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# The Effects of Relatedness and Order of Anagrams on the Ability to Recall

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# The Effects of Relatedness and Order of Anagrams on the Ability to Recall

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*This paper discusses the effects of the relatedness and order in which words are presented on a person's ability to solve anagrams. One of the hypotheses was that it would be easier to recall anagrams if they were related and presented in the same order as the study sheet. The other was that a person would more easily recall words if they are related rather than unrelated. Forty-eight participants were recruited and asked to complete two of four anagrams tests. The results of a one-way MANOVA examining the effect of consistency of item order did not reveal statistically significant results. The results of a paired t-test comparing the participants' performance on the related and unrelated lists revealed that there was significance.*

The purpose of this project was to determine whether the relatedness of words and the order in which the words were presented affected the ability to complete the word puzzles which required people to unscramble letter strings to form words. This study also showed the effectiveness of the order difference and the relatedness of words concerning the variance of gender, age, grade, primary language, and previous experiences with anagrams. We predicted that participants would be able to correctly complete the anagrams more when they receive the anagram list of related words in the same order as the test. Our study gave better understanding of our participants' memory skills, and this helped them learn how to be able to improve to know how to improve their learning techniques.

In the past, Williams (2003) conducted a study to evaluate the level of importance of verbal and nonverbal intervening task and it's retroactively intervention with learning. Retroactively interference is the problem when learning new information and at the same time recalling previous information. Williams (2003) referred to a study done by Underwood and Wheeler, in which they asked the participants to learn a word list of paired adjectives, and after 30 minutes they were asked to recall these articles. On the other hand, the participants that were in the experimental group were asked to learn a second list of words during the 30-minute delay period while individuals in the control condition did not learned any list of words during this period. The results were that the experimental group recalled half of the paired adjective in the list of words than the control group recalled. This was important to know in order to avoid any distraction in any experiment about memory. The experiment mentioned above demonstrates that interference is a key factor when learning a list of words, and recalling them. So this retroactive interference will affect the memory skills of the participant in a certain situation.

Studies similar to ours have been conducted in the past, but some of those studies manipulated other variables to determine the ability to complete the task. For instance, Cangoz (2005) did an experiment to find out if the solution type had anything to do with the ability to complete anagrams. In this study, there were two anagram lists. The first list contained thirty words with a single solution. The other list contained thirty words which had multiple solutions. The results showed that the participants solved more single solution words than multiple solution words, this results were due to the study phase.

Witte and Freund (2001) performed an experiment to determine if it is easier for participants to solve anagrams if the words started with a consonant or a vowel. Their anagram list contained ten words that began with a consonant and ten words that began with a vowel. They found that people are more likely to choose a consonant to determine an anagram's solution so the words beginning with consonants were solved more frequently. In the second part of their study, they wanted to determine if the frequency of the words had anything to do with the ability to solve anagrams. Of the twenty anagrams on this list, ten were high frequency and ten were low frequency words. The findings were that more people were able to solve more anagrams consisting of high frequency words and in a shorter amount of time rather than low frequency words.

Tan and Ward (2007) studied the effectiveness of order difference and pre-cued or post-cued for immediate serial recall tasks. They used and showed 32 lists with 8 words per each, and the participants are separated into three groups: one group is asked to write down the words with the same order of the lists before the experiment starts (Pre-cued); ones are asked to write down the words with any order before the experiments starts ( Pre-cued); one is asked to write down the words but they do not know which kinds of orders they do at the beginning, and after half of the trials, they were told which kinds of order (same or any) they did (Post-cued). The result showed significant difference between the same order and any order and there was also a significant difference found when informing the order to the participant at the beginning of the study or in the middle of the experiment. The proportion of the response with the same order becomes lower than any order, and the proportion of the responses when they were told after half of the trial became higher than when they did not know which order types they should do at the

beginning. The researcher suggested output order plays an important role in the primacy effect in immediate serial recall ISR and that the regency items are most highly accessible at recall.

Another important factor of remembering words depends in how frequent we use these words daily. Usually, specific words are lower-frequency, and general words are higher-frequency and better-recognized stimuli than specific ones. However, when specific words have been used more often, these become easier to recognize than common words. In other terms, when lower-frequency words are studied this make them easier to remember than general words. This is referred as the "mirror effect" (Van Overschelde, 2002).

Hulme et al (2003) conducted a study in which he used lists of high- and low-frequency word, and the participants were asked to recall the words. In the first experiment of the study he alternated low-frequency with high-frequency word lists. In the second experiment he included low- and high-frequency words in the same list. His results showed that low- and high-frequency words were recalled identically when he used the list that included low- and high- frequency words. This finding was contradictory to many results from other experiments that would state that higher-frequency words are recalled more easily than low-frequency words.

According to Kenrick, Neuberg, and Cialdini (2007), knowledge is remembered easier when it has been made accessible; this is referred to as priming. When the list of words are related to school, the specific circumstance has a strong effect for people who have spent time in school because they use the school-related words intensively, which is not used in other places, so they recognize the school words, or specific words, easier

than general words. The subjects are already primed to recall these words easier because they come across them in everyday life. Also, when the participants are given the list of related words, one word might prime another word because the words have the same theme. For example, when someone sees the word "pencil", they could be primed to recall the word "paper" because these words are closely related.

According to Humpreys, Dennis, Maguire, Reynolds, Bolland, and Hughes (2003) people simply recall familiar words and recollect words which they remember into consciousness.

However, on the other hand, Szarkowicz and Rankin (2003) conducted a study on the difference of the levels of accuracy when recalling related words and non-related words. It showed that related words are more confusing when trying to memorize them accurately, and errors when recalling them are most likely to occur. Non-related words are easier to remember when the specific meaning is given. The accuracy of recalling non-related words also increased, because there is only one learned meaning for it.

One problem that could have arisen from our study is what is known as the word length effect. The word length effect states that when it comes to word recognition, it is easier to process a short word rather than a long word. On average, it takes 60 milliseconds longer to recall a six-letter word than a four-letter word (Lee, 1999). In order to prevent this confounding variable in our study, we made sure that each study list contained the same amount of words with the same amount of letters. So the word length effect should not account for the amount of time it takes each participant to complete the anagrams on either lists.

In our experiment, we recruited 48 participants, who all were college students. The materials that we used were: 2 study list, 1 had school-related words and the list number 2 had unrelated words. Then we had 4 lists of anagrams, 2 for each study list. Our 48 participants were randomly assigned in 4 groups. The first group was given the anagrams in which the related words and unrelated words lists were in the same order as the original study list. The second group received the anagrams in the incorrect order, but they had to do first the related word list and then the unrelated list. The third group received the anagrams in which the words were not related but were in the correct order, and the fourth group was given the anagrams in which the words were related but not in the correct order. Our independent variable was the particular list of anagrams given to each group.

## Method

### *Participants*

Thirty-three college students who were enrolled in 100-level Sociology, Psychology, and Anthropology classes at Lindenwood University participated in this study through the Human Subject Pool. We also recruited 15 college students from Lindenwood University who were not part of the Human Subject Pool. These 15 participants took the experiment in a number of locations including the library, computer lab, and dorm room. All of these participants were either friends or classmates of the researchers. We based our data off of a total of 48 participants. They gave informed consent in accordance with the guidelines set by the American Psychological Association. The age range was between eighteen and 24 years old. 24 of the participants were female and 24 were male. In regards to the class status of the

participants, 47.9 percent were freshmen, 27.1 percent were sophomores, 6.3 percent were juniors, and 18.8 percent were seniors. The participants in our study spoke seven different languages. See table 1 in order to see a list of the different languages and the percentage of the participants who spoke each.

The largest percentage (20%) of the participants whose primary language was not English had been speaking English for 72 months. Other than that, 10% had been speaking English for 60 months, 10% 144 months, 10% 180 months, and all the rest were only 5% each. Only two of the participants had problems such as dyslexia or visual problems that could have affected their performance on the anagram tests.

The 33 students recruited through the Human Subject Pool received extra credit points for the class mentioned above, and the15 participants recruited outside of the Human Subject Pool received chocolate for their participations in our study. We had a total of fifty-two participants, but we excluded four because we accidentally gave them the anagrams test in the wrong order.

*Materials*

The materials used in this study included a non-standardized questionnaire (see Appendix A), a stop watch to measure the time, pens, a chair, a desk, and rooms to complete the anagrams in. The room used for the HSP participants was Lab D in first floor of Young Hall that consisted of one desk and two chairs. The rooms used for the fifteen participants not recruited through the HSP were the computer lab in Spellman, a room in the library with a desk and chairs, and a dorm room with a desk and a chair.

Some other materials include 30 words two different lists of the correct answers for the anagrams, and the two separate anagrams lists for each of the two different lists of

words. The 30 words from one of the lists are school related words (see Appendix B), and the other 30 words are common words which are not related (see Appendix C). In order to prevent any confounding variables, the words on each study list of thirty words contained the same amount of words with the same amount of letters. Each study list contained two four-letter words, six five-letter words, ten six-letter words, four seven-letter words, four eight-letter words, three nine-letter words, and one ten-letter word There were four lists of anagrams (see Appendices D-G): one had the anagrams in the same order as the list of related words lists, the second was another list of anagrams in the same order but this was of the unrelated words lists, the third list of anagrams was in a different order of the related words, and the last list of anagrams was in a different order of he unrelated words.

*Procedure*

In this study, a mixed-subject design was used. Of the 48 subjects, 12 subjects were randomly assigned to four different groups. The independent variable in our study is the particular list of anagrams that was given to each group. The order in which the participants received the anagrams lists was counterbalanced. The first group received the related in-order anagrams then the unrelated in-order anagrams. The second group first received the related out of order anagrams then the unrelated out of order anagrams. The third group first received the unrelated in-order anagrams then the related in-order anagrams second. The fourth group was given the unrelated out of order anagrams and then the related out of order anagrams.

The participants were first asked to sign two informed consent forms and a questionnaire which asked various questions about their anagram experience, any

disabilities they may have, etc. Then the experimenters passed out the list containing the correct answers for the anagrams and the participants were given one minute in order to attempt to remember all of the 30 words on the list.

After one minute, the experimenter picked up the list of correct answers and passed out one of the four different types of anagram papers. The subjects were divided into four different groups consisting of twelve people each based on which anagram list they were given first. One subject group will receive the anagrams in which the related words are in the same order as the study list. The second group will receive the anagrams in which the words are related but are not in the correct order. The third group will receive the anagrams in which the words are not related but are in the correct order, and the fourth group will receive the anagrams in which the words are not related or in the correct order. All four groups were given seven minutes to unscramble the letters to form words on the anagrams test.

After seven minutes, the experimenter stopped the subjects and gave them the second study list of words. After one minute, the experimenter picked up the list of correct answers and passed out one of the four anagrams tests. The first subject group will receive non-related words in correct order, the second will receive non-related words in incorrect order, the third will receive related words in correct order, and the fourth will receive related words in incorrect order.

The dependent variable in our study was the accuracy of the subjects' anagrams tests. We measured this based on the amount of anagrams the subjects were able to unscramble correctly among the four different anagram tests. When grading the anagram tests, the answer was counted as correct if it were spelled correctly in full. In other

words, even if the word was missing one letter or one letter was not in the correct spot, the answer was not counted as correct. All of the grades were taken out of thirty points because there were thirty anagrams on each test sheet. In addition, we related this to some of the answers obtained from the questionnaires such as the subjects' previous experience with anagrams, gender, disabilities, etc.

## Results

Our hypothesis was that the participants would be able to correctly solve more anagrams when they receive the anagram list of related words in the same order as the test. In order to find the results of our experiment, we conducted a one-way MANOVA in which the independent variable was the order received (correct vs. incorrect) and the dependent variables were the two means of the number of anagrams solved when related and the number of anagrams solved when unrelated. The analysis did not reveal any significance of the order received on the mean of the number of anagrams solved when related, $F_{(1,46)} = .152$, $p>.05$. There was also no significance found of the order received on the mean of the number of anagrams solved when unrelated, $F_{(1,46)} = .033$, $p>.05$. We failed to reject the null hypothesis.

However, upon further analysis, we did find significance when a paired t-test was conducted for the related versus non-related anagrams, $t_{(47)} = 10.122$, $p<.001$. The mean score for the related words anagram test was 18.54 while the mean score for the unrelated words anagram test was 12.19. Because the mean of the related words anagram test was significantly higher than the mean for the unrelated words anagram test, our hypothesis that it would be easier to solve anagrams that are related rather than anagrams that are not related was supported so we could reject the null hypothesis.

According to our analysis, a little over half (54.2%) of the participants had history with completing anagrams. Of these 26 participants who had history with anagrams, most of them (39.1%) had only done so once a year and 21.7% had only completed anagrams twice a year.

## Discussion

The results of this experiment only supported one of the hypotheses. According to the analyses, it does not make any difference if the order in which the words are presented on the anagram test are different from how the words were ordered on the study sheet. Maybe the reason for this is because since there were so many words to memorize on the study list, that it was simply too difficult to recall the order while taking the anagram test. Perhaps if the test had consisted of 15 words rather than 30, then the participants would have remembered the order of the words more and it would have helped them solve more anagrams.

Even though our hypothesis that the order of words affects the ability to recall words was not supported, the analyses proved our other hypothesis that the relatedness of words does make a difference. The analyses showed that on average, people solved more anagrams if they were related. The reason for this could be that it is easier to recall words that have a theme rather than words that have no similarities at all.

Even though we ended up being successful in supporting one of our hypotheses, there were several limitations in the study that could have affected our results. For instance, 41.8 percent of our participants spoke a primary language other than English. This could have negatively affected their test results because all of the anagrams were in English. Perhaps if the anagrams were written in their primary language, then they would

have been able to solve more anagrams because they would be much more familiar with how all of the words are spelled. According to some of our Spanish speaking participants, two or three of the words could actually be unscrambled into a word in Spanish. This could have affected their anagram solving ability because it caused confusion. If this study were to be redone, maybe the confounding variable of language could be eliminated by excluding all of the data of the participants whose primary language was not English.

An extraneous variable that could have affected some of the participants' ability to solve anagrams could be the noise and lack of lighting in the room. 33 of the participants took the experiment in Lab D, which did not have an actual door. Instead, it was located in the middle of a bigger room which consists of another lab without a door right next to it, and three other smaller rooms with doors. During this experiment, other groups were conducting experiments in some of the other labs and all of the noise they made was clearly audible to our participants. Also, there was also a loud sound that occurred every few minutes which was probably a result of the toilets flushing in the above floors. The conversations of the other groups, the sound of doors opening and closing, and the sound from the toilets flushing could have distracted the participants and caused them to solve fewer anagrams than they normally would have in a completely silent room. Also, the lighting in Lab D was very dim. Because of this lack of lighting, the participants might have had a harder time reading the words or perhaps the dim lighting caused them to become sleepy. Either way, their ability to solve anagrams could have been affected.

Fifteen of the participants did not do the experiment in Lab D because they were not a part of the Human Subject Pool. These fifteen participants took the experiment in a number of locations including the library, computer lab, and dorm room. The location of these experiments could have also affected the participants' abilities to solve anagrams due to a number of reasons ranging from noise to having other things distracting them such as computers.

The scores on some of the participants' tests might not have been the best to their ability because of lack of interest. Many of the participants seemed to get bored quite easily and asked if they had to keep trying to solve the anagrams for the full seven minutes. Other participants seemed rushed as if they wanted to get in and out quickly. Others said they were not good at anagrams and just gave up. Maybe some of the participants just did not care about solving the anagrams because it did not really matter to them what score they received on the tests because they got their extra credit or candy bar either way. If this experiment were to be redone, it would probably be a good idea to decrease the amount of time the participants got to solve the anagrams. In hindsight, seven minutes seems to be too much time. As mentioned before, many of the participants, probably over half, did not want to use the entire seven minutes to try to solve the anagrams.

The findings support the hypothesis that the relatedness of words affect a person's ability to recall the words later on. This finding could help people who have difficulty remembering information they study. Maybe if they categorize the information they need to study into themed groups, then they will be able to remember the information better. To improve this experiment, maybe the number of participants could be increased in

order to be a more representative sample. Also, maybe the experiment would be more accurate if some of the data were to be excluded, such as the data which represents the scores of participants who do not primarily speak English as mentioned before. The range of age could also be minimized to less than twelve years so that the argument could be eliminated that people who are older have more experience with words games and therefore are better at anagrams. If all of these limitations were eliminated as well as finding a well lit and noise-free room, then the experiment could be improved.

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TABLE 1

**Primary Language of Participant**

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | English | 28 | 58.3 | 58.3 | 58.3 |
| | German | 2 | 4.2 | 4.2 | 62.5 |
| | Japanese | 3 | 6.3 | 6.3 | 68.8 |
| | Nepali | 7 | 14.6 | 14.6 | 83.3 |
| | Polish | 1 | 2.1 | 2.1 | 85.4 |
| | Shona | 1 | 2.1 | 2.1 | 87.5 |
| | Spanish | 6 | 12.5 | 12.5 | 100.0 |
| | Total | 48 | 100.0 | 100.0 | |

Appendix A

Questionnaire

Subject's ID Number _____

1) Are you MALE FEMALE

2) Age _____years

3) Are you SENIOR JUNIOR SOPHOMORE FRESHMAN

4) Have you ever done anagrams, which requires unscrambling letters to form words?

YES NO

5) If so, how many times in a year do you solve anagrams? _____

6) What is your primary language?

ENGLISH OTHER_____

7) If English is not your first language, how long have you studied English (months)?

_____

8) If you feel that your performance in this experiment was affected negatively by whatever reason (including, although not limited to such things as test anxiety, learning disability, vision problems, dyslexia, problems with writing) please check here: _____

Appendix B

SENIOR
EXAM
BOARD
WATCH
PENCIL
STUDIO
LIBRARY
CHAIR
INTERN
STUDENT
LOFT
NOTEBOOK
BOOKSTORE
COMPUTER
MAILBOX
STAIRS
TEACHER
ERASER
GRADE
FRESHMAN
LOCKER
SOPHOMORE
JUNIOR
CLASSROOM
BINDER
ACTIVITY
STUDY
FRIEND
UNIVERSITY
LIGHT

Appendix C

BEHAVIOR
CHICKEN
RESPONSE
COUNTRY
STATION
FAVORITE
SHIRT
AIRPLANE
RESTAURANT
CONCERT
STORE
WINDOW
SHAKE
PERSON
SEPTEMBER
FRUIT
JACKET
LAKE
CANDY
HAIR
STREET
CRANBERRY
CLOWN
WALLET
ORANGE
CELLPHONE
HORSE
CLOUD
ANIMAL
MOTIVATE

Appendix D

ENSRIO _____
XMAE _____
DAORB _____
CWTHA _____
NIPELC _____
TIUDSO _____
YBARLIR _____
RICAH _____
RETINN _____
TUSTDEN _____
OTLF _____
OOBOTEKN _____
EBSOKOORT _____
MPREUTOC _____
MIXOLAB _____
TSIASR _____
RCATHEE _____
SRAERE _____
DERAG _____
MNESRHFA _____
EKOLCR _____
HOMOPOES _____
OJURNI _____
ASRSOCMLO _____
EIDNBR _____
TVAIYCTI _____
YUDTS _____
IDRNFE _____
YTURSIVINE _____
GTILH _____

## Appendix E

MIXOLAB _____
DAORB _____
GTILH _____
EKOLCR _____
SOLSMCARO _____
TUSTDEN _____
IDRNFE _____
OOBOTEKN _____
YUDTS _____
YTURSIVINE _____
MPREUTOC _____
CWTHA _____
TSIASR _____
LNPCIE _____
OJURNI _____
RCATHEE _____
RETINN _____
OTLF _____
DERAG _____
TVAIYCTI _____
TIUDSO _____
MNESRHFA _____
ENSRIO _____
XMAE _____
HOMOPOES _____
SRAERE _____
RICAH _____
EIDNBR _____
EBSOKOORT _____
YBARLIR _____

Appendix F

ORABEVIH _____
KCNIHEC _____
SOSPRENE _____
NOTRCUY _____
NOSATTI _____
TIFRVOEA _____
TRISH _____
PLINEARA _____
STREANURTA _____
OCTENRC _____
ESTRO _____
DIOWNW _____
KHSEA _____
SPNEOR _____
BESRTEPEM _____
UTFIR _____
KJATEC _____
ELKA _____
DYNCA _____
RIHA _____
ESRTET _____
ERRBAYCNR _____
WCOLN _____
LWTLAE _____
GEOANR _____
EPCLNOHLE _____
SORHE _____
UCODL _____
MALANI _____
OTVAMETI _____

Appendix G

ELKA _____
BESRTEPEM _____
UTFIR _____
SPNEOR _____
ORABEVIH _____
OTVAMETI _____
SORHE _____
KHSEA _____
ERRBAYCNR _____
NOTRCUY _____
ESRTET _____
SOSPRENE _____
WCOLN _____
KJATEC _____
GEOANR _____
KCNIHEC _____
LWTLAE _____
STREANURTA _____
EPCLNOHLE _____
TIFRVOEA _____
DYNCA _____
OCTENRC _____
PLINEARA _____
NOSATTI _____
UCODL _____
RIHA _____
DIOWNW _____
MALANI _____
ESTRO _____
TRISH _____