Investigating Proactive Interference Effects After Switching Encoding Language in Bilingual Individuals

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Abstract

Proactive interference (PI) is the phenomenon where previously learned information hinders recall of later learned information. A common method of studying PI is to ask participants to memorize several lists of words, with poorer recall of words from later lists attributed to interference from earlier lists. Previous research has shown that certain strategies can be used to increase recall performance by reducing PI. For bilingual individuals, this includes switching the language of presentation on the last list. However, there has not been any research on whether mental translation can be used as a conscious strategy to reduce PI.

In the current study, the aim was to investigate whether switching the encoding language in bilingual individuals reduces the effects of PI. The researchers adopted a 2 (English vs. Spanish) by 3 (Control vs. Shift vs. Translate) factorial design, recruiting both Spanish-dominant and English-dominant bilinguals. Participants were instructed to memorize words from four lists and then recall them later. The *Control* condition presented all four lists of words in the same language. In the *Switch* condition, words on the last list were presented in the other language relative to the first three lists. In the *Translate* condition, participants were asked to mentally translate the words on the fourth list. We expected participants in the mental translation condition to show a larger reduction in PI compared to those in the Control and Switch groups, resulting in higher recall of words from the last list. However, there were no significant differences across conditions on the basis of recall differences between List 1 and List 4. There were significant differences in List 4 recall precision.

Introduction

Proactive interference (PI) has long been a subject of interest in memory research. It refers to the phenomenon where previously learned materials interfere with the retrieval of newly learned materials (Underwood, 1957). Traditional PI testing involves using 3-4 lists of words for participants to recall, with PI buildup. Previous studies have established that changing the semantic categories of the words being remembered can release the effect of PI by making the words more psychologically distinct (Underwood, 1975). For example, if List 4 introduces a shift in material being encoded, such as a change in category from fruits to animals, it will release the PI effect. However, if the category of word remains the same, recall on List 4 decreases as it takes more mental effort to differentiate between the lists.

Bilingual individuals, who are proficient in two languages, commonly referred to as L1 and L2, can be used to investigate the effects of language change on PI. Goggin and colleagues have combined the ideas of introducing two types of changes in List 4 of words into a PI experiment: those being a language change from L1 to L2 or L2 to L1, and a semantic category change. It was found that recall increased for the language change condition, taxonomic category of word change condition, and dual change condition where both language and category of word changed, which is expected following the dual material change on List 4 (Goggin & Wickens, 1971). Compound bilinguals are defined as people who learned both languages at home whereas coordinate bilinguals are people who learned one language before the age of six, and another after age of six (Dillon et al., 1973). When examining only language change, it was found that language change alone was able to release both compound and coordinate bilingual participants of PI.

However, conflicting results have been found in other studies, suggesting the need for further research. For instance, another study found that only dual change showed significant release, while the other conditions were still higher than the control condition (Newby, 1976). Additionally, a study found that bilinguals recalled more words than monolinguals when controlling for vocabulary scores between the groups (Bialystok et al., 2009).

Another study found that earlier retrieval in Spanish reduced subsequent retrieval in English, but not vice versa (Gutierrez et al., 2013). The participants in that study were "unbalanced" bilinguals who spoke English better than Spanish. This finding is relevant to the current study because it showed that there is a possible retrieval backfire effect when the earlier encoded language is the language that a bilingual individual is less proficient in.

At present, there has been no study examining whether actively generating a translation of the word into the other language that the bilingual participants know can alleviate the effects of proactive interference (PI), which is the main focus of our current study. We designed our study with three different conditions for each language group. In all three conditions, participants are presented with four lists of words, but the language and instructions used for each list vary depending on the condition.

Previous studies have consistently demonstrated the effects of material shift on releasing PI, as well as how a deeper level of processing of information improves word recall (Moscovitch et al., 1976). Based on these findings, we hypothesize that participants in the *Translation* condition will exhibit a significant release from PI compared to the baseline level of PI.

Our objective was to compare and analyze the recall performance differences between the three conditions; *Control* condition, which helped us make sure that there is PI buildup; *Switch* condition, that helped to make sure that there is PI release per previous literature, in addition to

comparing with *Translation* condition to see whether the PI release in the two conditions were different.

Methods

Participants

Participants were recruited via Amazon Mechanical Turk. Individuals who had previously reported that they were bilingual received an email about the study. A total of 64 Spanish-English bilinguals were recruited. Participants were at least 18 years old, with a mean age of 34.171, *SD* = 9.652, and mean years of education received of 16.828, *SD* = 2.920.

Design

A 2 (English vs Spanish) x 3 (*Control, Switch, Translate*) factorial design was used. Participants were divided into a total of six groups, two between-subject manipulations being English-dominant word lists and Spanish-dominant word lists to counterbalance each other, and three within-subject manipulations. The first was the *Control* condition, where participants were shown four lists of words all in the same language (i.e., all in Spanish or all in English). In the *Switch* condition, on List 4, words were translated into the other language for them. For example, if in the first three lists the participants had been seeing words in English, then on List 4 they saw words presented in Spanish and were instructed to memorize those words. Lastly, the *Translation* condition, where participants saw the List 4 words presented in the same language as the previous three lists, but this time on the fourth list they were accompanied by instructions to translate, i.e., participants saw the word “Dog” and were instructed to translate the word into Spanish, “Perro.” Participants were told that they may be tested on any list, but they were only

going to be tested on List 1, to establish a baseline of recall, and on List 4, to assess PI buildup and release.

Materials

Participants' proficiency in both languages was measured with the LexTALE test. The LexTALE test is a vocabulary test designed to assess English proficiency level and Spanish Proficiency level (Baayan et al., 1995; Izura et al., 2014). It consists of a lexical decision task where participants have to decide if a word is a real word or a nonword. For the English version, there were 60 words total with 40 words and 20 nonwords; for the Spanish version, there were 60 real words and 30 nonwords. We also surveyed participants on certain demographic information such as years of experience with their languages. Experiments were conducted online via MTurk, surveys were made with psytoolkit (Stoet, 2010; Stoet, 2017).

As for words used in recall, we selected words that were normed for translation equivalence, which means English-Spanish bilinguals will agree on how to translate these words most of the time; we made sure these words are good examples of their semantic categories and weren't cognates, so we excluded words like *animal* because it's orthographically and phonologically similar or identical in Spanish and English. We matched the words based on both length (letter count) and frequency. Letter length match was perfect, on average 5.08 letters on both English and Spanish words; however, frequency match was only approximate, with the frequency for Spanish words being 3.63 and for English words 3.68. However, the difference was not statistically significant, $t(47) = 1.94$, $p = .058$.

Procedure

The participants of this study were instructed to view four lists of 12 words sequentially and to study these words for a later memory test. They were informed that they might be tested randomly on any list, but in fact, they were only tested after List 1 and List 4. The *Control* condition consisted of words presented in one language throughout the four lists; it could be either in English or Spanish depending on their condition. The *Switch* condition involved the first three lists of words presented in their L1 and the fourth list presented in their L2. They were instructed to memorize the words as presented. In the *Translation* condition, participants saw all four lists of words presented in their L1. However, on the last list, they were instructed to translate words from English to Spanish (or vice versa) and memorize the translation.

The test itself starts with a practice showing instructions, with four common words not used in the actual lists for participants to get used to the procedure. All of the words were presented with 2000 ms delay, 500 ms inter-stimulus interval, at the beginning of each list there's a 2000 ms delay fixation screen, followed by 8000 ms delay instruction screens.

For the recall tests, participants were asked to recall all of the words from the list they just saw in any order. They typed their answers into the computer and, when finished, indicated they were done by hitting the green button.

Analysis

Participants' recall performance was assessed through recall accuracy percentage. Analysis was done with a 3 Conditions (Control, Switch, Translate) x 2 Lists (List 1 or List 4) x 2 Languages (English or Spanish) framework, with one-way between groups ANOVA and *t*-test. Buildup of PI was assessed through analyzing the List factor. Random effects were included both on the

basis of participants and items. The main research interest was the interaction between Conditions and Lists.

We are primarily interested in the following outcome measures: (a) recall differences, assessed by subtracting List 4 recall from List 1 recall; list precision, and (b) the mean number of correctly recalled items divided by all the items recalled (correct recall + intrusions).

Results

Due to lack of sufficient sample size ($n = 64$), these results are preliminary. A one way between group ANOVA was performed to determine whether there was an effect of list conditions on recall. List 1 recall across the three conditions were not significantly different, $F(2, 62) = 0.85$, $p \approx 0.43$, see Figure 1; List 4 recall across conditions were not significantly different $F(2, 62) = 0.78$, $p \approx 0.46$, see Figure 2; there was no significant effect of proactive interference observed across conditions $F(2, 62) = 0.03$, $p \approx 0.97$, see Figure 3; there was no significant differences across conditions on List 1 precision $F(2, 62) = 2.08$, $p \approx 0.13$, see Figure 4; there was however a significant differences in List 4 precision across conditions $F(2, 62) = 4.87$, $p \approx 0.01$, see Figure 5.

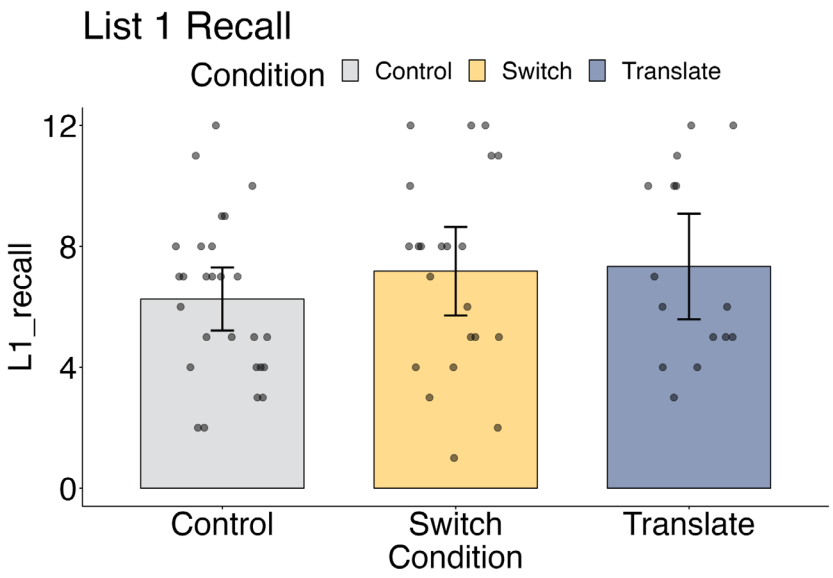

Figure 1. *List 1 recall by list conditions.* Mean recall is plotted as a function of list conditions, error bars represent standard errors of the means, individual dots represent individual participants.

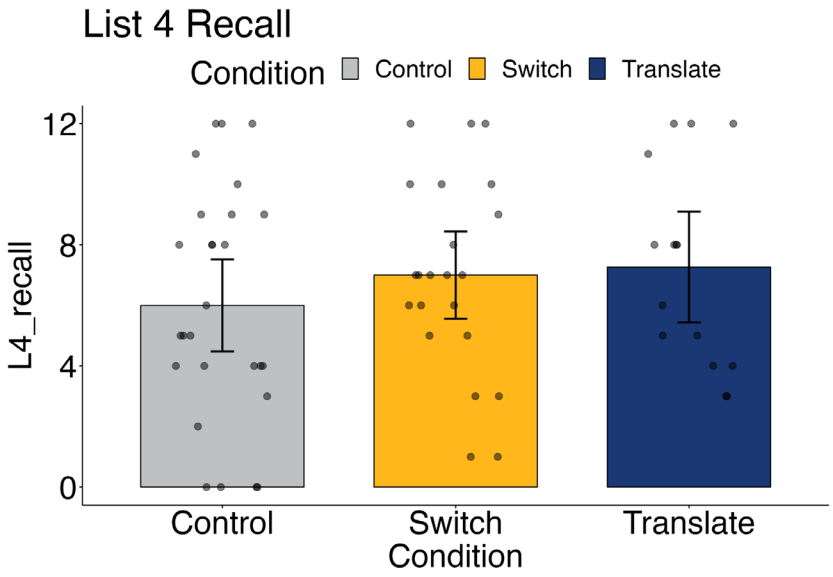

Figure 2. *List 4 recall by list conditions*. Mean recall is plotted as a function of list conditions, error bars represent standard errors of the means, individual dots represent individual participants.

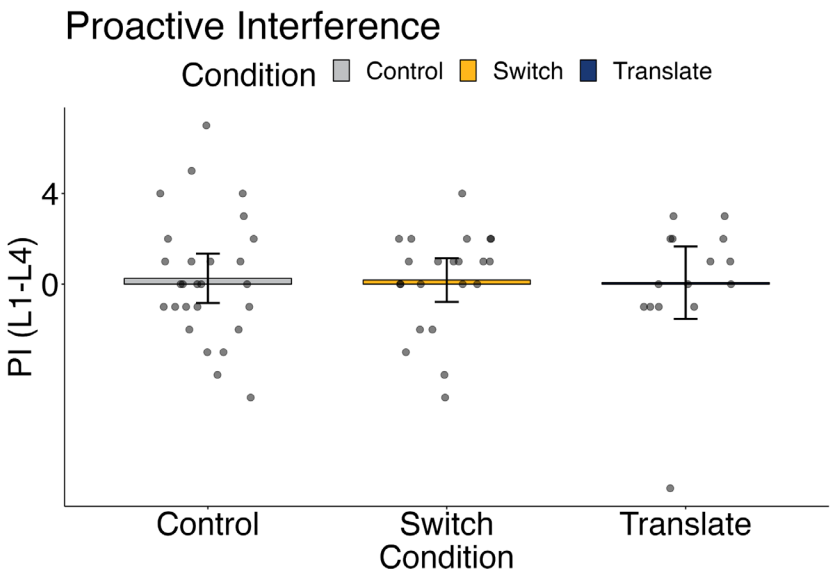

Figure 3. *Recall differences by list conditions.* Mean difference is plotted as a function of list conditions, error bars represent standard errors of the means, individual dots represent individual participants.

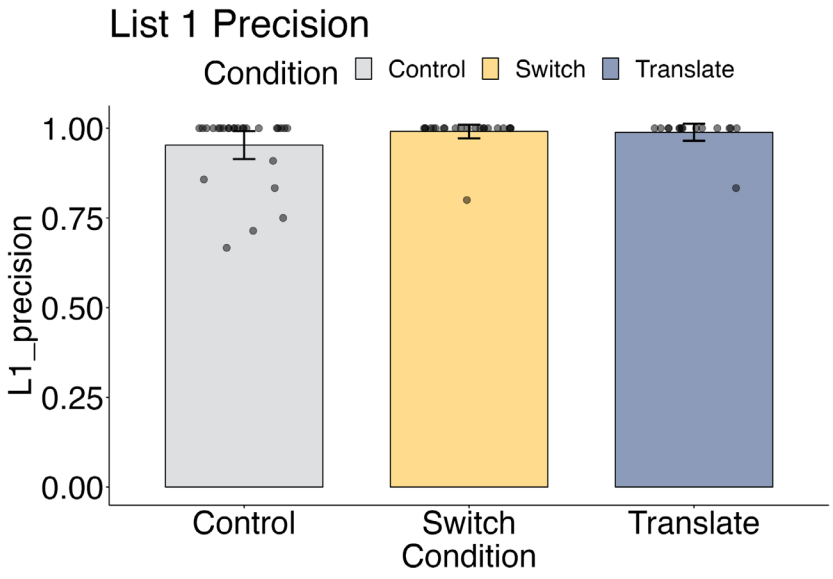

Figure 4. *List 1 Precision by list conditions*. Mean precision is plotted as a function of list conditions, error bars represent standard errors of the means, individual dots represent individual participants.

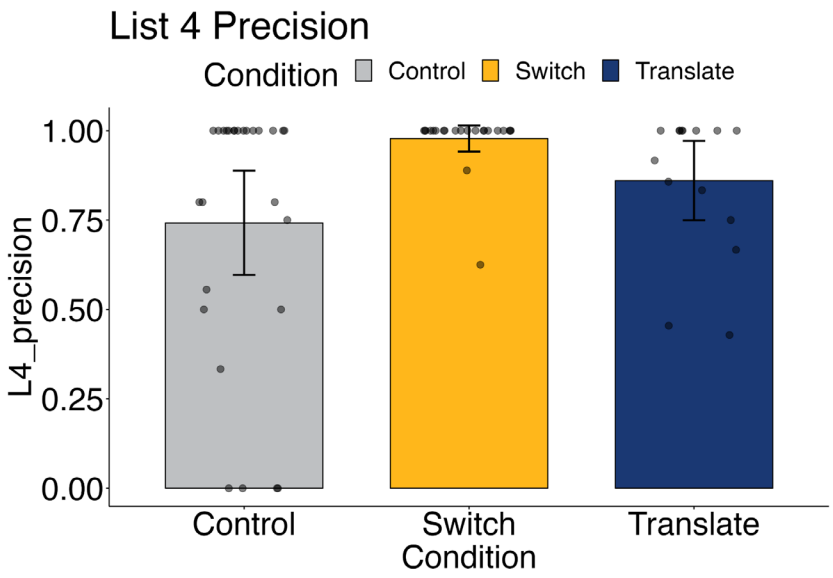

Figure 5. *List 4 Precision by list conditions.* Mean precision is plotted as a function of list conditions, error bars represent standard errors of the means, individual dots represent individual participants.

Conclusions

Bilingualism is a growing field of research that warrants increasing attention, as this area of study only gets more and more relevant each day as the world is further globalized. Our current research examined whether bilingual individuals can purposefully utilize their language skills as a strategy to induce release from PI in order to enhance their recall. Based on preliminary results, there were no significant differences between List 1 and List 4 recall performance across conditions; there were significant differences in List 4 precision across conditions. Given the sample size, it is hopeful to see that there are some significant differences in List 4 recall precision across conditions, as that measure also relates to the PI phenomenon.

This study is constrained by a small sample size, thus we were unable to conduct all the analyses we were originally hoping for. As a result, we had to collapse across the language

conditions (English vs. Spanish) to perform analysis at a higher sample size. Future studies should aim to reach a larger sample size, especially because considering there are six conditions total, a larger sample size would be necessary to make any meaningful conclusions confidently. Future studies should also examine whether, if there's an effect under the *Translation* or *Switch* conditions, the result replicates across other language pairs. Another direction future research could take is to investigate whether *Switch* and *Translation* conditions would yield better source memory, which could be done by determining how well participants remember in which list they encountered different words.

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