

ABSTRACT

Title of Thesis: THE CROSS-LANGUAGE ACTIVATION OF FIRST LANGUAGE (L1) HOMONYMS TRANSLATIONS IN SECOND LANGUAGE (L2) PROCESSING: AN INVESTIGATION OF WHETHER L1 TRANSLATION ARE ACTIVATED IN L2 SENTENCE CONTEXT

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A present study aimed to investigate the role of a first language (L1) translation on a second language (L2) word processing in a sentential context by relatively advanced Arabic learners of English. The focus is on cases where a homonymous word in the L1 is realized by independent words in the L2, (e.g. Arabic قرش realized by English *shark* and *coin*). Using the visual-world paradigm, Arabic-English bilinguals and English native participants were auditorily presented with English sentences that are predictive of a target word (e.g., “shark” in *Scuba divers saw the sharp teeth of a giant shark yesterday*) while looking at a visual screen. The screen contained one of the three critical objects: a target object whose English name corresponded to the target word (*shark*; Arabic: قرش) in the target condition, an Arabic competitor object whose Arabic name shared the same Arabic translation with the target word (*coin*; Arabic: قرش) in the Arabic condition, or an object that was unrelated to the target word (*drums*; Arabic: طبيل) in the control condition.

Compared to native speakers of English, relatively advanced Saudi learners of English made more fixations on the critical objects in the Arabic condition compared to the control condition. This study supports the potential automatic activation of L1 translations when processing sentences in L2, even in relatively proficient learners and suggests evidence for the verification model in L2 word recognition.

Key words: Visual-world Paradigm, Cross-language activation, Homonyms, Target-absent Task.

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HOMONYMS IN SECOND LANGUAGE (L2) PROCESSING:
AN INVESTIGATION OF WHETHER L1 HOMONYMS ARE ACTIVATED IN
L2 SENTENCE CONTEXT

by

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Chapter 1: Introduction

During the initial stages of second language (L2) acquisition, adult learners frequently establish connections between L2 vocabulary and their first language (L1) counterparts, especially within a structured learning environment. This phenomenon raises a crucial question: Do L1 translations continue to be automatically activated with an increased level of L2 proficiency? Online measurements make it possible to observe the automatic cognitive processes involved in language processing (Conklin et al., 2018). This paper seeks to investigate this question by examining whether eye movements captured in real time through eye tracking can reflect the automatic activation of L1 translations while processing L2 sentences by advanced L2 users.

The initial evidence supporting the automatic activation of L1 translations in L2 word recognition was provided by Thierry and Wu (2007), (2010), and (2011). Thierry and Wu (2007) employed the semantic-related judgment task using event-related potential (ERP) to assess the brain's responses. The ERP data have shown that Chinese-English participants must have automatically translated the English words because their performance was different for English word pairs (such as train-ham) that have hidden repeated characters (i.e., train; *Huo Che* [火车], ham; *Huo Tui* [火腿]) from the control pairs that do not have any hidden repeated characters. Indeed, ERP data revealed a decrease in N400 in English word pairs with repeated characters. In a follow-up study (2010), Thierry and Wu investigated whether Chinese phonology (the prime and the target's translations shared the same pronunciation, e.g., experience-surprise, jingyan-jingya, 经验-惊讶) and orthography (the prime and the target's translations shared the

same characters but different pronunciation, e.g., accountant-conference, kuaiji-huiyi, 会计-会议) were activated in English word recognition. Chinese ESL speakers did not exhibit any behavioral differences as a result of translation repetition, although they did exhibit a lower N400 for the phonology repetition condition.

Another study by Jiang, Li, and Guo (2021) used a lexical decision task (LDT) to ask English natives and Chinese-English bilinguals to determine if a letter string was an English word or not. Jiang et al. (2021) tested the translation frequency effect (i.e., L1 translations for L2 words were different in frequency) and the lexical frequency effect (with matched L1 translation frequency). Unlike the English natives, bilinguals responded faster to English words with a higher frequency of L1 translation than those with a lower L1 translation frequency. However, both groups responded faster to higher-frequency English words than lower-frequency words, demonstrating an effect of lexical frequency. In fact, this study was the first to report the L1 translation frequency effect on L2 word recognition. The findings also suggested that L1 translation is automatically activated during L2 word recognition among shorter immersion L2 learners, but this effect did not significantly appear in longer immersion groups, indicating that an increased level of proficiency is more likely to decrease the potentiality of L1 translations in L2 word recognition.

The above lexical decision task involves a full activation of the L1 translation word mitigated by the manipulation of its word frequency. On the other hand, in the semantic relatedness judgment task, the manipulation of a shared character in the L1 translation creates a kind of L1 form-repetition. This repetition of a character helps promote L2 word processing without the need to activate the whole L1 translation

word. Therefore, the L1 translation word may be fully involved in the lexical decision task but only partially involved in the task of semantic relatedness judgment (Zeng et al., 2022). Given the differences between the two tasks, it is worth exploring whether the L1 translation is fully or partially involved in L2 word processing in different task contexts. A study by Zeng et al. (2022) examined the role of L1 translation activation in L2 word processing using both tasks by proficient Chinese-English bilinguals. In the semantic related judgement, they found that participants were more accurate and responded faster when English semantically-related pairs with repeated characters in translation (e.g., college-student; 学大 学生) than semantically-related pairs but without repeated characters (e.g., milk-bread; 牛奶 - 麵包). In the LDT, participants responded faster to words with a higher translation frequency than those with a lower translation frequency. The activation of L1 translations in L2 word processing clearly explained these observed translation frequency effects. To confirm the ecological validity and broaden the generalizability of the few studies that explored the L1 automatic translation activation during L2 word recognition using single words, it is important to conduct more direct studies of the L1 automatic translation activation in real-life sentence contexts.

In the realm of bilingual language processing, eye tracking has provided a window into how L2 learners navigate between L1 and L2. Utilizing the visual-world paradigm (VWP), a substantial body of eye tracking studies has debated whether proficiency in L2 can mitigate or suppress the L1 activation of L1. This approach is instrumental for studying the interplay between visual and auditory stimuli and their effects on language processing. The VWP illuminates how focusing on an object can

trigger a cascade of associated information activation in memory, thereby providing insights into cognitive processing (Heuttig et al., 2011; Henderson, 2003).

Typically, VWP eye tracking studies incorporate a cross-linguistic visual eye tracking task. This involves presenting participants with a visual screen that includes a target item, a cross-language competitor, and unrelated objects all appeared simultaneously in a single trial (Altmann & Kamide, 1999; Huettig et al., 2011). This methodology has been widely employed in diverse linguistic pairings and under varied language conditions. For example, studies have asked participants to identify and ‘click’ on a target object amongst distractors, where one distractor may share phonetic similarities with the target word in another language. Such a task was in the work of Canseco-Gonzalez et al. (2010). Canseco-Gonzalez et al. (2010) examined L1 activation during L2 lexical access under different language conditions: monolingual, mixed, and bilingual. Participants were asked to ‘click’ on one of the objects appeared on a computer screen. For instance, images of *beans*, *moustache*, and *jail* appeared in one trial, and participants were requested to click on “beans” as a target object. “Jail” was an unrelated object, while the Spanish translation of “mustache” was *Bigot*, which shared a phoneme onset with the target word. Berghoff, McLoughlin, and Bylund (2021) also used the cross-linguistic visual eye tracking task where Afrikaans-English speakers and English natives viewed a screen with four objects and asked to click a target object. The objects on the screen were the target object, a cross-linguistic competitor whose Afrikaans translation overlapped phonetically with the target object, plus two unrelated objects (Berghoff et al., 2021). A similar eye-tracking design in a study on Spanish-English was conducted by Blumenfeld and Marian (2013).

Yet, the ecological validity of these studies for real-world usage remains a subject of ongoing exploration. Language does not exist in isolation, real-world language involves words in sentences, conversations, and broader discourse context. The research trajectory has thus expanded to explore how a sentential context may modulate cross-language lexical activation. There was an array of eye tracking research that investigated the effect of a sentential context on L1 activation by employing the cross-language visual eye tracking task in different languages (e.g., Dahan and Tanenhaus, 2004; Chamber and Cook, 2009; Van Assche et al., 2012; Libben and Titone, 2009; Schwartz & Tarin, 2021). Chamber and Cook (2009), for example, examined how the proficiency level and semantic content of sentences containing homophones that resembled a word in the inactive language may moderate cross-language activation (e.g., French “poule” [chicken] sounds like the English word “pool”). Participants heard restrictive and non-restrictive sentences such as ‘*Maria va décrire/nourir la poule*’ (*Maria will describe/feed the chicken*) while viewing the four objects: a chicken, a pool, and two distractors. Further continuing the landscape, Vanderberg, Guadalupe, and Zwaan (2011) investigated the same phenomenon on Dutch speakers of English who performed a “no-task-task” while hearing a sentence such as “the *boxers step into the ring*” and viewing four objects (a boxer, a ring, and a between-language competitor, which is a scooter because in Dutch the noun *step* means *scooter*, and an unrelated distractor).

Building upon these methodologies and exploring their limitations, the present study adopted a novel approach: a target-absent VWP (Huettig & Altamman, 2005; Rommers et al. 2011, and Huettig et al., 2011). Here, the target word object is purposely

excluded from the visual scene, sharpening the focus on how bilinguals react to objects that related to their L1 translations within an L2 sentence context. This approach aims to mitigate potential biases inherent in previous cross-linguistics visual eye-tracking tasks that present cross-linguistic competitors alongside the target objects, which may influence the gaze patterns and are more likely to inhibit fixation on the cross-linguistic competitor. Consequently, participants would fixate their gaze to the target directly (Ito, Martine, & Corley, 2018).

To my knowledge, there was only one study on Russian-English participants by Mariane and Spivey (2003) which interestingly compared participants' fixation patterns in two critical conditions: the between-language competition condition which had a 'phonological' cross- language competitor (e.g., Russian 'plat'e' [dress] phonologically similar to the English target word 'plug', the target plug, and two distractors), and the baseline condition which had an unrelated object to the target object, used as a control object (the control object razor, the target plug, and two distractors). Participants were asked in English to pick up individual objects (e.g., plug). In my current work; however, there were no target objects in the following two critical conditions: the Arabic condition and the control condition. So, the proportion of looks to objects that shared the Arabic translation with the English target word were compared to the proportion of looks to the control objects that were not overlapped semantically with the target word in the control condition. It is worth noting that the above-mentioned cross-language selectivity studies primarily focused on the involvement of L1 in L2 processing. Such L1 involvement is on a much more general scale than access to a specific translation in L1. Therefore, this paper focuses on the

specific question of whether L2 word processing automatically activates their L1 translations.

Despite recognition, this body of work suggests that our understanding of the specific role of L1 translations in L2 processing is still incomplete. Firstly, most previous eye-tracking studies have employed a visual task where a target object and its cross-language competitor appear simultaneously, potentially limiting fixation on the competitor (Ito, Martine, & Corley, 2018). This study aims to extend the understanding of L1 translation activation by using a target-absent version of the VWP, where the target word object is intentionally excluded from the visual display in the cross-language condition (Huettig & Altamman, 2005; Rommers et al., 2011; Huettig et al., 2011). Secondly, the L1 automatic translation activation in L2 word recognition was examined in the context of isolated words (Thierry and Wu, 2007; Jiang et al., 2021; and Zeng et al., 2022). In the actual language world, however, words are embedded in sentences, conversations, or larger discourse analyses, which can impact the dynamics of language processing.

In adopting the target-absent VWP, our research draws inspiration from Rommers et al. (2013), who demonstrated that participants anticipate the characteristics of forthcoming words in a sentence. The study presented participants with a visual scene that included three unrelated objects and one of the critical objects, such as the moon, a tomato, and rice. They presented these objects based on one of the critical conditions: a target condition, a shape condition, or an unrelated condition. Participants simultaneously heard the following sentence: "*In 1969, Neil Armstrong was the first man to set foot on the moon.*" Rommers et al.'s study revealed that participants focused

more visual attention on the tomato picture than the rice picture. These eye-movement patterns indicated that the participants were anticipating the shape of the upcoming word in the sentence, suggesting that they were activating the word's characteristics, such as its shape, to guide their visual attention (Rommers et al., 2013).

Our aim, however, was to explore the activation of L1 translations in L2 sentence contexts by relatively advanced Arabic-English bilinguals. To achieve this, we used competitors that shared the L1 translation with the target word in the L2 sentences, rather than based on shape or phonological relatedness. To my knowledge, our study will be the first to intentionally avoid displaying a target object when its competitor objects were present to investigate the L1 automatic translation activation. L1 translation activation could potentially occur during L2 word processing. However, because the target object was present with its cross-language competitor in previous visual-world paradigm studies, participants might not be able to show that their L1 is activated by fixating on cross-language competitor objects. Therefore, the key benefit of this experimental design lies in its ability to ensure that participants don't get distracted by looking at the target object, which could overshadow their initial focus on the competing objects. In other words, we may give participants a better chance to demonstrate L1 automatic translation activation if it happens by not showing a target object.

Chapter 2: The Current Study

The purpose of the present work is to examine the automatic activation of L1 translations, particularly the translation of L1 homonymous words, when processing L2 sentences by relatively proficient Arabic-English bilinguals. Accordingly, the research question is: Whether L1 homonymous words' translations are automatically activated when processing L2 sentences? Homonymous words refer to the existence of multiple unrelated meanings, such as the homonym Arabic [قرش] is realized by the English words *shark* and *coin*. To be noticed, no prior research has been conducted on examining the automatic activation of L1 homonym translations in L2 sentences. Using the VWP, L1 English speakers (who reported no knowledge of Arabic) and L2 English speakers whose native language is Arabic listened to sentences such as *Scuba divers saw the sharp teeth of a giant **shark** yesterday*. Eye movements were recorded while participants viewed a scene with four objects. Three of them are unrelated distractors serving as fillers, and the remaining one is used to create three conditions. The target condition contained an image of a shark (shark; قرش). For the Arabic condition, it includes the image of a coin (coin; قرش), and for the control condition, it includes a drum (*drums*; طبيل).

The critical hypotheses concern both the Arabic condition and the control condition. The Arabic condition contains an Arabic competitor object (e.g., a coin) whose English name shares the same L1 Arabic translation with the target word named in the sentence (e.g., a shark). The control condition contains a control object (e.g., a drum) that is semantically unrelated to the target or the Arabic competitor objects. Bilinguals' fixation patterns to the Arabic competitor objects (e.g., coins) were

compared to their fixation patterns to the control objects (e.g., drums), and those differences would demonstrate spontaneous activation of L1 translations. Therefore, if L2 speakers automatically activate the L1 translations of the target word, they should fixate on objects corresponding to the Arabic competitor objects (e.g., coins) more than control objects (e.g., drums).

Chapter 3: Method

Participants

We recruited twenty-nine Arabic-English bilinguals with Arabic as their native language and thirty native English participants without any Arabic language background to participate in an eye-tracking experiment. Of those 29 participants, one was excluded due to inadequate eye-movement tracking. All participants have normal vision and reported no language disorders. Their ages ranged from 18 to 40 years ($M = 26.58$, $SD = 7.8$) 19 female and 7 males.

The Arabic-English participants were residents of the District of Columbia, Maryland, and Virginia (DMV) area at the time of the experiment. Based on the information obtained from a language questionnaire, the mean of Arabic-English bilinguals' International English Language Testing System (IELTS) scores was 7.5 ($SD = 0.5$; ranging 5.5–8.5). The mean age of their first exposure to English was seven years old ($SD = 3.8$; ranging from 1 to 11 years old). Self-ratings have often been utilized in previous visual-world paradigm research that examined cross-language lexical activation (Chamber & Cook, 2009; Mishra & Singh, 2016). The mean self-ratings of their L1 proficiency were 6.5 ($SD = 0.5$), and their L2 proficiency was 5.5 ($SD = 0.7$), rated on a scale from 1 to 7. With regard to the native English participants, they were undergraduate students at the University of Maryland, College Park, reporting no history of Arabic learning. Their ages ranged from 18 to 30 years old ($M = 22$, $SD = 3.22$), 16 female and 14 males.

Stimuli

The development of test materials began with the selection of homonymous words. 24 such homonyms were selected from the “*ما اتفق لفظه واختلف معناه*” book by Al-Yazeedi (Al-Yazeedi, 1987). It is the most well-known Arabic homonym book. Several criteria dictated the selection of stimuli. All were concrete nouns (with the exception of *desalination* and *sweetening*) as well as monosyllabic, clearly excluding previous examples. We have administered a homonym translation task. Ten native Arabic participants, particularly Saudis, were asked to translate Arabic homonymous words with all the meanings they knew into English. The mean for 48 English target words that were translations of 24 Arabic homonymous words was 88% (SD = 14%; range = 55%–100%). The following are examples of homonyms that were used in the experiment: (1) shark—coin “قرش”, (2) eye—headwater “العين”, (3) chapter—door “باب”. (4) stem—leg “ساق”, (5) atom—ant “ذرة”, (6) mole—uncle “خال”, (7) suite—wings “جناح”, (7) dinner—night “عشاء” (8) carrier—pregnant “حامل”; (9) trunk—hose “خرطوم”.

24 English sentences, with an average of 10 words in length, were created, each containing an object named by the translation of an Arabic homonym. They were tested using the cloze probability task to ensure that the experimental sentences’ target words, which are the last two positions in the sentence but never occur sentence-finally, were highly predictable. Five native English speakers and five Arabic-English bilinguals (the average of their IELTS score was 6.5, ranging from 6 to 7) were asked to complete

each sentence fragment using the first word that came to mind. None of them participated in the eye-tracking experiment. The average cloze probability of the target word was 0.89 (range = 50%–100%; $SD = 15\%$), indicating that the critical words were highly predictable. A male native American English speaker recorded the sentences at a relaxed pace. The audio was edited using Audacity. Sentences had a mean duration of six seconds.

Three critical objects—a target object whose English name was the target word in L2 sentence [shark; Arabic: قرش], an Arabic competitor object whose English name shared the same L1 Arabic translation with the target word [coin; Arabic: قرش], or a control object that was semantically unrelated to the target word [drums; طببل]—and three distractor objects that were unrelated to the critical objects in terms of semantics or phonology make up the visual displays for the experiments. The colored images were selected from different sources or created by an artist. Colored objects have been used in order to make it easier to identify the objects (Rossion & Portois, 2004). We conducted a picture-naming task to assess name agreements for the selected objects. Five English native speakers and five Arabic-English bilinguals from a similar pool of the main eye tracking experiment’s participants, who didn’t participate in the eye tracking experiment, saw pictures of objects and were asked to give the first word that came to mind when seeing the pictures. Some pictures were changed and retested. The agreement on object naming of the target object and the Arabic competitor object for L1 and L2, respectively, was L1: 85% for the target objects ($SD = 0.23$, range = 25%–100%), 86% ($SD = 0.20$, range = 25%–100%) for the Arabic competitor objects, and

L2: 90% ($SD = 0.14$, range = 50%–100%) for the Arabic competitor objects, and 83% for the target objects ($SD = 0.19$, range = 25%–100%).

These items were used to create three presentation lists. Each list contained 24 experimental trials and 8 filler trials. Each trial consisted of an English sentence presented auditorily in English and a visual display of four pictures on a computer monitor. Three conditions were created via the pictures. The target condition contained a picture named by a word in the sentence, e.g., a picture of a shark for the following sentence "*Scuba divers saw the sharp teeth of a giant shark yesterday*", plus three other pictures. The Arabic condition included a picture whose name was also the translation of the Arabic homonym involved, e.g., the picture of a coin for the same sentence. The control condition contains a picture that is not related to the meaning of the sentence or the Arabic homonym, e.g., the picture of a drum for the above sentence. The three pictures for the same sentence were presented at the same location but never appeared on the same list. The 24 critical items were counterbalanced across the three presentation lists such that each list contained 8 target items, 8 Arabic competitor items, and 8 control items, but no item was repeated on the same list. The critical objects were all of the same size, 300x300 pixels. We also rotated the position of the pictures across conditions such that on each list, the critical pictures were presented in each of the four quadrants on the 1920x1080 pixel screen (Fig. 1). Eight filler items were also included on each list that contained the picture of an object mentioned in the sentence. Thus, for a total of 32 items on each list, an object was mentioned in 16 sentences, and was not mentioned in the other 16 sentences.



Figure 2: Example displays for each of the three conditions for the sentence “Scuba divers saw the sharp teeth of a giant **shark** yesterday”. Shown along with the three distractors (a shark, a coin, and a drum): the Target condition (with a shark), the Arabic competitor condition (with a coin), and the Control condition (with a drum).

Procedure

The participants were tested in The University of Maryland's eye tracking lab. The experiment administrator spoke exclusively in English to participants during the session, so the whole experiment context is exclusively English monolingual without any reference to Arabic. At the outset of the session, all participants signed an informed consent. The experiment began with the LexTALE test for non-natives, and the mean was 74, ranging from 96 to 64. Based on the LexTALE results, participants were upper intermediate to advanced learners of English (Lemhöfer & Broersma, 2012). All participants completed a picture familiarization task in which they read the English names of 50 experimental objects. Then, after seeing the objects, they were asked to write their correct English names.

We tested each native and bilingual participant individually in the eye-tracking experiment. They were seated with their chins on a chin rest in front of a computer screen and instructed to listen to the sentences and decide whether each sentence mentioned any of the pictures on display. With a sample rate of 1000 Hz, the EyeLink 1000 Plus was used to capture participants' eye movements. The experiment started with two practice trials, and then participants had the opportunity to ask questions about the experiment. A monitor with a 1920x1080 pixel resolution displayed the pictures. A drift correction was performed before each trial, and after each of the eight trials, there was a break.

The pictures were presented 1000 ms before the onset of the L2 sentences. After the spoken sentence's offset, the pictures remained on the screen for 750 ms, followed immediately by a screen that had a question. The question is, "*Did the sentence mention any of the pictures?*" Participants had to respond by pressing either "1" if "yes" or "2" if "no" using the keyboard. No feedback was given, and then the next trial began afterward. After the eye-tracking experiment, Arabic-English bilinguals completed a language background questionnaire. The session took 30 to 45 minutes.

Chapter 4: Results

The proportions of fixations on the critical objects (target, Arabic competitor, control) were calculated by dividing the total fixations on the critical objects by the total fixations on all objects, including the critical objects and distractors, to create the dependent variable, which indicates the strength of any bias toward each experimental object over the unrelated distractor objects (Fig.2). We counted as a fixation any event where the gaze was stable at the interest area (IAR), which is a square of 300x300 pixels around the target pictures. To investigate the time-course effect, we examined eye fixations that began at the start of the target word and lasted 1000 ms after its onset. It is important to recall that one critical object with three distractors was displayed in each trial.

	Groups	Target Condition Fixation Count	Arabic Condition Fixation Count	Control Condition Fixation Count
1	English Native Speakers	69.6	28.1666	24.5333
2	Arabic-English Bilingual Speakers	72	37.821	23.8571

Figure 3: Average of fixation proportions to Targets, Arabic, and Control conditions

Running a linear-mixed effect model in R that incorporates both conditions (target, Arabic, and control) and groups (English native speakers and Arabic-English bilinguals) as fixed effects was to explore the interactions between groups and conditions. We mapped the control condition as a reference condition in this model. The model illuminates how these groups differentially respond to the Arabic condition and the target condition. The interaction terms offer nuanced insights into group-

specific responses. The interaction between the Arabic condition and groups approached significance ($b = -10.3310$, $SE = 5.6636$, $t(112) = -1.824$, $p = .071$), suggesting that English speakers may exhibit a reduced increase in fixation counts in the Arabic condition compared to Arabic-English bilinguals. This trend, while ‘not statistically’ significant, hints at potential differences in how L1 automatic translation activation in bilinguals might modulate cognitive engagement during the eye tracking task. Conversely, the interaction effect for the target condition did not reveal a significant difference between groups ($b = -3.0762$, $SE = 5.6636$, $t(112) = -0.543$, $p = .588$), indicating that the heightened engagement in the target condition is a universal phenomenon, unaffected by the linguistic background of participants.

We also analyzed the eye tracking data for L1 and L2 speakers separately using another linear mixed-effect model in R (Ito et al., 2018; Rommer et al., 2013). The full model included a fixed effect of condition (target, Arabic, control) and the maximal possible random effect structure consisting of random intercepts for condition by participant. The control condition was also mapped onto the intercept as a baseline to compare the Arabic condition and target conditions to. The results from the linear mixed-effects models for both Arabic bilinguals and English native speakers show that both groups had significantly increased fixation counts in the target condition ($b = 48.143$, $SE = 3.866$, $t(81) = 12.453$, $p < .001$; $b = 45.067$, $SE = 4.062$, $t(87) = 11.094$, $p < .001$) relative to the control condition, respectively, as Fig.3 suggests. Importantly, the Arabic condition for L2 speakers also resulted in a significant increase in fixation counts ($b = 13.964$, $SE = 3.866$, $t(81) = 3.612$, $p < .001$); however, the Arabic condition for L1 speakers did not significantly change fixation counts ($b = 3.633$, $SE = 4.062$,

$t(87) = 0.894, p = .373$) compared to the control condition. The result suggests that bilingual Arabic-English speakers may exhibit cognitive automatic activation of their L1 translations when engaged in an L2 task. This is shown by the fact that there were more fixation counts in both the target condition and the Arabic condition by Arabic-English bilinguals. In contrast, English native speakers' fixation counts significantly increased only in the target condition, with no notable change in the Arabic condition. These findings underscore the unique cognitive processes underlying bilingual individuals' engagement with second-language tasks, highlighting the influence of first-language translation.

Fixed Effects of Condition on Fixation Counts from Linear Mixed-Effects Models

Fixed effects	Arabic-English Bilingual Speakers				English Native Speakers			
	Estimates	SE	t-value	p-value	Estimates	SE	t-value	p-value
Intercept	23.857	2.734	8.727	2.75e-13	24.533	3.294	7.447	1.10e-10
Target Condition	48.14	3.866	12.453	< 2e-16	45.067	4.062	11.094	5.75e-16
Arabic Condition	13.96	3.866	3.612	0.000525	3.633	4.062	0.894	0.375

Figure 3: Results of LMEM, table showing fixation proportions to Targets, Arabic, and Control conditions 1000 ms from the critical word onset *in both L1 and L2 speakers. The Control Condition was used as the reference group.*

The Mann-Whitney U test, as this test does not assume normal distribution of the data, was also run as an alternative to compare groups in the three conditions independently (the target, the Arabic, and the control conditions). Fig. 4 shows that the

Mann-Whitney U test indicates a statistically significant difference in the results of the Arabic condition between Arabic-English bilinguals and English speakers, with ($W = 572.5$; and a p-value of 0.00896). This suggests that Arabic speakers of English had increased fixations in the Arabic Condition more than English speakers. The Mann-Whitney U test with ($W = 431$; a p-value of 0.4351), indicates that there is no statistically significant difference in the target condition fixations between Arabic-English and English speakers. The p-value exceeds the typical significance level of 0.05, suggesting that the median scores of the target condition for Arabic speakers are not significantly greater than those for English speakers. The Mann-Whitney U test for the control condition, with a ($W=of 446$ and a p-value of 0.3456), indicates no statistically significant difference in the scores between Arabic-English and English speakers, suggesting that the median scores for Arabic speakers in the control condition are not significantly greater than those for English speakers. Overall, the findings from the series of Mann-Whitney U tests conducted to explore if the L1 translation activation occurs in situations where English language is predominant offer nuanced insights. While the significant result in the Arabic condition (p-value = 0.00896) points out that English-Arabic speakers performed significantly better (in terms of eye fixations) than English speakers, may suggest automatic activation of L1 translation, the lack of significant differences in the target condition and control condition (p-values = 0.4351 and 0.3456, respectively) indicates that this activation does not uniformly extend to all contexts.

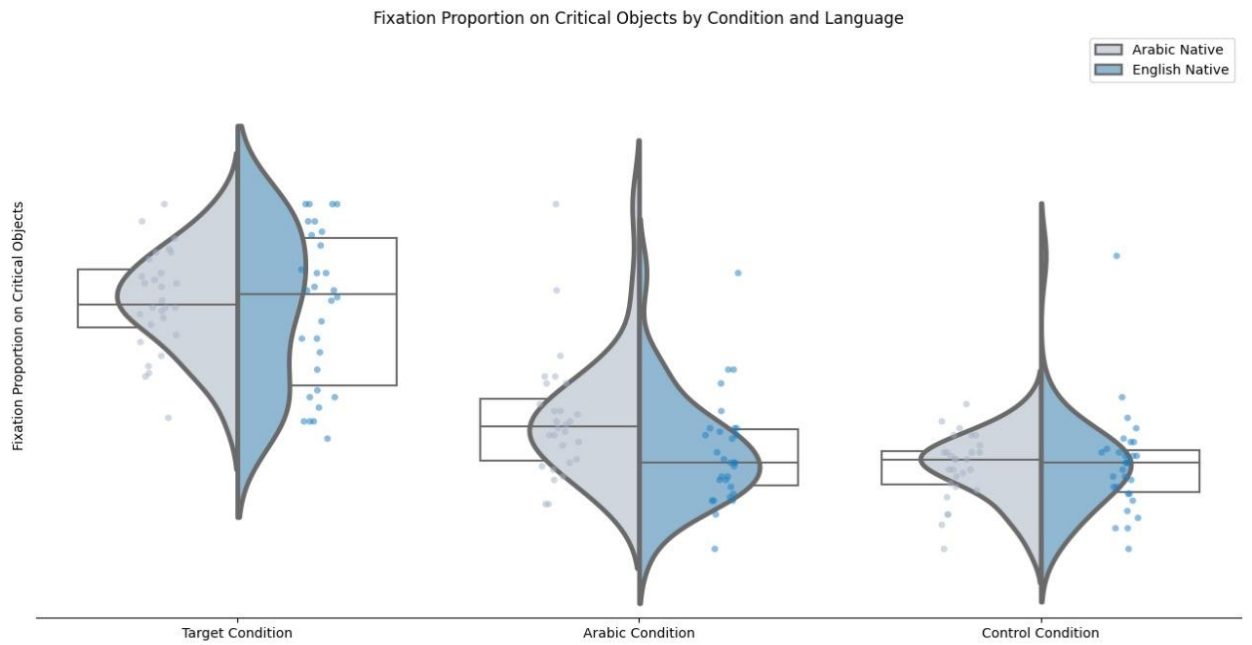


Figure 4: The graph compares the proportions of fixations to the critical objects (Target, Arabic competitor, unrelated) for L1 speakers and L2 speakers

Chapter 5: Discussion

Using the target-absent eye tracking task, the present study investigated L1 translation activation during L2 sentence processing. Specifically, we narrowed our focus to examine the activation of L1 homonyms translations when processing L2 sentences. The results indicated that relatively advanced bilinguals are more likely to activate the L1 translations. When listening to sentences such as “*Scuba divers saw the sharp teeth of a giant shark*”, Arabic-English bilinguals looked significantly more at the picture of a *shark* than unrelated distractors when the word ‘*shark*’ was heard. More importantly, the findings showed that bilinguals looked significantly at objects that shared the L1 translation with the target word (e.g., coins) more than control objects (e.g., drums). Interestingly, this effect wasn’t observed in English natives; in fact, they didn’t look more at the Arabic competitor object (e.g., coin) compared to the control object (e.g., drum). These results apparently may suggest the role of lexical-level translation connections in activating L1 translations from L2 words, even in highly proficient L2 users and even in tasks that solely involve the L2. It can be assumed that the inclusion of the target-absent design was useful in capturing the competition effects and examining the attraction of attention to items that shared the same Arabic translation with the targets compared to distractors or controls. By observing which objects participants fixate on in the absence of the target objects, researchers can accurately infer whether participants activate automatically the L1 translations. The effectiveness of the target-absent paradigm in revealing those competition effects between semantically related items versus unrelated distractors aligns with previous

research findings, further validating the utility of this approach in psycholinguistics studies (Huettig & Altamnn, 2005; Huettig, Rommers, & Meyer, 2011; Rommers et al., 2013; Ito et al., 2018).

It seems also plausible that the effects observed in this study align with previous findings by Thierry and Wu (2007; 2010; & 2011), Jiang et al. (2021), and Zeng et al. (2022) who have documented that L1 translations are automatically activated during the recognition of L2 words. Specifically, the present outcomes are more likely to support the presence of a “verification process in L2 word recognition”. Jiang et al., (2021) discussed the verification process in L2 word recognition that was evidenced by the frequency translation effect where English words with higher Chinese frequency were recognized faster than those with lower Chinese frequency. In the context of L2 word recognition, the initial analysis of the input involves identifying the L2 word that best matches the input. This process is fundamental to both L1 and L2 word recognition. According to Jiang (2021), L2 word recognition goes beyond those initial analysis and involves a verification or checking procedure. The verification step is where the activated L2 word is checked against its equivalent L1 translation (Jiang et al., 2021). In practical terms, this means that when advanced Arabic-English bilinguals of the present study looked for the correct L2 form-meaning, L1 translations were somewhat automatically co-activated because Arabic-English bilinguals had increased fixations on the cross-language competitors that shared the Arabic translation with the English target words more than control objects, and that, in turn, can be attributed to the verification process involved in L2 word recognition. In other words, the verification process may allow L2 speakers to confirm the accuracy of their L2 word

recognition by comparing the activated L2 words against their L1 translations.

Cheng et al. (2011) expanded on this idea by examining a translation lexicality effect in a series of studies involving Korean and Chinese speakers of English as a second language. Using a lexical decision task (LDT), participants were tested on English compound words. They manipulated the semantic transparency of the compounds and created a translation lexicality variable by including compounds that were directly translatable into Chinese and Korean, as well as those that were not. For instance, the compound “toothbrush” has a direct Chinese translation of “yashua,” while the compound “schoolbook” doesn’t have a direct translation equivalent, and if so translated, the translation will be “keben,” which means “lesson book.” The findings revealed that L2 speakers responded faster or more accurately to translatable L2 compounds compared to untranslatable ones. While the authors initially interpreted these findings in terms of morphological decomposition, the verification model provides an alternative and more promising explanation (Jiang et al., 2021).

In fact, the results of activation of L1 translations in L2 word recognition have long been documented in various models of bilingual representation and L2 lexical development. One such model is Kroll and Steward’s (1994) model of bilingual representation, which discusses that when bilinguals encounter a word in L2, the corresponding word in their L1 becomes active. Other models included Jiang’s (2000) model of L2 lexical development and Ecke’s (2015) model of parasitic vocabulary acquisition (Kroll et al., 2014).

The current experimental results also extend previous research (Elston-Güttler & Williamson, 2008; Chambers & Cooke, 2009; Zeng et al., 2022) regarding the proficiency effect over parallel language activation. Elston-Güttler and William (2008) provided evidence that advanced German learners of English activate the L1 polysemes during L2 reading. Advanced German learners made more errors and displayed longer response times compared to natives, particularly in cases where the translation equivalent of a polysemous word in their L1 was realized by interdependent words in English. They argued that the observed effect may reflect an intermediate stage of development towards language-specific lexicalization patterns in which L2 words activate the specific concepts associated with their L1 translation equivalents, and such interference, in turn, influences the learners' processing.

It is worth noting that Elston-Güttler and William (2008) acknowledged that cross-language interference can be limited to a certain type of L2 learner, suggesting that early acquisition of L2 is crucial in avoiding cross-language interference. However, participants of this study were somehow mixed, early and late L2 learners; some early advanced bilinguals demonstrated increased fixation on the Arabic competitor objects compared to the control ones, suggesting that both the length and the quality of exposure at the initial stages of development are significant factors that influence the degree of cross-language lexical activation (Berghoff et al., 2021). Thus, a specific type of advanced early learner of a language may not rely on their L1 lexicosemantic system for form-meaning mapping during L2 vocabulary acquisition. This, of course, remains an issue for future research.

Chapter 6: Conclusion

The study investigated the role of L1 translation in L2 word processing in a sentential context for advanced Arabic learners of English. It found evidence supporting the automatic activation of L1 translations when processing sentences in L2, even in highly proficient learners. The present study warrants caution. This research is the first to document the effect of L1 automatic translation activation within sentential contexts; further replication is required to confirm the findings. Future replications must take into account three notable limitations: firstly, the implementation of a more quantifiable and controllable method for assessing language proficiency, secondly, the enhancement of the study's statistical power by enlarging the number of participants and test items involved. It is also recommended to eschew the use of colored images as they may introduce unnecessary variables into the data due to the salience of certain colors.

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