

Effect of Languages on Digit Span Task (Hindi and English)

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Objective

Digit Span measures verbal short-term memory - the systems that allows temporary storage of information. It is pivotal in regular assignments, for example, recalling a phone number or seeing long sentences. Digit Span has a long history in neuropsychological assessments. An average adult is thought to have a digit span of 7 items, plus or minus 2 (Miller, 1956). In this study, we examine the digit span task in a set of 26 bilingual individuals, fluent in both Hindi and English. We test the digit span task performance in these bilingual individuals. Majority of these individuals have Hindi as their mother tongue. In spite of this, it is seen that performance in English is better for longer digit spans for both groups.

Literature Survey

Digit span task has been used for very long in the study of short term memory. In the study by Rumjahn, effect of digit span, both forward and backward was tested among bilingual teenage Chinese children. Vast difference was seen in both forward and backward digit span. This was attributed to bilingual auditory storage index during bilingual development. In another study by Annabel and Susan, short term memory on bilingual (fluent in French and English) and another set of monolingual people with good command over English language and limited knowledge of French, were tested. Words were used in the experiment. The findings indicate that language specific differences in verbal short-term memory do not exclusively originate in the sub-vocal rehearsal process.

The study by James et. al. experimented with various children from different age group from Chinese, American and Japanese ethnic races. Chinese children outperformed Americans on longer digit spans and explanation for this difference due to pronunciation time for digits. The study comprised of 3 experiments for each age group. The first study comprised of children from kindergarten. The performance of American and Japanese children were similar, whereas Chinese children performed significantly better than their counterparts. A hypothesis was that this might be due to counting system used for teaching in China which emphasises on serialability of numbers too. The second study was for children of about 6 or 7 years which included tasks like forward, backward and grouped conditions. The Chinese children outperformed the American children in both the forward and grouped conditions. But in the backward condition, the chinese children performed significantly poorly than American children. The third study was carried out on university students explored the possibility of pronunciation for digit span task differences. The chinese numbers were found to be shorter pronunciation duration compared to English. This study was based on the rationale by Baddeley, Thomson and Buchanan that given any particular list of words or digits, the numbers of items that can be stored in short term memory depended in the time it takes for pronunciation. i.e. an individual who pronounces the words more quickly will be able to remember more of the list than an individual who pronounces them more slowly. The Chinese children had longer spans than American children. The authors concluded that there is a significant difference in the digit span task between American and Chinese children and the difference was attributed to pronunciation time required for digits in languages.

We focus mainly on the study by Amâncio da Costa Pinto and the study by Ellis and Hennelly's. Several studies have shown negative relationship between memory span and digit word length. This could be especially true for bilinguals who are fluent in two languages. In a study by Amâncio da Costa Pinto, two experiments were conducted to test this theory. In the first investigation, the impacts of digit syllable length on speech rate in five distinctive bilingual gatherings was tried. Results showed that reading rates were faster in his/ her mother tongue than in the secondary language inspite of word length measured in phoenemes or syllables. Investigation 2 inspected all the more intently the correspondence between speech rate and digit length with Portuguese-English bilinguals. Results showed that

digit-reading rates were quicker and digit span bigger in the mother tongue regardless of whether the mean number of syllables per digit was higher. This difference was attributed to one's familiarity with mother tongue. Individuals tend to shorten and skip syllables while speaking in their mother tongue. The set of people tested in the second set were people with more familiarity in their mother tongue. In another study by Ellis and Hennelly's, Welsh-English bilinguals were experimented. The subjects were presented with a random list of numbers and were asked to read it as fast as they could, once in English and once in Welsh and then they were given a standard digit span test in both languages. The average duration of pronunciation for Welsh digits was significantly greater than that for English digits and hence digit span was significantly greater in English than it was in Welsh. Here, the sample had lower spans in their native language (Welsh) than in English. The authors had also noted that this may be due to the fact that these speakers used to use English numbers frequently than Welsh. They attributed this reason to longer spans in secondary language than in mother tongue. Familiarity effects may be the reason which decides the spans in the case of bilinguals.

Methodology

Subjects

26 individuals, proficient in both Hindi and English participated in the study. Their age varied from 22 to 29 with a mean of 24.96. 13 of them are students at IIIT, Hyderabad and others working in ISRO, Bengaluru. The subjects were from different ethnicities, few from North India and few from South India. 13 of them has stated Hindi as their mother tongue and 13 had stated 'Other'. All of them had learnt English as a language in school. For subjects, with mother tongue not stated as Hindi, had learnt Hindi as the secondary language in school. All subjects are capable in conversing well in Hindi as well as English.

Tasks and Procedure

The experiment was website based and was hosted at this site ([link here](#)). jsPsych was used for the experiment. jsPsych is a JavaScript library for running behavioral experiments in a web browser. The library provides a flexible framework for building

a wide range of laboratory-like experiments that can be run online. The data was store in a MySQL database and later exported to csv format and analysed.

Subjects were asked their age and their Mother tongue - Hindi or Other. Requirements for this experiment were knowledge of Hindi as well as English and had to be done from a laptop/ PC. Instructions were given in the website itself. Then the experiment consisted of 24 trials - 12 each for Hindi and English. Participants were given a string of random digits and must recall them in the same order in which they were presented and then enter the digits in a numeric keypad. The experiment followed a 1:2 staircase procedure. This means that the span increases by one whenever a participant is correct, and the span decreases by one whenever a participant is incorrect two trials in a row. The starting span was 3 for both Hindi and English. The participants were first presented with English digits for 12 trials and then another 12 trials for Hindi digits. Typical administration takes 15-20 minutes.

Results

Accuracy was given more importance than time. The dataset from this experiment can be found [here](#).

The mean scores obtained from this experiment is presented in Table 1. The results obtained from the experiment for all subjects is plotted in Fig. 1. We see that average span with English digits is higher than Hindi digits. Average span of English digits was 8.2 and 7.2 for Hindi digits. Majority of the subjects had reached highest span of 9 in English and with Hindi, about 11 subjects had digit span of 7.

Mother tongue of the subjects	Mean score of English Digits	Mean score of Hindi Digits
Hindi	8.75	7.2
Non-Hindi	7.5	6
Overall	8.2	7.2

Table 1

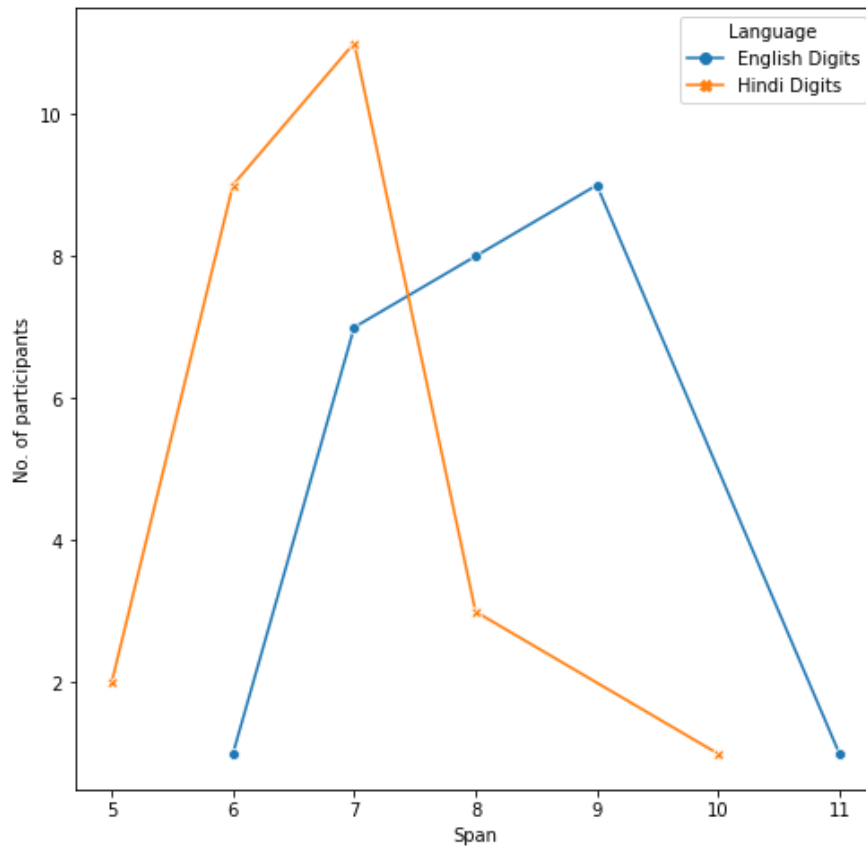


Figure 1

Here additional results are presented separately for subjects with Hindi as Mother tongue and separately for subjects with languages other than Hindi as Mother tongue in Fig. 2 and Fig. 3 respectively. Fig.2 has results of subjects who are fluent in Hindi have have their mother tongue as a language other than Hindi. The highest span in Hindi reached by these subjects is 7 where as the highest span in Hindi is 10 for subjects with hindi as their mother tongue. This difference can be attributed to the less familiarity with the language. For subjects with mother tongue as non-Hindi, the average digit span in English digits was 7.5 and 6.0 in Hindi digits. For subjects with mother tongue as Hindi, the average digit span 7.2 was in Hindi digits. This is obvious as subjects with Hindi as mother tongue would have advantage over subjects with mother tongue as non-Hindi.

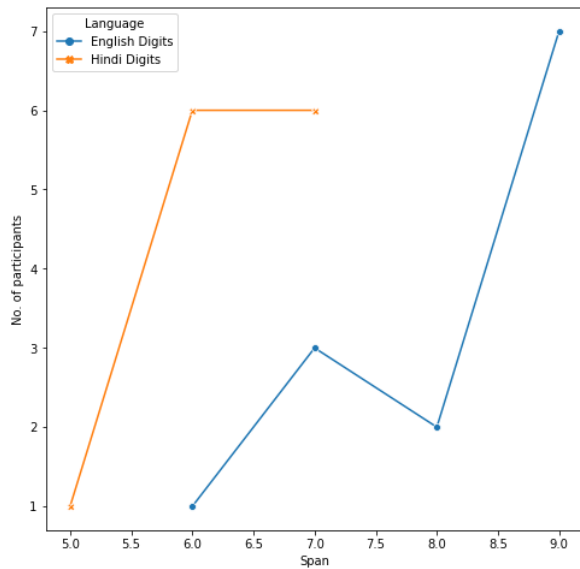


Figure 2

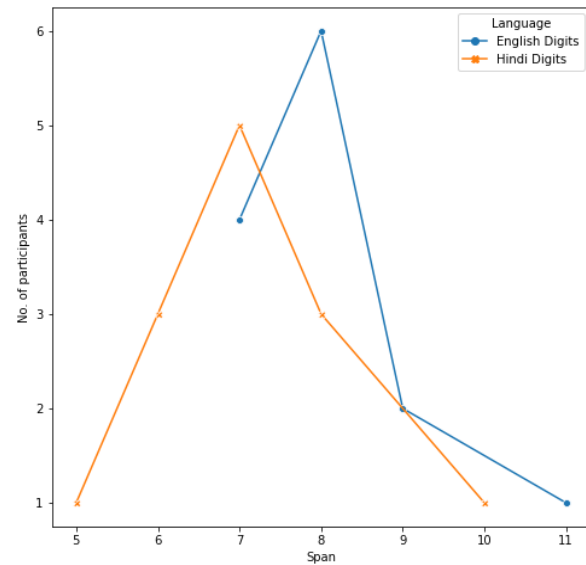


Figure 3

Discussion

From the results, we see that digit span performance in English is better than performance in Hindi. Among subjects with native language as Hindi, performance in English digits was better than the performance in Hindi. The digit span is longer in English inspite of the fact that these subjects have their mother tongue as Hindi. The reason for this can be explained by the following explanations below. Though this study contradicts the one by Amâncio da Costa Pinto, this is in accordance with the study by Ellis & Hennelly.

One reason for the results obtained is from the experiment by Baddeley Thomson and Buchanan (1975). Baddeley et. al. showed that the number of words an individual can hold in short-term memory is limited by the amount of time it takes to pronounce the words. This might have an effect on bilingual speakers fluent in both languages Hindi as well as English. By this theory, we might be able to store in more information in short term memory for English digits as the pronunciation time for English digits is shorter than that of Hindi digits. This was also observed in another study by Ellis and Hennelly (1980) with English and Welsh speakers. The same has been observed in multiple other studies too. The negative association between reading rates and span differences has important implications for theoretical and practical reasons. Regardless of the dominant language, the digit span is greater in English than in Hindi. The average duration of pronunciation for Hindi digits is longer

than that for English digits and digit span is greater in English than it is in Hindi. It seems to be a possible explanation for the cross-linguistic differences in digit span. Another possible explanation can be that the subjects had mentioned that they are comfortable in using English digits more often than Hindi. This familiarity with the language might be a cause for higher digit span in English. This is in concurrence with the study by Ellis et. al. They had also observed the same with English and Welsh speakers. Another reason can also be attributed to the small sample size. Given a larger sample size, the theory can be established with higher certainty. Though the reason for these results is completely not clear, it poses a significant problem - explanation for lower digit span in native language in the case of bilinguals, that can be studied further.

Conclusion

The methods, tasks and procedure for effect of languages on digit span in case of bilinguals has been presented. Results show that digit span is longer in English than in Hindi. But even in the case of individuals with mother tongue as Hindi, same results had been obtained. Possible explanation for the longer span in English can be attributed to the facts that the subjects might be more familiar or have affinity towards English digits in daily usage. This can be particular case of bilingualism. This study endorses that regardless of native language, subjects seem to have higher digit span in the language non native language. However, the actual reason behind this observation has to be explored further.

Reference

- Reading Rates and Digit Span in Bilinguals: The Superiority of Mother Tongue
Amâncio da Costa Pinto
- A bilingual word-length effect: Implications for intelligence testing and the relative ease of mental calculation in Welsh and English
Ellis, N. C., & Hennelly, R. A. (1980)
- Forward and Backward Digit Span in the Languages of the Bilingual
Rumjahn Hoosain

- Language differences in verbal short-term memory do not exclusively originate in the process of subvocal rehearsal
Annabel S C Thorn, Susan E Gathercole
- Digit memory in Chinese and English: Evidence for a temporally limited store
James W Stigler, Shin-Ying Lee, Harold W Stevenson
- jsPsych: A JavaScript library for creating behavioral experiments in a web browser
de Leeuw, J. R.