

MEMORY FOR ANIMATE AND INANIMATE ACTION SEQUENCES

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## ANIMACY AND ACTION SEQUENCE MEMORY

## Abstract

Recent research has discovered that individuals have better memory for animate words compared to inanimate words, indicating that the concept of animacy has implications for memory. However, no research to date has examined memory for more complex stimuli, such as action sequences. To investigate the influence of animacy on action sequences, 100 participants were recruited through the University of Regina Department of Psychology Pool of Research Participants to explore whether the same benefits of animacy were observed when physical contact with an animate object was involved. Participants were randomly assigned to one of two conditions – animate or inanimate – and shown a short demonstration with five target objects. The animate condition contained a toy dog whereas the inanimate condition contained a Lego structure. The participants' task was to correctly recall the order and actions of the demonstration. Participants also did a spatial working memory and a verbal working memory task to determine whether these memory systems are correlated with memory for action sequences. The results displayed that participants recalled more sub-actions and had significantly better memory for order in the animate condition compared to the inanimate condition. The findings of this study can have implications for individuals in their everyday life, as including animacy can provide a benefit in learning new skill sets at home, school, or work.

*Key words:* animacy, memory, action sequence, imitation

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### The Influence of Animacy on Action Sequence Recollection

Memory is a large field within cognitive psychology that has been heavily researched, especially in the last several decades. The continuous research on memory has deepened the understanding of how we retain information, what information we retain and overall the factors influencing memory. It is currently understood that long term memory can be broken down into declarative memory, which is explicit, and procedural memory, which is implicit (Cherry, 2017). Declarative memory can be further categorized as episodic memory and semantic memory, both of which differ in their retrieval processes. Declarative memory is the recollection of past events and relies solely on remembering experiences, whereas semantic memory is based on knowing factual information (Clayton, Salwiczek, & Dickinson, 2007). To gain a better understanding of episodic memory that gets utilized on an everyday basis, considerable research has been conducted to determine the factors influencing and enhancing memory retention.

Imitation has been one form of expressing retention of some previously experienced stimuli. It has been found that children develop the ability to mentally represent behaviours and repeat them (Heimann & Meltzoff, 1996). An example of such deferred imitation would be a child mimicking their parents cooking by playing with pots and pans and pretending to cook themselves (Deferred Imitation, 2017). Researchers examined whether imitation develops beyond childhood by comparing imitation in adults and children by allowing both to witness either a child or adult model performing goal-relevant and goal-irrelevant actions (Mcguigan, Makinson, & Whiten, 2011). The results suggested that individuals become more imitative as they mature and that adults are good imitators. Adults can imitate even unnecessary actions with a very high fidelity, having implications for social learning through imitation.

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One factor influencing memory of previous events is animacy. Memory for animacy has been one area that has recently piqued the interest of researchers within the field.

Animacy perception can be defined as “the perception and categorization of an entity as a living, and by some accounts intentional, being” (Kuhlmeier & Rutherford, 2013, p. 111). Differentiating between animate and inanimate objects has many advantages; for example, young children require the skill to identify which objects to apply social cognition (Kuhlmeier & Rutherford, 2013). Several studies have looked at the link between animacy and inanimacy influencing retention and have observed it can largely impact reasoning and comprehension of language as well as basic memory processes (Nairne, VanArsdall, & Cogdill, 2017).

Nairne, VanArsdall, Pandeirada, Cogdill, and LeBreton (2013) were interested in animacy and its influence on recall. These researchers analyzed the results of a study by Rubin and Friendly (1986) which looked at the properties that make certain words easier to recall. Rubin and Friendly (1986) examined six different variables to determine the best predictor of words recalled; however, animacy was not one of the initial variables. Nairne et al. (2013) took the data from Rubin and Friendly’s study and re-coded the words as animate or inanimate. Five separate word lists were created with 157 animate and inanimate words each and then ran recall tests on participants (Nairne et al., 2013). The results, with the added variable of animacy, displayed a strong correlation to recall ( $r = .42$ ), making animacy the strongest predictor compared to the original six variables. This suggests that animacy not only influences memory but can improve it as well.

The advantage of animacy on memory can be attributed to evolutionary benefits in recalling animate objects in the environment (Nairne et al., 2013). From an evolutionary standpoint, being attentive to animate things in the environment can be essential to survival as those animate things may be a predator, a prey (i.e. food source), or even a potential mate

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(Nairne et al., 2017). One phenomena that examines an individual's interaction between perceived animate and inanimate stimuli is the wolfpack effect. This is where individuals feel that moving shapes are chasing them, despite the randomness of their movement (Gao, McCarthy, & Scholl, 2010). To examine the wolfpack effect, participants were asked to avoid touching the darts on the screen by moving their target with a computer mouse. When the darts were oriented towards the target, the participants felt like they were being chased, despite the random movement of darts, resulting in them performing better at this task. However, when the darts were oriented away from the target, the effect weakened. Perceiving oneself to be a prey while 'being chased' by predators (i.e. the darts) resulted in better performance of the task. This provides support that individuals are more attentive to animate stimuli when examining the results from an evolutionary perspective. The overall results of this study suggested that the perception of animacy influences the interactive behaviour of the individual (Gao et al., 2010).

Nairne et al. (2017) further investigated animacy to determine whether a relationship existed between animacy status and retention. To examine this, a set of animate and inanimate words were created and then given to participants to study for a short amount of time. After studying the word list, the participant took a free-recall test. The results displayed greater recall for animate words compared to inanimate words. The researchers followed up by asking their participants to process a novel stimulus as either living or nonliving after ascribing them properties of living or nonliving objects. Consistent with their initial discovery, animacy showed to be advantageous in retention of objects. In the third task of the study, participants were asked to read sentences describing the interaction of living and nonliving things with inanimate objects. The participants displayed significantly better memory for the objects when they were touched by an animate object, compared to an

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inanimate object. The results of this experiment, including the three tasks completed by the participants, show an advantage in memory retention involving animate stimuli.

The format of stimuli presented to an individual is another factor that can impact their memory for that stimuli. Snow, Skiba, Coleman, and Berryhill (2014) conducted a study where they found that real world objects are far more memorable than pictures of objects. The task in this study was to freely recall and recognize household objects when presented in one of three forms: (a) real-world object, (b) coloured photograph, or (c) black and white line drawing (Snow et al., 2014). The results showed a significantly greater performance for the real-world object condition than the photograph or drawing conditions. This data suggests that memory is better for real objects compared to pictorial stimuli, and it contributes to the current understanding of mnemonic processing.

Despite all the recent research in memory for animacy, there remains room for investigation for memory and animacy in more complex situations, such as action sequences. Previous studies (Nairne et al., 2017; Nairne et al., 2013; Rubin & Friendly, 1986; Snow et al., 2014) have been based around words or images as stimuli, by comparing memory for animate versus inanimate words or pictures. However, little research has been conducted on witnessing actions involving animate and inanimate stimuli. Past literature and research has found a relationship between memory and animacy in word recall (Nairne et al., 2017), but, it is unknown if this relationship is restricted solely to word and image recall. One unexplored direction in research is determining whether this advantage also applied to action sequences.

There has been some research that has looked at memory for simple actions. Cohen (1981) has found that engaging in a simple action results in significantly better memory than only hearing or reading a description of that action. Hornstein and Mulligan (2004) examined memory for self-performed actions compared to memory for observed actions. Individuals had greater recall of an action when they performed the action, implying that the interaction

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involved in carrying out an action enhances memory. No research to date has examined memory for more complex things, such as actions involving animacy.

The purpose of this study was to establish a causal link between animacy and action sequence retention. It was hypothesized that individuals will have better recollection of action sequences involving an animate target, such as a toy dog, compared to an inanimate target, such as a Lego block. Barrett (2005) has proposed that evolutionary changes in humans have developed hyperactive animacy-detection systems which assist them in predator-prey situation, resulting in them being more attentive to animate stimuli. Additionally, literature has found positive effects between animacy and memory as well as actions and memory. This current study examined whether animacy could be applied to action sequences to enhance memory. It was anticipated that recall for action sequences involving animate stimuli would be greater than for inanimate stimuli.

### **Method**

#### **Participants**

In order to investigate the relationship between animacy and memory in action sequences, 100 participants were recruited through the University of Regina Department of Psychology Pool of Research Participants. The sample size was determined through power analysis. Of these 100, one participant was dropped and replaced with another participant due to her prior anticipation of it being a memory study. Although the participants consisted of both males ( $n=26$ ) and females ( $n=74$ ), the majority were female. One course credit was granted towards any 100 or 200 level psychology course for participation in the study.

#### **Stimuli**

The participants were randomly assigned to one of two conditions – animate or inanimate – and shown a short demonstration with five target objects. The animate condition contained a small toy dog, approximately 5 cm in size, and light brown in colour. The

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inanimate condition had a small structure made of Lego which was the same approximate size and colour as the toy dog. The demonstration board shown to the participants consisted of five different objects: (a) a green stick, (b) an orange cardboard tube, (c) a red block, (d) an abstract yellow structure, and (e) either the animate or inanimate object. The green stick and the orange tube were placed in the front whereas the red block and yellow structure were placed in the back. The placements of the four objects were arranged into a square with one object in each corner of the black board. The animate or inanimate object was situated in the middle of the board with the other four objects equal distances apart. The main task consisted of four different actions, involving the four objects on the board. The first action was to tap the stick on the condition object three times (A = tap), followed by picking up the object and going up and then down the orange tube (B = climb). The third action was to stamp the object on the block once (C = stamp), ending with the last action of circling the yellow structure around the condition object twice counter-clockwise (D = circle).

There were also two follow-up working memory tasks which assessed the spatial span and backward digit span of the participants. The spatial span task involved a small peg board with eight different coloured beads (yellow, red, black, pink, blue, white, green, and orange) glued equal distances apart from each other. The backward digit span task, which was administered verbally, required a google documents sheet with a list of number sequences and their corresponding reverse orders displayed. The order for the spatial span sequence and the numbers for the backward digit span were both randomly generated. The purpose of conducting these tasks was to determine whether spatial and verbal memory systems were correlated with memory for action sequences.

### **Procedure**

At the start of the session the participants were given a brief overview on the purpose of the study and were asked to fill out a consent form. Once consent was received, the

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researcher said, “Okay, before we start with the actual experiment, I have something I would like to get your opinion on. Someone else in this lab is in the process of developing a study with 5-year-olds, and she needs to choose stimuli. I would like you to watch this demonstration, and on a scale of 1 to 5 record on this sheet of paper how interesting you think this will be for kids.” A 5-point Likert scale was used, ranging from 1 (*uninteresting*) to 5 (*very interesting*). It was not revealed to the participants that this demonstration was related to the current study in order to prevent memorization or increased attentiveness to the demonstration. After the demonstration, the board containing the five target objects was placed in a different room and the participants were thanked for providing their opinion. Following the demonstration, participants were told “Alright, lets begin with the actual study. Today you will be completing four different tasks.” These tasks included: two general memory tasks, one distractor task, and the final surprise memory task.

The first general memory test, the spatial span task, assessed the working memory capacity of the participant. In order to do this task, a block with eight different coloured beads were placed in front of the participant. They watched the researcher tap the beads in a certain sequence and then were asked to repeat the sequence in the same order as presented. This task began with a sequence of three coloured beads, and then after two successful trials the number of coloured beads in the sequence moved up to four beads and continued to increase until the participant was unable to correctly recall the sequence. Incorrect recollection of the sequence resulted in the termination of the task. This task measured the longest sequence the individual was correctly able to recall, and that score was recorded.

In the second memory task the participants performed the backward digit span test. In this task the researcher verbally listed a sequence of numbers, beginning with three digits, and the participant’s task was to repeat back the sequence, but in reverse order. Similar to task one, the sequence started off with three digits, with two trials being conducted, and the

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success of those two trials then advanced the participant to the next level of four digits, then five digits and so on until the participant was unable to correctly recall the order. The backward digit span also measures for the participant's working memory capacity, the span recorded was the longest sequence of digits successfully recalled in the reverse order.

Following the two memory tasks, a three-minute distractor task was given to the participants in which they were asked to recall and write down as many United States as they could. The purpose of this task was to ensure sufficient amount of time had passed between the participants viewing the initial demonstration of the action sequence and being asked to repeat it, which was the fourth and final task of the study. The demonstration board was brought back out and placed in front of the participants while being asked to repeat what they observed at the start of the study. The participants' attempt at recalling the demonstration was video-taped so that it could be viewed again later when coding for their memory of the action sequence. During the final task, two criteria were measured, whether the participants repeated the actions correctly, and whether the actions were done in the correct order.

Once the participants had attempted the action sequence, they were debriefed about the real objective of the experiment and requested to not tell others the content of the study to maintain its integrity. This concluded the study and any questions or concerns the participants had were answered.

### **Coding**

**Target action score.** This measure examined the imitation of the four individual actions of A, B, C, and D, regardless of order. If a target was omitted or incorrectly recalled, participants were assigned a 0, if partially recalled then they were assigned a 0.5, and if they perfectly recalled the target a 1 was assigned. For example, for the first target action of tapping the animate or inanimate object three times with the stick, a score of 1 was given if three taps were executed. A score of 0.5 was given if less than three taps were executed, and a score of 0 was given for failing to tap or doing any other action with the stick. Thus, on this

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measure, a participant could receive a score ranging from a minimum of 0 and a maximum of 4.

**Action order score.** The measure examined the order of the targets and was scored based on a 3-point scale. A 0 was assigned for an entirely incorrect order of targets, or if any targets were omitted. A 1 was assigned for correctly sequencing one pair of targets; for example, tapping the target object with the stick followed by going up and down the orange tube. A 2 was assigned for correctly pairing three targets together; for example, going up and down the tube, stamping the block and circling the target object with the yellow tube, but forgetting to tap the object with the stick. A 3 was assigned for a perfect ordering of targets. Thus, a participant could have received a minimum score of 0 and a maximum of 3 on this measure.

**Reliability.** Two different individuals analyzed the video-taped footage of the participants' repeating the demonstration during the coding process. This was to ensure a greater reliability in the coding of the data for both the target action and action order scores. Inter-rater reliability analysis displayed a 95.8% reliability in order score, and 83.3% reliability in the action score.

### Results

To examine the relationship between animacy and memory, two independent samples *t*-tests were performed on target action scores and action order scores. The first *t*-test was conducted to compare the memory for target actions in the animate and inanimate conditions. As predicted, the results indicated a significant difference in the action scores for the animate ( $M=2.90$ ,  $SD=0.82$ ) and the inanimate ( $M=2.32$ ,  $SD=0.97$ ) conditions;  $t(98)=3.22$ ,  $p<0.002$ . The means for each of the four actions were higher in the animate condition compared to the inanimate condition, with the exception of action A, where the inanimate condition ( $M=0.68$ ,  $SD=0.28$ ) scored higher than the animate ( $M=0.63$ ,  $SD=0.32$ ). There was a significant difference in the memory for action B between the animate ( $M=0.89$ ,  $SD=0.21$ ) and inanimate

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( $M=0.76$ ,  $SD=0.38$ ) condition;  $t(98)=2.11$ ,  $p<0.037$ . Action C also displayed a significant difference in the animate ( $M=0.84$ ,  $SD=0.37$ ) and inanimate ( $M=0.43$ ,  $SD=0.48$ ) condition;  $t(98)=4.75$ ,  $p<0.001$ . The results described are displayed in Figure 1.

There was also a significant difference in the order scores for the animate ( $M=1.96$ ,  $SD=1.18$ ) and inanimate ( $M=1.40$ ,  $SD=1.20$ ) conditions;  $t(98) = 2.36$ ,  $p < 0.020$ . Forty-six percent of the participants in the animate condition were able to perfectly recall the order of the demonstration compared to only thirty percent in the inanimate condition. Based on the results, a positive correlation between action scores and order scores was observed,  $r = 0.69$ ,  $p < 0.001$ . Furthermore, the results displayed a medium effect size in both the order scores ( $d = 0.47$ ) and the action scores ( $d = 0.65$ ). However, there was no significant difference in the means for the spatial span and backward digit span tasks, between individuals in the animate and inanimate conditions. There was also no significant correlation observed between the two memory scores and the imitation scores. These results described are displayed in Table 1.

### Discussion

Consistent with the hypothesis and previous literature, animacy has shown to be advantageous for memory. The results indicated that participants in the animate condition were able to recall more actions correctly compared to individuals in the inanimate condition. Additionally, participants in the animate condition had significantly better memory for the order of the demonstration. A primacy effect is displayed in the inanimate condition for recalling the actions as the last two actions, C and D, were recalled poorly compared to the first two actions, A and B. However, this effect is not observed to the same degree in the animate condition. This may be due to a decreased interest in the demonstration faced by participants in the inanimate condition.

These results are consistent with previous research with words which display greater recall for animate words, compared to inanimate. Nairne et al. (2017) found that ascribing properties of living objects to novel stimuli enhances retention of that stimuli. The current

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study demonstrated that animacy's effect on memory goes beyond just words, as it effects memory for real things as well, such as actions.

Humans were evolutionarily predisposed to be more attentive to animate objects, as it was essential to survival (Barrett, 2005), this attentiveness may be a factor influencing how animate and inanimate stimuli are perceived differently. This could explain why individuals in the animate condition were able to recall more actions and remember the order more correctly. Another reason why individuals may have greater memory for action sequences in the animate condition may be due to their subconscious tendency to create a story. The animate stimuli may be perceived as being in control of engaging with the other target objects (ex. the dog jumped over the tube), whereas in the inanimate stimuli may not be perceived to have that control. Research has shown that the perception of an object as animate influences how an individual interacts with it (Gao et al., 2010), indicating that participants may have been less perceptive and engaged when viewing the inanimate condition demonstration, resulting in decreased memory.

The scores of the spatial working memory and verbal working memory task were not correlated with memory for action sequences. This suggests that our task was independent of those measures in memory. A reason for this finding may be that individuals were aware they were engaging in a memory task and thus are more attentive during them whereas participants were not aware they would need to remember the demonstration. Working memory was used in the spatial and verbal task, whereas declarative memory was required for recalling the demonstration, which may further explain why the results display no correlation.

There were several limitations to this study which may have influenced the overall results. Despite efforts to have similar stimuli in both of the conditions, there were subtle differences in size, shape, and colour. Another limitation was the restriction of recruiting

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participants solely through the University of Regina Department of Psychology Participant Pool. The results of the study are less generalizable to the wider population of university students, and adults as there was a relative homogeneity in the participants. Majority of the participants were young, Caucasian, female (74%), and planning to pursue a psychology degree. Greater diversity in the participants' backgrounds, academic pursuits, gender, and age would make the results more applicable to a broader population. Lastly, although participants were asked to keep the nature of this study hidden to maintain its integrity, it is possible that participants shared details of this study with their friends who also participated in the study, influencing the final results.

There are several factors future studies can explore that were not addressed in the current study. For instance, a larger sample size with greater diversity and gender should be incorporated. A larger sample size would allow researchers to examine sub-conditions within the animate and inanimate conditions, by having both a greater number, and different forms of animate and inanimate stimuli. Additionally, future studies can be conducted on adolescents to determine whether the same effect of animacy on memory exists outside of adults. The results of such study could be applied to pre-school settings where children are learning new skills on a daily basis. In contrast, future studies could also be done with an elderly population as animacy may have implications for individuals with decreased memory functioning, such as Dementia, in remembering their daily tasks better. Animacy influences memory for actions, however, future research can examine which specific age groups and settings benefit most from this effect.

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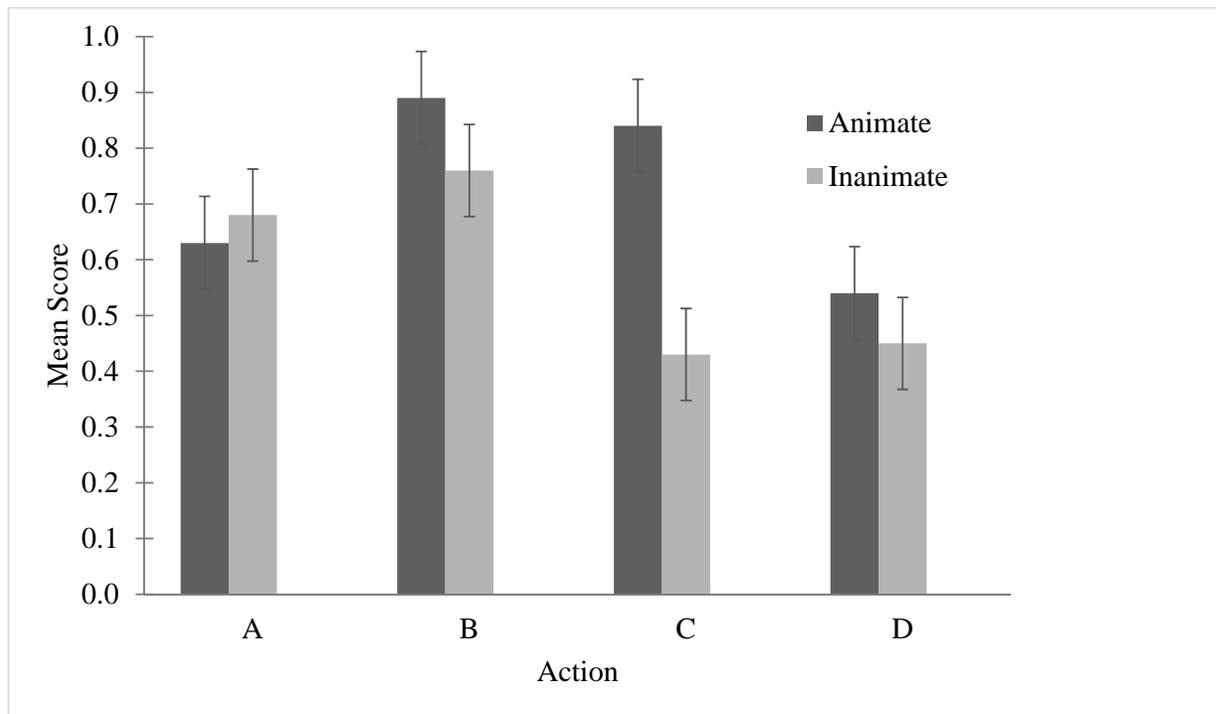
Table 1.

*Correlations Between the Two Memory Scores and Two Imitation Scores*

| Measure         | 1     | 2    | 3   | 4   |
|-----------------|-------|------|-----|-----|
| 1.Order Score   | ---   |      |     |     |
| 2.Spatial Span  | -.02  | ---  |     |     |
| 3.Backward Span | .03   | .14  | --- |     |
| 4.Action Score  | .69** | -.06 | 0.2 | --- |

\*\* . Correlation is significant at the 0.01 level (2-tailed).

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*Figure 1.* The participants' mean scores for each of the four actions in the animate and inanimate conditions. Error bars represent standard errors of the mean.