得资助]的家庭的小孩。

the child of the family that received financial support

5c)[嫌犯出卖]的小偷的组织

the organisation of the thief that is betrayed by the suspect

5d) [嫌犯出卖]的组织的小偷

the thief of the organization that is betrayed by the suspect

6a) [闯了大祸]的鼓手的乐队

the band of the drummer that got into big trouble

6b) [闯了大祸]的乐队的鼓手

the drummer of the band that got into big trouble

6c) [女孩喜欢]的贵族的王宫

the palace of the royalty that the girl likes

6d) [女孩喜欢]的王宫的贵族

the royalty of the palace that the girl likes

7a) [撞倒骑士]的男子的脚踏车

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the bicycle of the man that knocked down the rider

7b)[撞倒骑士]的脚踏车的男子周围

the man of the bicycle that knocked down the rider

7c) [男子撞倒]的骑士的脚踏车

the bicycle of the rider that was knocked down by the man

7d) [男子撞倒]的脚踏车的骑士

the rider of the bicycle that was knocked down by the man

8a) [贿赂高层]的律师的事务所

the office of the lawyers that bribed the high level personnel.

8b) [贿赂高层]的事务所的律师

the lawyers of the office that bribed the high level personnel.

8c) [律师贿赂]的高层的事务所

the office of the high level personnel that the lawyers bribed.

8d) 律师贿赂]的事务所的高层

the high level personnel of the office that was bribed by the lawyers.

9a) [失去客户]的经理的公关部门

the PR department of the manager that lost the customer

9b) [失去客户]的公关部门的经理

the manager of the PR department that lost the customer

9c) [经理看管]的员工的工厂

the factory of the workers overseen by the manager

9d) [经理看管]的工厂的员工

the workers of the factory overseen by the manager

10a)[邀请歌手]的主持人的节目

the program of the host that invited the singer

10b) [邀请歌手] 的节目的主持人

the host of the program that invited the singer

10c) [议员拜访]的村民的乡村

the village of the villagers that was/were visited by the minister.

10d)[议员拜访]的乡村的村民

the villagers of the village that was/were visited by the minister.

11a) [陷害卧底]的特务的秘密组织

the secret organisation of the special agent that framed the spy

11b) [陷害卧底]的秘密组织的特务

the special agent of the secret organisation that framed the spy

11c) [大家害怕]的老大的黑帮

the mafia of the Boss that everyone is afraid of

11d) [大家害怕]的黑帮的老大

the Boss of the mafia that everyone is afraid of

12a)[联络家属]的护士长的急诊部

the emergency department of the head nurse that contacted the family.

12b) [联络家属]的急诊部的护士长

the head nurse of the emergency department that contacted the family.

12c)[家属联络]的护士长的急诊部

the emergency department of the head nurse that was contacted by the family.

12d) [家属联络]的急诊部的护士长

the head nurse of the emergency department that was contacted by the family.

13a)[吹捧行政主管]的主任的部门

the department of the supervisor that curried the favor of the administration head

13b) [吹捧行政主管]的部门的主任

the supervisor of the department that curried the favor of the administration head

13c) [主任吹捧]的行政主管的部门

the department of the administration head that the supervisor curried favor for

13d) [主任吹捧]的部门的行政主管

the administration head of the department that the supervisor curried favor for

14a) [轰炸目标]的军队的战斗机师

the fighter jet pilot of the army that bombed the target

14b) [轰炸目标]的战斗机师的军队

the army of the fighter jet pilot that bombed the target

14c) [战斗机师寻觅]的军队的基地

the military base of the army that was sought out by the fighter jet pilot

14d) [战斗机师寻觅]的基地的军队

the army of the military base that was sought out by the fighter jet pilot

15a) [召开记者会]的老师的学校

 the school of the teacher that held the press conference

15b) [召开记者会]的学校的老师

 the teacher of the school that held the press conference

15c) [记者访问]的老师的学校

the school of the teacher that was interviewed by the reporter

15d) [记者访问]的学校的老师

the teacher of the school that was interviewed by the reporter

16a)[侵占土地]的经理人的房地产公司

the real estate company of the agent that usurped the land

16b) [侵占土地]的房地产公司的经理人

agent of the real estate company that usurped the land

16c) [大家讨厌]的经理人的房地产公司

the real estate company of the agent that everyone hates

16d) [大家讨厌]的房地产公司的经理人

the agent of the real estate company that everyone hates

17a)[帮助孤儿]的牧师的教会

the church of pastor that helped the orphans

17b) [帮助孤儿]的教会的牧师

the pastor of the church that helped the orphans

17c) [善心人士帮助]的宣教士的机构

the organization of the missionaries that the kind hearted helped

17d) [善心人士帮助]的机构的宣教士

the missionaries of the organization that the kind hearted helped

18a)[举办庆功会]的教练的篮球队

the basketball team of the coach that is hosting a celebration party

18b) [举办庆功会]的篮球队的教练

the coach of the basketball team that is hosting a celebration party

18c) [全校赞赏]的教练的篮球队

the basketball team of the coach that the whole school lauded

18d) [全校赞赏]的篮球队的教练后头

the coach of the basketball team that the whole school lauded

19a)[推行改革]的主席的委员会

 the committee of chairperson that pushed for change

19b) [推行改革]的委员会的主席

the chairperson of the committee that pushed for change

19c) [客户不喜欢]的发明家的产品

the product of the inventor that was disliked by customers

19d) [客户不喜欢]的发明家的产品

the inventor of the product that was disliked by customers

20a)[捧红名模]的摄影师的杂志

 the magazine of the photographer that brought the model to fame

20b) [捧红名模]的杂志的摄影师

the photographer of the magazine that brought the model to fame

20c) [女星选择]的摄影师的杂志

the magazine of the photographer that the female star chose

20d) [女星选择]的杂志的摄影师

the photographer of the magazine that the female star chose

21a) [荣获大奖]的演员的歌舞剧

the musical of the actor that received the grand award

21b) [荣获大奖]的歌舞剧的演员

the actor of the musical that received the grand award

21c) [观众投选]的演员的歌舞剧

the musical of the actor that was voted by viewers

21d) [观众投选]的歌舞剧的演员

the actor of the musical that was voted by viewers

22a)[支持博客]的粉丝们的网站

the website of the fans that supported the blogger

22b) [支持博客]的网站的粉丝们

with the fans of the website that supported the blogger

22c) [粉丝们支持]的博客的网站

the website of the blogger that the fans supported

22d) [粉丝们支持]的网站的博客

the blogger of the website that the fans supported

23a)[触犯国际条规]的总理的国家

a country of a president that violates international law

23b) [触犯国际条规]的国家的总理

a president of a country that violates international law

23c) [多国警惕]的暴君的核子武器国家

a nuclear weapon country of a tyrant ruler that many countries are wary of

23d) [多国警惕]的核子武器国家的暴君

a tyrant ruler of a nuclear weapon country that many countries are wary of

24a) [获奖]的主唱的乐团

the band of the vocalist that won the award

24b) [获奖]的乐团的主唱

the vocalist of the band that won the award

24c) [女班长欣赏]的主唱的乐团

the band of the vocalist that the monitress admires

24d) [女班长欣赏]的乐团的主唱

the vocalist of the band that the monitress admires

Appendix B: Noun Pairs Used for the Complex Noun Phrases in Production Study

English	Animate Chinese NP	English	Inanimate Chinese NP
actor	演员	musical	歌舞剧
owner	车主	car	车子
children	孩子	family	家庭
boss	老大	mafia	黑社会
coach	教练	basketball team	篮球队
villagers	村民	village	乡村
lecturer	教授	university	大学
players	玩家	game	游戏
volunteers	志愿义务者	organization	机构
farmer	农夫	farm	农场
prime minister	总理	country	国家
workers	员工	factory	工厂
singer	歌手	album	专辑
cyclist	骑士	bicycle	脚踏车
drummer	鼓手	band	乐团
host	主持人	program	节目
photographer	摄影师	magazine	杂志
author	作者	column	专栏
fans	粉丝	website	网站
commander	长官	military base	军事基地
female star	女星	artiste agency	经纪公司
participants	参赛者	marathon	马拉松
lawyer	律师	office	事务所
writer	作家	pen	笔

Appendix C: Language Questionnaire for Comprehension Study

<u>Language Questionnaire</u>   Participant Code: _____

Please fill in the following information.

Name: _____   Gender: _____   Place/Year of Birth:_____

Have you ever lived abroad? If so where and for how long? _____

1]   You have been invited for this study as an **English-Chinese** bilingual speaker.

 Now, please state the **period of your life** that you have been speaking each language:

Example: Language 1) <u>English</u>

 (If English is your second language acquired at age 3 and you have been speaking it till present, draw a line like the one below.)
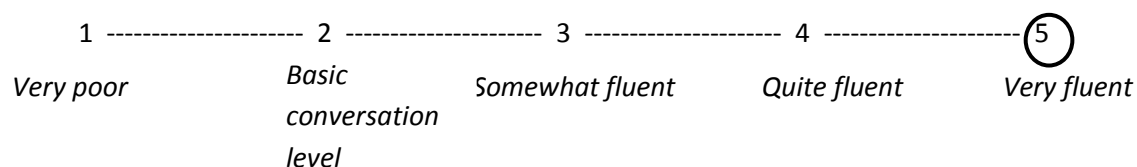
|——→
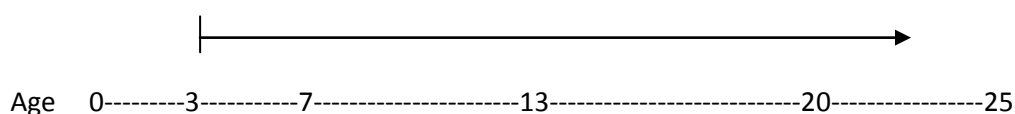
Age   0---------3-----------7----------------------13---------------------------20----------------25

Language 1) English

  Age   0---------3-----------7----------------------13---------------------------20----------------25

Language 2) Chinese

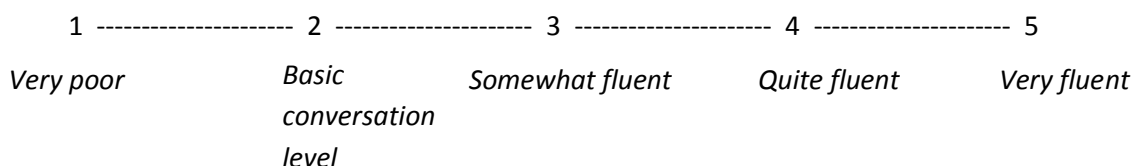 Age   0---------3-----------7----------------------13---------------------------20----------------25

2]   Now, please rate how well you **speak** each language.

Example: Language 2) <u>Mandarin Chinese</u>   (If you speak Mandarin Chinese very fluently, please circle 5.)

   1 --------------------- 2 -------------------- 3 -------------------- 4 --------------------(5)

Very poor   *Basic*   *Somewhat fluent*   *Quite fluent*   *Very fluent*
                          conversation
                          level

Language 1) English

   1 --------------------- 2 -------------------- 3 -------------------- 4 -------------------- 5

Very poor   *Basic*   *Somewhat fluent*   *Quite fluent*   *Very fluent*
                          conversation
                          level

Language 2) Mandarin Chinese

   1 --------------------- 2 -------------------- 3 -------------------- 4 -------------------- 5

Very poor   *Basic*   *Somewhat fluent*   *Quite fluent*   *Very fluent*
                          conversation
                          level

52

Language 1) English
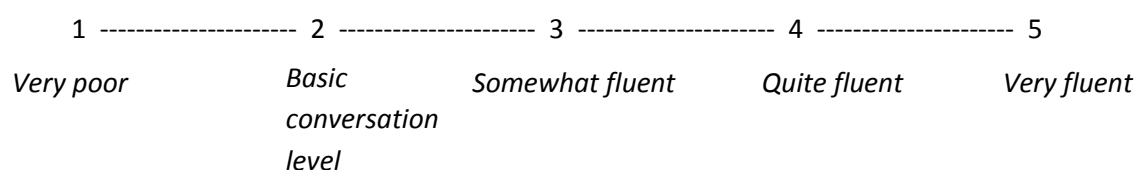
1 -------------------- 2 -------------------- 3 -------------------- 4 -------------------- 5

Very poor   *Basic reading*   *Moderately well*   *Quite well*   *Excellent*
                     skills

Language 2) Mandarin Chinese

1 -------------------- 2 -------------------- 3 -------------------- 4 -------------------- 5

Very poor   *Basic reading*   *Moderately well*   *Quite well*   *Excellent*
                     skills

4]   Now, please rate how **frequent** you use each language **at home**.

Language 1) English

1 -------------------- 2 -------------------- 3 -------------------- 4 -------------------- 5

Never   *Rarely*   *Somewhat frequently*   *Quite frequently*   *Always*

Language 2) Mandarin Chinese

1 -------------------- 2 -------------------- 3 -------------------- 4 -------------------- 5

Never   *Rarely*   *Somewhat frequently*   *Quite frequently*   *Always*

5]   Now, please rate how **frequent** you use each language **to read** (eg. Newspapers, magazines, novels etc).

Language 1) English

1 -------------------- 2 -------------------- 3 -------------------- 4 -------------------- 5

Never   *Rarely*   *Somewhat frequently*   *Quite frequently*   *Always*

Language 2) Mandarin Chinese

1 -------------------- 2 -------------------- 3 -------------------- 4 -------------------- 5

Never   *Rarely*   *Somewhat frequently*   *Quite frequently*   *Always*

6] Do you speak any other languages? (Eg. Hokkien, Cantonese, Japanese, Malay etc.)

Please list them here:

_____

Thank you!

Appendix D: Language Questionnaire for Production Study

Participants' Language Background Questionnaire

Name_____   Age _____

Year of Birth _____   Date _____

I. Language History.

1. Were you born in Singapore? Y/N

If not, please specify the age at which you arrived.

_____

2. Where did you grow up?

Country: _____

3. What is your mother's first language and/or dialect?

_____

4. What is your father's first language and/or dialect?

_____
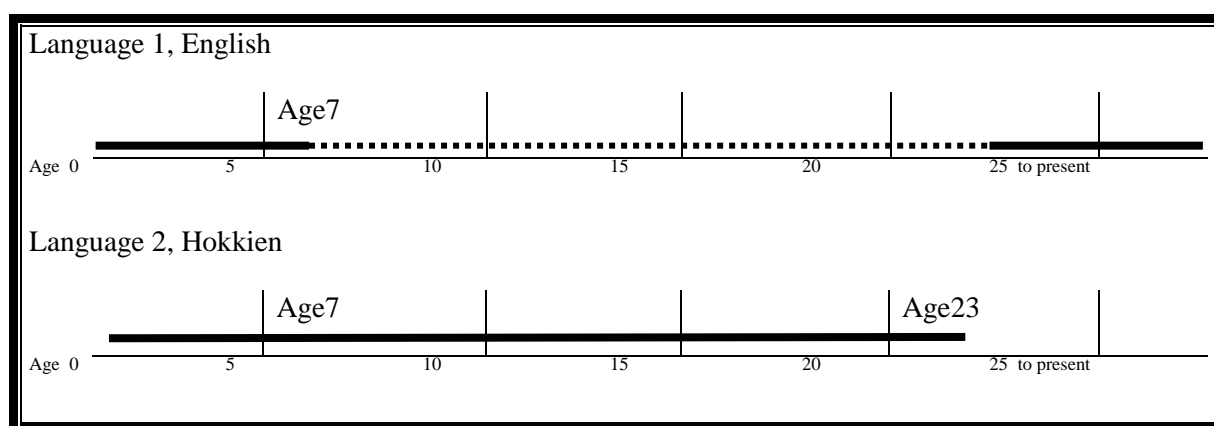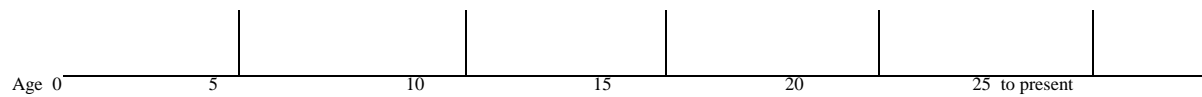
5. Please list **all** of the languages in which you are competent, either in speaking or in comprehension:

    1) from **the most proficient** to the least proficient, and
    2) indicate the age at which you were first exposed to each and the age at which exposure ended.
    3) Use a solid line ▬ if you both spoke and were spoken to in the language. Use a dotted line ▪▪▪▪ if you were mainly just spoken to in the language (and you answered in another langauge).
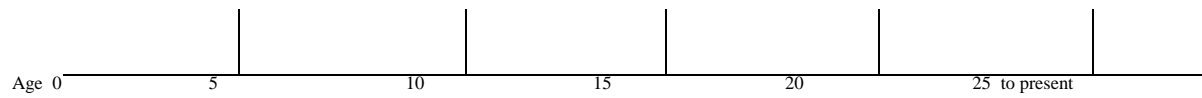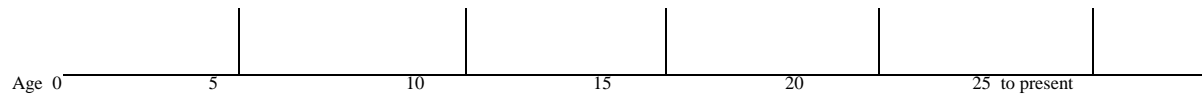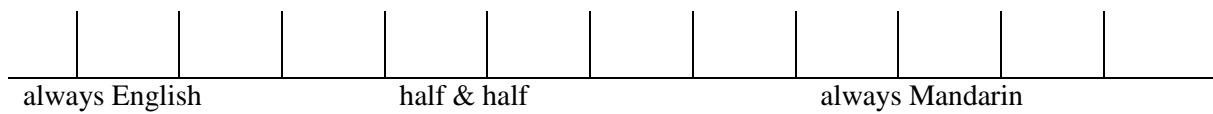 An example is given below.

Example

Language 1:

Age 0 ⎸——⎸————⎸————⎸————⎸————⎸———— to present
           5   10   15   20   25

Language 2:

Age 0 ⎸——⎸————⎸————⎸————⎸————⎸———— to present
           5   10   15   20   25

Language 3:

Age 0 ⎸——⎸————⎸————⎸————⎸————⎸———— to present
           5   10   15   20   25

6. How often do you use each language in your every day life?

always English   half & half   always Mandarin

7. Estimate which language you usually use when having conversation with the following people.

a. Father	Always English	Mostly English	Equal	Mostly Mandarin	Always Mandarin	NA
b. Mother	Always English	Mostly English	Equal	Mostly Mandarin	Always Mandarin	NA
c. Siblings	Always English	Mostly English	Equal	Mostly Mandarin	Always Mandarin	NA
d. Friends	Always English	Mostly English	Equal	Mostly Mandarin	Always Mandarin	NA
e. Grandparents	Always English	Mostly English	Equal	Mostly Mandarin	Always Mandarin	NA

8. Which language do you use for mental calculation/arithmetic?

Always English	Mostly English	Equal	Mostly Mandarin	Always in Mandarin

55

II. Self-assessed Proficiency

9. I can talk about my work or school without difficulty in

a) **English**

Strongly Disagree	Disagree	Somewhat Agree	Agree	Strongly Agree

b) **Mandarin Chinese**

Strongly Disagree	Disagree	Somewhat Agree	Agree	Strongly Agree

10. I can talk about my daily life or personal preferences without difficulty in

a) **English**

Strongly Disagree	Disagree	Somewhat Agree	Agree	Strongly Agree

b) **Mandarin Chinese**

Strongly Disagree	Disagree	Somewhat Agree	Agree	Strongly Agree

11. I can talk about abstract topics in

a) **English**

Strongly Disagree	Disagree	Somewhat Agree	Agree	Strongly Agree

b) **Mandarin Chinese**

Strongly Disagree	Disagree	Somewhat Agree	Agree	Strongly Agree

12. My pronunciation (accent) is native-like for

a) **English**

Strongly Disagree	Disagree	Somewhat Agree	Agree	Strongly Agree

b) **Mandarin Chinese**

Strongly Disagree	Disagree	Somewhat Agree	Agree	Strongly Agree

13. I can read a newspaper and understand most of it when it is

a) an **English** newspaper

Strongly Disagree	Disagree	Somewhat Agree	Agree	Strongly Agree

b) a **Chinese** newspaper

Strongly Disagree	Disagree	Somewhat Agree	Agree	Strongly Agree

14. I can read and understand most of a simple short article or letter/email in

a) **English**

Strongly Disagree	Disagree	Somewhat Agree	Agree	Strongly Agree

b) **Chinese**

Strongly Disagree	Disagree	Somewhat Agree	Agree	Strongly Agree

15. I can write academic research papers without difficulty in

a) **English**

Strongly Disagree	Disagree	Somewhat Agree	Agree	Strongly Agree

b) **Mandarin Chinese**

Strongly Disagree	Disagree	Somewhat Agree	Agree	Strongly Agree

16. I can write social and informal business correspondence with conventional openings and closings without difficulty in

a) **English**

Strongly Disagree	Disagree	Somewhat Agree	Agree	Strongly Agree

b) **Mandarin Chinese**

Strongly Disagree	Disagree	Somewhat Agree	Agree	Strongly Agree

17. I can write uncomplicated letters, and essays related to work and school experiences in

a) **English**

Strongly Disagree	Disagree	Somewhat Agree	Agree	Strongly Agree

b) **Chinese**

Strongly Disagree	Disagree	Somewhat Agree	Agree	Strongly Agree

I hereby declare that all the information provided above is accurate to the best of my knowledge.

Signature_____

I understand that this questionnaire may be used anonymously and in confidence at some point in the future to compile group (but not individual) profile statistics for research purposes. I herey consent to such use of the above information and release it for these purposes only.

Signature_____   Date _____