A Mnemonic Recall Based on 'Fast- Movement' Categorization Does Not Explain the Animacy Effect

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Abstract

Animate entities are better remembered than matched inanimate entities. The ultimate mechanism underlying the 'animacy effect' is evidently adaptative and foundational. However, the proximate explanation remains unclear. In this study we explored 'fast-movement' categorization as a potential proximate cause driving this effect. This study was largely based on the pioneering research by Nairne et al., (2013) and hence it adapted a similar paradigm of three trials involving presentation of words, followed by a distractor task and finally a recall task. The words were matched not only on the basis of linguistic features, but also on the basis of 'fast-movement' ratings. However, the results still showed a robust animacy effect. Thus, we concluded that the memory advantage of animate items over inanimate items cannot be explained by differential motion categorizations.

Introduction

Several lines of research have tried to explore why we remember some things better than the other. Many theories and models have explored the effect of visual imagery, phonological advantage, semantic schemas etc. which lead to preferential memory for certain entities (Gelin et al., 2017). However, none of the memory models can explain why animate entities are better remembered than inanimate entities. "Animate" entities can be understood as units which are made of biological structures that maintain life, grow, and reproduce (Nairne et al., 2013). Bonin et al., (2015) described them as, "living things which are capable of independent movement and can suddenly change their direction without warning." Hence, they have agency and control. Whereas inanimate entities can be understood as items ones which lack agency and show no signs of life (VanArsdall et al., 2013).

The memory advantage that the animates have over the inanimate is referred to as the 'animacy effect' (Nairne et al., 2013). Several experiments have propounded different hypothesis to explain this effect. The animate- inanimate distinction is widely considered as foundational and evident from early infancy and hence it explains the priority that is given to the detection and retention of the animate over the inanimate (Popp & Serra, 2016). This foundational base is further supported by an evolutionary backing which suggests that memory systems are biased to variables which potentially impact survival and fitness (Nairne et al.,2010; Nairne, 2017, Simion et al., 2008). Therefore, it has been suggested that humans developed a hyperactive animacy – detection system to maximize the chances of detecting a predator in their midst (Barrett, 2005). Thus, to understand this function of the memory, it is important to appreciate the fact that the cognitive systems evolved in relevance to fitness and hence our systems show sensitivity to animate entities (VanArsdall et al., 2017). This is the ultimate explanation for the animacy effect.

There have been many propositions about the 'proximate' explanation of the animacy effect. For example, VanArdalla et al., (2017) explored the categorical recall strategy, suggesting that animate entities form a stronger and more cohesive category in our memory system. However, they concluded that animacy effect remained intact even when they controlled for categorical retrieval. Additionally, Altman et al., (2016) suggested that there might be an attentional bias for the animates, Castelli et al. (2013) proposed the role of heightened sensory and perceptual activation for the animates and Bonin et al. (2015) explored an involvement of greater use of interactive imagery. Furthermore, Meinhardt et al, (2018) suspected whether the animacy effect could be explained due to emotional arousal. However, none of these studies were able to produce a causal link between their variables.

The importance of research trying to explain the proximate explanation behind the animacy effect can be highlighted by the fact that the strength of the animacy effect remained significant irrespective of whether the stimuli was presented as a word, a non-word, or a picture (Bonin et al, 2015; VanArsdall et al., 2013). Furthermore, Nairne et al, (2013) in their experiment using animate and inanimate words also controlled for several linguistic features like the frequency of use, imaginability, familiarity etc., and the animacy effect was still compelling.

This study proposes that there might be a mnemonic effect of motion categorization that favors animate recall. Developmental research has shown that motion is recognized readily from a very young age (Simion et al, 2008) and hence, we believe that the animate and inanimate memory distinction might be overriding this deep-rooted and easily activated foundational category. In addition, building on the categorical recall strategy (VanArsdall et al., 2013), we propose that the animate words have dual categorical activation involving the 'living' and the 'moving' category and hence they have better recall.

Furthermore, Samsonovich and McNaughton (1997) proposed the idea of a 'cognitive map' which functions as a mental representation for moving objects and helps individuals encode, store and recall information about animate entities more easily. Also, Burak and Fiete (2009) showed the involvement of the medial entorhinal cortex in motion perception, encoding, storage and recall. These studies strengthen our claim that the animacy effect might be explained through our cognition's strong motion categorization, especially fast motion (as it is easier to track and more activating).

Therefore, we advance the role of fast movement in the disparate memory for animate and inanimate entities. We explore the animacy effect while controlling for differential movement capacities and propose that there should be similar recall for the animate and the inanimate words when they are matched for 'fast-motion' categorization.

Method Participants

The study recruited 234 participants through opportunity sampling. However, there were some inclusion and exclusion criterion which were followed. For example, all participants were in the age group of 1865 years, and they were all native English speakers. The exclusion criterion followed was ensuring that none of the participants had any memory deficits, psychological/ neurological disorders affecting memory or any visual impairment that affected their ability to read the presented words. Additionally, informed consent from the participants was also ensured.

Study design

The experiment followed a within – subjects study design and therefore each participant took part in all the trials. The study had 2 independent variables, and they were, the word types (animate and inanimate words), and the number of trials (3 trials). The dependent variable was the proportion of items correctly recalled.

Material

14 animate and 14 inanimate 'fast – moving' words were shown to the participants using a computer (see Table 1). A total of 28 words were selected by an expert supervisor to avoid the ceiling or the floor effect. The animate and the inanimate lists were matched in terms of several linguistic features using data acquired from linguistic databases. Additionally, a pilot study was run with to ensure that the selected animate and inanimate words matched on being 'fast- moving' (see Table 2 for details).

Table 1 Words used in the experiment (Presented in an alphabetical order)

Animate	Inanimate	
Acrobat	Ambulance	
Athlete	Arrow	
Beetle	Cycle	
Dancer	Dart	
Gazelle	Drone	
Gymnast	Flash	
Hawk	Football	
Leopard	Frisbee	
Lizard	Missile	
Monkey	Truck	
Moth	Sledge	
Mouse	Spark	
Skier	Spear	
Spider	Rocket	

Table 2 Descriptive statistics for the dimensions that were matched between the word lists.

Dimension	Animate Mean (SD)	Inanimate Mean (SD)	t- value	p- value
Age of Acquisition (AOA)	6.60 (2.32)	6.57 (2.04)	0.04	.973
Familiarity	4.96 (0.34)	4.95 (0.37)	0.05	.962
Imaginability	5.86 (0.38)	5.71 (0.35)	1.04	.308
Written Word Frequency	3.69 (0.58)	3.92 (0.57)	-1.06	.299
Affect/ Valence	5.36 (1.17)	5.20 (1.07)	0.39	.701
Arousal	4.64 (1.16)	4.60 (1.02)	0.09	.931
Fast Movement *	2.38 (0.52)	2.67 (0.73)	-1.41	.158

Note. 'Fast movement' was rated by 43 participants on a 5-point scale (1 - very slow to 5 - very fast). * The mean, SDs and t-values are reported for all scales except the 'fast movement' scale. The median values and z-statistic are presented for this scale because the data are non-parametric. Written frequency values were calculated based on the norms provided by Subtlex-UK database. Affect and Arousal were calculated based on the ratings provided by Warriner's Affect Lexicon Database. Values for Imageability, Age of Acquisition & Familiarity were calculated based on the norms provided by the MRC linguistic database.

Procedure

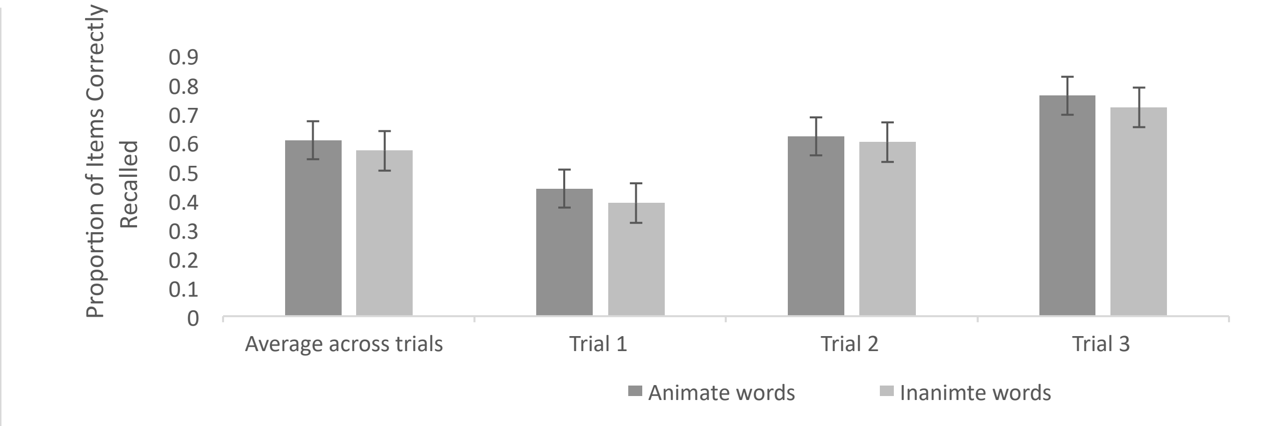
To ensur e good ethical practice, all participants were required to fill out a 'participant information sheet' and a consent form. Then, they were exposed to one of the two randomly amalgamated list of animate and inanimate words. 28 words (14 animate and 14 inanimate) were presented one at a time for 4 seconds each using a computer. The inter-stimuli interval between the words was 2 seconds. The words, timing, font, size, and all other aspects of design were constant across participants.

After viewing the final item, the participants saw the instructions for a distractor task. They were asked to count backwards from 100 in 3s for a minute. Participants were then asked to recall the words that they remembered. After this, they repeated the viewing, distractor, and recall tasks two more times. Finally, they were thanked and debriefed, and the contact details of the researcher were provided for any follow-up queries.

Results

The results of the recall tasks over the three trials are shown in Figure 1. A 2*3 repeated measures ANOVA was conducted. It showed a significant main effect of word type, $F(1,233)=18.97$, $p<0.001$, partial $\eta^2 = .075$. There was a significant recall advantage for the 'fast-moving' animate words over the 'fast moving' inanimate words. A significant main effect of number of trial was also reported, $F(2, 373)=926.05$, $p<0.001$, partial $\eta^2 = .799$ (Greenhouse Geisser). The recall performance increased for both animate and inanimate words over the trials. Further, the post-hoc Bonferroni test confirmed that the recall performance for trial 2 was significantly higher than trial 1 ($p<.001$, $d=1.14$). The recall performance for trial 3 was significantly higher than that for trial 1($p<.001$, $d=1.91$) and for trial 2 ($p<.001$, $d=0.74$). The interaction between the word type and the number of trials was not significant, $F(2, 436)=1.63$, $p=.200$, partial $\eta^2 = .007$ (Greenhouse Geisser) . Additionally, the average proportion of recall across trials for animate items was $M=.61$ and for inanimate, $M=.57$ (also shown in Figure 1).

Figure 1 Mean proportion of items correctly recalled as a function of word type and number of trials



Note- Bars show the mean recall for each level of the IV. The error bars represent show standard errors. Moreover, 118 recalled words were classified as false recall. They did not reveal any significant pattern, rather, most of these words could be explained by simple precision errors. For example, instead of the correct recall of the word 'cycle', some participants reported 'cycling' and 'cyclist', for the word 'acrobat'- 'acrobatic', for 'gymnast'- 'gymnastics' etc.

Discussion

Initially, we believed that the proximate explanation behind the animacy effect was a mnemonic privilege exercised by the animate words based on their ''fast-movement' categorization. Our argument was grounded by developmental understandings of foundational motion categorization (Simion, 2011) and research suggesting the presence of a 'cognitive map' for fast-moving entities (Samsonovich & McNaughton, 1997). Therefore, inspired by Nairne et al., (2013) we conducted three recall tasks which included the viewing phase, the distractor task and finally, the recall task. We also controlled for several linguistic features like Nairne et al. (2013), additionally, we also matched our animate and inanimate words on 'fast-movement' ratings. Thus, we hypothesised that if fast-movement categorisation drives the animacy effect, and we eliminated its role, we should have similar levels of recall for the animate and the inanimate words across the trials.

However, the results showed that even after controlling for fast-movement, there was a significant main effect of the word type, with notably better memory for the animate words suggesting that the animacy effect cannot be explained by fast-movement categorization. Therefore, our study concluded that animacy effect is independent of any link between an animate and inanimate entity and its property of fast movement. Furthermore, the recall performance rose with each trial suggesting a main effect of the number of trials. This was explained by practice effects.

We started with the question of why we remember some things better than the other, with special emphasis on animacy effect. We explored the evident ultimate explanation that memory evolved in line with the nature's criterion for survival and enhanced fitness (Bonin et al., 2015). However, even though the ultimate explanation for this distinction in memory is obvious, there have been many propositions for its proximate cause. Several studies explored different memory, perception and emotion models that could explain this effect, like categorical recall, emotional arousal, sharpened sensory and perception activation etc (VanArsdall et al., 2013; Meinhardt et al., 2018; Altman et al, 2016). But, just like our experiment, none of these studies were able to derive a significant causal link.

In conclusion, even though the field lacks a proximate explanation, we can still appreciate the how the animacy effect significantly impacts several cognitive functions like perception, encoding, storage, recall etc. Additionally, as highlighted by Nairne et al. (2013) the ultimate explanation is extremely robust and capable of independently driving the evolution of cognition and making it biased to the animate. Therefore, it's not a surprise that our memory shows greater sensitivity to the animate. Nonetheless, there is a need for more nuanced studies to explore more intricate details like which stage of memory (encoding, storage, or retrieval) is excessively biased to animate entities and why. Also, future research should explore more potential proximate explanations like propensity to attract attention, perceived agency associated with animate entities, etc. as they might be driving the animacy effect.

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