Does the Central Executive have higher efficiency in Bilinguals compared to Monolinguals in regards to short-term memory recall of meaningful auditory information?

Anindya Auveek

Oct 29, 2019

ABSTRACT

Previous studies have shown that lexical-semantic knowledge is a key contributor to the effectiveness of the "phonological loop" in working memory; resulting in the better performance of memory recall in monolinguals than bilinguals of a target language. This study will investigate whether the higher efficiency of the central executive (CE) portion of working memory in bilinguals claimed by other studies can compensate for their lesser lexical-semantic knowledge of the target knowledge; resulting in better performance in difficult memory recall tasks. The results confirmed that lexical-semantic knowledge does help in "easy" short-term memory recall tasks, but no conclusive evidence was found to suggest the effect of higher efficiency of working memory in bilinguals during "difficult" short-term memory recall tasks. Suggesting that in tasks of higher difficulty, both monolinguals and bilinguals perform the same.

For humans, memory affects many of our daily activities. The ability to hold semantically relevant information for both short and long term is clearly important for many cognitive tasks (eg. understanding

lectures). “Working Memory” (WM), which refers to the portion of memory related to short term storage and information manipulation, is the main contributor to short term memory recall and general computation. Having a higher Working Memory capacity has been linked to better performance on tasks related to cognition, and more controversially, having higher “intelligence”. In correspondence, an important area of research in Cognitive Psychology is finding the causes of individual differences in Working Memory, and understanding possible ways in which WM performance can be improved. A proposed theory is that bilinguals have better WM performance than monolinguals; which allow them to both hold and recall information in “short term” better than monolinguals.

On the contrary, some studies have shown a superior verbal memory performance in monolinguals over bilinguals. In particular, in a study by Messer et. al, Dutch preschoolers, who are monolingual rather than bilingual, showed better performance in non-word memory recall of words which have distinct phonotactic correlation with the Dutch language. This research displays that lexical-semantic knowledge is indeed supportive for short term memory recall.

Nevertheless, other studies have shown the positive effects of bilingualism on both inhibition of irrelevant information, and short term memory capacity [Bialystok et al, 2004]. In the study by Bialystok et al., the researchers attempt to show the relationship of bilingualism and the negative effects of aging. Their results found that for both age groups, bilinguals performed better in a memory recall activity, exhibiting quicker results in a memory activity, and less interference from incongruent trials.

Taking into consideration the results of the conflicting findings in these two studies, the effect of bilingualism in difficult memory recall activities vs. easy memory recall activities was not addressed. More specifically, the performance of WM between monolinguals and bilinguals, and its effect on the recollection of semantically relevant information presented in the monolinguals first language was not shown.

According to the "Working Memory Model" proposed by Alan Baddeley and Graham Hitch, the "Central Executive" (CE) is the branch of WM responsible for inhibitory control (directing attention) whilst the phonological loop deals with short term storage of auditory information. Additionally, it has also been shown that long term memory does indeed play a part in the effectiveness of the phonological loop in information storage (eg. remembering semantically relevant information is easier than non relevant) [Thorn & Gathercole].

In our study we will examine the two groups English-Speaking "monolinguals" and English-Speaking "bilinguals" and explore the effect of long-term knowledge of a language on short-term memory recall of words presented in English. This will explore the effect of lexical-semantic knowledge on short-term memory recall. Furthermore, by varying the difficulty of the memory recall task (increasing/decreasing the size of the list of words presented), we will try to determine the difference between the efficiency of CE performance of the two groups. This will be similar to the study by Jewon Yoo and Margarita Kaushanskaya, but instead of testing "Words", "Non-words" and "Digits" in the memory recall task, we will only use lists of semantically relevant English words and vary the difficulty (size of the list). We will not specify whether the target language (English) is the Bilingual individual's "first" language.

Due to the findings of previous research showing higher efficiency of CE performance in bilingual individuals, and also the relevance of long term knowledge to the phonological loop, I predict that individuals in the monolingual group will perform better in easier tasks (due to having better lexical-semantic knowledge). Nevertheless, due to the higher effectiveness of the CE in bilinguals, I expect them to compensate for their lower lexical-semantic knowledge in more difficult tasks, allowing them to perform better than monolinguals.

Method

Participants

The participants were 114 University of Toronto students who are taking a Cognitive Psychology course. They were divided into two independent groups; the first being the group of individuals who speak only one language (Monolinguals), and the second being the opposite i.e. the group of individuals who speak more than one language (Bilinguals). The participants all understood English.

Materials and Design

The participants were presented with two different groups of data. The first being a list of 5 English words, and the second being a list of 15 English words. Each group (5 /15 word lists) had multiple different samples presented to the participants. The participants were asked to remember the words from the given sample to them after that sample was presented and write them on paper.

All the participants (Monolinguals & Bilinguals) were presented the same data. The independent variable in this experiment is the length of the list of words being presented and the dependent variable is the number of words recalled from each sample. This experiment has a within-subject design, therefore the control variable is the students participating.

Procedure

Before the experiment, all 114 of the students taking part were asked to prepare a piece of paper and a pen/pencil to write. Simultaneously, for all the participants (Bilinguals and Monolinguals), each sample from both word groups (based on number of words in the list) was announced auditorily in English; starting with the group containing lists of 5 English words and ending with the group containing lists of 15 English words. There were 3 different samples (lists) presented from each group.

Each word from the sample was announced verbally, one at a time after a momentary pause between the words. After the complete list of words from the sample were announced to the students,

they were asked to write the words they could recall (in any order). Following this, the list of words from the given sample were shown to the students visually on the projector, and they were asked to input the number of words they recalled through an online survey platform (Tophat). This was repeated for all three samples from both groups.

Results

Using the data, an Independent Sample T test was performed for both groups (lists of 15 english words and lists of 5 english words). The degree of freedom of the T tests was 112. The null hypothesis for both tests was that the average number of words recalled for both samples (Monolinguals and Bilinguals) are the same.

The first Independent Sample T test, analysed the number of words recalled from every list containing 5 words. For Monolinguals, the mean (X_1) number of words recalled was 4.58, and standard deviation (S_1) of the number of words recalled was 0.51. For Bilinguals, the mean (X_2) number of words recalled was 4.17, and standard deviation (S_2) of the number of words recalled was 0.86. This resulted in a t value of 2.011 which outputs a 2-tailed significance of 0.047. This is less than the required p value of 0.05, therefore the null hypothesis is rejected i.e on average monolingual English are seen to performance of short-term memory recall of a list of 5 english words than bilinguals who also speak english.

The second Independent Sample T test, analysed the number of words recalled from every list containing 15 words. For Monolinguals, the mean (X_1) number of words recalled was 5.89, and standard deviation (S_1) of the number of words recalled was 1.52. For Bilinguals, the mean (X_2) number of words recalled was 6.26, and standard deviation (S_2) of the number of words recalled was 1.77. This resulted in a t value of 0.84 which outputs a 2-tailed significance of 0.401. Therefore the null hypothesis for this

test still stands i.e. the average number of words recalled from a list of 15 words is the same for bilinguals and monolinguals.

Discussion

The first part of my hypothesis was shown to be correct, and Monolinguals do present better performance in an easier memory recall task. This is parallel to the results found in the experiment done by Messer et. al. Therefore, lexical-semantic knowledge does affect the effectiveness of the phonological loop in short-term memory storage.

On the Contrary, the second part of my hypothesis was wrong. Since a significant difference was not found in the performance of memory recall of a difficult activity (list of 15 words) between monolinguals and bilinguals, the data from this experiment cannot be shown to support previous research presenting the higher effectiveness of CE in bilingual individuals.

A possible reason for this finding may be that the size of the list in the difficult group was too little. Unlike in the study by Yoo, J et. al., the difficult group only contained 15 words rather than 20. This may have not allowed for enough compensation by CE of the bilinguals for their lesser amount of lexical-semantic knowledge during memory recall task.

The first limitation in this study is the lack of selection of bilinguals which have english as their “Secondary language” rather than their “first language”, therefore difference in lexical-semantic knowledge was not confirmed to be significant before the experiment began. Furthermore, another limitation was the limited variability of independent variable, more list sizes should have been tested. Lastly, the limited number of samples per variable may have affected the accuracy of the findings.

Bibliography

Yoo, J., & Kaushanskaya, M. (2012). Phonological memory in bilinguals and monolinguals. Memory & Cognition. 1314-1330.

Thorn, A. S. C., Gathercole, S. E., & Frankish, C. R. (2002). Language familiarity effects in short-term memory: The role of output delay and long-term knowledge. Quarterly Journal of Experimental Psychology, 55A, 1363–1383.

Baddeley, A. D., & Hitch, G.1977. Working Memory. Human Memory.

Messer, M., Leseman, P., Boom, J., & Mayo, A. (2010). Phonotactic probability effect in nonword recall and its relationship with vocabulary in monolingual and bilingual preschoolers. Journal of Experimental Child Psychology, 105(4), 306–323.

Bialystok, E., Craik, F. I. M., Klein, R., & Viswanathan, M. (2004). Bilingualism, aging, and cognitive control: Evidence from the Simon task. Psychology and Aging, 19, 290–303.