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Exploring the Nature of Syntactic Priming of English-Mandarin Bilinguals Comparing with English Monolinguals

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Abstract: This study investigates the nature of syntactic priming in English-Mandarin bilinguals. Compared with the English monolinguals, the results show that differences between bilingual and monolingual groups can be attributed to the different syntactic structures and subtle linguistic differences between English and Mandarin, including the impact and potential language interference. The study also emphasizes that there are marginally significant differences between passive and locative conditions among bilingual groups, with passive priming showing a stronger priming effect. Importantly, the study elucidates the sensitivity of English-Mandarin bilinguals to argument structure and the influence of animacy distribution on the generation of passive sentences, as well as the reduced use of passive sentences by bilinguals compared to monolinguals. The research demonstrates that the argument structure priming hypothesis and animacy distribution also exist in English-Mandarin bilingual groups the same as the English monolinguals [1].

Keywords: syntactic priming, argument structure, animacy distribution, English-Mandarin bilinguals

1. Introduction

Syntactic or structural priming is the tendency of speakers to reuse a recently encountered syntactic structure but with different words. Bock [2] proposed that using a specific syntactic structure makes it more likely to be used again. For instance, after hearing a sentence like "John gave a book to Mary" (a prepositional object or PO structure), one is more inclined to produce another PO-structured sentence, such as "Sarah passed the salt to Alex," even if the words differ. This priming effect relies on a shared abstract syntax, not on identical words [2][3]. As an example, Bock & Loebell found that after participants heard a passive sentence like "The mouse was chased by the cat," they were more likely to create another passive sentence, e.g., "The cake was eaten by the children." This shows that exposure to a specific syntactic pattern, like passive construction, makes it easier to produce sentences with the same structure. The concept of constituent structure priming has been a prominent explanation for priming effects for over three decades.

Bock and Loebell [3] found that hearing sentences describing a location (like "The construction worker was digging by the bulldozer") led to the same number of passive sentences being made by people as when they heard other passive sentences (like "The construction worker was hit by the bulldozer"). However, active sentences (like "The construction worker repaired the bulldozer")

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resulted in fewer passive sentences being made. This happened even though passive sentences and intransitive locative sentences both follow the same sentence pattern of NP (noun phrase)-V (verb)-PP (prepositional phrase). The difference lies in the roles: in passive sentences, the bulldozer is doing something to the construction worker, while in locative sentences, the bulldozer is just part of the setting. Konradt [1] and Konradt & Szendroi [4] acknowledge the structural similarities but also discuss the subtle differences in how sentences are built (syntactic nuances) and how their components interact with the verb (argument structure), which affects meaning. Grimshaw [5] defines argument structure as the relationship between a verb and its arguments (the noun phrases that surround it), which can change how a sentence is understood. For example, in a sentence like "The construction worker was digging by the bulldozer," the verb "digging" doesn't require an object, and "by the bulldozer" tells us the location. But in a sentence like "The construction worker was hit by the bulldozer," the verb "hit" does need an object, and the roles are switched—the construction worker is now the one being acted upon.

Konradt & Szendroi [4] indicated that the strength of syntactic priming relates to a predicate's argument structure. Their research echoed Bock & Loebell's [3] findings, showing a more pronounced increase in passive responses after hearing passive primes than locative primes compared to active primes. Simply, passive-to-passive priming proved more robust than locative-to-passive priming, leading to their proposed Argument Structure Hypothesis. Their results challenge models based only on the repetition of surface linear phrase order. Even if two sentences share the same phrase sequence, they might not elicit equal priming if their argument structures differ. This underscores the Argument Structure Priming Hypothesis, suggesting that passive priming isn't just influenced by surface structure and shared words, but also by the prime verbs' syntactic features.

Bock & Loebell [3] used images of transitive events, with human [patient/theme] arguments and inanimate [cause/instrument/agent] arguments. Such setups inherently created differences in argument prominence, leading to more passive voice sentences. Data reveals passive voice usage rates as 79% for passive, 80% for locative, and 74% for active conditions. Notably, about 75% of responses in the active condition were passive, even with an active priming structure. Similar trends appeared in Fleischer et al. [6] and Gamez & Vasilyeva [7] under conditions of asymmetrical animacy. Thus, as Konradt [1] and Konradt & Szendroi [4] suggested, the results might better reflect a decrease in passive responses in other conditions than an increase in passive responses after hearing passive or locative primes versus active primes.

The animacy of nominal elements significantly influences syntactic structure. Animacy is a primary semantic feature of nominal elements that imposes constraints on syntax. Comrie [8] highlighted the relationship between the animacy of nominal elements and syntactic positioning. He found that many languages place animate elements in the subject position because animate entities are often viewed as the initiators of actions. Furthermore, in passive voice constructions, inanimate entities frequently become the subject, while animate entities shift elsewhere in the sentence. Ovrelid [9] and Snider & Zaenen [10] analyzed corpus data from Norwegian and English and found that subject nouns typically exhibit higher animacy than object nouns. This animacy refers to the perceived "life-like" quality of nouns functioning as subjects. Studies across languages such as English [11][12][13], German [14], and Spanish [15] show that active voice is favored when the agent is animate and the patient inanimate. In contrast, passive voice dominates when the agent is inanimate and the patient animate, emphasizing the prominence of animate nouns. A consistent observation is that nouns with strong animacy often start sentences as subjects. This pattern, known as the "Animate First Principle," indicates that animate entities typically precede in sentences [15][16].

Turning to Mandarin, Gao's [17] study supports Comrie's [8] assertions. Gao found that in Chinese, the relative animacy of arguments significantly influences the choice between active and

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passive sentence forms, consistent with Comrie's observations. Specifically, Mandarin speakers tend to use the active voice when the subject is more animate than the object. Conversely, if the object is perceived as more 'alive' or significant than the subject, the passive form is preferred. This choice underscores the emphasis on the more animate component, drawing the reader or listener's attention to the most significant entity. For example, when an inanimate object (e.g., a book) affects an animate entity (e.g., a person), a Mandarin speaker might favor the passive structure to underscore the person's experience.

In Mandarin, active structures are dominant when the subject is more animate than the object. However, passive structures are preferred in scenarios like when a human subject impacts an animal or inanimate object or when an animal subject affects an inanimate object. In situations where the animacy levels are equal, both forms can be used, exemplified by sentences such as "The cat ate the mouse" or "The mouse was eaten by the cat." Chen, Chen & He [18] highlighted that animacy is more influential in Chinese than in English. Chinese speakers typically position entities with higher animacy as subjects, suggesting a profound consideration of animacy in sentence construction. Li [19] went further, asserting that in Chinese, animacy even outweighs syntactic cues like word order in sentence processing. In understanding and creating sentences, Mandarin speakers place substantial emphasis on animacy cues. They tend to interpret highly animate nouns as agents, whereas less animate nouns are viewed as patients.

About half of the world's population is bilingual, regularly using two or more languages [20]. Thus, understanding how bilinguals process language is crucial. Do they have separate syntactic information for each language, or is it shared? Jia [21] found little difference in syntactic priming within Chinese or between English and Chinese. This indicates a shared representation in syntactic structures, even when word orders differ between languages but have the same function. Evidence suggests that syntax may be shared between languages, leading to frequency overlap of similar syntactic structures for bilinguals [22]. Huang et al. [23] posited that Mandarin speakers, like those of English and German, have distinct syntactic representations during language comprehension.

Many studies have employed syntactic priming to examine bilingual syntactic storage [24][25][26]. Kantola and Gompel [27] state that this technique, inspired by monolingual research, assesses if shared or linked representations impact structure production across languages. Some research, like Lambert & Rawlings [28], suggests early bilinguals might have more interdependence between languages than later bilinguals. Mägiste [29] observed bilinguals taking longer in naming tasks, possibly due to interference between their languages. Supporting this interference notion, Runnqvist et al. [30] proposed that bilinguals might experience influence from one language to another, impacting their perception of grammatical structures. This interplay underscores the intricate relationship between languages in bilingual minds.

Mandarin and English, two of the most spoken languages, have distinct passive voice structures, a universal grammatical feature. While both languages follow the Subject-Verb-Object (SVO) pattern, their passive voice usages differ.

To provide a more in-depth understanding, let's delve into the use of the English passive voice. In English, the passive voice is versatile, often emphasizing the recipient over the actor, especially when the actor is unknown or intentionally left out. For example, in "The cake was eaten", the focus is on the cake, with the eater unspecified. This enhances English's expressiveness, making the passive voice a staple of the language. In Mandarin, many think of the bei-passive structure, illustrated by "张三被李四打了" (translated as "San Zhang bei Si Li Dale"). However, passive sentences in Mandarin extend beyond the bei-passive. Defining passive sentences as ones where the subject is the action's recipient, most Mandarin passive sentences don't use bei-passive but the active ba-structure.

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This experiment, based on Bock & Loebell's [3] and Ziegler et.al.'s [31] work, aims to ascertain if argument structure is primable in English-Mandarin bilinguals similarly to monolingual English speakers. Drawing from Konradt & Szendroi [1], we seek to understand any syntactic differences between English-Mandarin bilinguals and monolingual English speakers. The exposure to Mandarin might affect bilinguals' syntactic choices in English. We hypothesize that participants will show less locative-to-passive priming than monolinguals. Moreover, we'll investigate if animacy distribution influences priming tasks for bilinguals as it does for monolinguals. Bilinguals might be particularly attuned to animacy distribution due to its similar impact on syntactic structure in both languages.

2. Methodology

2.1. Participants

The experiment was conducted online using Gorilla Experiment Builder. 83 English-Mandarin bilingual speakers (Mean age=37) were recruited through Prolific to participate in this study. The participants were all English-Mandarin early bilinguals who were exposed to English and Mandarin before the age of 6 and had a native-like command of both languages. All participants received university education or above and had no language or reading difficulties. Participants were allocated randomly to one of three conditions: active (n = 16), passive (n = 16), or locative (n = 16). They received £3.75 in compensation for participation.

2.2. Design

We implemented a 2 x 2 x 2 mixed design (refer to the table below). A between-subject design minimized cross-prime contamination risks. This method ensured a true baseline condition where participants described targets without prior exposure to primes and allowed comparison of lexically identical target responses post differing prime exposures.

Table 1: Prime Type and Condition

Prime Type	Target Animacy	Condition	
		Passive	Locative
active	EA	active	active
	UA	active	active
Non-active	EA	passive	passive
	UA	passive	passive

Diverging from Bock & Loebell [3], we presented images with prime sentences. Their study lacked visual cues, potentially leading to misinterpretations of passives, such as 'The construction worker was hit by the bulldozer', as short passives with locative by-phrases. To clarify, we incorporated prime event illustrations.

Another critical change addressed the manipulation of animacy in targets. Bock & Loebell's design majorly presented animate or human subjects alongside inanimate objects, possibly influencing the choice of passive sentence construction irrespective of the prime. We refined the animacy of potential arguments in targets, with further specifics provided below.

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2.3. Materials

Stimuli were displayed on a tablet or desktop through a two-frame animated sequence, sequentially showing each event from start to finish. We developed two sets of experimental items: one for the experimenter (prime set) and another for participants (target set).

The experiment used a set of 32 prime images depicting transitive events, divided into equal prominence (EP) where inanimate agents and objects were equally prominent, and unequal prominence (UP) where inanimate agents acted on animate patients. Another set of 32 images was designed for locative conditions, showing intransitive events with either both inanimate subjects and locations, or animate subjects with inanimate locations. Passives were used as sentences for passive conditions and intransitive structures for locative conditions. A no-prime baseline was also included for balance, with all nouns starting with a definite article. The verbs used varied, with transitive events using verbs like "squash" and intransitive ones using verbs like "lay." The target images, mirroring the primes, used unaccusative verbs to reflect the argument structure of passives and transitive primes. Target images also displayed either EP or UP.

Participants were shown prime-target pairs in a pseudo-random order with fillers in between. ANOVA showed that the matching animacy distribution between primes and targets didn't significantly affect passive response rates. The prime-target pairs had consistent animacy distribution, with diverse target verbs for each set of prime verbs.

2.4. Procedure

Initially, participants accessed Gorilla via a url that served as a link between Gorilla and Prolific. Upon entry, they selected the “Consent Given” option marked with a “√” and proceeded to complete a questionnaire. The syntactic priming experiment tailored for English-Mandarin bilinguals commenced with an introduction and an overview of the forthcoming procedure, coupled with short training. Participants were instructed to vocalize each sentence, offer precise descriptions of each displayed picture using a provided verb while recording their voices using microphones. Each participant had a single attempt to record their response, with a microphone functionality check occurring prior to the task's initiation. In the passive, locative, and active conditions of the experiment, each prime image was matched with a corresponding sentence (either framed in passive voice or as an intransitive sentence with a locative adjunct). Participants were instructed to read these sentences and then verify their accuracy in relation to the images by choosing either “yes” or “no”. This step aimed at ensuring attentive reading of the prime sentences by the participants. While all prime sentences accurately described the images, some filler sentences did not correspond with the pictures shown. In baseline scenarios, only filler images (not prime event images) were occasionally repeated. Participants were shown target images, including filler targets, without any accompanying descriptions. They were instructed to quickly compose and input appropriate descriptions in the provided space using simple, full sentences, without paying undue attention to the precision of punctuation and spelling. The entire procedure took roughly 25 to 30 minutes to complete. Participants’verbal responses were captured via audio recording, subsequently transcribed, and prepared for analysis.

3. Results

The analysis found that Target Animacy significantly affected the results, with Unanimate (UA) targets resulting in more passive constructions than Animate (EA) targets. The Prime Condition's effect on passive response frequency was close to being significant, indicating passives were more common in the Passive condition than the By-locative condition, but this was not statistically significant. There was a significant interaction between Prime Type and Prime Condition,

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suggesting that passive primes led to more passive responses than by-locative primes. However, no significant difference was found in passive response frequency between active and locative primes, and only a marginally significant difference between active and passive primes. No other significant effects or interactions were found.

The difference in the use of passive voice between Active and Non-active conditions was more noticeable for Animate (EA) targets than Unanimate (UA) targets, but this difference wasn't statistically significant. Overall, UA targets led to more passive constructions than EA targets. Additionally, passive usage was lower in locative conditions than in active conditions, with 20.1% for active versus 17.5% for locative in equal animacy scenarios, and 37.3% for active compared to 32.2% for locative in unequal animacy scenarios.

Table 2: Proportion of passives by condition

Animacy	Prime Condition	Prime Type	Proportion
Equal	act Vs Pass	act	0.2271062
Equal	act Vs Pass	non-act	0.2771536
Equal	act Vs Loc	act	0.2014388
Equal	act Vs Loc	non-act	0.1775362
Unequal	act Vs Pass	act	0.4243542
Unequal	act Vs Pass	non-act	0.4725275
Unequal	act Vs Loc	act	0.3731884
Unequal	act Vs Loc	non-act	0.3223443

As it can be seen from Table 2, there wasn’t a substantial difference in the proportion of passive constructions generated following active primes compared to thosefollowing locative primes. (Locative Condition) ($p = 0.2$). It was also worthy to note that we observed less passives after locative primes than after active primes.

Table 3: Data analysis for 83 English-Mandarin bilingual participants

Animacy	Prime Condition	Prime Type	Proportion
Equal	act Vs Pass	act	0.2271062
Equal	act Vs Pass	non-act	0.2771536
Equal	act Vs Loc	act	0.2014388
Equal	act Vs Loc	non-act	0.1775362
Unequal	act Vs Pass	act	0.4243542
Unequal	act Vs Pass	non-act	0.4725275
Unequal	act Vs Loc	act	0.3731884
Unequal	act Vs Loc	non-act	0.3223443

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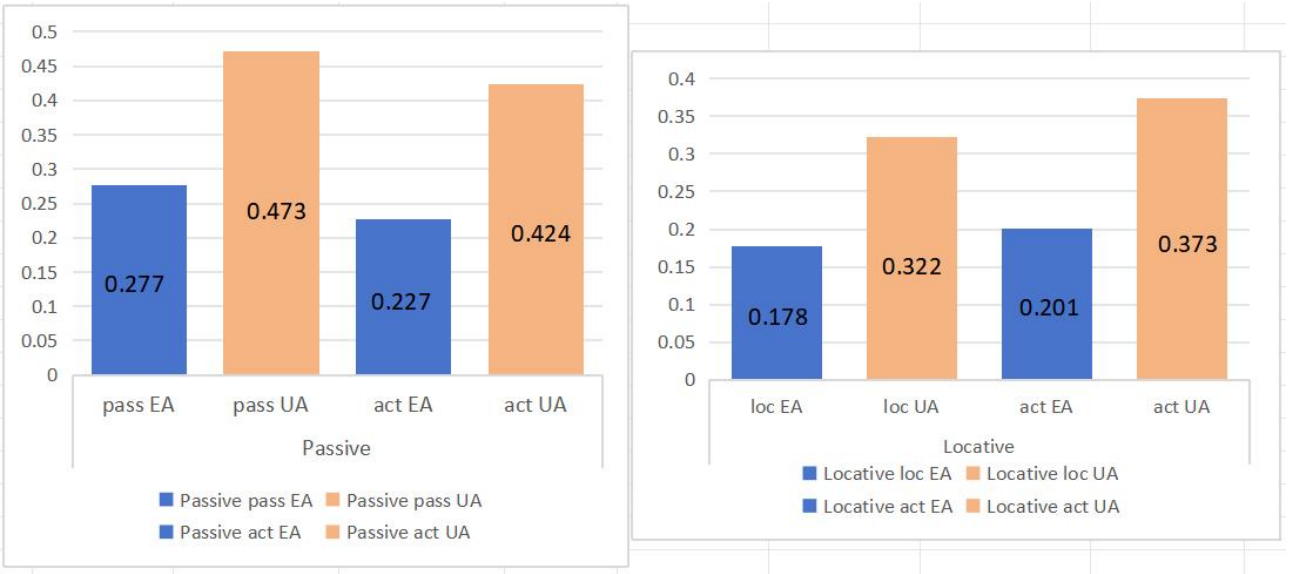

Figure 1: Overall proportion of passive responses by Prime Type, Prime Condition and Target Animacy. pass = passive primes; act = active primes; loc = by-locative primes: EA = equal animacy in targets; UA = unequal animacy in targets.

4. Discussion

First and foremost, no significant difference was found in the use of passive voice following active (20.1% for equal animacy, 37.3% for unequal animacy) versus locative primes (17.5% for equal animacy, 32.2% for unequal animacy) ($p=0.17$). This suggests that locative primes don't necessarily lead to more passive sentences, contradicting Bock & Loebell's findings. The preference for passive constructions, especially when describing events with inanimate agents and human patients, seems to stem from a natural tendency in English to emphasize the roles and relationships of the entities involved, not just from the priming effect.

English monolinguals showed a significant difference in the use of passive voice depending on the type of prime—more passives followed locative primes than active primes, as reported by Konradt [1]. However, for English-Mandarin bilinguals, no significant difference was observed in the frequency of passives after active or locative primes, and fewer passives followed locative primes, indicating no locative-to-passive priming effect in this group [1][4].

The differences between English monolinguals and English-Mandarin bilinguals in passive voice usage can be attributed to several factors. First, the structures of locative and passive sentences in Mandarin are distinct from those in English, with each belonging to different language families—Indo-European and Sino-Tibetan respectively [32]. English uses similar lexical elements in both passive and locative sentences, which facilitates passive priming [31]. However, in Mandarin, the elements differ, preventing the locative structure from triggering a passive response. Mack [33] suggested that bilingual language organization differs from monolinguals, potentially causing interference between languages. Additionally, Huang et al. [23] noted that Mandarin, like English and German, has distinct syntactic representations. Consequently, English-Mandarin bilinguals do not show the same locative-to-passive priming effect as English monolinguals due to these linguistic and cognitive differences.

In addition, the difference in passive response between Passive (combined active and passive) and Locative (combined active and locative) conditions was marginally significant. Passive primes had a stronger priming effect ($p=0.02$), but locative primes did not lead to more passive constructions. In contrast to English monolinguals [4], who had more passive responses in Passive

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than By-locative conditions and a stronger effect for passive primes, there was no locative-to-locative priming in English-Mandarin bilinguals. Overall, passive-to-passive priming was significantly stronger than locative-to-passive priming for both bilinguals and monolinguals.

This study confirms the idea that syntactic priming is influenced by a verb's argument structure, supporting theories by Konradt [1] and Konradt & Szendroi [4]. Participants showed a small priming effect for passive structures, but not for locative ones, which shows they are tuned to the verbs' argument structures. Similar to Mandarin, English speakers form syntactic representations that consider semantics when creating sentences. Verbs like "alert" (needing an agent and patient) and "land" (needing an agent and location) have different requirements. In English, "by" can indicate both passive and locative roles, while Mandarin uses distinct words ("bei" for passive, "zai...pangbian" for locative), suggesting that bilinguals can be primed for argument structures similarly to those who only speak English.

Mandarin speakers, however, use passive structures less frequently than English speakers, and typically prefer active over passive sentences. Mandarin reserves passive sentences marked with "bei" for negative events and uses an active voice, with structures like "ba", for positive ones. Bilinguals' lesser use of passives may show their Mandarin influence.

In terms of animacy, English-Mandarin bilinguals, unlike monolinguals, don't increase their use of passives with locative hints. However, they do use more passives after being primed with passive sentences. When the target has an animate patient and inanimate agent (UP), bilinguals make more passive sentences than with both agents and patients being inanimate (EP). This follows the trend that nouns with more animacy often come first in a sentence, which is consistent in Mandarin and also observed in bilinguals, suggesting that animacy affects syntactic preferences in both groups.

5. Conclusion

The study found that English-Mandarin bilinguals and English-only speakers produce passive sentences similarly, with bilinguals naturally using full passive structures, regardless of certain linguistic cues. Bilinguals' ability to do this seems innate and not just based on language exposure.

It's important to note that Mandarin and English have different sentence structures, which affects how bilinguals form passive sentences. Bilingualism from a young age creates a special cognitive setup that influences how these individuals respond to certain linguistic cues, making their approach to sentence construction unique.

The research also showed that passive sentence construction is more influenced by passive prompts than by locative ones, with the argument structures in the prompts playing a key role. While both English and Mandarin speakers show similarities in how they structure arguments, the slight difference in bilinguals' responses to passive prompts highlights Mandarin's tendency to favor active sentences.

Bilinguals also react differently to animacy, which affects whether they use passive constructions. Overall, passive-to-passive priming was stronger than locative-to-passive priming for both groups, supporting the idea that verb-related argument structures are crucial in sentence formation. The study adds to the knowledge of language processing, showing how bilingualism, sentence structure, and animacy factors interact.

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