

Mandarin speakers undergoing attrition produce more explicit referring expressions*

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Abstract: Continuous immersion in a second language causes speakers' first language to change, a phenomenon known as L1 attrition. We explored (1) whether bilingual native Mandarin speakers display any attrition-related changes in their use of referring expressions in Mandarin after exposure to English, and (2) whether the severity of attrition is affected by the amount of exposure to both Mandarin (L1) and English (L2). All participants completed a questionnaire to assess their language experience, and a picture description task in spoken Mandarin. The results show that where more monolingual Mandarin speakers preferred null pronouns, bilingual speakers tended to use overt pronouns and/or NPs (i.e., proper names), suggesting attrition-related changes in their native language which favoured explicitness. Our study also shows that decreased use of L1 coupled with increased use of L2 is likely to result in a greater degree of attrition, although such an association is not statistically reliable in all models.

Keywords: L1 attrition, Mandarin Chinese, Referring expressions, Production

1. Introduction

Continuous immersion in a second language causes the speaker's first language to change, a phenomenon known as L1 attrition (Cook, 2003; Sorace, 2005). Attrition has been shown to affect phonology (Bergmann et al., 2016), the lexicon (Olshtain & Barzilay, 1991), and syntax (Flores, 2012; Tsimpli et al., 2004). Notably, syntactic attrition is selective, insofar as certain linguistic structures are more easily affected by attrition than others (Chamorro & Sorace, 2019; Gürel, 2004). The Interface Hypothesis (Sorace & Filiaci, 2006) predicts that structures involving syntax and other cognitive domains, such as pragmatics, are more susceptible to change than those that do not involve such an interface.

The structure of referring expressions serves as a pertinent example of such an interface in the exploration of L1 attrition. Many previous studies on L1 attrition have focused on the interpretational biases of null and overt subject pronouns in forward anaphoric sentences in pro-drop languages, such as Italian and Spanish, where the subject of a finite clause can be phonetically empty, as illustrated in (1).

(1) a. Italian

E' partito

Is-3s gone-M

'He left.'

Tsimpli et al.(2004), p. 259

b. Spanish

Pedro/*pro* salió del restaurante.

Pedro/*pro* left of+the restaurant.

'(Peter) left the restaurant.'

Chamorro (2018), p. 2

Speakers of pro-drop languages who are undergoing attrition tend to accept overt pronouns in contexts where monolingual speakers would prefer null pronouns (Spanish in Chamorro et al., 2016; Turkish in Gürel, 2002; Greek in Kaltsa et al., 2015; Italian in Tsimpli et al., 2004). Similar overextension of overt pronouns has been reported in research across various language development fields, including heritage language (e.g., Spanish in Montrul, 2004;

Greek in Kaltsa et al., 2015), child bilingualism (e.g., Greek-English in Argyri & Sorace, 2007; Italian-English in Serratrice et al., 2004; Spanish-Italian in Sorace et al., 2009), and second language (L2) acquisition (e.g., Italian in Belletti et al., 2007; Spanish in Margaza & Bel, 2006). Additionally, some studies have reported an overuse of noun phrases (NPs) in L2 learners (e.g., Italian in Chini, 2005; French and English in Leclercq & Lenart, 2013; English in Ryan, 2015) and child bilingualism (German-Greek in Torregrossa et al., 2021). Over-explicitness in reference therefore appears to be a widespread phenomenon in bilingualism.

Mandarin Chinese is a radical pro-drop language that permits both subject and object drop and is distinct from often closely related Indo-European languages like Spanish and Italian that have been the focus of many studies on attrition. A growing number of Chinese people study, work, and live abroad, and are likely to be experiencing attrition. Despite this, the effects of L1 attrition in Mandarin have not been adequately explored, specifically regarding referring expressions. Investigating L1 attrition in Mandarin can reveal whether the bilingual over-explicitness in reference is particular to certain languages or reflect a wider linguistic trend. Here we explore (1) whether bilingual native Mandarin speakers display any attrition-related changes in their use of referring expressions after exposure to English as an L2, and (2) whether the severity of attrition is affected by the amount of exposure to both L1 and L2.

1.1 Pronoun comprehension and production in Italian and Spanish

There has been extensive research on bilingual over-explicitness in reference. In this section, we review studies conducted in monolingual speakers of Italian and Spanish, as their characteristics as null-subject languages can provide valuable insights for comparative analysis with Mandarin Chinese. In subsequent sections we review studies on: the effects of bilingualism (including attrition) on reference in Italian and Spanish; reference in

monolingual Mandarin speakers, and finally the effects of bilingualism on reference in Mandarin.

Comprehension

It is well-established that the interpretation of referring expressions is based on an interplay of various sources including syntax (Carminati, 2002; Chambers & Smyth, 1998; Fukumura & Van Gompel, 2015), semantics (Arnold, 2000), and pragmatics (Almor, 1999; Ariel, 1990). From a pragmatic perspective, Accessibility Theory (Ariel, 1990) posits that the appropriateness of a referring expression is associated with the accessibility of the referent under discussion. The accessibility of the referent in the speaker's mental representation is influenced by multiple factors, with topicality being one of them. In many cases, a discourse topic is typically the grammatical subject of a sentence. As such, an antecedent in the subject/topic position has higher mental accessibility than an antecedent in a non-subject/non-topic position, and is thus more likely to be referred to with a more reduced expression (e.g., overt or null pronouns). Furthermore, NPs and overt pronouns can be used to refer to a referent of lower mental accessibility, signalling topic shift (Chamorro, 2018).

Studies on the interpretation of null and overt subject pronouns in Romance languages such as Italian and Spanish are compatible with predictions proposed by the Accessibility Theory. Carminati (2002) asked native Italian speakers to choose a preferred interpretation after reading ambiguous sentences involving either a null pronoun or an overt pronoun, where participants presented with the sentence in (2) chose either (a) or (b) as their interpretation (a involves interpreting the pronoun as the subject, b as the object). The findings indicated a subject bias for the null pronoun (81%) and an object bias (83%) for the overt pronoun, leading to a clear division of labour between null and overt pronouns, known as the Position of Antecedent Strategy (PAS).

- (2). Marta scriveva frequentemente a Piera quando \emptyset /lei era negli Stati Uniti.
‘Marta wrote frequently to Piera when \emptyset /she was in the United States.’
- a. Quando Marta era negli Stati Uniti.
‘When Marta was in the United States.’
- b. Quando Piera era negli Stati Uniti.
‘When Piera was in the United States.’

Filiaci et al., (2014) explored interpretational biases of null and overt subject pronouns in Spanish and Italian using similar methods. They found that, as for Italian, Spanish null pronouns are consistently interpreted as referring to the subject antecedent. However, the overt pronoun in Spanish behaves differently from the overt pronoun in Italian, and is roughly equally likely to be interpreted as referring to subject and object antecedents.

Production

In production, existing research indicates that native Italian and Spanish speakers prefer to use NPs over overt pronouns when referring to referents with a relatively low degree of prominence, such as an antecedent in the non-subject/topic position (Belletti et al., 2007; Contemori et al., 2023; Montrul, 2004); note that this is despite the comprehension preferences reviewed above, where overt pronouns are often understood as referring to these less prominent antecedents.

Montrul (2004)¹ analysed the elicited oral narrations of Spanish monolinguals.

Monolinguals used significantly more null subjects (57.2%) than overt subjects (42.8%),

¹ In null-subject languages like Spanish, Italian, and Greek, subjects can appear before or after verb, depending on information structure and verb types (Tsimpli et al., 2004). Montrul (2004) explored the role of verb types in the production of preverbal and postverbal subjects in Spanish. For example, subjects of unaccusative verbs often occur in postverbal position (a), while subjects of unergative verbs prefer preverbal position (b).

- a. María llegó ayer. /Ayer llegó María. (preferred)
‘Mary arrived yesterday. / *Yesterday arrived Mary.’
- b. María trabajó ayer. (preferred) / Ayer trabajó María.
‘Mary worked yesterday. / *Yesterday worked Mary.’

Here we only discuss their findings on preverbal subjects. This is because such distinctions of preverbal and postverbal subjects are not relevant to Mandarin Chinese and are not the focus of this study.

including both NPs and overt pronouns). They consistently used overt subjects in contexts involving a change of referent or to make emphasis, and null pronouns when referring to the same referent mentioned in the preceding sentence. In terms of overt subjects, more NPs (84.6%) were used than overt pronouns (15.4%). This production pattern of referring expressions is also observed in Italian monolingual speakers. Belletti et al. (2007) studied reference production in Italian among Italian monolinguals and L2 near-native learners of Italian in a storytelling task. Monolingual Italian speakers used significantly fewer overt pronouns (4%) compared to 59% null pronouns and 22% lexical phrases. Generally, native Italian and Spanish speakers rarely use overt pronouns in production, instead alternating null pronouns with NPs.

1.2 Bilingual pronoun comprehension and production in Italian and Spanish

The pronominal structure in null-subject languages serves as a testbed for the investigation of L1 attrition. Many previous studies in Italian and Spanish focus on attrited speakers' interpretations of null and overt pronouns in comparison to those of monolinguals. However, there is a gap in the literature when it comes to attrition effects on production in Spanish and Italian. Therefore, the review will primarily focus on the comprehension of Italian and Spanish pronouns in L1 attriters and the production in other bilingual populations such as L2 learners and heritage speakers.

Comprehension

Tsimpli et al. (2004) tested Italian L1 speakers with near-native proficiency in English as an L2 on their interpretation of null and overt subject pronouns in Italian, using sentences as shown in (3); participants chose between images illustrating the subject referent, the object referent, and a third referent that was not mentioned in the main clause to indicate their

interpretation. They found that monolingual Italian speakers tended to coreference the overt pronoun with the object referent (as in Carminati, 2002), whereas their English-proficient Italian speakers (presumably undergoing attrition) tended to interpret the overt pronoun as referring to the subject referent, suggesting that L1 attrition affects pronoun interpretation, and that attrited speakers have a preference for more explicit forms of reference.

(3). L'anziana signora saluta la ragazza quando lei / *pro* attraversa la strada.

‘The old woman greets the girl when she crosses the street.’

Chamorro et al. (2016) conducted a similar experiment exploring attrition in Spanish. They tested three groups of participants (monolingual Spanish speakers, attrited L1 Spanish-L2 English speakers, and a group of attrited Spanish speakers who were re-immersed in Spanish during a short period of stay in Spain). The experiment consisted of two tasks, covering both online processing (via eye-tracking) and offline interpretation (via acceptability judgements) of Spanish null and overt pronouns in forward anaphoric sentences similar to Tsimpli et al. (2004). While the offline acceptability judgement task showed no difference between groups, the eye-tracking data revealed, in the attrited group, a lack of sensitivity to a pronoun mismatch condition where an overt pronoun is coreferential with a subject referent, compared to the monolingual and re-exposed groups. These findings are consistent with a greater acceptance of overt reference in speakers undergoing attrition, and suggest that re-immersion to the L1 can partially reverse the process of L1 attrition. This study also supported the prediction in Sorace (2011) that L1 attrition at the individual level may only affect the speakers' ability to process the interface structure online without affecting their knowledge representations.

Production

Studies on reference production in Italian and Spanish by L2 learners (Belletti et al., 2007), heritage speakers (Contemori et al., 2023; Montrul, 2004), and child bilinguals (Serratrice et al., 2004; Serratrice, 2007; Torregrossa et al., 2021; Torregrossa & Bongartz, 2018) reported two different forms of referential overexplicitness among bilingual speakers: (1) the overuse of overt pronouns and (2) the overuse of lexical phrases.

In Belletti et al. (2007), L2 near-native learners of Italian (L1 English) produced significantly more overt subject pronouns (14%) than monolingual Italian speakers (4%) in a storytelling task. Torregrossa & Bongartz (2018) analysed reference production of German-Italian bilingual adolescents in Italian using a picture description task, revealing an overuse of NPs by bilingual speakers where null pronouns would be more appropriate. Montrul (2004) tested both advanced and intermediate proficiency Spanish heritage speakers on their reference production. The two groups of heritage speakers used 25.7% and 30.2% overt pronouns respectively, compared to 15.4% produced by monolingual speakers, revealing an overuse of overt pronouns. In a study of the referential choices of heritage Spanish speakers in a picture description task, Contemori et al. (2023) reported overuse of NPs by bilingual speakers in three situations: (1) when referring to a single character mentioned in the preceding context; (2) after introducing a second character, referring to it in the presence of the first character; and (3) when re-introducing the first character in the discourse.

1.3 Pronoun comprehension and production in Mandarin Chinese

Comprehension

As previously discussed, the interpretation of Italian and Spanish null and overt pronouns aligns with the predictions of the Accessibility Theory. Specifically, null pronouns in these languages consistently corefer with the more accessible referent in the subject/topic position,

whereas overt pronouns are more likely to refer to the less accessible referent in the non-subject/non-topic position (in Italian this preference is very strong, whereas in Spanish the interpretation of overt pronouns is more flexible). In contrast to monolingual Italian/Spanish speakers, the bilingual and attrited speakers appear to be less well aligned with Accessibility Theory in their overuse of overt pronouns.

In Mandarin Chinese, there appears to be a strong subject bias for both null and overt pronouns in comprehension (Yang et al., 1999). However, a recent study conducted by Zhang & Kwon (2022) on the interpretational biases of the two pronoun types in forward anaphoric sentences as shown in (4) demonstrates that while both pronoun types prefer coreference with the subject referent, null pronouns exhibit a stronger bias than overt pronouns. This is consistent with Accessibility Theory.

(4). Li Gang_{male} gei Wang Qiang_{male} da dianhua deshihou, \emptyset /**ta**_{male} haizai bangongshi.

‘When Li Gang_{male} called Wang Qiang_{male}, (he) was in the office.’

Production

Hwang (2021) explored the production of referring expressions in written and spoken Mandarin, using methods adapted from similar studies conducted in English (Arnold & Griffin, 2007; Fukumura & van Gompel, 2010). Mandarin Chinese uses distinct written forms for third-person singular pronouns "他 (he)" and "她 (she)" to indicate gender, whereas in spoken Mandarin, they share the same pronunciation, remaining gender-neutral. The study used a story-continuation task in which participants were asked to read a sentence and then to continue the story. Participants were presented with one-character prompts (example 5a) or two-character prompts (examples 5b-c) where the two characters were of the same (example 5b) or different (example 5c) genders. In the two-character conditions, participants were

instructed to continue the story with either the subject or the non-subject antecedent.

Participants were instructed to avoid the use of null pronouns as they can lead to ungrammatical sentences in written Mandarin but not in spoken Mandarin.

(5) a. Xiaohong_{female} xiangqu chaoshi.

‘Xiaohong_{female} wants to go to a supermarket.’

b. Xiaohong_{female} xianggen Xiaoli_{female} quchaoshi.

‘Xiaohong_{female} wants to go to a supermarket with Xiaoli_{female}.’

c. Xiaohong_{female} xianggen Xiaogang_{male} quchaoshi.

‘Xiaohong_{female} wants to go to a supermarket with Xiaogang_{male}.’

Consistent with findings for a similar task in English (Arnold & Griffin, 2007), both written and spoken tasks in the two-character condition resulted in more use of NPs (i.e., proper names) compared to the one-character condition. In the written task, speakers produced more pronouns in different-gender contexts than in same-gender contexts, while no significant difference between the two gender contexts in pronoun use was observed in the spoken task. Mandarin speakers’ pronoun usage therefore seems to be influenced by referential ambiguity, indicating a preference for avoiding potentially ambiguous expressions. However, this strategy does not fully explain the notable reduction in pronoun usage observed in the different-gender context of the two-character condition in the written Mandarin task, where pronoun usage is not inherently ambiguous. Arnold & Griffin (2007), in their study conducted in English, proposed that the decreased usage of pronouns in the two-character condition is driven by semantic competition, where two referents compete for attention. This implies that reference production is constrained by speaker-internal cognitive

pressures such as attention, as well as partner-directed factors such as potential ambiguity; overall, the process of reference production might involve an interplay of different strategies.

1.4 Bilingual pronoun comprehension and production in Mandarin Chinese

No research has looked at L1 attrition effects on pronoun comprehension and production in Mandarin Chinese. The most relevant studies we are aware of are those examining the comprehension and production of referring expressions among L2 learners (Slabakova et al., 2024; Zhao, 2014), child bilinguals (Zhou et al., 2022), and heritage speakers (Jia & Paradis, 2015; Wu, 2020) of Mandarin Chinese.

Comprehension

Findings from studies on comprehension of Mandarin referring expressions are again consistent with the general picture that late bilinguals diverge from native speakers when it comes to pronouns, favouring more explicit options. Slabakova et al. (2024) investigated the interpretation of null and overt pronouns within embedded sentences, as illustrated in (6). L2 learners and native speakers differed only in the interpretation of overt pronouns, with L2 learners more frequently coreferring overt pronouns with subject referents (71.5%) compared to native speakers (56.4%).

(6) Daxiang_i change-de Ø_{i/*j}/tai_j/Little Monday_j ku qilai le².

‘Big Elephant sang, and as a result he began to cry.’

Zhao (2014) also examined how L1 English L2 learners of Mandarin, alongside native Mandarin speakers, interpret null and overt pronouns in both forward and backward

² Previous studies claim that the overt pronoun *ta* in such Mandarin resultative sentences only allows disjoint reading (refer to Huang J., 1992; Huang Y., 1994; Shibata & Yashima, 2014). However, Slabakova et al. (2024) present findings that contradict this claim.

anaphora sentences, as shown in (7), using a picture verification task. Participants in both groups consistently interpreted null pronouns as referring to subject referents in both forward and backward anaphora conditions. They also allowed overt pronouns to be coreferential with subject referents in the forward condition (albeit with indeterminacy) but did not allow such coreference in the backward condition. Overall, L2 learners did not statistically differ from native speakers in those contexts. However, when analysing the data of individual participants in the backward condition, some L2 learners accepted the overt pronoun as referring to the subject referents, while native speakers consistently rejected this coreference.

(7) a. *Forward anaphora*

Xiao Zhang_i chi fan de shihou, e_i/ta_{i/j} dai zhe yi tiao haokan de xianglian.

‘When Xiao Zhang is eating, he is wearing a pretty necklace.’

b. *Backward anaphora*

e_i/ta_j changge de shihou, Li Hong_i chuan zhe yi tiao baise de qunzi

‘When she is singing, Li Hong is wearing a white dress.’

Production

Wu (2020) investigated the acquisition of Mandarin pronouns among two groups of L1 English L2 learners of Mandarin with low and high Mandarin proficiency and two corresponding groups of heritage speakers in an oral narration task.³ Production patterns of highly proficient L2 learners and heritage speakers were in line with native speakers, having comparable use of NPs and both overt and null pronouns. Consistent with the previously

³ Wu categorized NPs used by speakers into six types, including bare nouns, proper names, possessive + NP, demonstrative + NP, numeral + NP, "The" + NP, and "Another" + NP in referent introduction, maintenance, and re-introduction contexts. Our primary concern is with the distribution of NPs rather than their types in referent maintenance. As such, we combined the usage frequencies of various NP types in the maintenance condition from the original paper.

discussed research in Italian and Spanish, these speakers also used fewer overt pronouns than NPs and null elements. Conversely, L2 learners and heritage speakers of low Mandarin proficiency diverged from native speakers in two ways. L2 learners used a higher percentage of overt pronouns (36.9%) compared to native speakers (17.5%), while heritage speakers used more NPs (56.2%) than native speakers (43.4%). This study did not differentiate the referring expressions used for subject referents and those for non-subject referents; further in-depth analysis may therefore reveal variations in the distribution of the three types of reference.

1.5 The causes of bilingual over-explicitness in reference

The role of L1 exposure

The correlation between the amount of L1 exposure and the severity of attrition has been extensively explored. The Activation Threshold Hypothesis (ATH) (Paradis, 1993) proposes that each language has an activation threshold and a linguistic element in one language may fall below this threshold if it is not frequently used. According to ATH, attrition occurs when an element in the L1 is not used frequently enough and competes with a corresponding element in the L2 that is used more often (Paradis, 2007). This hypothesis is supported by Chamorro et al. (2016) suggesting an inverse relationship between L1 exposure and the severity of attrition. Other studies have also observed a higher attrition level in participants experiencing diminishing exposure to their L1 (Bergmann et al., 2016; Flores, 2012; Kasparian et al., 2017; Opitz, 2013; Schmid & Yılmaz, 2018). However, some studies present contrasting results (Jarvis, 2003; Schmid & Jarvis, 2014). These divergent outcomes may arise from the inherent difficulty in quantifying the amount of L1 use (Schmid, 2007). Firstly, the concept of “language exposure” is not consistently defined and its form of measurement varies across different research studies (Carroll, 2017; De Cat et al., 2023). As such, there is

no universal form of quantification. Second, the assessment of L1 exposure often relies on participants' self-reports, which can be influenced by subjective factors such as their attitude towards their native language (Schmid, 2002). Moreover, the decrease in L1 exposure typically aligns with an increase in L2 exposure among late bilinguals, thus making it difficult to disentangle these two intertwined processes (Schmid & Yilmaz, 2018). The intricate nature of these challenges pinpoints the importance of considering the dynamic relationship between L1 and L2 exposure in understanding the process of L1 attrition.

Cross-linguistic interference

In studies exploring L1 attrition at the pronominal interface structure, where participants' L2 is a not null-subject language, such as English, the preference for a more explicit form of reference is often considered as attributed to cross-linguistic interference – the transfer effect of L2 on L1 (Tsimpli et al., 2004). For instance, the extension/overuse of overt pronouns is understood to be influenced by English, which has only one pronominal option in the specific discourse context examined in those studies. However, this phenomenon of bilingual over-explicitness in reference cannot be solely explained by cross-linguistic interference. This is evident in studies on child bilinguals (Sorace et al., 2009) and L2 learners (Belletti et al., 2007; Margaza & Bel, 2006) of two null-subject languages (e.g. Spanish and Italian), which show the same over-extension of overt pronouns.

It has therefore been suggested that a general principle of bilingual processing is to select a cognitively less demanding option in real-time, due to fewer available cognitive resources in bilinguals who handle more than one language in their mind (Gürel, 2019; Sorace, 2011, 2016). Some studies have attempted to explore how cognitive capacity influences bilinguals' referential choices. Contemori & Ivanova (2021) examined the impact of working memory (both verbal and visual) on the referential choices of Spanish-English

bilinguals in English (L2). They set up three conditions in a picture description task: verbal load (memorising five digits while describing pictures), no load (memorising digits after description), and visual load (memorising square positions during description). Results revealed that bilingual speakers used more pronouns than English monolinguals, yet their reference usage did not differ across memory load conditions, while monolinguals showed a slight increase (marginal effect) in pronoun use under verbal load compared to no load. The study concluded that increased cognitive demands did not affect bilinguals' overuse of pronouns. However, previous research has shown that bilinguals are more adept in ignoring irrelevant information (Treccani et al., 2009). As such, the findings in Contemori & Ivanova (2021) could also suggest enhanced inhibitory control efficiency among bilinguals during the picture description task, given that the added cognitive demands were completely unrelated to the language task and could be seen as an irrelevant distraction task, in which case the absence of an impact on overuse of pronouns might be expected. Furthermore, other research often finds no difference between bilingual and monolingual groups in behaviour measures but reveals differences in brain imaging (e.g., greater activation in different brain regions; Bialystok et al., 2005). As such, drawing definite conclusions from Contemori & Ivanova (2021) may be premature.

Similarly, cross-linguistic influence cannot explain the overuse of NPs in other bilingual populations such as L2 learners since NPs are a common feature in both languages of bilinguals. (Ryan, 2015) argues that the overuse of NPs by bilingual speakers may stem from the motivation for ensuring clear communication, even at the expense of redundancy, rather than risking ambiguity.

2. The current study

Here we report an experiment investigating the use of three referential forms (null and overt pronouns, and NPs) in spoken Mandarin through a picture description task. In order to explore the effects of reduced L1 exposure / increased L2 exposure, we tested three groups of speakers: a control group consisting of more monolingual speakers based in China, and two experimental groups of more bilingual speakers resident in the UK. We address two research questions: (1) Do bilingual Mandarin speakers undergoing attrition in their L1 Mandarin tend to be more explicit in reference, as seen in L2 Mandarin and in attrition in L1 Italian and Spanish? (2) If so, is there a correlation between their attrition-related changes and their usage of L1 and L2 in their daily lives?

2.1 Methods

Participants completed a questionnaire adapted from the Language and Social Background questionnaire (Anderson et al., 2017), to assess their use of and exposure to Chinese and English, then completed an experiment consisting of a picture description task in spoken Mandarin, adapted from Arnold & Griffin (2007) and Hwang (2021).

Participants

We recruited participants for two experimental groups and a control group. The control group consisted of 31 mainland Chinese PhD researchers who had not travelled abroad, with an age range from 22 to 31 years (Mean: 26.87, SD: 2.23). The first experimental group consisted of 35 UK-based Masters students aged 20 to 29 years (Mean: 23.43, SD: 1.79) who had resided in the UK for 1 to 12 months (Mean 7.31 months, SD: 3.12). This group is referred to as the Short-Term English Exposure group. The second experimental group consisted of 35 UK-based PhD researchers who were either studying or had completed their PhD program in the UK. They ranged in age from 22 to 37 years (Mean: 28.6, SD: 3.34) and had spent between

33 and 131 months in the UK (Mean: 60.57 months, SD: 23.39). This group is referred to as the Long-Term English Exposure group. Each participant was paid £5 for their participation.

Stimuli

In the picture description task⁴, we used a sentence structure similar to Hwang (2021)⁵. The task was built using JsPsych (De Leeuw et al., 2023) to elicit spoken production from participants in response to images, audio descriptions, and text. The images were based on scenarios adapted from those in Zhang & Kwon (2022) and Hwang (2021). We designed images depicting a total of 224 scenarios, comprising 128 scenarios for the critical two-character condition, 64 for the one-character condition and 32 filler scenarios. These scenarios were constructed around four referents, comprised of two female characters (Xiaozi “Little Purple” and Xiaohong “Little Red”) and two male characters (Xiaolan “Little Blue” and Xiaohuang “Little Yellow”). The color of their hair and clothes matches their name, making it easier for participants to remember these character names.

Each scenario consisted of two actions, illustrated in two separate images – the context image and the target image (see Figure 1). The critical condition is the two-character condition, where the context image featured two animate referents of either the same or different genders, and the target image featured one of those two referents (either the subject or non-subject referent from the context image). We constructed critical two-character trials around 16 pairs of verbs (one verb for the context image, one verb for the target image; e.g. the context verb in the scenario in Figure 1 is “greeted”, the target verb is “picked up”); for

⁴ To access the full list of sentence and image stimuli, please go to the Stimuli folder via the link: https://osf.io/q2ev3/?view_only=d83cee3363ec4c1a91dfb2298dd402be

⁵ We used a sentence structure similar to Hwang (2021) instead of the extensively examined *when*-clause in those L1 attrition studies and in Zhang & Kwon (2022). This is because in the “when” temporal clause in Mandarin, where the pronoun is null, the sentence entails an adverbial clause inserted inside the matrix one; whereas in the case of the overt pronoun, this is the structure in which the adverbial clause precedes the matrix one (Yan, 2022). So, in principle, these two sentences are structurally different, thus naturally leading to different results.

each of these verb pairs we created 4 same-gender and 4 different-gender combinations, featuring different assignments of characters to the various roles in the context and target events, yielding an inventory of 128 possible two-character trials.

Scenarios in the one-character condition were adapted from the two-character condition, but the context image featured only one referent who reappeared in the target image. Each of the 16 verb pairs used for the two-character condition provided four possible one-character scenarios which differed only in the character involved, providing an inventory of 64 items for the one-character condition.

In filler scenarios, two animate referents, either two human characters (e.g., “Xiaozi and Xiaohong”) or one human and one animal character (e.g., “Xiaozi and the little bunny”), are depicted performing actions together in both context and target image, thereby forming a compound subject within a coordinative structure. Target image descriptions featured neither the NPs nor the pronoun forms we were interested in in the critical trials (e.g., a filler trial might be “Xiaozi and the little bunny took a nap together. They felt hungry afterwards.”).

We generated 16 experimental lists using the Latin Square method. Each list has 64 trials, including one variation of each of the 16 verb pairs from both the two-character and one-character conditions, alongside 32 fillers. Each referent appears an equal number of times within each list and across lists. Each variation of the 16 verb pairs in both two-character and one-character conditions was equally distributed across the lists. The presentation order of trials within each list was randomised, starting with two filler trials, and then following the pattern of one filler trial, one one-character trial, one filler trial, and one two-character trial throughout the task. Additionally, the 64 trials of each experimental list were divided into two blocks, each comprising 32 trials; to avoid potential priming effects between two-character and one-character trials, if a two-character scenario featuring a particular verb pair appeared

in the first block, then the corresponding one-character scenario adapted from it would not be presented in the same block.



Figure 1: An example of image stimuli used in the picture description task. In this given example, the audio description says “Xiaozi [Little Purple] greeted Xiaohong [Little Red]”. Participants are prompted to “Please repeat what you heard and then complete the story”, positioned above text giving target sentence. Above that is a prompt word, meaning “picked up”. In this scenario, in the subject continuity condition, we expected the participant to say (in Chinese) something like “Xiaozi greeted Xiaohong, then null/she/ Xiaozi [Little Purple] picked up the backpack”; in the shift condition we expected something like “Xiaozi greeted Xiaohong, then null/she/Xiaohong [Little Red] picked up the backpack”.

Questionnaire

The questionnaire was adapted from the Language and Social Background Questionnaire (Anderson et al., 2017). It comprises three sections: personal information, language

background, and language use in the community. A variety of question types was incorporated, including multiple-choice, short answers, and Likert scales⁶.

Procedure

All control participants in mainland China took part in the experiment online via a Zoom or Tencent (a widely used online meeting platform in mainland China) session with the researcher. UK-based participants were offered the flexibility to take part in the experiment either online (via Zoom or Teams) or in person in one of the labs at the University. During the online meeting, participants shared their screens with the researcher while completing the tasks – we adopted this procedure after finding in a pilot experiment that unsupervised remote participation from mainland China resulted in very low-quality production data.

During the experiment, participants first completed the questionnaire and then proceeded to the picture description task. During the picture description task, the context image and an audio description of the image were presented first in the centre of the screen for five seconds. Then, the target image, a prompt word positioned above the image, and a microphone icon below were displayed on the screen. Participants were instructed to repeat what they heard and then proceed to describe the target image using the provided prompt word. Recording of verbal responses was initiated by clicking the microphone icon, and participants could stop recording and move on to the next trial by clicking the icon again.

2.2 Predictions

We aim to address two primary research questions. First, we attempted to probe whether bilingual speakers, with Mandarin as L1 and English as L2, exhibit attrition effects in their

⁶ To access the full list of questions, please go to the Stimuli folder via the link: https://osf.io/q2ev3/?view_only=d83cee3363ec4c1a91dfb2298dd402be

native language, particularly concerning the choice of referential forms. In the critical two-character condition, we expected more NPs than pronouns for all three groups (following Hwang (2021), who found that speakers tend to use more NPs than pronouns in discourses involving two characters). Since bilingual speakers generally show a preference for the more explicit referential choice (Tsimpli et al., 2004; Slabakova et al., 2024), we expect our experimental groups to use more explicit referring expressions than our control group. Given that overt pronouns in spoken Mandarin are gender-neutral, they are inherently ambiguous in the two-character condition; indeed they might be more ambiguous in practice than null pronouns, which have a stronger subject bias⁷ (Zhang & Kwon, 2022). We therefore expect an increased use of NPs in our experimental groups presumably undergoing L1 attrition. This prediction is clearest for our Long-Term English Exposure group; the potential differences between the control group and the Short-Term English Exposure group remains uncertain partly due to their relatively shorter stay in the UK.

We expected minimal distinctions among the three groups in the one-character condition. This expectation arises from the fact that there is only one referent in the context, eliminating any ambiguity/competition introduced by an additional character. Additionally, since both overt and null pronouns exhibit a strong subject bias, the use of an overt pronoun is expected to be indistinguishable from the use of a null pronoun.

⁷ We conducted a baseline comprehension experiment following the sentence structure from Hwang (2021) in order to explore the interpretational biases of null and overt pronouns in this particular sentence structure. In the pilot experiment, 48 native Mandarin speakers in mainland China completed a picture verification task. They were asked to choose a picture from two options that they thought best matched the given sentence. After each trial, participants rated their confidence level on a Likert scale from 1 (very unsure) to 4 (very confident) regarding their choices. Bayesian mixed-effects logistic regression and ordinal logistic regression were computed to analyse the interpretation (binary) and confidence (ordinal) data, respectively. The results align with (Zhang & Kwon, 2022), suggesting a strong subject bias for both null (81.7%) and overt pronouns (73.6%). Overt pronouns are likely to have a weaker subject bias than null pronouns; however, this difference is not certain ($b = -0.53$, $CrI = [-1.21, 0.16]$, $pd = 94\%$). Additionally, it suggests that participants felt more confident when co-referring both null and overt pronouns with subject referents than with non-subject referents ($b = 1.01$, $CrI = [0.14, 1.88]$, $pd = 99\%$) but there is substantial uncertainty between overt and null pronouns in confidence ($b = -0.03$, $CrI = [-0.85, 0.76]$, $pd = 53\%$). The full analysis can be accessed in the Data Analysis – Comprehension folder via this link: https://osf.io/q2ev3/?view_only=d83cee3363ec4c1a91dfb2298dd402be

The second research question concerns the role of exposure to L1 and L2 in attrition effects. Previous studies indicate that increased exposure to L2, coupled with reduced use of L1, may lead to more severe attrition effects. Accordingly, we hypothesized that speakers with higher English exposure and lower Mandarin exposure would demonstrate more severe attrition in their reference production, showing a preference for the more explicit form. This difference should show up in a coarse-grained fashion by comparing across our three groups, but can also be assessed in a more fine-grained way by correlating our questionnaire data with participants' explicitness in the production task.

2.3 Data Analysis

We focused on participants' production of three referential forms, namely NPs (which were always proper names in the context of our experiment), overt pronouns and null pronouns, in the two conditions of the picture description task. We analysed the referential forms that speakers used in their first complete sentence when mentioning the target referent. Empty responses and responses containing plural forms (such as "Xiaozi and Xiaohong", or "They") or possessive forms (such as "Her hands") were excluded from data analysis. We also omitted responses in instances where participants altered the order of the context and target images and provided descriptions accordingly, for example, "Xiaohong picked up a backpack and greeted Xiaolan". Responses were also excluded in cases where there was a topic shift before speakers described the target referent in the topic-continuity context of the two-character condition, for example, "Little Red met Little Blue on the campus. Little Blue is Little Red's enemy, so Little Red was particularly unhappy."

Consequently, a total of 1515 trials in the two-character condition and a total of 1551 trials in the one-character condition were analysed using Bayesian mixed-effects logistic regression models with the brms package (Bürkner, 2017) in R (R Core Team, 2023).

Relevant pairwise comparisons between groups were extracted using the `emmeans` function from the `emmeans` package (Lenth et al., 2024). The probability of direction (pd) was obtained accordingly using the function `pd()` from the `bayestestR` package (Makowski et al., 2019). For each model, we used very weakly informative priors with mean 0 and standard deviation 1.5 (log-odds) for both the intercept and the other effects (which corresponds to a 95% Credible Interval between -3 and + 3 log-odds, equal to almost 0 to 100% probability)⁸. Four MCMC chains of 4000 iterations each were executed and the first 1000 iterations were warmup.

2.4 Results

Reference Production

Figure 2 and Figure 3 show the production distribution of the three referential forms in the two-character condition and one-character condition, respectively.

⁸ We use weakly informative priors because no existing research has examined reference production among late bilinguals of L1 Mandarin and L2 English in their L1 using the picture description task employed in the current study. Relevant research, such as Hwang (2021), suggests that speakers are likely to use more NPs than full pronouns in the condition involving two animate referents, but their study excludes Mandarin null pronouns. Wu (2020) suggests that low-proficiency heritage speakers of Mandarin used more NPs and L2 Mandarin learners used more overt pronouns compared to monolinguals Mandarin speakers, but their study focuses on a different bilingual population and uses a different experimental method. Although their research presents converging findings in terms of bilingual reference production, it is not appropriate to set our priors based on their data. Therefore, we decided to employ weakly informative priors in our models.



Figure 2: The production of three referential forms in the two-character condition when the target referent is the subject or non-subject of the previous context across three groups. Each dot corresponds to the results of one participant. The diamond shape represents the mean of by-participant percentages, with error bars showing bootstrapped 95% confidence intervals of the mean.

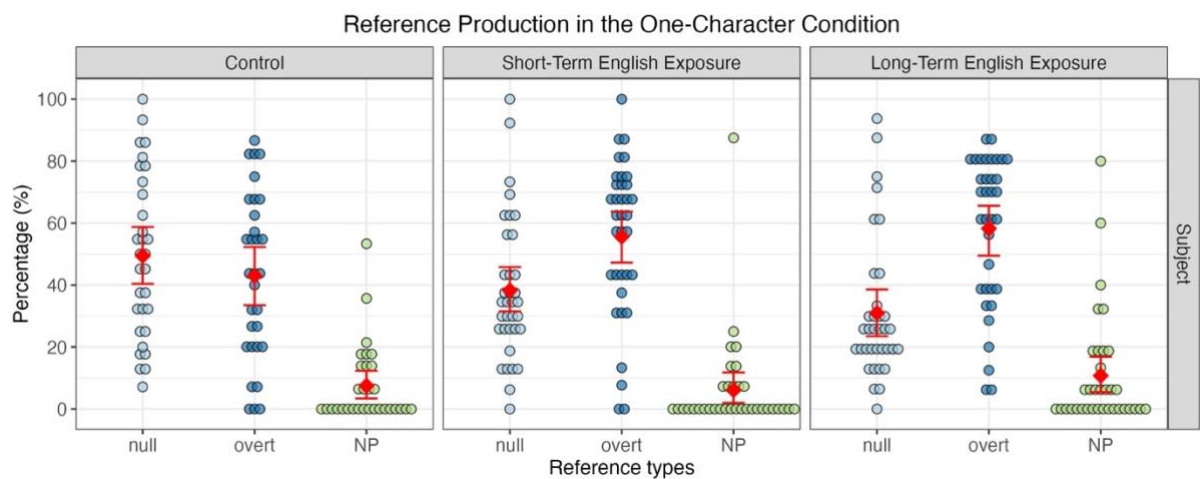


Figure 3: The production data of three referential forms in the one-character condition where there is only one referent in the context.

Our analysis⁹ of referring expressions for two-character scenes included fixed effects of the referent role (subject or non-subject of the context sentence), group (Control, Short-term English Exposure, Long-term English Exposure), and their interaction. The subject role was set as reference levels in all models. We used Reverse Helmert contrast for Group, which produces two Group fixed effects: one which compares the Long-term and Short-term English Exposure groups against each other, and a second which compares the two bilingual groups against the control group. Additional marginal comparisons of interest were obtained using emmeans. The model included by-participant and by-item random intercepts and slopes for referent role. We ran two analyses, one comparing production of NPs with production of pronouns forms (coding NPs as 1 and overt or null pronouns as 0), and a second analysis comparing production of overt versus null pronouns (overt pronouns coded as 1, null pronouns as 0, with NPs coded as NA and excluded from this analysis).

Table 1 provides the results of all Bayesian models for group comparisons between NPs and pronouns as well as between overt and null pronouns in the two-character condition. When comparing NPs with pronouns, the analysis indicates that there is a slight preference to use NPs for subject referents ($b = 0.74$, $\text{CrI} = [0.34, 1.16]$, $\text{pd} = 100\%$), but that NPs were used substantially more for non-subject referents ($b = 3.31$, $\text{CrI} = [2.59, 4.16]$, $\text{pd} = 100\%$). For Subject referents, the Short-Term English Exposure group uses fewer NPs than the Long-Term English Exposure group ($b = -0.36$, $\text{CrI} = [-0.70, -0.03]$, $\text{pd} = 98\%$), although the magnitude of this effect is uncertain; the second group-based contrast comparing the Control group and the combined data from the more bilingual groups indicates similarly shows less use of full NPs in the more monolingual group, but substantial uncertainty regarding the directionality and magnitude of the effects ($b = -0.11$, $\text{CrI} = [-0.31, 0.09]$, $\text{pd} = 87\%$).¹⁰

⁹ The full analysis can be accessed in the Data Analysis – Production folder via this link: https://osf.io/q2ev3/?view_only=d83cee3363ec4c1a91dfb2298dd402be

¹⁰ Pairwise comparisons obtained via emmeans are consistent with the contrasts from the main model for subject referents: the Long-Term English Exposure group uses more NPs than the Short-Term English Exposure group

The interaction terms represent the way in which the effect of Role differs among the groups with the first term capturing the difference in the effect of Role between the Short-Term and the Long-Term groups ($b = 0.19$, CrI = [-0.40, 0.76], pd = 74%) and the second term capturing the difference between the Control group and two bilingual groups combined ($b = 0.22$, CrI = [-0.15, 0.62], pd = 88%); in both cases, the wide credible intervals that span both negative and positive values for both interaction terms suggest substantial uncertainty regarding the directionality and magnitude of those effects, although in both cases the positive estimates indicate a larger effect of Role in the more bilingual groups e.g. a larger shift towards NPs for non-subjects in the Control group relative to the more bilingual groups).

When comparing overt vs null pronouns, the analysis reveals no clear indication of a speaker preference for overt over null pronouns, for both subject and non-subject referents, as indicated by the wide range of credible intervals that include both negative and positive values (intercept, indicating subject role: $b = -0.41$, CrI = [-1.14, 0.30], pd = 87%; effect of non-subject role: $b = -0.07$, CrI = [-2.13, 1.92], pd = 53%). The credible interval for the comparison between the Long-Term and Short-Term English Exposure groups for subject referents also indicate considerable uncertainty ($b = -0.22$, CrI = [-0.42, 0.90], pd = 74%). In contrast, the Control group tends to use fewer overt pronouns, i.e. more null pronouns than the two more bilingual groups combined ($b = -0.44$, CrI = [-0.90, -0.04], pd = 98%), although again with substantial uncertainty regarding the magnitude of this effect.¹¹ The directionality

($b = 0.72$, CrI = [0.06, 1.39], pd = 98%) and Control group ($b = 0.69$, CrI = [-0.01, 1.38], pd = 98%), although the magnitude of the effect is quite uncertain since the credible interval is wide; for the comparison between the Short-Term English Exposure and Control groups, the credible intervals include both large negative and positive values thus not enabling us to make statements about this comparison ($b = -0.03$, CrI = [-0.70, 0.66], pd = 53%; i.e. both a negative or a positive effect is possible).

¹¹ Pairwise comparisons obtained via emmeans show that, for subject referents, the Short-Term English Exposure group use more overt pronouns than the Control group ($b = 1.50$, CrI = [0.17, 2.98], pd = 99%), although the magnitude of this effect is quite uncertain as the range of CrIs is very wide. The estimate and credible intervals suggest that the Long-Term English Exposure group is likely to use more overt pronouns than the Control group ($b = 1.06$, CrI = [-0.30, 2.60], pd = 94%); however, the possibility of the effect in the opposite direction cannot be ruled out and the effect magnitude is highly uncertain.

and magnitude of both interaction terms involving Role and Group are very uncertain ($b = -0.57$, $CrI = [-2.62, 1.55]$, $pd = 71\%$; $b = -0.85$, $CrI = [-2.72, 0.81]$, $pd = 85\%$).

Table 1: The outputs of Bayesian models for effects involving Role and Group in the two-character condition. For the NP vs pronouns analysis, positive estimates indicate more use of NPs than pronouns; for the Overt vs Null pronoun analysis, positive estimates indicate more use of overt than null pronouns. Role = Subject was set as the reference level; group is Helmert coded such that the two group fixed effects compare the more bilingual groups to each other (Group 1) and the Control group to the mean of the two more bilingual groups (Group 2).

Reference	Predictors	Estimates	95% CrI	PD (%)
NP vs Pronouns	Intercept (Role = Subject)	0.74	[0.34, 1.16]	100
	Role = Non-subject	3.31	[2.59, 4.16]	100
	Group 1 (Short-Term English Exposure vs Long-Term English Exposure)	-0.36	[-0.70, -0.03]	98
	Group 2 (Control vs Short-Term English Exposure + Long-Term English Exposure)	-0.11	[-0.31, 0.09]	87
	Role = Non-subject * Group 1	0.19	[-0.40, 0.76]	74
	Role = Non-subject * Group 2	0.22	[-0.15, 0.62]	88
Overt vs Null	Intercept (Role = Subject)	-0.41	[-1.14, 0.30]	87
	Role = Non-subject	-0.07	[-2.13, 1.92]	53
	Group 1 (Short-Term English Exposure vs Long-Term English Exposure)	0.22	[-0.42, 0.90]	74
	Group 2 (Control vs Short-Term English Exposure + Long-Term English Exposure)	-0.44	[-0.90, -0.04]	98
	Role = Non-subject * Group 1	-0.57	[-2.62, 1.55]	71
	Role = Non-subject * Group 2	-0.85	[-2.72, 0.81]	85

Second, we analysed the production of NPs, overt and null pronouns in the one-character condition. Since this condition features a single animate referent consistently assuming the role of the subject in the context sentence, the model contained only a fixed effect of Group (Control, Short-Term English Exposure, Long-Term English Exposure), with by-participant and by-item random intercepts.

Table 2 provides the model results of all Bayesian models for group comparisons in the one-character condition. When comparing use of NPs versus pronouns, the model shows that speakers produced more pronouns than NPs in this condition (as indicated by the model intercept, $b = -3.75$, $\text{CrI} = [-4.45, -3.16]$, $\text{pd} = 100\%$); the contrasts between groups show a wide range of positive and negative values in CrIs, indicating substantial uncertainty about the directionality and magnitude of any effect of degree of English exposure.

When comparing overt vs null pronouns, the analysis indicate that speakers are likely to use more overt pronouns but the possibility of the effect in the opposite direction cannot be ruled out and its magnitude is uncertain (as indicated by the model intercept, $b = 0.45$, $\text{CrI} = [-0.02, 0.93]$, $\text{pd} = 97\%$). The directionality in pronoun preference when comparing Long-Term and the Short-Term English Exposure groups is unclear ($b = -0.23$, $\text{CrI} = [-0.64, 0.17]$, $\text{pd} = 87\%$); however, the Control group uses fewer overt pronouns, i.e. more null pronouns, than the two more bilingual groups combined ($b = -0.32$, $\text{CrI} = [-0.56, -0.09]$, $\text{pd} = 100\%$).¹²

Table 2: The outputs of Bayesian models for Group in the one-character condition. For the NP vs pronouns analysis, positive estimates indicate more use of NPs than pronouns; for the Overt vs Null pronoun analysis, positive estimates indicate more use of overt than null pronouns. Group is Helmert coded such that the two group fixed effects compare the more bilingual groups to each other (Group 1) and the Control group to the mean of the two more bilingual groups (Group 2).

Reference	Predictors	Estimates	95% CrI	PD (%)
NP vs Pronouns	Intercept	-3.75	[-4.45, -3.16]	100
	Group 1 = Short-Term English Exposure vs Long-Term English Exposure NP	-0.46	[-1.11, 0.16]	93
	Group 2 = Control vs Short-Term English Exposure + Long-Term English Exposure NP	0.02	[-0.37, 0.41]	55

¹² Pairwise comparisons obtained via emmeans show that speakers in the Long-Term English Exposure tend to use more overt pronouns than speakers in the Control group ($b = 1.20$, $\text{CrI} = [0.38, 2.01]$, $\text{pd} = 100\%$) although the magnitude of the effect is uncertain. The Short-Term English Exposure group is likely to use more overt pronouns than the Control group; however, the opposite direction of this effect is still possible ($b = 0.74$, $\text{CrI} = [-0.09, 1.55]$, $\text{pd} = 96\%$).

Overt vs Null	Intercept	0.45	[-0.02, 0.93]	97
	Group 1 = Short-Term English Exposure vs Long-Term English Exposure Overt	-0.23	[-0.64, 0.17]	87
	Group 2 = Control vs Short-Term English Exposure + Long-Term English Exposure Overt	-0.32	[-0.56, -0.09]	100

2.4.2 Bilingual over-explicitness and the use of L1 and L2

We also conducted separate analyses using as predictors participants' questionnaire responses on English use in four skills (listening, speaking, reading, and writing), and English use in specific contexts. These analyses address our second question in a fine-grained manner: whether increased L2 use correlate with a preference for more explicit forms of reference.

We computed the average percentage of English use for each participant in the 4 skills of listening, speaking, reading and writing. We also computed the average self-reported percentage of English use in 12 specific contexts for each participant. We only included 12 contexts out of 20 included in the questionnaire: "at school", "with roommates", "with neighbours", "with friends", "social events", "activities", "shopping", "reading", "emails", "texting", "on social media", "watching shows". This is because speakers in all three groups reported using over 90% of Chinese in six contexts related to communication with family members at home and two contexts related to communication with colleagues at work were not applicable to speakers in the Short-Term English Exposure group.

Figure 4 illustrates the mean proficiency of English, Mandarin, and dialects in listening, speaking, reading, and writing, self-reported on a scale of 0-10. Speakers from the Long-Term English Exposure group reported the highest English proficiency in all four skills. All speakers reported the highest proficiency in Mandarin Chinese, with the Long-Term English Exposure and Short-Term English Exposure groups slightly surpassing the control group. In terms of dialects, 16 out of 35 speakers in the Long-Term English Exposure

group, 19 out of 35 in the Short-Term English Exposure group, and 10 out of 31 in the control group indicated a lack of daily use or proficiency in dialects. Speakers in the control group exhibited higher proficiency in dialect listening and speaking compared to their counterparts in the other groups.

Figure 5 depicts the mean proportion of language use in English, Mandarin, and dialects in the four skills by group. Figure 6 demonstrates the proportion of English use against Mandarin and dialects in 12 specific daily situations by group. As expected, speakers in the Long-Term English Exposure group reported the highest percentage of English use in the four skills and in daily contexts.

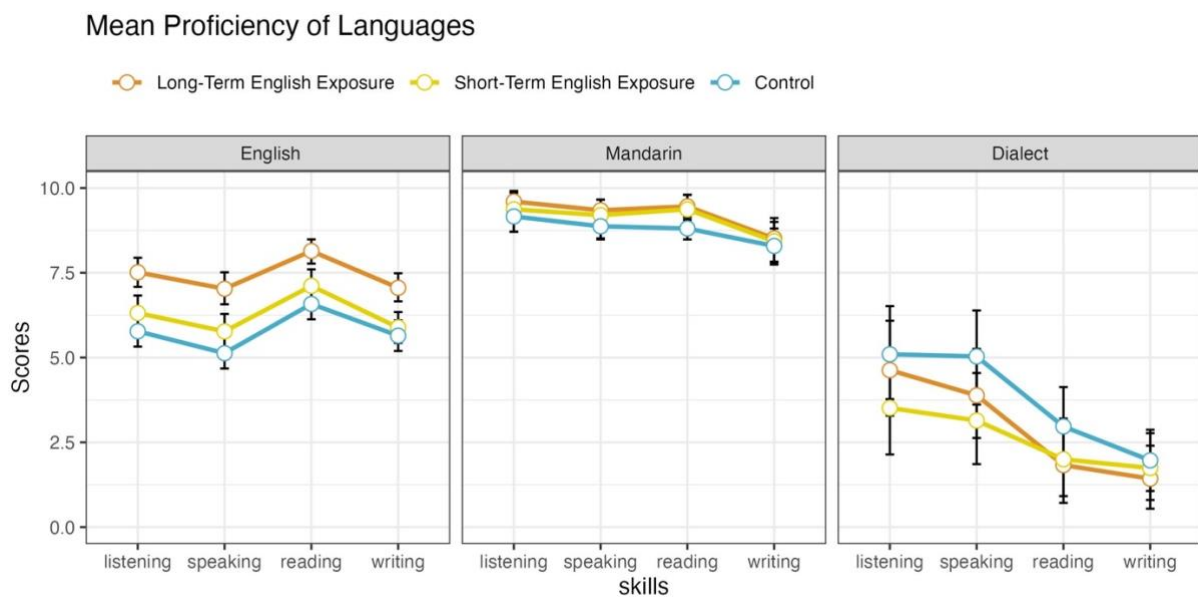


Figure 4: The mean proficiency scores in English, Mandarin, and Chinese dialects, across our three groups. Error bars show bootstrapped 95% confidence intervals of the mean.

Mean Proportion of Language Use

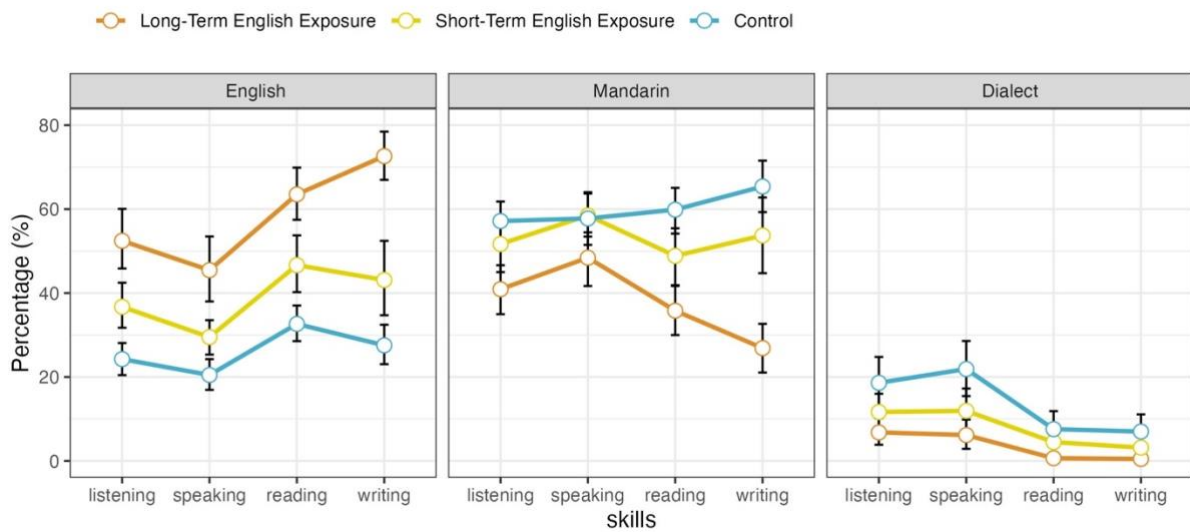


Figure 5: The mean percentage of language use in English, Mandarin, and Chinese dialects in the respective four skills across groups. Error bars show bootstrapped 95% confidence intervals of the mean.

Mean Proportion of English Use in Specific Contexts

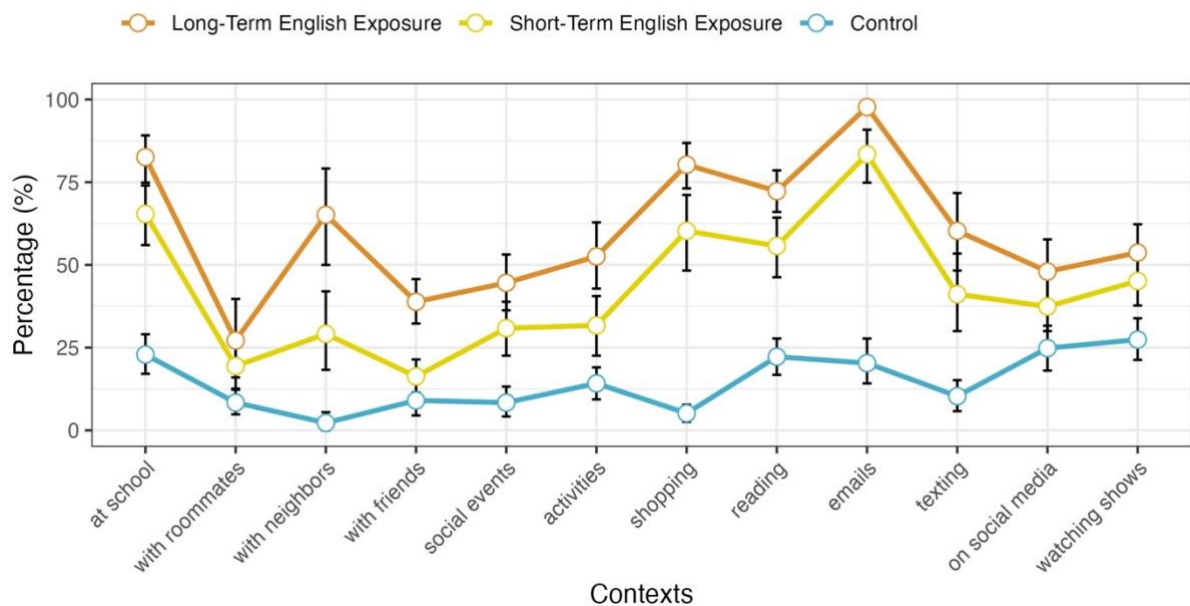


Figure 6: The mean percentage of language use in English against Mandarin and Chinese dialects in 12 specific daily situations.

We conducted separate analyses to investigate whether increased L2 (English) use correlates with a preference for more explicit forms. To ensure consistency, we scaled all continuous predictors in the models. Results are summarised in Table 3 and 4.

In the comparison of NPs with pronouns in the two-character condition, the probability of obtaining NP changes by -0.03 to 0.54 log-odds at 95% CrI (pd = 96%) for each increase of one standard deviation of the average percentage of English use in the four skills. It indicates that more English use in the four skills is likely to be positively associated with the more explicit form of reference, full NPs, but there is some chance this association could be very small or negative. A similar pattern is observed for English use in the 12 daily contexts and the use of NPs over pronouns ($b = 0.24$, CrI = [-0.03, 0.52], pd = 96%). In the analyses of the use of overt versus null pronouns, the association between English use in the four skills and the preference for overt pronouns is uncertain, with the credible interval including both large positive and negative values ($b = 0.18$, CrI = [-0.42, 0.97], pd = 74%). Additionally, the increased English use in daily contexts is likely to be positively associated with the use of overt rather than null pronouns ($b = 0.56$, CrI = [-0.00, 1.17], pd = 97%). The interaction terms in four different models represent the way in which the effect of Role differs in English use in four skills and English use in daily contexts on reference production. The CrIs for all interaction terms include both large positive and negative values, indicating substantial uncertainty of directionality and magnitude.

In the one-character condition, the directionality of the association between English use in the four skills and the use of overt rather than null pronouns is not reliable ($b = 0.20$, CrI = [-0.15, 0.56], pd = 88%). In contrast, increased English exposure in daily contexts tends to result in a preference for overt pronouns ($b = 0.37$, CrI = [0.10, 0.63], pd = 100%).

Table 3¹³: The outputs of Bayesian models for effects of role and English use in the two-character condition. The subject role was the reference level.

Reference	Effect	Estimate	95% CrI	PD (%)
	English Use in the Four Skills	0.25	[-0.03, 0.54]	96

¹³ We do not repeat coefficients for the Intercept (Role = Subject) and Role (= Non-subject) in this table as they have been presented in Table 1.

NP vs Pronoun	Role Non-subject * English Use in the Four Skills	0.04	[-0.45, 0.56]	55
	English Use in the 12 Daily Contexts	0.24	[-0.03, 0.52]	96
Overt vs Null	Role Non-subject * English Use in the 12 Daily Contexts	-0.22	[-0.72, 0.27]	81
	English Use in the Four Skills	0.18	[-0.42, 0.97]	74
	Role Non-subject * English Use in the Four Skills	1.38	[-0.45, 3.31]	94
	English Use in the 12 Daily Contexts	0.56	[-0.00, 1.17]	97
	Role Non-subject * English Use in the 12 Daily Contexts	0.44	[-1.45, 2.48]	68

Table 4: The outputs of Bayesian models for the effects of English use in the one-character condition.

Reference	Effect	Estimate	95% CrI	PD (%)
Overt vs Null	English Use in Four Skills	0.20	[-0.15, 0.56]	88
	English Use in 12 Daily Contexts	0.45	[0.13, 0.79]	100

3. Discussion and future work

We examined reference production in native Mandarin speakers with varying degrees of bilingualism, in order to probe for attrition effects in their native language. Speakers were asked to complete stories in two discourse conditions, a two-character condition involving two animate referents, and a one-character condition.

Our findings partially align with our predictions. In line with previous studies on reference production by Arnold & Griffin (2007) and Hwang (2021), all speakers, irrespective of their proficiency in their L2, used more NPs than pronouns in the two-character condition. Our more bilingual speakers tend to use more explicit forms of reference compared to their more monolingual peers, indicating attrition occurring in their L1. However, the two groups of more bilingual speakers demonstrate distinct preferences for explicitness. Specifically, speakers in the Short-Term English Exposure group tended to use more overt pronouns than Control speakers (as shown by the pairwise comparison reported in footnote 11), while speakers in the Long-Term English Exposure group tended to use more

NPs than monolingual speakers (as shown by the pairwise comparison reported in footnote 10). In the one-character condition, most participants used pronouns rather than NPs, as expected, but again we see a preference for more explicit forms of reference (more overt than null pronouns) in our more bilingual Long-Term and Short-Term English Exposure groups.

Our experiment also involved self-reports regarding speakers' language use in both Mandarin and English. When asking speakers to assess their language exposure, we took into consideration the dynamic change between L1 and L2, reflecting decreased L1 coupled with increased L2. Speakers were also asked to assess their language exposure through two lenses: (1) general language skills encompassing listening, speaking, reading, and writing, and (2) language use in more specific contexts such as communicating with friends, shopping, and participating in social events. This approach aims to capture a more comprehensive picture of speakers' language use across various aspects of their daily routines and interactions. The results show that using more L2 (English) and less L1 (Mandarin) are likely to deepen the attrition process, although the directionality of this association is not certain in some models. This tendency is consistent with previous studies on the role of language exposure in the attrition process (Chamorro et al., 2016).

Why does attrition result in the particular pattern of reference use that we see here? One possibility is that the production preferences of our participants relate to potential ambiguity, with more bilingual speakers going to greater lengths to avoid ambiguity and using more explicit forms. The more monolingual speakers in the control group reliably preferred null over overt pronouns for subject referents, indicating a stronger subject bias with null pronouns. This production pattern aligns with the preferences for pronoun interpretation in Zhang & Kwon and our comprehension study (see the results in the footnote). This makes sense since, as discussed earlier, the use of an overt pronoun in the two-character condition would lead to more ambiguity than a null pronoun, given that the

null pronoun has a stronger subject bias. We found no systematic preference between pronoun types in our two groups with more substantial exposure to English; however, as we do not have comprehension data for bilingual speakers, it remains unclear whether this production pattern aligns with their interpretational biases of null and overt pronouns (i.e. they may have a weaker subject bias for null pronouns, resulting in less preference for null pronouns in these contexts in production), indicating attrition occurring in both comprehension and production. The ambiguity avoidance strategy also appears insufficient to explain the referential choice of the more bilingual speakers in the one-character condition, where the use of an overt pronoun or a null pronoun is equally acceptable as there is no ambiguity caused by (or competition from) the presence of an additional character. In this condition, speakers of all three groups used overwhelmingly more pronouns than NPs; however, the two bilingual groups used more overt pronouns than the monolingual Control group.

One possible explanation is that the pronominal system in Mandarin for our bilingual speakers might simply be influenced by the English pronominal system, potentially resulting in increased usage of overt pronouns throughout. However, this cross-linguistic interference account does not explain the overuse of NPs in the Long-Term English Exposure group, since both languages have NPs. No single account appears to fully explain the two different forms of explicitness in bilinguals, and it may be that bilinguals' preference for explicitness could also reflect a more complex interplay of cognitive resources, language exposure, and perhaps even individual processing strategies. To understand and tease apart its underlying mechanisms, further research is essential. To delve deeper into the impact of cross-linguistic influence in the attrition process, we next plan to study late bilingual speakers whose two languages both permit subject drop, by testing native Mandarin speakers currently residing in Italy. Given that Italian and Mandarin are pro-drop languages, but with different distributions

of null and overt pronouns, we are intrigued to see how Mandarin-Italian speakers make referential choices in those discourse contexts.

4. Conclusion

We used a picture description task in spoken Mandarin to explore referential over-explicitness, a phenomenon often regarded as a sign of L1 attrition, among L1 Mandarin speakers with English as their L2. Speakers' referential choices referring to the subject referents were examined in both the two-character and one-character conditions. Our bilingual speakers show a preference for more explicit forms in both conditions compared to their more monolingual peers, suggesting attrition-related changes in their native language. Specifically, where more monolingual speakers preferred null pronouns, bilingual speakers tended to use overt pronouns and/or NPs (i.e., proper names) to refer to the subject referent of the preceding context sentence. Furthermore, there is likely to be a positive association between the degree of explicitness and language exposure to L1 and L2, although the magnitude of this association is uncertain in some of our models. However, the underlying mechanisms that motivate bilingual over-explicitness of reference in attrited speakers still require further investigation, in particular to differentiate between cross-linguistic interference and other cognitive mechanisms.

Declaration of competing interest

The authors have no known conflicts of interest to disclose.

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