Human Visual Memory Capacity for Abstract and Concrete Stimuli

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Human Visual Memory Capacity

Human Visual Memory Capacity for Abstract and Concrete Stimuli

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The purpose of this study was to determine the differences between human visual memory capacity regarding abstract and concrete visual stimuli. The procedure was a replication, with revisions, of Vaughan and Greene's (1984) "Pigeon Visual Memory Capacity". The birds scored an average of 90% correct during the first ten trials. When tested two years later, the birds maintained a high accuracy rate. Ten post-secondary students were shown 40 cards, one at a time, and were asked if they belonged to S+ or S-. This procedure was repeated two weeks later to examine if any discrimination was retained. There were no significant effects found regarding the type of stimuli or accuracy during immediate and delayed recall. A variety of factors influence human memory and perhaps this type of testing favours unrationlizing animal minds as opposed to humans.

One of the major findings of memory research has been that human memory is fallible, imprecise, and subject to interference. Miller (1956) showed that people are severely limited in terms of the amount of information they can receive, process, and remember. He found that people tend to only be able to store $7 \pm 2$ bits of information in their working memory. Working memory has been defined as the system which actively holds information in the mind to do verbal and nonverbal tasks such as reasoning and comprehension, and to make it available for further information processing. This is contrasted to long-term memory, which describes associations among items that are more permanently stored within the brain.
Human Visual Memory Capacity

However, Brady, Konkle, Alvarez & Oliva (2008) demonstrated that long-term memory is capable of storing a massive number of objects with details from the image. Participants viewed pictures of 2,500 objects over the course of 5.5 h. Afterward, they were shown pairs of images and indicated which of the two they had seen. Performance in each of these conditions was remarkably high which suggest that participants successfully maintained detailed representations of thousands of images. A possible explanation of this result is Brady et al.'s (2008) use of concrete visual stimuli, a similarity of the observed Concreteness Effect. The Concreteness Effect refers to the observation that concrete nouns are processed faster and more accurately than abstract nouns in memorization tasks. Concrete visual stimuli will be defined as an object which already has language to define it and an innate meaning attached to it, for the purposes of this paper. This is contrasted to abstract visual stimuli is an object that does not have meaning or reason and does not conjure any definitive language to efficiently name the stimuli.

Verhaeghen, Palfai & Johnson (2006) examined the effect that presenting a verbal stimulus alongside an abstract visual stimulus enhances recognition memory for the abstract visual stimulus. Experiment 1 demonstrated that the character-plus-word combination at both encoding and retrieval results in better recognition than does a character-alone presentation or presenting the combination at encoding only. Experiment 3 showed that the concreteness value of the word, not familiarity, is the critical factor.

This study tests two different stimuli in a memorization task and their ability to be retained to produce immediate learning and information retention. The procedure is a replication with revisions, of the Vaughan and Greene (1984) study 'Pigeon Visual
Human Visual Memory Capacity

Memory Capacity’, however, adapted to human participants. Vaughan and Greene (1984) found that pigeons have an unsuspected capacity with regard to both breath and stability of memory for abstract stimuli and pictures. Four experiments examined visual memory capacity in 13 White Carneaux pigeons through a Go / No Go procedure. In Experiment 1, Ss learned to discriminate between 80 pairs of random abstract shapes. Memory for 40 of those pairs was only slightly poorer following 490 days without exposure. In Experiment 2, 80 pairs of photographic slides were learned; 629 days without exposure did not significantly disrupt memory. During the initial training trials, the birds approached a near perfect asymptote and even after two years between trials, the birds maintained a 70% accuracy rate.

This study will examine if these results are comparable to healthy adolescents’ memory capacity. This design will compare the effectiveness in which abstract versus concrete stimuli is memorized and encoded into short term and reference memory of adolescent humans. The accuracy rate at the time of initial training and after an intermission period of two weeks within each procedure, and also between groups will be analyzed. Based on findings of current literature on the topic of visual memory capacity, it is hypothesized humans will be able to discriminate between the visual stimuli to the extent which was performed by the pigeons. A second hypothesis is that the concrete stimuli will induce a higher accuracy at the end of Session 1 than the abstract stimuli. A third hypothesis is that the concrete stimuli will induce a higher accuracy at the end of Session 2 than the abstract stimuli.
Human Visual Memory Capacity

Method

Participants

This experiment was comprised of ten Caucasian participants who are current university or college students at the University of Western Ontario and Fanshawe College, both located in London, Ontario. Participants were recruited through social networking on Facebook and in person at Huron University College. The participants included five males and five females, between the ages of 19 to 21 years old. This study excluded persons with known learning disorders or uncorrected impaired vision.

Materials

A study room in the Huron University College library was used as the testing room. The two types of visual stimuli were used in this experiment. One type of visual stimuli was a regular playing card deck, with 40 of the 52 cards randomly selected to be used (the names of these cards can be found in appendix A). Of the 40, 20 were randomly selected as S+. This would provide two to aid memory: suit and number. The second form of stimuli consisted of 40 white cards, on which black ‘squiggles’ were hand drawn in black marker (a photocopy of these cards can be found in appendix B). Half the cards contained one squiggle, and half two, but the number of squiggles was uncorrelated with S+ or S-. This stimuli was simple, nonrepresentational and achromatic. Cards were assigned to the S+ or S- randomly. Four dimensions were provided: the number of lines, shape, orientation & position.
Human Visual Memory Capacity

Procedure

Participants were told that participation was voluntary and that they may refuse to participate, refuse to answer any questions or withdraw from the study at any time. As well, participants were told all information and data provided will remain confidential. Participants were separated by sex and then randomly assigned to Group 1 or 2.

Groups 1 and 2 were presented with visual stimuli of 40 cards, one at a time, and asked if the card belongs to the ‘correct’ group. Group 1 was presented with the playing card stimuli and Group 2 was presented with the abstract stimuli picture cards. Randomly assigned, 20 ‘correct’ cards were presented and the participants were shown one card at a time. Participants had up to 10 seconds to respond and then were told after each response if they were correct. A lack of a response was recorded as an ‘incorrect response’. Five of these trials were conducted back to back, with a three minute inter-trial interval, in one session. The total time for the first session did not exceed forty minutes. A second session was conducted two weeks later, in which one trial was conducted.

Results

The results from the fifth and sixth trials are shown in Figure 1. Figure 1 shows the accuracy proportion collected during Trial 5 and Trial 6. The mean accuracy rate for Trial 5, regarding the immediate recall of the concrete visual stimuli was 0.536 (SD=0.034) and the abstract stimuli recall was 0.562 (SD=0.034). The mean accuracy rate for Trial 6, regarding the delayed recall of the concrete visual stimuli was 0.484 (SD=0.032) the delayed recall of the abstract visual stimuli was 0.488(SD=0.032). The between subjects parameter (the concreteness of the visual stimuli) had a sum of squares and means square
Figure 1. Average accuracy proportion for memorization task for Concrete and Abstract groups for Trial 5 and Trial 6.
Human Visual Memory Capacity

of 0.001, 1 degree of freedom, an F value of 0.446 with a significance of 0.523 with p<0.05. The intercept of the two conditions' sum of squares and mean square was 5.356, had 1 degree of freedom and the F value was 2121.238 with a 0.00 significance value with p>0.05. The within subjects effect between Trials 5 and 6 revealed a sum of squares and a mean square of 0.020, 1 degree of freedom, an F value of 2.321 with a significance value of 0.166. The intercept of these factors produced a sum of squares and mean squares of 0.001, 1 degree of freedom, an F value of 0.071 with a significance of 0.797 p>0.05. None of these effects was found to be significant. A summary of these numbers can be found in Table 1.

Figure 1 visually demonstrates little difference between the four conditions. There is no difference between the concreteness of the visual stimuli and not a significant difference between the accuracy proportion of immediate and delayed recall. It can be concluded that the level of concreteness of visual stimuli does not aid or hinder memory immediate or delayed retention.

Discussion

The results of this study do not support the proposition that concrete stimuli presented in a memorization task produces higher accuracy rate during immediate recall and during delayed recall of two weeks than an abstract visual stimuli. It was demonstrated that humans were not able to discriminate between the visual stimuli to the extent which was performed by the pigeons, as shown in Figure 1.

Vaughan and Greene (1984) demonstrated that pigeons were able to learn and retain a vast amount of visual discriminatory stimuli on a Go / No Go procedure. The
Human Visual Memory Capacity

birds displayed rapid acquisition of the discrimination that, at asymptote, was nearly perfect, and this took fewer than 10 sessions. The human participants in this study did not approach that high level of accuracy during their first five sessions. A lack of motivation could be responsible for this result. This study differed than Vaughan and Greene (1984) due to the lack of material reinforcement. Pigeons were given access to food after each correct response but these human participants were only given verbal reinforcement, such as “Yes, correct” or “Yes, good job”. While the participants seemed to be paying attention, and genuinely excited at correct guesses and frustrated at failures, it would be worthwhile to conduct this experiment again using a small monetary reward for correct responses. In the Huron University College Journal of Learning and Motivation vol.47, Mincer describes a similar memory study in which three out of four participants were compensated monetarily. The participant who was not compensated preformed significantly worse than the other three participants. Compensation was originally rejected from this experiment due to the potential costliness.

While human picture memory studies have indicated that people can separate old from new pictures when originally shown several thousand stimuli as in the Brady et al. study (2008), this task is presumably more demanding than simple recognition. The participants were required not simply to recognize pictures, but to sort previously seen pictures into two categories. These categories did not have any distinguishing conceptual characteristics that would aid classification.

It can be argued that humans do not have the motivation or the need the extreme visual memory that pigeons seem to possess due to our other natural cognitive abilities. Skills like rationalization and complex language are useful tools in which we use to
Human Visual Memory Capacity

navigate our environment. Luck and Vogel (1997) measured the capacity of working memory for simple features and demonstrated that it is possible for humans to retain information regarding only four colours or orientations in visual working memory at one time. It is possible that we simply do not need to retain any more information in our working memory because we are able to use other rational techniques, which have not been demonstrated by other animals, to solve everyday problems.

Eng, Chen & Jiang’s (2005) research show that the estimated capacity of the visual working memory decreased for more complex stimuli, suggesting that perceptual complexity was an important factor in determining visual working memory capacity. However, if subjects were allowed longer displays of the stimuli then it was determined that perceptual complexity affects, but does not determine, visual memory capacity.

This set up is probably more realistic to the type of ‘important’ or ‘meaningful’ visual displays to which humans are exposed. Eng et al.’s (2005) work suggests that human visual memory improves with longer exposure time, however the current study only allowed participants a maximum of 10 seconds of exposure of each stimuli per trial. This skill set may be more valuable to birds than humans due to the greater speed at which pigeons travel in the air. In that they need a more ‘photographic’ memory because they can be only briefly aware of their peripheral surroundings during flight. It could be suggested that this ability is tied to the prey-bird’s fight or flight drive. This drive has arguably decreased in humans as we shape our surroundings to be of optimum safety and comfort for us. Perhaps a better procedure for measuring human visual capacity would take into account the differences between animal and human minds, and emulate a more humanistic real-world memorization design.
Human Visual Memory Capacity

By observing the raw data, it doesn’t appear that much, or any, learning was achieved during the first five trials. After the Trial 5 the participants were still performing at or near chance level. It can be suggested that the participants were simply not given enough practice trials and could not learn to discriminate. More trials could potentially lead to higher accuracy proportions because it would give the participants more exposure to the stimuli.

As well, all participants reported feeling the Recency Effect reported by Miller and Campbell (1959). This theory states that people tend to remember items at the beginning and end of a list, but have the hardest time remembering the middle subjects. Repeating the middle subjects can help reduce the effect. This would be achieved by conducting more training trials.

This design contained some uncontrollable methodological flaws such as controlling the participants amount of sleep and or wakefulness during testing. A lack of sleep and poor execution on testing and memory has been linked (Mu, Mishory, Johnson, Nahas, Kozel., Yamanaka & George 2005). Session time slots were arranged with the constraints of school and work schedules of the participants and resulted in widely varying times of day. As well, internal distractions like hunger and stress (especially since the trials were conducted near the end of the school year) could have contributed to the results. Testing participants at the same time of day, and same day of the week (sand such as testing on a Wednesday morning as opposed to a Monday morning) and providing a monetary reward to increase focus and motivation could help control these variables.
Human Visual Memory Capacity

When questioned after the procedure, some participants expressed distrust that the stimulus was randomly assigned into S+ or S-. Instead, they were convinced that they had found a pattern or a ‘half-pattern’ to explain the division. No patterns were intentionally created into the design the experiment. From the data collected, participants that thought they could find a pattern did not perform differently than those who accepted that the cards were discriminated randomly. Human brains seek coherence, structure, and order and have a strong want to complete patterns (Beitman 2009). These participants may have achieved lower scores than the pigeons due to our innate response to rationalize, not that pigeons possess a better memory. In other words, this task was too simplistic leading the participants to think it was harder than it truly was.

By observing the raw data, it doesn’t appear that much, or any, learning was achieved during the first five trials. After the Trial 5 the participants were still performing at or near chance level. It can be suggested that the participants were simply not given enough practice trials and could not learn to discriminate. More trials could potentially lead to higher accuracy proportions because it would give the participants more exposure to the stimuli.

This study is limited in that it only focuses on the memory capacity of young adults. It would be interesting to conduct this type of research on children and older adults to see if they retain information equally. As well, correlational studies involving Alzheimer's symptoms and participation in simple memorization tasks. Ideally, if conducted again, random sampling of a larger sample size would be employed. Participants that were recruited do not necessarily accurately reflect the student population in London, Ontario because they were selected due to their friendship with the
Human Visual Memory Capacity

experimenter. This group of people may share certain similar characteristics, related to the reason friendship occurs, which are not found in the general population. Larger sample sizes generally lead to increased precision when estimating unknown parameters. Only ten people participated in the experiment because a larger number of willing participants (that needed to make time to devote two sessions with the experimenter) that kept the number of each sex balanced could not be found.

Visual memory studies are useful in the education domain. Visual memory, in an academic environment, entails work with pictures, symbols, numbers, letters, and especially words. Students must be able to look at a word, form an image of that word in their minds and be able to recall the appearance of the word later. The current practice of introducing new vocabulary involves an immersive technique in which the children learn to recognize it through spelling the word, reading it and using it in conversation. Students with good visual memory will recognize that same word later in their readers or other texts and will be able to recall the appearance of the word to spell it. Further exploration into this topic could unearth more efficient ways to encode visual data into long-term memory and perhaps be useful to students who suffer from learning disorders.

This study examined healthy adolescents’ visual memory capacity. The effectiveness of encoding abstract and concrete visual stimuli into short term and reference memory was tested. It was found that humans were not able to discriminate between the visual stimuli to the extent which was performed by the pigeons. As well, the concrete stimuli did not induce a higher accuracy at the end of Session 1 or Session 2 than the abstract visual stimuli. Similarly, the present results corroborate other research on human memory capacity, and suggest that the design of this experiment works against
Human Visual Memory Capacity

the natural memorization techniques used by humans. A closer examination into the way in which people encode information most efficiently could be useful in unlocking the expanse of human memory potential.
Human Visual Memory Capacity

References


Appendix A: List of the randomly selected standard deck cards used

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Appendix B: The hand drawn visual stimuli
Human Visual Memory Capacity

Table 1

*Summary Table for ANOVA calculations*

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