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Bilingual Semantic Storage: Evidence from a Thai-English False Memory Experiment

Tanakorn Korjai
Faculty of Humanities, Chiang Mai University, Thailand
Email: trac.tanakorn@hotmail.com
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Abstract

Before code-mixing sentences can be conceptualised and structured, bilinguals necessarily access their semantic knowledge in their cognition. This is where the debate over whether semantic storage of bilinguals is shared or separate plays a role. The current study applied a code-mixing context to a psycholinguistic experiment, specifically exploring whether semantic storage is shared or separate. A false memory experiment was run. The results show a possibility and a tendency to support the shared storage argument and the Revised Hierarchical Model. The analyses also suggested the possible relation between language proficiency and the use of code-mixing in conversations.

Keywords: psycholinguistics, code-mixing, bilingualism, semantic storage, false memory

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แหล่งจัดเก็บความหมายแบบทวิภาษา : หลักฐานจากการทดลองความทรงจำเท็จในรูปแบบภาษาไทย-อังกฤษ

ธนกร ก้อใจ
คณะมนุษยศาสตร์ มหาวิทยาลัยเชียงใหม่ ประเทศไทย
Email: trac.tanakorn@hotmail.com
รับบทความ 2 ตุลาคม 2565 แก้ไขบทความ 14 มกราคม 2566 ตอบรับ 15 พฤษภาคม 2566

บทคัดย่อ

ก่อนที่ประโยคที่มีการปนภาษาจะถูกสร้างมโนทัศน์และผลิตขึ้นมานั้น ผู้รู้ทวิภาษาจำเป็นที่จะต้องเข้าถึงตัวความหมายของทั้งสองภาษาที่นำมาปนกันในปริชานของตนก่อน ซึ่งกระบวนการตรงนี้ได้มีข้อถกเถียงถึงการใช้พื้นที่ร่วมกัน หรือแยกออกจากกันระหว่างแหล่งจัดเก็บความหมายของแต่ละภาษาในปริชาน งานวิจัยชิ้นนี้จึงถูกจัดทำขึ้นโดยมีวัตถุประสงค์เพื่อศึกษาข้อถกเถียงดังกล่าวผ่านการทดลองความทรงจำเท็จ ซึ่งเป็นการทดลองที่นำบริบทของประโยคที่มีการปนภาษามาปรับใช้กับการทดลองทางภาษาศาสตร์จิตวิทยา ผลการศึกษาของงานวิจัยชิ้นนี้แสดงให้เห็นถึงความเป็นไปได้ในการสนับสนุนข้อถกเถียงที่ว่า แหล่งจัดเก็บความหมายของแต่ละภาษามีการใช้พื้นที่ร่วมกันในปริชาน รวมทั้งสนับสนุนแหล่งจัดเก็บความหมายในรูปแบบลำดับขั้น นอกจากนี้ ผลการวิเคราะห์ยังได้เสนอแนวโน้มความสัมพันธ์ระหว่างความสามารถทางภาษาของและการใช้ประโยคที่มีการปนกันของภาษาในบทสนทนา

คำสำคัญ ภาษาศาสตร์จิตวิทยา การปนภาษา ผู้รู้ทวิภาษา แหล่งจัดเก็บความหมาย ความทรงจำเท็จ

1. Introduction

Code-mixing (CM) is a common communicative tool for bilingual interlocutors. It refers to the switch between two languages simultaneously within a single utterance (Akhtar et al., 2016; Chaiwichian, 2007; Hahyesalaemae, 2017; Kangkha & Mahadi, 2018; Promnath & Tayjasanant, 2016; S. N. Sridhar & Sridhar, 1980; Yiamkhamnuan, 2011). Bilinguals may switch from their first language (L1) to their second language (L2), from L2 to L1, from L1 to L2 and then back to L1, or from L2 to L1 and then back to L2. Since code-mixing requires bilinguals to simultaneously control and deal with two linguistic systems, this signifies the way bilinguals may have certain linguistic proficiency, competence and fluency in both languages that they are code-mixing in (Akhtar et al., 2016; Chaiwichian, 2007; Kroll & Tokowicz, 2005).

Before a code-mixing utterance can undergo the syntactic process, it must first be conceptualised. For bilinguals, it is necessary for them to access semantic storage of certain lexical items; that is, words, of both languages of code-mixing in their cognitive system. This indicates the stage which is called *Conceptual Preparation*. The output of this stage is the concept of particular words or lexical concepts that the speakers want to convey (De Bot, 1992).

As per semantic storage is cognitive storage located in the cognition of bilingual speakers, there has been a debate over whether semantic storage is shared or separate between each language. Exploring this debate, most of the previous studies gave importance to the code-switching context where one language is presented at a time. The bilinguals might be stimulated with French (Kirsner et al., 1984) or Spanish (Durgunoğlu & Roediger, 1987), and tested in another language such as English, and vice versa. Studies in a code-mixing context where two languages are presented simultaneously, therefore, are rarely seen or have yet to be paid much attention. This gives rise to the current study which explores bilingual's semantic storage with application to a Thai-English code-mixing context.

Research Questions & Predictions

This current study has two research questions which are 1) Do Thai-English bilinguals hold separate or shared semantic storage in order to conceptualise Thai-English code-mixing sentences? and 2) Which semantic model does this study support? Before answering the questions, this study also gives the predictions in terms of a) recall language, and b) false recognition rate of the critical non-presented words. According to recall language, if the participants hold separate semantic storage, there should not be a cross-language recall for each list since the language of the studied and the test items are the same. Then, if they had used both languages in recalling, their semantic system was shared. Regardless of the recall language, if the false recognition of the critical non-presented words influenced by Thai was as strong as by English, then the semantic storage of Thai-English bilinguals might conform to the *Separated Model*, *Distributed Model* and *Concept-Mediated Model*. On the other hand, if they were not equally strong (in cases where L2 was weaker than L1), then it might conform to the *Word-Association Model* and *Revised Hierarchical Model*.

2. Literature Review

2.1 Semantic/Conceptual Storage

Studies that support separate storage assume that L1 lexical items and L2 items have their own link between conceptual representation and lexical representation (Dong et al., 2005; Mitchel, 2005; Yang, 2020). According to Weinreich's (1953) *Separate Storage Model*, the link between conceptual representation and lexical representation of each language will not come into contact in bilingual cognition. However, De Groot (1993) was able to provide one aspect of shared semantic storage added to the former model. De Groot (1993) named this model as the *Distributed Model.* This model assumes that conceptual and lexical representations can be

shared between languages, but only in some aspects such as the concepts of concrete words or cognates. On the other hand, studies that support the idea of shared storage postulate that there is one common conceptual storage for lexical items that both L1 and L2 share together (Dong et al., 2005; Kirsner et al., 1984; Kroll & Tokowicz, 2005; Menenti & Indefrey, 2006; Mitchel, 2005; Potter et al., 1984; Weinreich, 1953; Yang, 2020). There have been three semantic models supporting this hypothesis. The *Concept-Mediation Model* (Potter et al., 1984) claims that shared semantic storage can be accessed directly both through the lexical items of L1 and L2. The *Word-Association Model* (Potter et al., 1984) assumes that the common storage cannot be accessed directly through L2 lexical items, but rather through its L1 translation equivalents only. Regarding Kroll and Stewart's (1994) *Revised Hierarchical Model*, semantic storage can be accessed either directly through L2 lexical items or through L1 translation equivalents. However, the relation between the semantic representation and L1 is claimed to be stronger than between the concept and L2 lexical items.

2.2 False Memory Experiment

False memory refers to remembering non-occurring events or misremembering occurring events from their accurate realities (Graves & Altarriba, 2014; Riesthuis et al., 2019; Roediger & McDermott, 1995; Sahlin et al., 2005). Unlike previous experimental approaches such as a lexical decision task, a Stroop effect task, or a fragment completion task, and so forth, the false memory task has been used to investigate concepts without considering the surface linguistic features of lexical items. This means the false memory paradigm is one of the most suitable and effective methodologies for examining semantic storage.

One of the most widely known experiments in false memory is the *Deese-Roediger-McDermott* paradigm (DRM). Roediger and McDermott (1995) extended Deese's (1959) experiment by presenting 24 lists of 15

associated words, or studied items, to the participants and asking them to recall them. After encountering the studied items, the participants were also given critical non-presented words as test items. A critical non-presented word is a word that is conceptually associated or shares some semantic features with the studied items. The participants were tested to see whether they showed any sign of false memory in their responses. These responses included false recall and false recognition. As a result, recall for critical non-presented words was as high as it was for studied items. The participants were also confident that the critical non-presented words were recognised as the previous studied items even though they were not presented during the study phase.

Later studies have applied the *Deese-Roediger-McDermott* paradigm with bilingual speakers and for different purposes. For instance, comparing the results between bilingual and monolingual participants (Riesthuis et al., 2019), examining the between-language effect in false memory (Marmolejo et al., 2009; Mitchel, 2005; Sahlin et al., 2005) or deeply investigating bilinguals' semantic storage (Mitchel, 2005). Regarding bilingual speakers, the *Deese-Roediger-McDermott* word lists were translated into various target languages. For instance, Sahlin et al. (2005) and Graves and Altarriba (2014) presented DRM 24-word lists with half of them in English and another half in Spanish. Taking mixed-language mode into consideration—within one DRM word list of 12 words, Mitchel (2005) presented six words in English and another six in Spanish. As a result, bilingual participants did show a sign of false memory whether the studied and the test languages were the same or not. However, Mitchel (2005) and Sahlin et al. (2005) claimed that same-language presentation caused false recognition more than different-language presentation. Their results indicated a stronger link between L1 lexical items and semantic storage than L2 lexical items.

Regarding Mitchel's (2005) study, there was no statistically significant difference when compared to the monolingual mode, either in Spanish or

English, even though the participants were presented in a mixed language mode. Presenting the mixed-language *Deese-Roediger-McDermott* paradigm at the word level did not ensure that the participants were in bilingual mode. This experiment, therefore, extends Mitchel's (2005) research by presenting DRM lists in mixed-language sentence structures to explore semantic storage.

3. Thai-English False Memory Experiment

3.1 Participants

The participants were 20 Thai-English bilingual undergraduates, 6 males and 14 females, within the age range of 20 to 23 years old (Mean = 21.50, SD = 0.77). Bilinguals herein refer to people who have linguistic competence in Thai as their first language and English as their second language. The participants' language proficiency of both Thai and English languages was assessed. Thai proficiency was obtained from the Thai component of the Ordinary National Education Test (ONET), a required national test for all Thai students. The mean scores were 76.67 (SD = 4.86). English proficiency was measured using the C-TEST (Babaii & Shahri, 2010). For the C-TEST assessment, participants were required to fill missing letters to complete words for five paragraphs and they would have been scored if the responses were identical to the prototype answers with the exact letters. The mean scores for English were 81.70 (SD = 10.74).

Regarding their linguistic background and exposure, an open-ended questionnaire was given. The participants were asked to provide the contexts of where they use Thai and English language as well as hours of language usage per day. Most participants had used Thai language in their daily life conversations, either with friends or family, for approximately 10.60 hours each day (SD = 4.10). They mostly used English language in their academic, working or business contexts, approximately 6.70 hours per day (SD = 4.33).

3.2 Stimuli

3.2.1 DRM Lists

The twenty-four-item *Deese-Roediger-McDermott* (DRM) lists were adapted from Roediger and McDermott (1995) and Marmolejo et al. (2009) for this experiment. Originally, DRM lists were produced for the English language. Therefore, to apply to the Thai-English context, twelve DRM items were translated into Thai, and twelve remained in the English language. One DRM word list contained twelve studied items and one critical non-presented word as the test items.

3.2.2 Critical Non-Presented Words

Critical non-presented words (CNW) were the focus words used to test the participant's false memory response. From the overall list of 24 CNWs, there were twelve abstract critical non-presented words and twelve concrete words.

3.2.3 Studied Items

The studied items were those words being semantically related to the critical non-presented words. They were used to prime and create a false memory of critical non-presented words to the participants.

Critical Non-Presented Word (English): King
Studied Items: Queen, Chess, Crown, Prince, Palace, Monarch, ...
Critical Non-Presented Word (Thai): หมอ /mɔ̌ː/ (Doctor)
Studied Items: พยาบาล /pʰá jaː baːn/ (Nurse), ป่วย /pùaj/ (Sick),
ยา /jaː/ (Medicine), สุขภาพ /sùk kʰà pʰâːp/ (Health), ...

To effectively prime the participants, the studied items and the critical non-presented words were in the same language throughout all 24-item DRM lists in this study.

3.2.4 Fillers & Combination

This study has the objective of extending Mitchel's (2005) experiment, thus DRM lists will be presented in Thai-English code-mixing sentence structures.

Within a word list containing twelve studied items, each item was combined with fillers to generate a Thai-English code-mixing sentence. Fillers were those unnecessary and irrelevant lexical items. There were two types of fillers: those combined with a studied item at the phrase level and those combined with a studied phrase at the sentence level.

The fillers were combined at first with a studied item to generate a *studied phrase*. At the phrasal level, the language of the fillers and a studied item was the same. Accordingly, the undergone *studied phrase* was combined with other *filler phrases* to make a full Thai-English code-mixing sentence. The *filler phrase* was in a different language from the *studied phrase*. If the *studied phrase* was in English, the *filler phrase*, therefore, was in Thai, and vice versa.

The (Filler Item)	+ ***Queen*** (Studied Item)	: Phrase Level
The ***Queen***	+ กำลังทักทายประชาชน	: Sentence Level
(Studied Phrase)	(Filler Phrases)	
The ***Queen***	kam laŋ tʰák tʰa:j pràʔ tɕʰa: tɕʰon	
'The Queen	is greeting the crowds.'	

The control variables over the stimuli throughout the experiment included the switch of language and the length of the sentences. These variables were mainly intended not to affect as well as interfere with the participant's responses. Accordingly, the switch of the languages unidirectionally took place at the phrase level, not at the word level. Also, it would not switch back in the patterns of L1-L2-L1 or L2-L1-L2. This was to minimalise confusion.

In language processing, syllables and phonemes are able to influence memory (Baddeley et al., 1975). It was therefore necessary to generate long sentences since the participants were required to only remember the studied items, not the whole sentences. The sentences were for setting and ensuring the effectiveness of the bilingual mode but were unintended to draw participants' attention to memorise them. Long sentences herein are defined as containing more than six syllables which this experiment controlled not to exceed 13 syllables (Mean = 9.95, SD = 1.63).

The sentences were validated by three native Thai speakers who have high proficiency in the English language. The conversational possibility of each sentence was rated on a scale of five. If the percentage of each sentence reached more than 70 per cent of the conversational possibility, it would be used as the stimuli. If it did not reach 70 per cent, the sentence would be reconstructed. Sentences were proofed again until the sentence reached the conversational possibility of 70 per cent.

To summarise, by deviating from the traditional DRM paradigm that each CNW were primed with twelve isolated studied items, this experiment primed participants with twelve Thai-English code-mixing studied sentences.

Critical Non-Presented Word (English):	King
Studied Sentence:	The ***queen*** กำลังทักทายประชาชน, คืนนี้มีงานเลี้ยง at the ***palace***, ...
	The ***queen*** kam laŋ tʰák tʰaːj pràʔ tɕʰaː tɕʰon, kʰɯːn níː miː ŋaːn líːaŋ at the ***palace***, ...
	'The queen is greeting the crowds,' 'There is a party at the palace tonight,'...

From the overall 24-item DRM lists, there were 288 Thai-English code-mixing studied sentences in this experiment.

3.2.5 Test Items

Test items were the stimuli primed by the studied items. They were used to test the participants' response of false memory. There were six test items for each DRM list, including three studied words, two non-studied words, and one critical non-presented word. Studied words were those previously being presented to the participants before while non-studied words were not so. If the participants were presented with the DRM set A, the non-studied words would be from *Deese-Roediger-McDermott* set B. The critical non-presented words were those words not being presented to the participants but conceptually related to the studied words. The language of the test items was also the same language as the studied items and CNW. Accordingly, there were 144 test items overall: 72 studied words, 48 non-studied words and 24 critical non-presented words.

Studied Sentence:	The ***queen*** กำลังทักทายประชาชน, คืนนี้มีงานเลี้ยง at the ***palace***, ... The ***queen*** kam laŋ tʰák tʰa:j pràʔ tɕʰa: tɕʰon, kʰɯ:n ní: mi: ŋa:n lí:aŋ at the ***palace***, ... 'The queen is greeting the crowds,' 'There is a party at the palace tonight,'...
Studied Items:	Queen, Palace, ...
Test item:	King (Critical Non-Presented Word), Queen (Studied word), Cake (Non-Studied Word)
Studied Sentence:	I withdraw some money จาก***ธนาคาร***, ***ตำรวจ*** 5 คน are going on a patrol, ... I withdraw some money tɕà:k tʰá na: kʰa:n, tam rû:at hâ: kʰon are going on a patrol, ... 'I withdraw some money from the ***bank***,' 'Five ***police*** are going on a patrol,'...
Studied Items:	ธนาคาร /tʰá na: kʰa:n/ (Bank), ตำรวจ /tam rù:at/ (Police), ...

Test item: โจร /tɕo:n/ (Robber; Critical Non-Presented Word),
ธนาคาร /tʰá na: kʰa:n/ (Bank; Studied word),
เรือ /rɯ:a/ (Boat; Non-Studied Word)

3.3 Presentation & Design

The studied stimuli were presented with Microsoft PowerPoint slides both auditorily and visually. The Thai-English studied sentences were recorded first with a voice recorder by a female confederate who was a native Thai speaker with high language proficiency in both Thai and English. Each recorded sentence, therefore, was inserted in each slide by also having the studied item in the middle of the screen. The slides were set to automatically advance with a pause of two seconds between each slide transition. Accordingly, the participants would hear the recorded studied sentences as well as see the studied items on the screen at the same time length.

What participants heard: The ***queen*** กำลังทักทายประชาชน
The ***queen*** kam laŋ tʰák tʰa:j prà? tɕʰa: tɕʰon
'The queen is greeting the crowds,
What participants saw: Queen

The experiment employed two *Deese-Roediger-McDermott* sets (A or B) as a between-participants factor. Ten participants were assigned to Set A and another ten to Set B, randomly. This experiment also employed 2 presentation languages (Thai and English) * 2-word types (Abstract and Concrete) as a within-participants factor. Within one set, all participants were presented with six lists of twelve Thai-English code-mixing studied sentences with both the studied and test items in Thai, and another six lists where both the studied and test items were in English. Also, there

were six lists of studied sentences where the critical non-presented words were concrete and another six were abstract.

3.4 Procedure

The experiment was conducted in a closed room at Chiang Mai University, Faculty of Humanities, Department of English. The experiment included one practice and one test session. It took one hour for each participant.

The participants had been first informed that the experiment was mainly for examining their memory. Before proceeding to the practice session, they were given instructions about the experiment. The instruction languages were in both English and Thai, respectively. Using both languages enabled the participants to be in Thai-English bilingual mode and the order of the instruction languages allowed them to clearly understand the instruction since the participants were native Thai. The participants practiced the whole experimental procedure before proceeding to the actual test session.

During the practice session, the participants were primed with the recorded studied sentences auditorily and the studied items visually through Microsoft PowerPoint slides (See Section 3.3). Since the practice session was for revising the instruction of this experiment only, not to cause any stress before the actual test session, the participants, therefore, practised with only three Thai-English code-mixing studied sentences and three studied items, not the entire DRM list.

Accordingly, they were required to memorise the words they had seen on the screen to fulfil the objectives of the memory experiment they had been previously informed about. After finishing three studied sentences, the word “RECALL” was visually presented on the screen as a sign. Encountering this sign, the participants had to recall as many words as they could from those previously seen in any order and in any language.

The participants were told to ring a desk bell once they had finished recalling the words.

After the recall task, the participants proceeded to the recognition task. This included the recognition test of a studied word, critical non-presented word, and non-studied word. The participants only saw the test items on the screen, with no audio presentation for the test items. The test items were in the same language as the studied items. They had to respond with "Yes" if they recognised that a particular word they had seen was presented to them before, or "No" if was not.

When all three test items were presented, the participants proceeded to the drawing task. They would see a word, such as "house", on the screen. The participants needed to draw a picture representing this word within 15 seconds. This task was for clearing their mind only, or to be exact, erasing their short-term memory of the studied items they were exposed to previously. Therefore, their drawing and their artistic ability would not be taken into consideration as a part of the data analysis.

If the participants had understood the instruction and accurately done the practice session, they would proceed to the test session. The procedure between these two sessions was similar. In the actual test session, the experimental procedure for each DRM list ran in the pattern of a studied task followed by a recall task, a recognition task, and a drawing task, respectively.

During the study task, twelve *Deese-Roediger-McDermott* lists were presented. For each list, the participants were primed with twelve recorded Thai-English code-mixing studied sentences audio along with twelve studied items on the screen. After encountering the studied list, they would proceed to the recall task. While the participants were recalling the studied items during the test session, the recall languages would be recorded whether the participants used only one language in recalling or not, either in Thai or English or both languages.

The participants next proceeded to the recognition task of six test items. In the recognition task, the recognition of the test items would be scored if the participants showed a sign of false recognition, either of studied words, of non-studied words or of critical non-presented words. The responses were further observed to see the influence of the presentation language and the concreteness on the false recognition of the critical non-presented words. The observation was for exploring the link between the lexical item and its concept in each language.

Following the recognition task, the participants encountered the drawing task. The words used for the drawing task were not in either Set A or Set B. The actual test session ended when all twelve DRM lists had been presented.

The last procedure asked the participants to do the C-TEST as well as the questionnaire on linguistic background and exposure. The participants were also debriefed about this experiment.

3.6 Data Analyses

The data gathered included recalled language and the false recognition rate of critical non-presented words. Both were analysed using the R statistic programme version 4.1.1 (R Core Team, 2011).

3.6.1 Recalled Language

According to Venables and Ripley (2002), the results based on the participant's choice of answer or performance could be analysed using multinomial logistic regression. Similar to this study, the participants had their options in using language, either "Thai", "English", or "Both" languages, in recalling the studied words during the recall session. This model, therefore, was used.

3.6.2 False Recognition Rate of Critical Non-Presented Words

The response of false recognition rate of critical non-presented words (CNW) could be analysed using a generalised linear mixed-effects

model (Bates et al., 2015; Bates & Maechler, 2021). This model was used to analyse the binary response (Yes/No).

4. Results & Discussion

4.1 Results

In terms of recalled language, the results revealed that the participants recalled words in English for 114 lists (47.50%), in Thai for 104 lists (43.33%) and in both languages for 22 lists (9.17%).

As seen in Table 1, there was no effect of the presentation language ($p > .82$). The way studied items and test items were in the same English or Thai language did not affect participants' language choices in recalling the study items. On the contrary, the multinomial logistic regression indicated a marginal effect of language proficiency.

Table 1

The Analysis of Participants' Language Choices in Recalling

Predictor	β	*SE*	*Z*	*p*
English				
Presentation Language: English	-0.33	66.66	-0.004	.996
Presentation Language: Thai	-29.01	133.33	-0.218	.828
Thai Proficiency	-0.98	0.53	-1.831	.067
English Proficiency	1.01	0.56	1.816	.069
Both				
Presentation Language: English	4.47	31.71	0.140	.888
Presentation Language: Thai	-13.29	63.44	-0.209	.934
Thai Proficiency	-0.63	0.34	-1.858	.063
English Proficiency	0.69	0.39	1.757	.079

Regarding Thai language proficiency, the more proficient in Thai the participants were, the greater the possibility they would recall the

studied items in Thai (English: β = -.98, p = .067; Both: β = -.63, p = .063). English proficiency, on the other hand, showed a possible tendency in encouraging the participants to choose either English (β = 1.01, p = .069) or both languages (β = .69, p = .079) in recalling the studied items. This implied that the participants showed likeliness for cross-language recall (using both languages in recalling) when they were more proficient in English. This cross-language recall could support shared semantic storage. However, recall that marginal effect only suggests the possibility not certainty of the analysis.

The false recognition of critical non-presented words was further investigated. The results revealed that the participants falsely recognised critical non-presented words at 23.75% while they falsely recognised the studied words at 6.81% and non-studied words at 0.42%.

Table 2

Analysis of False Recognition of CNW

Predictor	β	*SE*	*Z*	*p*
Presentation Language				
English	-1.48	0.33	-4.473	< .001
Thai	1.57	0.55	2.868	.004
Concreteness				
Abstract	-1.36	0.36	-3.766	< .001
Concrete	-0.73	0.47	-1.567	.117

As shown in Table 2, the results from the simplest model of the generalised linear mixed-effects model showed that the estimate for English presentation language was negative, implying that the participants did not have false recognition of CNWs from the way studied and the test items were both in the English language (β = -1.48, p < .001). On the

contrary, false memory was caused mainly by having the studied and the test items both in the Thai language (β = 1.57, p = .004). This effect of Thai presentation language was statistically significant, indicating the direct access of the first language to concepts in the bilinguals' cognition. Regarding concreteness, the estimate was negative. Even though the analysis revealed that the way CNW is abstract did not cause false memory to the participants (β = -1.36, p < .001), having CNW as concrete words was also not found to have any significant effect (p = .117). This could be generalised that there was no effect of the concreteness of CNW on causing participants to have false recognition of CNWs. For the analysis of Table 2, trends were the same as with the maximal model, but the models did not converge.

4.2 Discussion

The results from both analyses in the experiment suggest that semantic storage between Thai and English is shared. The participants' English proficiency allowed them to possibly choose to use either only English language or both Thai and English languages in recalling the studied words. This indicates the possibility of cross-language recall. As predicted in the introduction of this paper, cross-language recall assumed that the semantics of Thai and English were shared. Both languages could come across in the participants' cognition. This trend agrees with Kroll and Tokowicz (2005), Chaiwichian (2007), Madriñan (2014) and Akhtar et al. (2016) who suggest the parallel activation of two languages which bilinguals are capable of simultaneously handling in their cognition. To generalise with the code-mixing context, cross-language recall in this study could imply the tendency of language proficiency to influence the use of code-mixing in bilinguals' conversations.

Considering false recognition of the critical non-presented words, there was one responsible factor involved: Thai presentation language. From the analysis, Thai presentation language suggested a stronger effect

in causing false recognition of critical non-presented words in native Thai participants than English presentation language. This could possibly go with the prediction of this study to assume that, in case L2 was weaker than L1, semantic storage of Thai-English bilinguals might conform to the *Word-Association Model* and *Revised Hierarchical Model*. However, recall language could also not be taken out of consideration. Since the participants used both languages in recalling studied items, there were also links between English lexical items and the semantic representations which these links somehow were weaker than the link between Thai lexical items and the concepts (Brysbaert & Duyck, 2010; Dong et al., 2005; Menenti & Indefrey, 2006; Yang, 2020). Therefore, this study showed a tendency to support Kroll and Stewart's (1994) *Revised Hierarchical Model.*

Marginal Effect & Small Sample Size Discussion

It could be seen from the analyses that the marginal effect of language proficiency could be observed. The results and discussion were therefore drawn from the possibility of the small sample size. However, with this marginal effect from the small sample size, this study proved its significance and power in detecting the influence of language proficiency that could lead to the support of cross-language recall, shared semantic storage, and Kroll and Stewart's (1994) *Revised Hierarchical Model.* But remind again that marginal effect could only imply a trend in this study. Accordingly, more participants or more data can be gathered to explain the debates with the certainty of the significant effects rather than the possibility of the marginal effect.

4.3 Future Studies

There are some aspects of this study that need to be further developed and extended in future studies. Even though cross-language recall was observed, the use of both languages in recalling the studied items was lower than for monolingual recall. This might be due to the priming effect of the presentation language. The studied and the test

items were presented in the same language throughout each list. This presentation could prime the participants to recall the items in the particular language they had been presented. This priming effect therefore should be minimalised in future studies to see whether the influence of cross-language responses remains or not. The test and the studied items in future studies can be in different languages to directly investigate cross-language false recognition, for instance. Since the participants in this study were proficient in the second language, cross-language recall may be observed. Future studies on participants with various levels of proficiency should be investigated to determine whether shared or separate storage is a matter of proficiency.

5. Conclusion

This study conducted one main empirical experiment on false memory, to specifically investigate the semantic storage of Thai-English bilingual speakers by applying it to the Thai-English code-mixing context. The results as a sign of cross-language recall in this study only show a tendency to support shared storage in terms of semantics. With the influence of Thai presentation language, the false recognition of critical non-presented words would be likely to further affirm the *Revised Hierarchical Model*. Applied to the code-mixing context, language proficiency possibly points towards a trend as a responsible factor in encouraging participants to use code-mixing sentences. As a contribution to the literature, this study is eventually expected to be a part of providing one aspect to answer the questions closer to the debate over shared or separate storage. Experimenting with the bilingual context, this study also hoped to provide insight into bilingualism and second language acquisition. As code-mixing has been mainly investigated in the sociolinguistic or corpus linguistic fields, this study helps to bridge the field of psycholinguistics and code-mixing contexts.

Declarations

Conflicts of Interest

There is no conflict of interest, including financial, non-financial and/or competing interest, to declare.

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There has not been any financial funding sources that assisted this research.

Ethics and Consent

All of the participants participating in this research were informed through electronic mail as well as on the written paper about the procedures, objectives of this study and their rights to participate in the experiment. They had read, signed, and given their consent on the written ethical form.

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