I bet I'll remember "biochemistry" – Meta-memory as a function of lexical features and language background

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ABSTRACT

Previous research has shown that people are more likely to remember positive and negative words compared to neutral words. The present study investigates whether participants with varying language backgrounds would differentially remember words based on the words' lexical feature of valence. In a meta-memory task, participants placed a bet on each word in a series based on how likely they think they would recall the word. After the words were presented, participants freely recalled as many words as they could. Findings from over 140 English monolingual, English dominant bilingual, or English non-dominant bilingual college students show that participants chose to bet higher on negative and positive as compared to neutral words, but remembered more negative than positive or neutral words. However, English non-dominant bilinguals bet more points on positive words than their peers did, but they were similarly accurate in their overall recall, indicating that cultural/language background might differentially affect individuals' sensitivity to word valence.

Keywords: metacognition, metamemory, bilingualism, language dominance, valence

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1. INTRODUCTION

1.1. Metamemory

A metamemory (MM) task tests how well participants can predict their memory of target learning materials as well as participants' actual memory, and the target materials are typically words. For example, words paired with potential points are presented one at a time to participants, who are to place a bet on whether they will be able to recall that word later [9]. This exemplifies strategy-based learning, as participants can influence their memory performance by focusing more on fewer, select words that they believe they will have a higher chance of remembering. Previous studies on MM showed that there may be differences in MM strategies based on person-level characteristics such as age [6]. Less is known about other features that may affect people's memory (and MM).

1.2. Language Background

Specifically, studies have shown that bilingual individuals tend to lag behind monolinguals in their vocabulary [e.g., 3,4], yet it is unclear whether these language background differences may affect people's word memory. For example, despite having similar English reading abilities, Chinese-speaking English language learners have more difficulty recognizing English words than Romance-language speakers do [8]. Chinese speakers seem to rely more on memories from previous rote studying whereas Portuguese and Spanish speakers make use of cognates [8].

The linguistic differences may affect the learners beyond the feature of cognates. For instance, despite a universal positivity bias across human languages (i.e., there are more positive words than negative words), languages differ in their happiness score as indexed by the valence rating of the most common words in the languages. Across 10 languages examined by researchers, Spanish is found to be the most positive and Chinese to be the least [5]. It is unclear whether the profile of bilingual individuals' first language (L1) may influence their processing and memory of words in English. Thus, we aim to also investigate MM among young adults from different language backgrounds.

1.3. Lexical features and memory strategies

Just as how person-level characteristics such as age or language background may affect memory performance

and metamemory strategies and tendencies for words, the characteristics of the task stimuli, e.g. the lexical feature of target words, may also affect memory performance and strategies.

For example, valence, or the pleasantness of a stimulus [10], has been shown to affect how quickly participants can identify words and how well they can remember them. In naming tasks where participants name the presented word aloud as quickly as possible, participants' reaction time tend to be faster for negative stimuli [7]. In another study focused on memory, recognition performance is better for the words with extreme valence (either very positive or very negative), but not for neutral words. Closer examination with the extreme valence words indicated no difference between the two. That is, participants remembered no more positive words compared to negative words [1]. Given the conflicting findings from previous research, more studies are needed to examine how lexical features, especially related to valence may affect human memory. Additionally, previous studies focused on behavioral results of reaction time and recognition of words varying in valence; it is yet unknown whether participants may be sensitive enough to the valence of words to use different strategies to approach a metamemory task.

1.4. Current study

The current study is designed to better understand how participants from different language backgrounds choose to bet and recall words with varying levels of valence in a meta-memory task. Our work builds on McGillivray & Castel's [9] MM paradigm but modified it so participants can place a value on how likely they are to remember each word. Participants may end up remembering more words at specific levels of valence. In particular, we hypothesize that participants will bet and recall more positive and negative words (e.g., comfort, meanness) rather than neutral words (e.g., brush, step), since emotionally charged words have been shown to influence memory consolidation [1, 7]. Given that there is no previous literature, we have no directional hypotheses for the language groups, but it is possible that different patterns for bets and recall may emerge, as one group may be more sensitive to valence than another group. We also predict that participants will remember more words that are presented first or last, due to primacy and recency effects.

2. METHOD

2.1. Participants and conditions

One hundred and forty-one students from a selective university in western United States participated in this study. Participants were recruited through a human subjects pool and either received 1.5 participation credits or $15 gift cards. Based on their self-reports (see SOM), participants were categorized as English only (EO, $n = 45$), English-dominant bilinguals (EDB, $n = 50$), or English non-dominant bilinguals (ENDB, $n = 40$). Six balanced bilingual individuals were excluded for analyses due to a small sample size. Most EDB participants spoke Spanish as their other language ($n = 18$). In contrast, 85% ($n = 34$) of ENDB spoke Chinese as their first language (L1). Because of the language group breakdown, we use the term "bilingual" to refer to both EDB and ENDB participants, and the term "language dominance" pertains only to EDB or ENDB participants. Additionally, participants either received a randomized version of the task (words were displayed in random order, $n = 66$) or a nonrandomized version (all negative words first, then neutral, ending with positive words, $n = 69$). Table S1 in the Supplementary Materials displays the breakdown of participants' language and order groups.

2.2. Stimuli

A total of 60 nouns were used in the study. The words were selected based on their valence ratings from Warriner and colleagues' [10] work. The positive and negative words have the highest and lowest valence ratings (the top and bottom 10^{th} percentile), and the neutral words have valence values in the middle 10 percentile from the original dataset. The words were balanced across the three valence levels on other lexical features, e.g. frequency, imageability, polysemy. The 60 words were split into five balanced lists of 12 words each, and each list consists equal numbers of positive, neutral, and negative words. (See Supplementary Materials for the word lists and the words' lexical features.)

2.3. Metamemory task

The MM task was a computerized task administered via the PsychoPy program. It consisted of five rounds that each contained a list of 12 words. After each word was presented, the participants were asked to place a bet on the likelihood that they would remember that word (on a scale from 0-10). Words were either presented in a non-randomized or randomized order throughout the sections. At the end of word presentation and bets for each list, participants were asked to recall all the words they could remember by typing them into the computer. The program added the bets of the words remembered by the participant

and subtracted the bets of the words not remembered, and the resulting number was displayed at the end of each round as a "score." The participant received this score as feedback before moving onto the next list (see Supplementary Materials Figure S1 for further descriptions). The dependent variables were the points the participants bet on the words and their recall accuracy.

2.4. Procedure

This study is part of a larger project on memory and cognition. Following the informed consent process, participants completed a survey on their language dominance or skills in reading, speaking, writing, and listening in their language(s). After the survey, participants completed the MM task in a quiet laboratory room.

3. RESULTS

Two within-between 3 (valence: positive, negative, neutral) x 3 (language group: EO, EDB, ENDB) x 2 (order: randomized vs. non-randomized version) repeated measures ANOVAs were performed on bets and recall accuracy.

3.1. Bets

For bets, there was a significant main effect of language group ($F(2, 129) = 3.41$, $p = .036$, $\eta_p^2 = .05$); ENDB group bet more points than the EO participants. There was no significant main effect of order ($p = .70$, $\eta_p^2 = .001$). There was a significant main effect of valence ($F(2, 258) = 52.08$, $p < .001$, $\eta_p^2 = .29$) with higher bets placed on negative words ($t(258) = 9.56$, $p < .001$) and positive words ($t(258) = -7.86$, $p < .001$) than neutral words. There was a significant valence × language group interaction ($F(4, 258) = 8.88$, $p < .001$, $\eta_p^2 = .12$), where ENDBs bet more on positive than negative words ($t(258) = -3.32$, $p = 0.03$) and EOs bet more on negative and positive than they did on neutral words ($t(258) = 4.79$, $p < .001$; see Figure S2). There was a significant valence × order interaction ($F(2, 258) = 27.81$, $p < .001$, $\eta_p^2 = .18$) showing that those in the non-randomized group placed higher bets on negative words that came first in the list. The three-way interaction was significant ($F(4, 258) = 3.95$, $p = .004$, $\eta_p^2 = .06$). English monolinguals, and to a lesser extent, English dominant bilinguals, seemed particularly susceptible to valence × order effect as they bet fewer points on neutral words when they were presented in the middle of the list (see Figure 1).

Figure 1: The average value of bets as a function of valence, order, and language group.

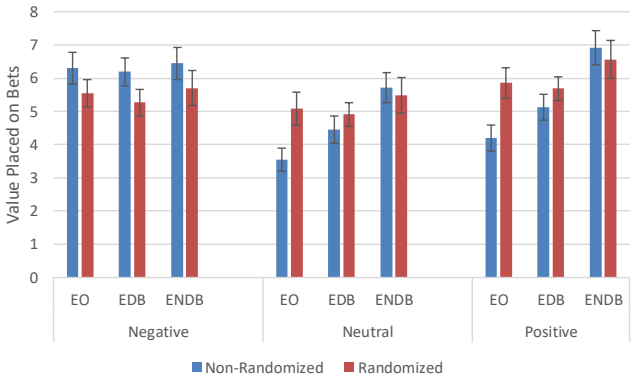
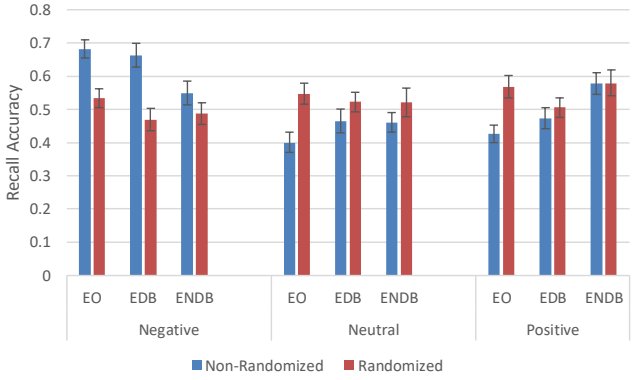


Figure 2: The average recall accuracy as a function of language group, valence, and order.



3.2. Recall Accuracy

For recall accuracy, there was neither a significant main effect of language group ($p = .84$, $\eta_p^2 = .002$), nor order ($p = .84$, $\eta_p^2 = .000$). There was a significant main effect of valence ($F(2, 258) = 12.64$, $p < .001$, $\eta_p^2 = .09$) with more negative words being accurately remembered than positive ($t(258) = 2.73$, $p = .02$) or neutral words ($t(258) = 5.02$, $p < .001$). There was a significant valence × language group interaction ($F(4, 258) = 5.88$, $p < .001$, $\eta_p^2 = .08$), in which the EOs remembered more negative words compared to positive ($t(258) = 4.16$, $p = .001$) and neutral words ($t(258) = 5.03$, $p < .001$; see Figure S3). There was a significant valence × order interaction ($F(2, 258) = 30.49$, $p < .001$, $\eta_p^2 = .19$), as participants who saw negative words first were more accurate in recalling them than recalling neutral ($t(258) = 8.72$, $p < .001$) or positive words ($t(258) = 6.40$, $p < .001$). In addition, participants in the non-randomized version remembered more negative words than those in the randomized version

($t(315) = 5.00$, $p < .001$). The three-way interaction was significant ($F(4, 258) = 2.51$, $p = .04$, $\eta_p^2 = .04$). English monolinguals were particularly sensitive to valence × order as they were able to remember more negative words when they were presented first and less able to remember neutral and positive words when they were presented later on in the list (see Figure 2).

4. DISCUSSION

Our hypotheses were partially confirmed by our findings. Participants bet significantly higher on words with emotional valence as compared to neutral words. With respect to accuracy, the overall valence effect was restricted to negative words over neutral words. Though the finding may seem to conflict with previous evidence that words higher on emotionality are better remembered [1], our results appear to be an artifact of the order in which the participants viewed the words. Specifically, English monolingual participants (and to a lesser extent, English dominant bilinguals) who received negative words first appeared to remember the negative words very well but could hardly recall the neutral and positive words that were presented later.

As hypothesized, students from different language background indeed displayed differential performance, as English non-dominant bilinguals bet approximately one point higher than the English only group, but there was no difference in recall. In addition, the ENDBs bet more on positive words compared to negative words while the EO and EDB groups bet more on negative words compared to positive words. The ENDBs' placing more points on positive words may have to do with the positivity bias in English, as positive word types are more prevalent in English [5] and may therefore influence the type of words English learners might tend to pick up first. Future studies should examine the characteristics of the lexicon in participants L1s.

Additionally, further analyses might reveal a more detailed understanding of our findings. For example, it would be worthwhile to examine the calibration score to investigate how well participants' bets matches their actual recall performance and whether such calibration varies by lexical features or language backgrounds. To further examine the impact of words or language backgrounds, other analytic methods such as mixed effects modeling [2] can be employed.

Overall, we found that participants from different language backgrounds do not differ in their overall accuracy, but ENDBs are more likely to place higher bets on positive words whereas EOs are more likely to bet on negative words. This pattern suggests that ENDB group may be differentially sensitive to word valence, which might be due to the linguistic and/or cultural differences between English and other languages. Additionally, there is evidence for an order × valence effect where if negative words are presented first, participants tend to be less able to remember the words presented near the end of the list, and this effect is particularly strong for English monolingual participants. Future studies should investigate this potential interaction and examine the mechanisms behind the pattern of differences.

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