The Role of Pictures in the Encoding of Information in our Everyday Life

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Abstract

This paper assesses if unrelated images paired with words decrease the ability to recall words compared to words paired with related images. Previous research discovered that images paired with words increase our ability to remember because they are encoded differently. We wanted to see if this is also the case for the converse. We tested our subjects by showing them slides on which words paired with either related or unrelated images were shown. After showing 15 slides, the subjects had time to write down as many words as they could remember. Our results show that unrelated images paired with words decrease the ability to recall words compared to related images, confirming our research question. Thus, if we want to use images to help us remember, we need to avoid unrelated details and should focus on related parts.

Introduction

Every day, we need to remember hundreds of things, and information in modern time, even called the information age, is a very valuable asset. Thus, storing as much information as possible is important. We get a lot of information and our brain filters and interprets this information, which then goes on to be stored in our short-term memory. However, our short-term memory is limited and can only store a certain amount of information (Miller,1956).
So is there a way to improve short-term Memory? Well, the number of items that can be in short-term memory can not be increased, but we can chunk information (e.g. instead of remembering the numbers 4,6,7, remember them as one number 467), because that way we can store more information in our short-term memory(Miller, 1956). But what if we can not chunk the given information? Can we already perceive information that is better remembered? Scientists discovered the picture superiority effect, which describes that pictures are better remembered than words(Curran & Doyle, 2011). But why are pictures better remembered?

Through the use of positron emission tomography, scientists figured out that pictures are encoded differently than words and in different brain areas(Grady et al.,1998). For pictures, there is greater activity in the bilateral visual and medial temporal cortices and for words in the prefrontal and temporoparietal regions(Grady et al., 1998). Scientists believe that the brain regions for the encoding of pictures may be more effective for memory and thus pictures are remembered better(Grady et al., 1998). Pictures can even help us to understand text better. If images are paired with explanatory text, then those images can improve our comprehension(Wajong et al., 2020), and if we understand a concept well, then we also memorize the concept better. Scientists experimented before with related images with words compared to just words and figured out that words paired with images are better recalled and that people with low literacy skills benefit especially from images(Grady et al., 1998). Hence, related images improve our ability to remember and thus show us an alternative to chunking for better short-term memory use. Moreover, this was tested using a recall test(Grady et al., 1998), a common way to test short-term memory. However, the opposite has not been tested so far.

Thus, to get clarification, we ask the question: Do unrelated images decrease word recall in a free recall test? Since related images paired with words improve our ability to remember, we want to see if the converse is also true. Subsequently, our hypothesis is: Unrelated images are less recalled than related images in a free recall test.

To test this, we conduct a free recall test, in which words are shown with related and unrelated images. Related images are pictures that are related to the paired word (i.e. display the word). For example, if we have the word bear, then a related picture would be a picture of a bear. Subsequently, an unrelated picture is one that is not related to the word (i.e. if the word computer is displayed paired with a picture of a banana, so not related). Participants go through each condition twice and after a condition is finished, they write down the words they remember. After the test, we compared under which condition participants could recall more words. Since we already know that related images paired with words improve our ability to recall words, we believe the opposite will happen for unrelated images.

Method

Participants

This test can be taken by anyone who is not visually or mentally impaired because variables like age and gender do not matter, especially since participants are compared to themselves and not to their respective groups. We recruited 20 Participants. We asked our friends and family to do the test and they agreed, hence there was no need for a reward for participating. The mean age is 25 with an age range of 15 – 44 (12 male and 8 female). Since the age range is so big, it is difficult to give an approximation of the educational level, but everyone over the age of 18 finished at least high school and everyone below is still in high school. The participants signed a consent form issued from the University of Groningen. The participants are all fluent in English. One participant was color blind, but we still included his data (more to that later).

Material and Stimuli

We created a website that uses a database of 90 related images and words and 90 unrelated images and words, the stimuli of the experiment. The words were chosen via a random word generator, and matching images were chosen based on how well they represented an item (e.g., for the word umbrella, we chose a picture that showed an umbrella). We wanted the words and images to be symmetrical (e.g. the semantics of the word are displayed by the image). For the unrelated pictures, we again used a random word generator. This time, we generated two words and compared if they were unrelated. The relation was measured by looking for overlaps between the two words. If one could create a logical, high-frequency sentence with the two words, then they are considered related. But if not, then they are unrelated (e.g. consider the words scale and umbrella. A sentence could be: I was on the scale while holding the umbrella. This is a possible sentence, however, since people use scales inside their houses, this sentence does not seem probable). If they were, we used a picture of one of the words and paired it with the other word. Furthermore, when we compared words, we thought about the categories of a word and compared intersections (e.g., for the word banana, there are several categories: Food, fruit, yellow, monkeys). So we had to choose a word that has no connections to all those categories (e.g., a music box that is not yellow). The pairs are randomized, meaning that there is no apparent order in which the pairs will appear or if they even appear. Furthermore, the fact that the participants go twice through the experiment minimizes the chance of having just an 'easy' to recall series of pairs. Furthermore, participants might need to adapt to the test and by doing the test two times, they can improve. The website's background is white, and the words are shown above the picture. We decided on a website because it looks better than just slides, and that way, we were completely free in our design choice. The website was displayed on a computer and was programmed using java. Furthermore, the subjects are equipped with a paper and pen to write down the remembered words.

Procedure

The participant sits in a quiet room facing the computer. Before the experiment is conducted, the participant signs the consent form and tells us their age, gender, and if they are mentally or visually impaired. Then, the participant is introduced to the test. A website that contains the experiment is already open, and the participant clicks on the "begin" button when ready. After that, 15 words paired with related images are displayed, each for 3 seconds. We chose 3 seconds because in this test we need participants to look at words and images which can be a lot to process. Thus, 3 seconds give the participants enough time to look at the picture and the word. After the last image of the first condition, a timer is displayed, counting down from 5 minutes and instructing the participant to write down as many words as the participant remembered. After the 5 minutes, another 15 words and images are displayed with 3 seconds between each word, but this time the words and images are unrelated. The participants once again write down as many words as they remember. After the second condition, a 5-minute break sets in, giving the participant time to refresh their memory. After that, the experiment is again conducted, so first condition 1, recall, break, condition 2, recall, and then the end. The mean result of the two tests for the words with related images and words with unrelated images is taken, and the difference will be compared. Subsequently, after each test, the subjects are asked if they could connect a word paired with an unrelated picture. This gives us opportunities to revise our design and can also explain possible anomalies in the data, and is crucial to mostly minimize a confounding variable which is that we can not predict subjective connections. The software used is a created website, and the code was written in java.

Design

The independent variable of our experiment is the relation of the shown picture to the shown word, with the relation being either related or unrelated. These are also the conditions. The manipulation is within-subjects because subjects are not compared to each other but themselves, saving us the need to further distinguish and elaborate between more variables like gender and age. Such data is only collected to explain possible abstractions in the result. Our dependent variable and hence what we measured is the number of recalled words after each try.

Results

Used data

We used the data we gathered from our test. There was no need for training since participants had a second try. One of the participants is color blind, but we decided not to exclude his data since he performed like the average person. Hence, we had no outliers, and there is no need to exclude any data.

Participants performance

We expected that Participants should recall more words on average in the related image condition and that there would be a significant difference between the two conditions. Participants in the condition related images outperformed participants in the condition unrelated images in the recall test, as shown in Figure.1. Furthermore, we can see a clear difference between the two conditions. The figure illustrates the average recalled word per condition. We chose the mean value because it is the best value to measure for our research question. We compare the mean results of both conditions to see if there is a difference in recall of words between the two conditions, and that mean value represents the general number of recalled words, which is what we want to measure. The worst recall was 3 words and the best 9. As depicted in Figure 1., related images were recalled more than unrelated images. This means if participants were shown words paired with related images, they could better

recall those words than if words were paired with unrelated images. The results indicate that unrelated images in comparison to related images decrease our ability to remember.

Statistical Test

For further evaluation, we conducted a paired two-tailed t-test. We decided to do so because we want to be safe with our results, so although we test in only one direction, we decided on a two-tailed test for scientific accuracy and to be sure about our results. Moreover, we decided on a paired test because the subjects participate in both conditions, and a paired test is used when two related groups are compared. The alternative-Hypothesis is that there is a difference between the two conditions. The mean result for the related image part (mean=6.975,SD=1.164) and the unrelated image part (mean=5.7,SD=1.117). Both conditions have a standard error of (SE=.18). If we calculate the t-value with 38 degrees of freedom, we get ($t(38) = 3.5345$, $p=0.001$). The p-value is below the 5% of alpha. Hence, we reject the null-Hypothesis.

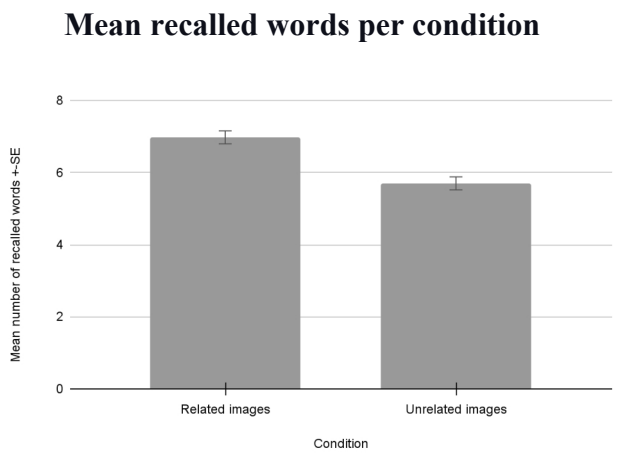

Figure 1: A bar plot showing the mean number of recalled words for related and unrelated conditions with error bars indicating ±0.18 standard error(0.18 SE used for error bars).

Discussion

Do unrelated images decrease word recall in a free recall task? After analyzing our results, we think that they do, because participants recalled more words in the related image condition than they did in the unrelated image condition. Unrelated images paired with words decrease word recall compared to related images paired with words. This means that we accept our hypothesis that unrelated images paired with words are less recalled than related images with words. Furthermore, we confirmed our results by doing a statistical test.

The bigger picture

So what do these results mean for our everyday life?
First of all, we now see that in contrast to related images(Curran& Doyle,2011), unrelated images decrease word recall in a word recall test. If we want to use pictures to help us remember, we should avoid unrelated details. For example, school books use pictures in their chapters because they illustrate what was written in the text, and they help us to remember the chapter(Price & Finkelstein, 1994). A long text might be challenging to remember, but if we have 1 or 2 pictures related to that text and those display important parts of the text, then they help us to remember the text(Price & Finkelstein, 1994). Hence, it is important that unrelated details in images are avoided. Often statistics are shown, but those might only partially show what was said in the chapter, so we have a related and an unrelated part. If we were now to delete the unrelated part, we would probably improve our ability to remember the chapter because we would first remember the image and then connect to the text. Images are often used in education to improve students' abilities since they are superior to texts in terms of memory(Curran & Doyle, 2011). For example, pictures help students to achieve speaking skills(Episiasi et al., 2015), but it is important, that those pictures consist of information that is relevant to the topic because irrelevant details might decrease the effectiveness of learning with pictures. Moreover, it was figured out that pictures improve health communication when linked to written text(Houts et al., 2006). With our experiment, we have figured out that it is important to keep those pictures as related as possible because unrelated images and details would not trigger the same effect. As mentioned in the beginning, pictures (especially diagrams) can help to understand explanatory text(Wajong et al., 2020). Moreover, we can add now that it is important to minimize unrelated details in those pictures and completely avoid pictures that are not linked to the text because otherwise, this effect might not appear.

This is also important for people with low-literacy skills for example because they also benefit from the use of pictures(Grady et al., 1998) as discussed earlier, but they should also avoid unrelatedness in images. To summarize, pictures can improve our comprehension(Wajong et al., 2020), memory and help us learn(Episiasi et al., 2015; Price & Finkelstein, 1994). But, those pictures have to be related, because otherwise, this effect might not appear or, in a bad case, might actually be an obstacle in learning, memorizing and comprehension.

Problems

Although our research has precise results, we encountered some problems. The first problem is that of personal relations. Of course, it is impossible to tell if a person has a subjective relation to a picture. We can not predict personal relations, but our research needs the subject not to build bridges to unrelated images. That is why we surveyed after conducting the test to ask our subjects if they could make a connection between unrelated images and words, but they never were. Moreover, because of the big sample size, there is enough generalisability which spreads the effect of personal relation well enough. Another problem is that there is no objective solution to how related pictures and words are. We chose our images based on our own opinion because there is no objective solution. Some websites give some

general regard about semantics and how pictures relate to words, but there is no formula nor program to calculate an exact value, which just helps us in picking those pictures(e.g. they display the same semantics), but it does not make sure that pictures and words are completely unrelated. The last problem we have is the pairing problem. After the test, some subjects told us they did not even pay attention to the unrelated images but instead just looked at the words. Luckily, this was for only a few, so it does not impact our research too much, but it clearly shows that our test design is not optimal.

Future Research

Those problems lead to some improvements we suggest for future research. First of all, there is a need for a model which assigns a numeric value to how related images and words are so that way we would have an objective and general solution. Second, the test should be designed differently. The slides are not optimal because, as stated before, sometimes the subjects did not pay attention to the unrelated images. So maybe words should be shown after images, or they should be closer together. Furthermore, the performance of unrelated and related pictures should also be compared to just words, to see if unrelated images paired with words are worse in recall than just words. Moreover, since we discussed mostly the use of images for educational purposes, it would be a good idea to implement this experiment into an educational environment, to clarify the effects of unrelated images. Subsequently, it would also be interesting to observe how unrelated details in images influence our ability to remember because that way we could tell to which degree a picture has to be related to improve our memory.

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