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The Effects of Music-Induced Emotions on English-Chinese Bilinguals’ Resolution of Standing Ambiguity

Name: Ho Sher Min
Supervisor: Assistant Professor Chan Hiu Dan Alice

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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<tr>
<td>NP</td>
<td>Noun Phrase</td>
<td>2-8, 10-13, 15-16, 18-19, 21-25</td>
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<td>Second Noun Phrase</td>
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<tr>
<td>SVO</td>
<td>Subject-Verb-Object</td>
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<tr>
<td>SOV</td>
<td>Subject-Object-Verb</td>
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<td>VP</td>
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<td>ERP</td>
<td>Event-Related Potentials</td>
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<td>ANOVA</td>
<td>Analysis of Variance</td>
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Abstract

Cross-linguistic studies have shown that speakers of different languages have differing strategies in resolving sentences with standing ambiguity (Felser, 2003; Shen, 2006) with most languages preferring NP2 or NP-low attachment (e.g. English, Danish) while some others prefer NP1 or NP-high attachment (e.g. Greek, German). The strategy taken by Chinese speakers remain controversial with some studies showing it to be a NP-low preferring strategy (Shen, 2006) while some others show otherwise (Cai, 2010). The strategies adopted by bilingual speakers have yet to be thoroughly explored. External factors like lexical factors (Felser, 2003) and animacy (Desmet et. al, 2006) are also found to be of influence on speakers’ strategies in resolving these sentences.

This study investigates the strategies of English-Chinese bilinguals in their resolution of sentences with standing ambiguity and also the effects of emotional cues on these strategies. 75 English sentences were used in the study with 50 manipulated (BIASED) sentences and 25 neutral (UNBIASED) sentences. The biased sentences are manipulated in a way that adjectives are added to both NP1 and NP2 where the context of attaching the relative clause to NP1 would give rise to a sadder context than when attached to NP2. Since music is proven to have an effect on its listeners’ emotions, whether directly or indirectly (Trainor, 2003; Levinson, 1997), sad music is used to induce sad emotional cues for the context of reading the sentences.

27 English-Chinese bilinguals in Singapore participated in two experiments, 9 in Experiment 1 and the other 18 in Experiment 2. Participants in Experiment 1 rated 75 sentences on a scale of 1 to 7 on how they feel the relative clause should be attached (1: most NP1; 7: most NP2). To eliminate possibility of inherent ‘bias-ness’ in the sentences, the ratings were used for counterbalancing Experiment 2. In Experiment 2, 18 participants were asked to read the sentences with either no music, neutral music or sad music in the background. A question is asked after each sentence regarding the relative clause and responses are recorded through the pressing of number keys on a keyboard.

Results showed that under sad music, participants perform significantly different from the other conditions. Musicians (≥3 years of musical training) are shown to perform significantly different
than those with 0 or <3 years of musical training. Musicians perform significantly different under the neutral music condition than in the sad music condition, responding with significantly more NP2 attachment for UNBIASED sentences in the sad music condition and significantly more NP1 attachment for BIASED sentences in the same condition.

This study shows that emotional adjectives attached to the NPs have an effect on the way bilinguals resolve standing ambiguity and that musicians are more greatly affected by emotions induced by music and lexical items, thus responding significantly different from their counterparts. This study also shows that sad music does create a sad context for the sentence and hence causes the readers to interpret the sentences in a sad context.
The Effects of Music-Induced Emotions on English-Chinese Bilinguals’ Resolution of Standing Ambiguity

Chapter 1. Literature Review

1.1 Introduction

It has been a longstanding question in the area of psycholinguistics regarding how humans process language mentally and if there is a universal to the way we process and parse sentences. One of the best sources of evidence of parsing strategies is through the analysis of how speakers handle syntactic or structural ambiguity. Structural ambiguity or standing ambiguity refers to cases where the grammatical structure of a particular sentence can give rise to two or more equally plausible and acceptable interpretations grammatically. Take for example the sentence:

1. Someone shot the servant of the actress who was on the balcony.

It can be interpreted as the servant (of the actress) was the one on the balcony and was shot, or that the actress was on the balcony and her servant was shot. Some can even interpret it as both the servant and the actress were on the balcony, but few follow this interpretation. Both of the former interpretations are equally possible and sensible. Although the words in the sentence are exactly the same, it can lead to different methods of resolving it, and thus the result is only dependent on the speakers’ method of resolution.

Parsing strategies are argued to be a reflection of the analytical processes ‘by which the mind structures incoming words into a hierarchical representation according to the grammar of the language (Boland & Blodgett, 2001). Many studies in the area have actively sought to explore this and attempted to draw links and universals to how speakers resolve this ambiguity.
1.2 Cross-linguistic differences in resolving Standing Ambiguous Sentences

Studies have shown that there are cross-linguistic differences in the way language speakers resolve standing ambiguity. Furthermore, there is strong evidence that these differences are not universal, but instead are language-specific and thus suggests that it may need to be learnt through experience. Considering the sentence below again:

Someone shot the servant of the actress who was on the balcony.

Previous studies have shown that native English speakers prefer to refer the second noun phrase (NP2) to the relative clause ‘who was on the balcony’, which in the case of sentence 1 would be the ‘actress’ (Felser, 2003). Other languages that share this similar NP2-attachment or low attachment preference include Danish, Norwegian and Arabic (Shen, 2006). However, there are languages that have a NP1-attachment or high attachment tendency and this includes Greek and German (Felser, 2003).

![Parse Tree of 'Someone shot the servant of the actress on the balcony']

Researchers have commonly used the Late Closure Strategy or Recency Preference to explain NP2-attachment preference. Since NP2 appears nearer to the relative clause in the sentence, it is a more recent item in the speakers’ mind compared to NP1, which explains speakers’ preference to attach it with the relative clause. With memory decay over time, it seems to take less effort and cost to prefer NP-low attachment since according to Figure 1, the Complement Phrase (CP) or relative clause in this case, is nearer to NP-low. On the other hand, the idea of Predicate Proximity has been used to account for NP1-attachment preference. Predicate Proximity tells the speaker to
'attach as structurally close as possible to the head of a predicate phrase' (Felser, 2003). Although the Recency Preference is widely taken as a universal tendency in language speakers, some argue that the Predicate Proximity effect could possibly overrule this tendency and thus result in a NP1 or NP-high attachment preference. Others argue that both tendencies are universal, and speakers’ preference would be the result of the comparison of the strength of the competing tendencies.

Gibson et al. (1996) explains that the Recency preference and Predicate Proximity effect interact with each other. He further tells that in languages with a freer word order like Greek and German, Predicate Proximity would tend to overrule the Recency tendency and result in a high attachment while for languages with a much more fixed word order like English, speakers would follow the Recency tendency to a much higher extent.

Another language that was more recently explored was Chinese. Chinese is a non-alphabetic language and instead uses an ideographic writing system. Linguists have argued about the word order of Chinese. While some believe it is in the SVO (Subject-Verb-Object) order like English, others claim it to be more of a SOV (Subject-Object-Verb) language, but there are a few characteristics of the language that linguists generally come into consensus with. When dealing with verb phrases (VPs) and prepositional phrases, Chinese is head-intial; when dealing with noun phrases (NPs) and postpositional phrases, Chinese is head-final and also, relative clauses always precedes the item that it modifies, unlike in English, where the modifying clause would follow the item it modifies (Shen, 2006).

Taking the Chinese equivalent of sentence 1, we get:

1a. 某人开枪打死了站在阳台上的女演员的仆人。
   someone(NP) shot(VP) standing-on-balcony-DE actress(NP1)-DE servant(NP2)
   ‘Someone shot the servant of the actress on the balcony.’

The relative clause precedes both NP1 and NP2. Unlike languages like English, where disambiguity can be done through number agreement or tense agreement between the verb phrase and the noun phrase, this cannot be achieved in Chinese where inflection is rare. In Chinese, disambiguity can only be achieved through the change of order in the segments of the sentence.
Likewise in the case of English, the Chinese equivalent can be resolved in NP-low or NP-high attachment. As seen from Figure 2, NP1 is always nearer to the relative clause than NP2. Judging solely on this fact, it seems that it would require lesser cost on the speaker to attach NP1 to the clause than NP2, taking into consideration the presence of memory decay. In Shen’s study (2006), 40 native Chinese speakers, mostly students, did a study to find out the relative clause attachment strategy of these Chinese speakers. He varied some factors of disambiguation to find out the strategies and preferences Chinese speakers adopted. Amidst several conclusions that he found, the one critical to this paper is that there is support that there is a NP-low bias for relative clause attachment in Chinese. However interestingly, although this was the final conclusion and overall finding he had, he admitted that there were little consistency across all the participants. It seems to suggest that different individuals with similar background and experience seem to give different responses and strategies. He further suggested that students often gave the most varied responses as students tend to strive to give the most ‘accurate’ or ‘right’ answers, which resulted in them probably to over-think or overly resolve in some situations. Nevertheless, he concluded
that NP-low attachment of Chinese. He accounts this preference to the Recency effect as speakers assign the closest NP to the relative clause that precedes it.

However, Cai (2010) studied 80 native speakers of Chinese in the Daxuecheng community in China to investigate the online preference in relative clause attachment in Chinese, and he found that there was a preference for NP-high attachment. He further looked into relative clause and sentential length as a factor influencing this preference and found that these speakers tend to attach the relative clause to the longer noun phrase in the sentence. Thus, if the NP-low is longer than NP-high, speakers would prefer NP-low attachment. This is a conflicting finding to Shen who suggests a low attachment preference. However, as the sentences used in both studies are neither the same nor equivalents, it is difficult to use one to overrule the other.

Chinese makes a distinction between subject relative clause and object relative clause, which is less important or applicable to English. Therefore it is difficult to draw a direct comparison between the two and determine if their attachment strategies are conflicting or complementing. Research on Chinese relative clause attachment strategies is insufficient to draw a conclusion as to whether Chinese speakers prefer high or low attachment.

1.3 Bilinguals’ Strategy

More recent researches have been more interested in investigating how bilinguals would resolve these ambiguities. Given two languages and possibly two different language strategies, how are these two competing preferences resolved in the minds of the reader. Over the years, the field of bilingual studies has always been interested in how the two languages interact with each other in both offline and online domains. With two languages instead of one working in the speakers’ mind, how would the two affect these bilinguals’ way of processing one of the languages? Studies on bilingual children in the past have actively sought to prove if bilingual children have a Unitary System or a Separate System. The Unitary System Hypothesis states that ‘the bilingual child initially forms only one collective grammar and lexicon for the target languages involved’ (Volterra & Taeschner 1978). The opposing Separate Systems Hypothesis however believes that ‘from the onset of acquisition, the bilingual child forms separate grammatical systems for each of the target languages involved’ (Morales, Salustri & Gilkerson, 2003). Both hypotheses have
strong support for each and it is very difficult to overthrow one with the other. However, despite the many different investigations over the years, it is difficult to deny that the two languages do affect each other in one way or another and to use the L2 is to actively suppress L1. Therefore, likewise in the domain of parsing, bilinguals may be actively suppressing L1 strategies while parsing in their L2.

In Felser et. al.'s study (2003), they compared first and second language learners of English in the way they resolve ambiguity in English. These L2 learners have either German or Greek as their first language, and as mentioned earlier, these two languages both prefer NP-high attachment as compared to English which prefers NP-low attachment. They found that the L2 learners of English did not perform like the native English speakers. Although they showed similar responses towards the lexical cues whereby they showed NP2-bias in the *with* condition (elaborated below), they did not show such bias in the other conditions. It shows that it is very possible that their L1 strategy of high attachment or NP1-bias could have competed with their L2 strategy and thus resulted in this lack of pattern with native speakers.

However, if one was to look at bilinguals whose L1 and L2 have similar attachment strategies, one can safely predict that there would be no conflicting interests. For example, an English-Chinese bilingual will most likely prefer NP-low attachment since both English and Chinese have NP-low attachment preference, if Shen's (2006) finding is conclusive. However, the attachment preference of Chinese speakers is yet to be confirmed for sure, and thus strategies adopted by English-Chinese bilinguals are rather controversial.

### 1.4 Other factors influencing Parsing Strategy

#### 1.4.1 Animacy

Animacy has been found to be an important factor of parsing strategy as well. Desmet et al. (2006) found strong evidence that attachment in Dutch depends strongly on the animacy of NP1. In their eye-tracking experiment with 48 native Dutch speakers and corpus analysis, they concluded that if NP1 was animate, there is a bias towards high attachment; but if NP1 was to be inanimate, there is a bias towards low attachment. Although in overall performance, Dutch
speakers still showed a higher preference for high attachment, they did not deny that animacy had an extensive influence on the speakers’ decision.

1.4.2 Lexical Factors

Consider the comparison of this pair of sentences:

2. Someone shot the servant of the actress who was on the balcony.
3. Someone shot the servant with the actress who was on the balcony.

Felser (2003) found strong NP2 bias with the with conditions as compared to the of conditions. Native English speakers also showed a higher percentage of NP2-attachment preference in the with conditions as compared to the of conditions. With with as the connecting item, the lexical properties of with propels the speakers to be more inclined towards NP2 attachment. With significant differences in both conditions, although the differing item is only the lexical item connecting the two noun phrases, it is evident that lexical factors play an important role in determining the speakers’ resolution of the ambiguity. This factor is also present in native Greek and German (high attachment/NP1-bias) speakers learning English as a second language (L2), showing that the weight lexical factors have on standing ambiguity resolution is fairly large.

The issue of conflicting strategies in bilinguals was brought up in Felser’s study. With two languages of different attachment strategies, how would a bilingual resolve standing ambiguity? It is possible that the strategies will conflict within the bilingual, but also possible that the bilingual would simply adopt the strategy of the language the sentence is presented in.

1.5 Current Study

1.5.1 Emotions as a possible factor for strategy?

Another important factor in speakers’ understanding of sentences is context. Contextual cues or background information can influence a person’s judgment or interpretation of a sentence. If this is so, would the emotions the speaker is feeling at the moment of reading a sentence, affect the way he or she parses it? Take for example the sentences below:
4. The poor daughter of the vicious murderer who was shot dead is in the news now.

If the context was a sympathetic and tragic one, would the reader interpret as the poor daughter who was shot dead? As compared to a context of having a police-and-thief or justice-being-upheld situation, would that lead to the interpretation of the vicious murderer being the one shot dead? However this would only apply to sentences with an obvious bias in emotions. With the addition of two opposite or different adjectives to modify the two NPs separately, the emotions induced by the two different interpretations would be very different and thus if the emotions the reader is feeling is different, it may lead to a different interpretation.

However, the strength of the contextual cues is doubtful. As previous literature has clearly shown, different languages show different tendencies in their attachment strategies. It is still unknown whether the emotion cues would overrule these language tendencies or if it would be the other way around.

Emotions are intangible and difficult to control. Given its ‘transparent’ and ‘fluctuating’ manifestations, studies that aim to study on these are extremely difficult and cumbersome. Music is one source or influential factor to emotions. Trainor and Schmidt (2003) stated in their paper that ‘music is not only about emotion, but that it elicits emotions directly, (and it) can be seen clearly from the physiological responses it induces.’ In their study, they found that when exposed to different music, the listener experiences changes in heart rate, respiration rate, blood flow and other physical changes and these are evidences to the fact that music does induce emotions to a certain extent. Furthermore, they found evidences online as well. There was evidence that there is activity in the frontal lobes that is a similar phenomenon to activation by other emotion stimuli. Thus there are both online and offline evidences to prove that music does elicit emotions.

However, some others argue that the emotions caused by music are merely a ‘mirror’ of a real emotion (Levinson, 1997). Levinson argues on the basis of negative emotions like sadness. He believes that sorrow needs an ‘object’ of sorrow. With music, there is no identifiable object of this negative emotion, and thus cannot be taken as a real emotion being induced. However, in agreement with Radford (1989), one cannot deny that when we hear a piece of sad music, we will respond with a ‘sympathetic sadness’.
Therefore, there is strong evidence and support that music does induce emotions in its listeners and this is a fair replica of the real emotions we experience in real life. Thus, music can be a good source and factor in controlling and ‘manipulating’ emotions.

1.5.2 Music influences Language Processing

Literature has shown that music and language are closely linked to each other and there is also evidence that music does influence language processing. Moreno (2009) sought to see whether music affects language and cognition, and concluded that music and language does seem to ‘share special features that allow music to improve and shape language processing’, although literature has yet to provide a truly concrete causal link between the two. He quoted Magne et al. (2006)’s study on in their study to investigate how short-term musical training of 8 weeks will or will not improve 8 year-old children’s detection of pitch alteration in language. Although they failed to find a difference between the two groups of children (one underwent musical training, the other underwent a painting training) behaviorally, they found ERP (Event-Related Potentials) evidence that musical training did influence the children which was not found in the painting group. They concluded that a relatively short exposure to music training did modify the brain processing involved in language (Magne, 2006).

Marques et al. (2006) also did a similar experiment, this time on Portuguese sentences. Extending the musical training to 6 months, he found that 6 months of musical training appeared to be sufficient to modify behavior and also to influence brain function. He concluded that there is a ‘causal link between musical training and language processing modifications at both the behavioural and brain levels’ (Marques, 2007). Schellenberg and Moreno (2009) compared between musicians and non-musicians and found that musicians performed significantly better and faster at pitch discrimination tasks.

All of these studies aimed to investigate the relationship between music and language. Although studies are still inconclusive on how music influences language processing specifically, the fact that music does have an influence on language processing is prominent. Patel (2007) concluded that music and language processing are ‘unlikely to be unique in terms of resource sharing’ since the resources provide both of them the specific functions of processing that is needed in both of
these domains. However, this sharing is not unique to this pair of domains only. Patel states that it is possible for any other domain to share these resources as long as that domain requires the same processes as the latter pair.

Therefore there have been several findings that support the idea that music influences language processing in the phonological and pitch discrimination aspect, its influence on syntactic or semantic aspect of language processing is yet to be discovered conclusively.

Chapter 2. Aims of Study

(1) To find out the influence of L1 and L2 in sentence processing by bilinguals.

The influence of L1 on L2 and vice versa remains a controversy in linguistics research, especially when applied to English-Chinese bilinguals. English and Chinese are languages that come from different families. With their different orthography and phonetic system, the two languages are quite different from each other in nature. Singapore is a country in which citizens are predominantly English-Chinese bilinguals (Chinese is the main ethnic group in Singapore). As mentioned earlier, attachment preference in English is widely determined to be NP-low attachment but attachment preference in Chinese is yet to be determined conclusively. Therefore, this study aims to investigate how bilingual speakers of these two languages would process and resolve sentences with standing ambiguity.

(2) To find out the influence of music on sentence processing (specifically, resolution of standing ambiguous sentences)

Music has been proven to influence sentence processing and that it differs between musicians and non-musicians. This study also serves to further determine if music will influence sentence processing and specifically, if the emotions induced by sad versus neutral music would affect the resolution of standing ambiguous sentences.

To achieve these aims, this study will adopt the following experimental design.
Chapter 3. Experimental Design

Participants were presented 75 English sentences, 50 BIASED and 25 UNBIASED sentences. All of these sentences contain the syntactic structure of ‘NP1 of NP2 who ________________’ like sentence 1 mentioned in the section 1, where both NP1 and NP2 refers to equally animate human references. The sentences all have the conjunction ‘of’ instead of ‘with’ so as to reduce the natural tendency and pressure towards NP2 attachment in the ‘with’ condition (as explained in Felser 2003). In the BIASED condition of sentences, emotional adjectives are added to both NPs. These adjectives are manipulated in the way that to attach the relative clause to NP1 would give rise to a sadder context or situation than if it is to attach to NP2. For example, in the sentence below:

The poor daughter of the vicious murderer who was shot dead is in the news now.  
NP1          NP2

A question is asked after each sentence, for example with regards to this sentence, the question would be ‘who was shot dead?’ Subjects are shown what NP1 and NP2 refer to as well. If the relative clause is attached to NP1, meaning that poor daughter was the one who was shot dead, compared to the situation where it was the vicious murderer who was shot, the reader would most probably feel that it is a sadder situation in the former interpretation. This is the case of the BIASED condition. In the UNBIASED condition, we will see sentences that resemble sentence 1 mentioned earlier. The sentences in this condition are adapted from materials used in Shen (2006). A list of all the sentences used can be found in the appendix.

3.1 The Experiment Conditions

The experiment consists of 3 different conditions:

1. NO_MUSIC condition
2. NEUTRAL_MUSIC condition
3. SAD_MUSIC condition

Each condition is further split into two for experimental purposes, one consisting of 12 sentences and the other consisting of 13 sentences. Each of these 6 subgroups of sentences has similar
average ratings of their ‘bias-ness’ towards NP1 and NP2 (based on the Experiment 1). Each subgroup has both BIASED and UNBIASED sentences, however the number of each is not controlled. To counterbalance, the 6 subgroups are also arranged into 6 different sequences. Each sequence is taken by 3 subjects. In other words, 3 subjects would face the sad condition before the neutral condition and then the no-music condition while another 3 may face the neutral-music condition before the sad-music condition and then the no-music condition and so on. This is to eliminate possibility of confounding factor between the conditions influencing one another.

<table>
<thead>
<tr>
<th>NO_MUSIC 1</th>
<th>NEUT_MUSIC 1</th>
<th>SAD_MUSIC 1</th>
<th>NEUT_MUSIC 2</th>
<th>SAD_MUSIC 2</th>
<th>NO_MUSIC 2</th>
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<tbody>
<tr>
<td>6 BIASED sentences +</td>
<td>8 BIASED sentences +</td>
<td>10 BIASED sentences +</td>
<td>9 BIASED sentences +</td>
<td>9 BIASED sentences +</td>
<td>10 BIASED sentences +</td>
</tr>
<tr>
<td>6 UNBIASED sentences</td>
<td>4 UNBIASED sentences</td>
<td>2 UNBIASED sentences</td>
<td>4 UNBIASED sentences</td>
<td>4 UNBIASED sentences</td>
<td>3 UNBIASED sentences</td>
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Figure 3 Illustration of one sequence presented to a subject in Experiment 2

The illustration above represents an example of one sequence of subgroups that a participant would face in Experiment 2. The total number of BIASED sentences and UNBIASED sentences is 50 and 25 respectively. This particular order of the subgroups is only presented to 3 subjects, and altered for the next three and the pattern continues for reasons mentioned above.

For the NO_MUSIC condition, there would be no music played in the background as participants carry out the experiment. For NEUTRAL_MUSIC condition, a neutral music is played in the background (neutral mood is confirmed by a separate group of 9 participants during the pilot testing). The music used is titled Pure Delight by Roy Todd on the piano. Lastly for the SAD_MUSIC, a sad music is played (sad mood is also confirmed by a separate group of 9 participants during pilot testing). The music used is titled ‘Sad Romance’ by Ji PyeongKeyon on the violin. The participants in Experiment 1 also rated these two music pieces in terms of their mood and they all rated the neutral music as ‘neutral’ and the sad music as ‘sad’. The NEUTRAL_MUSIC condition is to test if music itself (and not music-induced emotions) is a factor
influencing sentence processing. The music is played through a stereo headphone set and kept at the same volume level for all subjects.

3.2 The Experiment Program (For Experiment 2 only)
The experiment is administered on the E-prime 2.0 program. Sentences are presented in black fonts on a white screen. Each sentence is presented with a question together with the options and will stay on-screen for 6000ms. Whether or not the subject makes a response, the program will continue after 6000ms. Subjects were to press 1 for the option NP1 and 2 for the option NP2 on the keyboard. After each subgroup (of either 12 or 13 sentences), the subject will be prompted to take a 30 second break through a message from the screen, before they are allowed to continue. The music track changes where applicable once the last sentence of the previous subgroup ends and the next track starts promptly when the ‘take a break for 30 seconds’ message is shown. This thirty-second break is to allow some degree of conditioning of the music mood for the subjects to be fully within the mood before entering the next subgroup of sentences. This conditioning factor is with exception to the first subgroup in which the subject deals with the sentence without hearing the music beforehand like in other cases.

Chapter 4. Predictions of Results
As the pool of subjects come from Singaporean Chinese undergraduates who are English-Chinese bilinguals, and whose English is generally more dominant since the medium of instruction in school is English and that the experiment deals with English sentences, it is predicted that these bilinguals would follow the attachment strategies concluded for English speakers. In other words, these bilinguals would tend towards NP-low attachment, choosing more NP2 as their answer in the NO_MUSIC condition and NEUTRAL_MUSIC condition.

However, it is also predicted that their preferences would change in the SAD_MUSIC condition, giving rise to an increase in their preference for NP1 as the answer, since the context is now a sad one; participants are predicted to attach the relative clause to the NP that will give rise to a sadder connotation, and hence take on a NP1 attachment (NP-high attachment).
Chapter 5. Methodology

5.1 Experiment 1

The aim of Experiment 1 is to ensure that all the sentences in each subgroup are presented in a manner that is equally biased towards NP1 and NP2 attachment during Experiment 2, so that the inherent influence of the sentences themselves can be minimized in the study. This is to ensure that any difference in subjects’ performances is due to the music played in the background to investigate the influence of music-induced emotions on resolving sentence ambiguity.

Experiment 1 consist an offline paper-and-pen study. A separate group (from Experiment 2) of 9 subjects aged between 21 and 24 were involved in this study (5 males; 4 females). 5 of them are musicians with more than 3 years of training and 4 of them have no training or training less than 3 years. They are all English-Chinese bilinguals and are all currently studying with the exception of one who has recently graduated. They are also compensated SGD5 for their effort. They were presented with the 75 English sentences and asked to rate these them on a scale of 1 to 7 as to how much they feel the attachment of the relative clause is towards NP1 and NP2 (1: NP1; 7: NP2). A sample of the questionnaire can be found in the appendix. There is no time limit to how long they can take on the questionnaire but they are instructed to not take too long and rate based on their first impression whichever they deem most appropriate. They were also later showed the two sound clips to be used in the experiment and asked verbally if the music were sad, happy or neutral.

The results of Experiment 1 are collated and rating for each sentence is averaged out across the 9 subjects. The sentences are then arranged according to their ratings and sorted into 6 different groups of equal average ratings for use in Experiment 2: NO_MUSIC_1, NO_MUSIC_2, NEUTRAL_MUSIC_1, NEUTRAL_MUSIC_2, SAD_MUSIC_1, and SAD_MUSIC_2 (illustrated in Figure 3 of section 3.1). The sentences are sorted into these 6 groups for ensuring counter-balancing in Experiment 2 and each subgroup contain both BIASED and UNBIASED sentences. In this case and for following sections, BIASED sentences will now refer to sentences with emotional adjectives attached to the NPs and UNBIASED sentences refer to those which do not, since ratings of inherent ‘bias-ness’ is already balanced out after Experiment 1.
5.2 Experiment 2

5.2.1 Participants

A total of 18 participants (8 males; 10 females) were involved in the study. They are all students from Nanyang Technological University, Singapore, aged between 21 and 25. 11 of them have musical training for 3 years and above while the other 7 have either no musical training or has had training for less than 3 years. Subjects are all English-Chinese bilinguals with English as their dominant language. Subjects may know a third or fourth language but this is not taken into account if their proficiency in those languages is minimal. Handedness is not controlled. The subjects are tested prior to the study to have normal hearing abilities in both ears for 500Hz, 1000Hz, 2000Hz and 4000 Hz at 25dB and have also claimed to be neurologically normal.

These subjects are all invited to the study by the experimenter personally but the subjects are not obliged to accept the invitation. Upon completion of the study, the participants are compensated SGD10 for their effort.

5.2.2 Procedure

Prior to the experiment, all subjects filled a consent form for the experiment and also an online questionnaire regarding their language background, musical background and handedness and also tested for the hearing.

Subjects carry out the experiment in a soundproof room with headphones on throughout the experiment. The experimenter explains the instructions of the study and also points out the controls of the experiment to be used. Subjects are also informed that music may be played amidst the experiment and that they do not have to pay special attention to it. Subjects are also given 7 sentences with no music in the background as a trial so as to ascertain that they understand the task demand. Once the subjects are cleared of all doubts regarding the experiment procedure, they began the study.
Chapter 6. Results

6.1 Experiment 1

*Table 1 Average ratings for BIASED and UNBIASED sentences*

<table>
<thead>
<tr>
<th></th>
<th>Biased (50)</th>
<th>Unbiased (25)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average rating out of 7 (9 participants)</td>
<td>3.45</td>
<td>4.62</td>
</tr>
</tbody>
</table>

Legend: NP1 – 1; NP2 – 7

Taking the average across all 9 participants from Experiment 1, the average ratings for each sentence were calculated. The sentences are then sorted into whether they are biased or not, meaning if they have emotional adjectives within the sentence, and the average for the two conditions are calculated, listed in Table 1 above. Interestingly, the average ratings showed that participants did not show a NP2 preference, with their ratings staying around the mid-way point of 3.5 out of 7. However, as predicted, UNBIASED sentences (no emotional adjectives attached) gave a higher rating than BIASED sentences (with emotional adjectives attached). The sentences from the two conditions are then combined and then sorted into 6 subgroups with the average rating of each subgroup as 3.83, 3.78, 3.85, 3.87, 3.87 and 3.84.

6.2 Experiment 2

6.2.1 First Analysis: 3 by 2 Within-Subjects ANOVA (All 6 conditions)

*Table 2 Descriptive Statistics for all 6 conditions across all 18 subjects*

<table>
<thead>
<tr>
<th></th>
<th>Total M (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>No_Biased</td>
<td>1.40 (0.18)</td>
</tr>
<tr>
<td>No_Unbiased</td>
<td>1.41 (0.28)</td>
</tr>
<tr>
<td>Neutral_Biased</td>
<td>1.41 (0.22)</td>
</tr>
<tr>
<td>Neutral_Unbiased</td>
<td>1.40 (0.24)</td>
</tr>
<tr>
<td>Sad_Biased</td>
<td>1.45 (0.17)</td>
</tr>
<tr>
<td>Sad_Unbiased</td>
<td>1.56 (0.32)</td>
</tr>
</tbody>
</table>

Legend: NP1 – 1; NP2 – 2

For the first round of analysis, a 3 by 2 one-way fully-within-subjects ANOVA analysis was done on all the 18 subjects and 6 sequences. The means of the NO_MUSIC condition and NEUTRAL_MUSIC condition are almost identical, with the SAD_MUSIC condition being a higher than the two.
Table 3 significance levels for 3 by 2 one-way ANOVA analyses of music, attachment main effect and interaction effect

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>F</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Music</td>
<td>18</td>
<td>3.48</td>
<td>*0.042</td>
</tr>
<tr>
<td>Attachment</td>
<td>18</td>
<td>0.51</td>
<td>0.483</td>
</tr>
<tr>
<td>Music*Attachment</td>
<td>18</td>
<td>0.33</td>
<td>0.333</td>
</tr>
</tbody>
</table>

There is no significant main effect of Attachment ($F(2)=0.51$, $p=0.483$) nor was there an interaction effect of Music × Attachment interaction effect ($F(2)=0.33$, $p=0.333$). However there is a significant main effect of Music ($F(2)=3.48$, $p=0.042$).

Figure 4 3 by 2 ANOVA plot for all 6 conditions

According to Figure 3 above, it can be seen that the SAD_MUSIC condition is different from the NO_MUSIC and NEUTRAL_MUSIC condition. Post-hoc T-tests has showed that the SAD_MUSIC condition is significantly different from both the other two conditions at p-value <0.05.

Therefore for further analysis, only the relationship between SAD_MUSIC condition and NEUTRAL_MUSIC condition will be focused on. The NO_MUSIC condition serves more as a control experiment to contrast between the absence and presence of music and if it influences speakers’ attachment strategies. Since the findings have shown there is no significant difference between the NO_MUSIC condition and the NEUTRAL_MUSIC condition, it can be concluded (for
the purpose of this paper) that there is no effect on the strategies simply by the existence of music. Therefore further analysis serves to investigate the effects of sadness induced by the SAD_MUSIC condition on sentence processing and so for the second analysis, only the NEUTRAL_MUSIC condition and SAD_MUSIC condition is taken into account.

6.2.2 Second Analysis: 2 by 2 by 2 Within-Subjects ANOVA (Music Experience)

To further test the effect of music and the emotions induced by it on sentence processing, the second analysis has included music training length as an independent variable as well. Subjects are sorted into two groups: ‘3 years or more of training/experience in music’ and ‘less than 3 or has no music training at all’. 11 subjects fall in the former group and 7 into the latter.

Table 4 Descriptive Statistics for 2 by 2 by 2 Within-Subjects ANOVA analysis with music experience as independent variable

<table>
<thead>
<tr>
<th>Music Experience (1: ≥ 3 years; 0: &lt; 3 years)</th>
<th>N</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Neut_biased</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>7</td>
<td>1.31(0.14)</td>
</tr>
<tr>
<td>1</td>
<td>11</td>
<td>1.48(0.24)</td>
</tr>
<tr>
<td>Total</td>
<td>18</td>
<td>1.41(0.22)</td>
</tr>
<tr>
<td>Neut_Unbiased</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>7</td>
<td>1.43(0.28)</td>
</tr>
<tr>
<td>1</td>
<td>11</td>
<td>1.38(0.23)</td>
</tr>
<tr>
<td>Total</td>
<td>18</td>
<td>1.40(0.24)</td>
</tr>
<tr>
<td>Sad_Biased</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>7</td>
<td>1.48(0.15)</td>
</tr>
<tr>
<td>1</td>
<td>11</td>
<td>1.43(0.18)</td>
</tr>
<tr>
<td>Total</td>
<td>18</td>
<td>1.45(0.17)</td>
</tr>
<tr>
<td>Sad_Unbiased</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>7</td>
<td>1.49(0.42)</td>
</tr>
<tr>
<td>1</td>
<td>11</td>
<td>1.61(0.24)</td>
</tr>
<tr>
<td>Total</td>
<td>18</td>
<td>1.56(0.32)</td>
</tr>
</tbody>
</table>

Legend: NP1 – 1; NP2 – 2

Table 5 Significance level of 2 by 2 by 2 ANOVA analysis with music experience interaction effect

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>F</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Music</td>
<td>18</td>
<td>3.703</td>
<td>0.072</td>
</tr>
<tr>
<td>Music*Music_Exp</td>
<td>18</td>
<td>0.030</td>
<td>0.865</td>
</tr>
<tr>
<td>Attachment</td>
<td>18</td>
<td>0.755</td>
<td>0.398</td>
</tr>
<tr>
<td>Attachment*Music_Exp</td>
<td>18</td>
<td>0.049</td>
<td>0.828</td>
</tr>
<tr>
<td>Music*Attachment</td>
<td>18</td>
<td>1.406</td>
<td>0.253</td>
</tr>
<tr>
<td>Music<em>Attachment</em>Music_Exp</td>
<td>18</td>
<td>9.793</td>
<td>*0.006</td>
</tr>
</tbody>
</table>
After the subjects are separated according to the length of their musical training/experience and compared to their attachment strategies, there was a significant interaction effect between Music × Attachment × Music-experience effect \((F(1)=9.793, p=0.006)\). However, there is no significant main effect of Music \((F(1)=3.703, p=0.072)\) and Attachment \((F(1)=0.755, p=0.398)\). There was no significant Attachment × Music-experience interaction effect \((F(1)=0.049, p=0.828)\) nor Music × Attachment interaction effect \((F(1)=1.406, p=0.253)\).

**Figure 5** Plot for 2x2x2 ANOVA at music experience = 0 (<3 years training)

Estimated Marginal Means of RELATIVE CLAUSE ATTACHMENT

at musicexp = .00

![Graph](image)

**Legend:**
1 = NP1
2 = NP2

**Figure 6** Plot for 2x2x2 ANOVA at music experience = 1 (>3 years training)

Estimated Marginal Means of RELATIVE CLAUSE ATTACHMENT

at musicexp = 1.00

![Graph](image)

**Legend:**
1 = NP1
2 = NP2
Results showed that the SAD_MUSIC condition had a different degree of influence on musicians (with training ≥ 3 years) as compared to non-musicians (with training < 3 years). Further analysis was done to investigate this relationship and to find out if musicians are more greatly affected or non-musicians are more affected. A post-hoc 2 by 2 ANOVA analysis was done for the two groups separately and presented below.

6.2.3 Third Analysis: 2 by 2 Within-Subjects ANOVA

(1) Music Experience = 0

*Table 6 Significance level of Music*Attachment interaction effect on non-musicians*

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>F</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Music</td>
<td>7</td>
<td>1.917</td>
<td>0.216</td>
</tr>
<tr>
<td>Attachment</td>
<td>7</td>
<td>0.358</td>
<td>0.572</td>
</tr>
<tr>
<td>Music*Attachment</td>
<td>7</td>
<td>1.216</td>
<td>0.312</td>
</tr>
</tbody>
</table>

For non-musicians (with training < 3 years), there is no significant main effect of Music ($F(1)=1.917, p=0.216$) nor Attachment ($F(1)=0.358, p=0.572$). There is no Music × Attachment interaction effect ($F(1)=1.216, p=0.312$).

(2) Music Experience = 1

*Table 7 Significance level of Music*Attachment interaction effect on musicians*

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>F</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Music</td>
<td>11</td>
<td>1.902</td>
<td>0.198</td>
</tr>
<tr>
<td>Attachment</td>
<td>11</td>
<td>0.344</td>
<td>0.571</td>
</tr>
<tr>
<td>Music*Attachment</td>
<td>11</td>
<td>14.293</td>
<td>*0.004</td>
</tr>
</tbody>
</table>

For musicians (with training ≥ 3 years), there is no significant main effect of Music ($F(1)=1.902, p=0.198$) nor Attachment ($F(1)=0.344, p=0.571$). However, there is a significant Music × Attachment interaction effect ($F(1)=14.293, p=0.004$).
To further investigate this relationship between music and attachment, a simple main effects analysis is done on the Music × Attachment interaction effect.

**Table 8 Simple Main Effects of Music*Attachment interaction effect on musicians**

<table>
<thead>
<tr>
<th>Condition</th>
<th>Main effect</th>
<th>F</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>NEUTRAL_MUSIC</td>
<td>Attachment</td>
<td>0.670</td>
<td>0.431</td>
</tr>
<tr>
<td>SAD_MUSIC</td>
<td>Attachment</td>
<td>5.540</td>
<td>*0.040</td>
</tr>
<tr>
<td>BIASED</td>
<td>Neutral vs Sad</td>
<td>1.32</td>
<td>0.277</td>
</tr>
<tr>
<td>UNBIASED</td>
<td>Neutral vs Sad</td>
<td>8.03</td>
<td>*0.018</td>
</tr>
</tbody>
</table>

**Figure 7 Plot for the Simple Main Effects of Music*Attachment interaction effect**

Tests of the simple main effect of attachment showed that the attachment effect was significant in the SAD_MUSIC condition ($F(1,10)=5.540$, $p=0.040$), but not in the NEUTRAL_MUSIC condition ($F(1,10)=0.670$, $p=0.431$). Subjects showed a significant difference in their attachment strategies for UNBIASED sentences compared to BIASED sentences in the SAD_MUSIC condition. In the SAD_MUSIC condition, subjects had a significant NP2 preference in the UNBIASED condition as compared to in the BIASED condition, as illustrated in Figure 6 above.
Tests of the simple main effect of music showed that the music effect was significant in the UNBIASED condition of sentence NP attachment ($F(1,10)=8.03$, $p=0.018$), but not in the BIASED condition ($F(1,10)=1.32$, $p=0.277$). Subjects showed a significant difference in their choices for the UNBIASED sentences across the two music conditions. For the SAD_MUSIC condition, subjects had a significant preference for NP2 for their answers compared to NP1 preference for the NEUTRAL_MUSIC condition, as illustrated in Figure 6 above.

Chapter 7. Discussion

7.1 Lack of NP2 attachment preference: L1-L2 interaction?

Interestingly, participants did not show a strong NP2 or NP-low attachment preference in Experiment 1 and NO_MUSIC condition as predicted. This is true for both UNBIASED and BIASED sentences. Although according to previous literature, English speakers would show a preference for NP2 attachment for unbiased and neutral standing ambiguous sentences, these bilinguals did not pattern this preference despite their English dominance. This could be due to the influence from their knowledge of Chinese, which still remains as a controversy as to whether Chinese speakers prefer NP-low or NP-high attachment. This could suggest that Chinese native speakers have a NP-high attachment preference, but further evidence is needed to prove this point. If Chinese does have a NP-high attachment preference, it could prove that bilinguals experience a L1-L2 interaction effect and that the conflict in each language’s strategies leads to their lack of NP2-bias. However, if Chinese is also a NP-low preference language, the lack of NP2-preference would probably be due to another reason since there is no conflict of strategies for the bilinguals. This could be a case unique to Singaporean English-Chinese speakers. Singaporeans have a rather unique case where English-Chinese bilinguals generally learnt both languages together simultaneously from young, and almost all of them would be able to speak Singapore Colloquial English, or Singlish for short, which has a different structure from the Singapore Standard English. Also, most of these bilinguals are very capable of code-switching between the two languages, and even code-mixing is very common. This frequent use of the two languages together may have caused an even more pronounced interaction between the strategies of the two in the bilinguals. Still, further investigation is needed to determine the situation.
Participants’ preference for NP1 in the BIASED condition of sentences is predicted. Participants showed more NP1-attachment preference for sentences in the BIASED condition than in the UNBIASED condition, showing that emotional lexical items do have an effect on readers’ resolution of standing ambiguity. Even in a condition where music is absent, these lexical items have affected these bilinguals’ decision on the attachment of the relative clauses. This finding supports the idea that emotional factors from lexical items attached to the noun phrases have an influence on bilinguals’ relative clause attachment strategies. Although without music inducing the emotional context of these sentences is not prescribed to the participants, participants still tend to take on a more compassionate context and sympathise with the NP1 more, resulting in a NP1-attachment tendency.

7.2 Musicians are influenced by music-induced emotions more greatly than non-musicians

In Hallam’s (2010) paper, she talked about the impacts of music on its learner in various aspects. She found that music ‘may have the capacity to increase emotional sensitivity’ towards both the music itself, and also general emotional cues in the social aspect. Although she did not do a study to specifically investigate if non-musicians are less affected or less aware of emotional cues from music, she did conclude that musical training will increase emotional sensitivity in general. Madsen et. al. (1990) also investigated the different patterns of music listening in musicians and non-musicians and found that there was a significant difference in the way these two groups listen to music. The two groups pay attention to different aspects like melody, rhythm, dynamics and timbre. Although no study has done specifically to investigate the specific influence musical training has on a person’s ability to detect emotional cues from music, it is evident that musicians and non-musicians do have different ways or methods in listening and breaking down music. The results achieved from this study also support this idea.

According to the results attained in this study, musicians performed significantly different from the non-musicians in their response to the emotional cues from music, in which they responded significantly different under the SAD_MUSIC condition and the NEUTRAL_MUSIC condition. Non-musicians, although also performed differently under these two conditions, the difference was not significant. This could be due to the difference in their exposure to music and musical
training. With more musical exposure and official training, musicians have more awareness of
the emotional cues from music than non-musicians. With this greater awareness and experience
with music in general, musicians are more greatly influenced, even subconsciously. As they are
more susceptible to the influence of music and music-induced emotions, they find themselves
mirroring these emotions to a greater extent as well, during the experiment. Taking on the
sadness induced by the music, they interpret the sentences with a sad context to a greater extent
than non-musicians. Therefore, they performed significantly different in the SAD_MUSIC
condition and the NEUTRAL_MUSIC condition.

However, this performance difference is more significant in the UNBIASED condition of
sentences. Musicians responded with significantly more NP2-attachment in the SAD_MUSIC
condition than in the NEUTRAL_MUSIC condition and also the difference between responses for
sentences in the BIASED condition and the UNBIASED condition was the most significant in the
SAD_MUSIC condition as well. Only in the SAD_MUSIC condition did participants pattern with the
prediction of the results of this study, with more NP2-attachment in UNBIASED sentences and
more NP1-attachment in BIASED sentences. This shows that the sad emotion induced from the
sad music does propel these musically-trained bilinguals to take on a sad context and resolve the
sentence accordingly, giving rise to more NP1-attachment. Likewise, their experience with music
increased their awareness to the negative emotional cues from the music, causing them to take on
a negative-feeling context of the sentence. Non-musicians however, are probably less influenced
by these emotional cues.

The emotional cues from the lexical items have a greater influence on musicians as well, in the
SAD_MUSIC condition. There is a significant increase in NP2-attachment preference for
UNBIASED sentences when comparing between the SAD_MUSIC condition and in the
NEUTRAL_MUSIC condition. Under the NEUTRAL_MUSIC condition, there were no external
emotional cues from the background music and thus emotions induced could only be from the
lexical items in the noun phrases. However, ‘sadness’ cues were being induced in the
SAD_MUSIC condition through the music and thus the distinction between UNBIASED and BIASED
sentences is clearer. Since UNBIASED sentences do not have any additional adjectives attached to
induce biased emotions, it appears less influenced by the sad emotions from the music in the
background, giving rise to its significant increase in NP2-attachment preference during the
SAD_MUSIC condition. This also explains the significant difference between UNBIASED and BIASED sentences in the SAD_MUSIC condition.

Therefore, we see that musical training does influence language behavior through their sensitivity to emotional cues in the context of the sentences. Musicians are not only more sensitive to the cues from music, and also lexical items in a sentence.

7.3 Sad music induced more NP2 attachment?
An interesting finding that conflicted with the predictions of the results was the increase in NP2-attachment preference for SAD_MUSIC condition than in the NEUTRAL_MUSIC condition in general. Although the increase is not significant, the fact that the sad music propelled participants to attach the relative clause to NP2 is worth discussing. According to the predictions of results, participants should have more NP1 attachment in the SAD_MUSIC condition than in the NEUTRAL_MUSIC condition due to reasons explained before, however the reverse finding was found. One possible explanation could be the active inhibition of these emotional cues in musicians. As the participants are all briefed the instructions verbally prior to the commencement of the experiment, and that they are also told specifically to not pay special attention to the music, they may have actively or deliberately inhibit the ‘sadness’ induced by the music in the SAD_MUSIC condition to ensure they remain fair for experimental purposes. However, by actively inhibiting this emotion, participants have subconsciously resulted in an increase in their NP2-attachment preference. Still, further investigation needs to be done to confirm this analysis.

Chapter 8. Limitations and Future Directions
One of the limitations in the experimental design was the lack of control over the total number of BIASED sentences and UNBIASED sentences in each subgroup (as illustrated in Figure 3 in Section 3.1). For a better controlled and balanced experiment, the number and proportion of the two types of sentences should be balanced for all the subgroups for more accuracy in the results analysed later in the experiment.
One of the limitations of concluding the results achieved from this study is the uncertainty of Chinese speakers’ language strategy in resolving standing ambiguity. As mentioned above, the attachment preference of Chinese speakers would have an effect on these bilingual speakers’ language strategies. Future research can look into their attachment preferences and also how the two languages learnt by a bilingual speaker interact to influence their performance in resolving standing ambiguity. Studies can look into whether if the two languages have conflicting strategies, would the bilingual follow the strategy of his dominant language, or would an alternate or possibly a hybrid strategy be resulted.

Another limitation is the exposure to music. Some participants may listen to music more frequently than others and exposure to music may not be directly proportionate to the amount of musical training participants have received officially. Exposure to music may have an effect on how sensitive the participants are to the emotions induced by music, especially the sad emotions from the sad music in this study. Future studies can look into the exposure to music in these participants (e.g. how often they listen to music, what kind of music they listen to) and take into account the exposure of music in the analyses of results.

Chapter 9. Conclusion

This study supports the idea that musicians and non-musicians are influenced by music-induced emotions to a significantly different degree: Musicians are more aware and affected by these cues. This study also found that language learnt is not the only factor determining relative clause attachment strategies and emotional cues from lexical items in the sentence and from the context play an important part in the strategies as well. Emotions of the reader affect his/her way of interpreting sentences.


Chapter 10. Bibliography


### Chapter 11. Appendix: (1) List of Sentences

<table>
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<td>It was horrible to know that the meek wife of that incorrigible gambling addict who was hospitalised is turning for the worse.</td>
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### Data Sentences (Unbiased – no adjectives attached)

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<td>The husband of that woman who likes to talk behind others just walked past us.</td>
<td>Who likes to talk behind others?</td>
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<td>The father of the artist who devoted loads of money to the poor area enjoys planting.</td>
<td>Who devoted loads of money to the poor area?</td>
</tr>
<tr>
<td>57</td>
<td>The wife of the boss who is always hard on others was shopping in the mall.</td>
<td>Who is always hard on others?</td>
</tr>
<tr>
<td>58</td>
<td>The housekeeper of the rich woman who was very rude had a very bad cold.</td>
<td>Who was very rude?</td>
</tr>
<tr>
<td>59</td>
<td>The secretary of the politician who is a racist should be fired.</td>
<td>Who is a racist?</td>
</tr>
<tr>
<td>60</td>
<td>The boyfriend of the girl who is an artist is having a showcase over there.</td>
<td>Who is an artist?</td>
</tr>
<tr>
<td>61</td>
<td>The female manager of that actress who just dumped her boyfriend has decided to quit her job.</td>
<td>Who just dumped her boyfriend?</td>
</tr>
<tr>
<td>62</td>
<td>The father of the daughter who is about to leave is crying badly.</td>
<td>Who is about to leave?</td>
</tr>
<tr>
<td>63</td>
<td>The grandfather of the boy who cooks really well once fought a battle in WWII</td>
<td>Who cooks very well?</td>
</tr>
<tr>
<td>64</td>
<td>The parents of the student who was very excited all went</td>
<td>Who was very excited?</td>
</tr>
<tr>
<td>No.</td>
<td>Sentence</td>
<td>Question</td>
</tr>
<tr>
<td>-----</td>
<td>--------------------------------------------------------------------------</td>
<td>--------------------------------------------------------------------------</td>
</tr>
<tr>
<td>65</td>
<td>The assistant of the journalist who had been to Tibet will publish his own book.</td>
<td>Who had been to Tibet?</td>
</tr>
<tr>
<td>66</td>
<td>The daughter of my friend who is working in a supermarket was offered a place in a university.</td>
<td>Who is working in a supermarket?</td>
</tr>
<tr>
<td>67</td>
<td>The servant of the king who loves to read was shot.</td>
<td>Who loves to read?</td>
</tr>
<tr>
<td>68</td>
<td>The pupil of the monk who talks endlessly is now cleaning the yard.</td>
<td>Who talks endlessly?</td>
</tr>
<tr>
<td>69</td>
<td>The friend of my aunt who just came back from the UK is a scientist.</td>
<td>Who just came back from the UK?</td>
</tr>
<tr>
<td>70</td>
<td>The child of that researcher who was playing football is a math genius.</td>
<td>Who was playing football?</td>
</tr>
<tr>
<td>71</td>
<td>The client of the businessman who looks pale just came out of the hospital.</td>
<td>Who looks pale?</td>
</tr>
<tr>
<td>72</td>
<td>The nurse of the patient who wears a pink wig is a very nice person.</td>
<td>Who wears a pink wig?</td>
</tr>
<tr>
<td>73</td>
<td>The landlord of the writer who has a nasty nose went to the beach this morning.</td>
<td>Who has a nasty nose?</td>
</tr>
<tr>
<td>74</td>
<td>The kid of the woman who was crying by the road is a very kind person.</td>
<td>Who was crying by the road?</td>
</tr>
<tr>
<td>75</td>
<td>The researcher of the professor who left for America was diligent.</td>
<td>Who left for America?</td>
</tr>
</tbody>
</table>
Appendix: (2) Information Sheet for Experiment 1

NANYANG TECHNOLOGICAL UNIVERSITY
Linguistics and Multilingual Studies
Final Year Project Experiment 1

I am a final year student of Linguistics and Multilingual Studies in Nanyang Technological University. I am currently carrying out my Final Year Project to find out the way English-Chinese bilinguals analyze English sentences.

You are invited to participate in a Experiment 1 for this Final Year Project that would take up about 30 minutes of your time and will be compensated $5 for your effort.

Below are the instructions for the study, please read them carefully:

You will be given 75 English sentences. The sentences will contain the structure ‘NP1 of NP2 who _____ ’ where NP1 stands for Noun Phrase 1 and NP2 stands for Noun Phrase 2. For example, in the sentence “someone shot the servant of the actress on the balcony”, the “servant” is NP1 while the “actress” is NP2. Following the sentence, you will be asked a question regarding the two Noun Phrases. You will be asked to rate from 1 to 7 regarding which NP you believe to be the best answer to the question (1: definitely NP1; 4: both NP1 and NP2 is equal; 7: definitely NP2) There is no right or wrong answer so just rate it as you deem best with respect to the way you read the sentence.

Here is an example:

Someone shot the servant of the actress on the balcony. (NP1: servant            NP2: actress)
NP1----------------------------------------------------------NP2
  1  2  3  4 5  6  7

If you have any questions, you may ask the experimenter now.
Otherwise, you may begin. Read the sentences carefully and rate as you deem most appropriate.
If you have any doubts regarding the questions or noun phrases, you may ask the experimenter as well.
Once you are done with the study, you may notify the experimenter.

Thank you very much 😊
Appendix: (3) Questionnaire for Experiment 1

1. The **young child** (NP1) of that **drunken father** (NP2) who was knocked down has gotten much of media's attention.
   Who was knocked down?
   
   NP1-----------------------------------------------NP2
   1  2  3  4  5  6  7

2. That **tiny apprentice** of the **infamously critical** editor who recently got fired has found a new job.
   Who was recently fired?
   
   NP1-----------------------------------------------NP2
   1  2  3  4  5  6  7

3. The **docile wife** of that **abusive husband** who met with an accident has held the funeral around here.
   Who met with an accident?
   
   NP1-----------------------------------------------NP2
   1  2  3  4  5  6  7

4. That **kind employee** of that **evil boss** who declared bankruptcy has declined help from us.
   Who declared bankruptcy?
   
   NP1-----------------------------------------------NP2
   1  2  3  4  5  6  7

5. A **meek subordinate** of a **demanding mentor** who fell off the building has created uproar.
   Who fell off the building?
   
   NP1-----------------------------------------------NP2
   1  2  3  4  5  6  7

6. The **chauffeur** of that **malicious lady** who drowned was an acquaintance of ours.
   Who drowned?
   
   NP1-----------------------------------------------NP2
   1  2  3  4  5  6  7
7. The **little child** of **that terrible mother** who was diagnosed with cancer has gotten much pity. Who was diagnosed with cancer?

```
NP1--------------------------------------------NP2
  1  2  3  4  5  6  7
```

8. That **poor maid** of **cruel Andy** who was knocked over has caused much heartbreak. Who was knocked over?

```
NP1--------------------------------------------NP2
  1  2  3  4  5  6  7
```

9. That **helpless old father** of **that malicious cunning businessman** who was hospitalized has passed away last night. Who was hospitalized?

```
NP1--------------------------------------------NP2
  1  2  3  4  5  6  7
```

10. The **neglected son** of **that impulsive father** who knocked his head is in a coma now. Who knocked his head?

```
NP1--------------------------------------------NP2
  1  2  3  4  5  6  7
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11. That **pitiful student** of **that very strict teacher** who was accused of theft is still undergoing trial. Who was accused of theft?

```
NP1--------------------------------------------NP2
  1  2  3  4  5  6  7
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12. The **dutiful servant** of **that mean mistress** who fell badly ill has been hospitalized. Who fell badly ill?

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NP1--------------------------------------------NP2
  1  2  3  4  5  6  7
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13. That **poor cousin** of **obnoxious Arthur** who broke his ankle is not getting better. Who broke his ankle?

```
NP1--------------------------------------------NP2
  1  2  3  4  5  6  7
```
14. The **really kind-hearted daughter** of **that stern step-mother** who broke her arm is not getting better.
   Who broke her arm?

   NP1--------------------------------------NP2
   1   2   3   4   5   6   7

15. That **sweet niece** of **that moody uncle** who turned blind was sent to the hospital.
   Who turned blind?

   NP1--------------------------------------NP2
   1   2   3   4   5   6   7

16. The **conscientious helper** of **that nasty lady** who got shot is now hospitalized.
   Who got shot?

   NP1--------------------------------------NP2
   1   2   3   4   5   6   7

17. That **polite child** of **that dogmatic father** who came down with depression is getting professional help.
   Who came down with depression?

   NP1--------------------------------------NP2
   1   2   3   4   5   6   7

18. A **lovely assistant** of **quick-tempered Sally** who lost her parents in an accident came by just now.
   Who lost her parents?

   NP1--------------------------------------NP2
   1   2   3   4   5   6   7

19. The **caring daughter** of **that malicious mother** who is missing was a friend of Mary’s.
   Who is missing?

   NP1--------------------------------------NP2
   1   2   3   4   5   6   7

20. That **innocent-looking son** of **that rude man** who got injured walked past just now.
   Who got injured?

   NP1--------------------------------------NP2
   1   2   3   4   5   6   7
21. The **pleasant child** of *sly Jim* who got scalded badly has been admitted into the hospital. Who got scalded badly?

NP1-----------------------------------------------NP2
1  2  3  4  5  6  7

22. The **loving mother** of *abusive Tony* who got cut in the forehead is bleeding badly. Who got cut in the forehead?

NP1-----------------------------------------------NP2
1  2  3  4  5  6  7

23. The **honest father** of *ungrateful Jane* who got stranded abroad has finally returned. Who got stranded abroad?

NP1-----------------------------------------------NP2
1  2  3  4  5  6  7

24. That **helpful maid** of *that bossy actor* who got crippled is now on a wheelchair permanently. Who got crippled?

NP1-----------------------------------------------NP2
1  2  3  4  5  6  7

25. The **trustworthy housekeeper** of *that demanding actress* who came down with dengue fever is in peril danger. Who came down with dengue fever?

NP1-----------------------------------------------NP2
1  2  3  4  5  6  7

26. Jane cried when she saw the news of that **lovely servant** of the *abusive mistress* who was killed. Who was killed?

NP1-----------------------------------------------NP2
1  2  3  4  5  6  7

27. Celine met the **quiet son** of *that violent father* who was diagnosed with cancer. Who was diagnosed with cancer?

NP1-----------------------------------------------NP2
1  2  3  4  5  6  7
28. Everyone present cried at the funeral of the **pretty daughter** of **that irresponsible manager** who was killed.
   Who was killed?

   NP1---------------------------------------------------------------NP2
   1  2  3  4  5  6  7

29. Jesse saw the **obedient helper** of **that fierce supervisor** who just lost his job.
   Who lost his job?

   NP1---------------------------------------------------------------NP2
   1  2  3  4  5  6  7

30. Someone told me about that **generous father** of **that greedy salesman** who just passed away.
   Who just passed away?

   NP1---------------------------------------------------------------NP2
   1  2  3  4  5  6  7

31. I recently spoke with **the brave mother** of **that cowardly man** who fell ill.
   Who fell ill?

   NP1---------------------------------------------------------------NP2
   1  2  3  4  5  6  7

32. Tom bumped into that **clever nephew** of **nasty Ken** who was badly abused by his teacher a while ago.
   Who was badly abused by his teacher?

   NP1---------------------------------------------------------------NP2
   1  2  3  4  5  6  7

33. Kelly just called **the diligent cousin** of **my haughty friend** who came down with high fever to find out how he is.
   Who came down with high fever?

   NP1---------------------------------------------------------------NP2
   1  2  3  4  5  6  7
34. Today is the birthday of the kind young daughter of the bad-tempered manager who died a month ago. Who died a month ago?

NP1----------------------------------------NP2
  1 2 3 4 5 6 7

35. Someone saw the conscientious friend of the selfish boy who broke his arm walk past. Who broke his arm?

NP1----------------------------------------NP2
  1 2 3 4 5 6 7

36. Someone told me the sad news of the docile friend of the insensitive lady who lost her job. Who lost her job?

NP1----------------------------------------NP2
  1 2 3 4 5 6 7

37. Sam cried at the news of the charitable relative of the arrogant businessman who fell off the cliff. Who fell off the cliff?

NP1----------------------------------------NP2
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38. Rachel met the intelligent housekeeper of the petty actor who became handicapped. Who became handicapped?

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39. The news of the helpful son of the grumpy father who turned blind spread around. Who turned blind?

NP1----------------------------------------NP2
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40. Someone saw the devoted wife of the domineering politician who got robbed on the street. Who got robbed?

NP1----------------------------------------NP2
  1 2 3 4 5 6 7
41. Janice saw the kind-hearted girlfriend of that bossy guy who was orphaned last summer at the bus station.
Who was orphaned last summer?

\[NP1\]  
1 2 3 4 5 6 7

42. Mike spoke with the thoughtful grandfather of that fussy girl who met with an accident in the hospital.
Who met with an accident?

\[NP1\]  
1 2 3 4 5 6 7

43. The news that the diligent pupil of that aggressive teacher who got kicked out of school shocked many people.
Who got kicked out of school?

\[NP1\]  
1 2 3 4 5 6 7

44. Michael met the nice landlord of the inconsiderate writer who fell gravely ill yesterday.
Who fell gravely ill?

\[NP1\]  
1 2 3 4 5 6 7

45. I cried when I heard about that young friend of my rude aunt who got diagnosed with lung cancer has already passed away.
Who got diagnosed with lung cancer?

\[NP1\]  
1 2 3 4 5 6 7

46. It was heartbreaking to see that delightful cousin of my mean friend who fell into a coma in her plight.
Who fell into a coma?

\[NP1\]  
1 2 3 4 5 6 7
47. It was heartbreaking to hear the news about *that joyful grandmother* of *that terrible footballer* who passed away.  
   Who passed away?

   NP1--------------------------------------------------------NP2
   1   2   3   4   5   6   7

48. It was terrible to hear about the *young and quiet nanny* of *that bossy kid* who lost her legs in an accident last week.  
   Who lost her legs?

   NP1--------------------------------------------------------NP2
   1   2   3   4   5   6   7

49. It was heart-wrenching to hear about *that beautiful housekeeper* of *that nasty housewife* who fell out the window.  
   Who fell out the window?

   NP1--------------------------------------------------------NP2
   1   2   3   4   5   6   7

50. It was horrible to know that *the meek wife* of *that incorrigible gambling addict* who was hospitalized is turning for the worse.  
   Who was hospitalized?

   NP1--------------------------------------------------------NP2
   1   2   3   4   5   6   7

51. The *sister* of *the singer* who danced just now is drinking some orange juice over there.  
   Who danced just now?

   NP1--------------------------------------------------------NP2
   1   2   3   4   5   6   7

52. The *friend* of *the girl* who smokes is driving a car without a legal license.  
   Who smokes?

   NP1--------------------------------------------------------NP2
   1   2   3   4   5   6   7
53. **The wife** of **the professor** who likes Chinese food has applied for a cooking course here. Who likes Chinese food?

```
NP1-----------------------------NP2
  1  2  3  4  5  6  7
```

54. **The classmate** of **the girl** who always lies has decided to be honest for once. Who always lies?

```
NP1-----------------------------NP2
  1  2  3  4  5  6  7
```

55. **The husband** of **that woman** who likes to talk behind others just walked past us. Who likes to talk behind others?

```
NP1-----------------------------NP2
  1  2  3  4  5  6  7
```

56. **The father** of **the artist** who devoted loads of money to the poor area enjoys planting. Who devoted loads of money to the poor?

```
NP1-----------------------------NP2
  1  2  3  4  5  6  7
```

57. **The wife** of **the boss** who is always hard on others was shopping in the mall. Who is always hard on others?

```
NP1-----------------------------NP2
  1  2  3  4  5  6  7
```

58. **The housekeeper** of **the rich woman** who was very rude had a very bad cold. Who was very rude?

```
NP1-----------------------------NP2
  1  2  3  4  5  6  7
```

59. **The secretary** of **the politician** who is a racist should be fired. Who is a racist?

```
NP1-----------------------------NP2
  1  2  3  4  5  6  7
```
60. The boyfriend of the girl who is an artist is having a showcase over there.
   Who is an artist?

   NP1-----------------------------------------NP2
   1  2  3  4  5  6  7

61. The female manager of that actress who just dumped her boyfriend has decided to quit her job.
   Who just dumped her boyfriend?

   NP1-----------------------------------------NP2
   1  2  3  4  5  6  7

62. The father of the daughter who is about to leave is crying badly.
   Who is about to leave?

   NP1-----------------------------------------NP2
   1  2  3  4  5  6  7

63. The grandfather of the boy who cooks really well once fought a battle in WWII.
   Who cooks really well?

   NP1-----------------------------------------NP2
   1  2  3  4  5  6  7

64. The parents of the student who was very excited all went home.
   Who was very excited?

   NP1-----------------------------------------NP2
   1  2  3  4  5  6  7

65. The assistant of the journalist who had been to Tibet will publish his own book.
   Who had been to Tibet?

   NP1-----------------------------------------NP2
   1  2  3  4  5  6  7
66. **The daughter** of **my friend** who is working in a supermarket was offered a place in a university.
   Who is working in a supermarket?
   
   \[
   \begin{array}{ccccccc}
   NP1 & \cdots & \cdots & \cdots & \cdots & \cdots & \cdots & NP2 \\
   1 & 2 & 3 & 4 & 5 & 6 & 7 \\
   \end{array}
   \]

67. **The servant** of **the king** who loves to read was shot.
   Who loves to read?
   
   \[
   \begin{array}{ccccccc}
   NP1 & \cdots & \cdots & \cdots & \cdots & \cdots & \cdots & NP2 \\
   1 & 2 & 3 & 4 & 5 & 6 & 7 \\
   \end{array}
   \]

68. **The pupil** of **the monk** who talks endlessly is now cleaning the yard.
   Who talks endlessly?
   
   \[
   \begin{array}{ccccccc}
   NP1 & \cdots & \cdots & \cdots & \cdots & \cdots & \cdots & NP2 \\
   1 & 2 & 3 & 4 & 5 & 6 & 7 \\
   \end{array}
   \]

69. **The friend** of **my aunt** who just came back from the UK is a scientist.
   Who just came back from the UK?
   
   \[
   \begin{array}{ccccccc}
   NP1 & \cdots & \cdots & \cdots & \cdots & \cdots & \cdots & NP2 \\
   1 & 2 & 3 & 4 & 5 & 6 & 7 \\
   \end{array}
   \]

70. **The child** of **that researcher** who was playing football is a math genius.
   Who was playing football?
   
   \[
   \begin{array}{ccccccc}
   NP1 & \cdots & \cdots & \cdots & \cdots & \cdots & \cdots & NP2 \\
   1 & 2 & 3 & 4 & 5 & 6 & 7 \\
   \end{array}
   \]

71. **The client** of **the businessman** who looks pale just came out of the hospital.
   Who looks pale?
   
   \[
   \begin{array}{ccccccc}
   NP1 & \cdots & \cdots & \cdots & \cdots & \cdots & \cdots & NP2 \\
   1 & 2 & 3 & 4 & 5 & 6 & 7 \\
   \end{array}
   \]
72. The nurse of the patient who wears a pink wig is a very nice person.
    Who wears a pink wig?

    NP1---------------------------------------------------------------NP2
    1 2 3 4 5 6 7

73. The landlord of the writer who has a nasty nose went to the beach this morning.
    Who has a nasty nose?

    NP1---------------------------------------------------------------NP2
    1 2 3 4 5 6 7

74. The kid of the woman who was crying by the road is a very kind person.
    Who was crying by the road?

    NP1---------------------------------------------------------------NP2
    1 2 3 4 5 6 7

75. The researcher of the professor who left for America was diligent.
    Who left for America?

    NP1---------------------------------------------------------------NP2
    1 2 3 4 5 6 7

END