

# Animacy and attentional processes: Evidence from the Stroop task

Quarterly Journal of Experimental Psychology  
2019, Vol. 72(4) 882–889  
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DOI: 10.1177/1747021818771514  
qjep.sagepub.com



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## Abstract

In visual perception, evidence has shown that attention is captured earlier and held longer by animate than inanimate stimuli. The former are also remembered better than the latter. Thus, as far as attentional processes are concerned, animate entities have a privileged status over inanimate entities. We tested this hypothesis further using an adaptation of the Stroop paradigm. Adults had to categorise the colours of words that referred to either animate or inanimate concepts. In two experiments, we found that it took longer to process the ink colour of animate than inanimate words. Indeed, this effect was found when the words were presented in an oral animacy Stroop task (Experiment 1) and in a manual animacy Stroop task (Experiment 2). Using ex-Gaussian analyses and examining the distribution of RTs as a function of percentiles per animacy condition, we did not find a specific localisation of the animacy effect. The findings are interpreted as providing further evidence that animates are prioritised in processing because their fitness value is higher than that of inanimates.

## Keywords

Animacy; attention; evolutionary psychology; Stroop task

Received: 30 October 2017; revised: 19 March 2018; accepted: 20 March 2018

Several lines of evidence suggest that animate (living) entities (e.g., *lion*, *baby*) have a privileged processing status over inanimate (nonliving) ones (e.g., *mountain*, *kettle*). We refer to animates as *living things* that are capable of independent movement and can suddenly change direction without warning. More precisely, Gelman and Spelke (1981) identified four fundamental differences between animates and inanimates: (1) animates can act, whereas inanimates move only when something/someone initiates the action; (2) animates grow and reproduce; (3) animates can know, perceive, emote, learn, and think; (4) animates are made of biological structures that maintain life and allow reproduction.

In several domains of cognitive science, a growing body of evidence supports the view that animates are given processing priority over inanimates (see below). One ultimate explanation is that animates attract more attention than inanimates because it was important for our ancestors' survival to identify potentially dangerous entities quickly. In the domain of perception, it has been shown that visual attention is captured more quickly and, importantly, held longer by animate than inanimate stimuli (Abrams & Christ, 2003; New, Cosmides, & Tooby, 2007;

Öhman, Flykt, & Esteves, 2001; Öhman, Lundqvist, & Esteves, 2001; Pratt, Radulescu, Guo, & Abrams, 2010). In a visual search paradigm, Abrams and Christ (2003) showed that onset of motion (i.e., an object that has just started to move), but not motion per se, was important to capture attention because motion onset is indicative of animacy (in accordance with the definition of animates provided at the start of the Introduction). According to the authors, the reason why motion onset captures attention is that it may signal a biologically significant event, because objects that undergo motion onset must have their own

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internal energy source. Since survival may depend on the rapid detection of nearby predators and prey, one can easily imagine why a visual system in which motion onset captures attention would be important for protection against predators (see also Pratt et al., 2010). Moreover, in change detection tasks, individuals detect changes to humans and animals more quickly and accurately than changes to inanimate objects (New et al., 2007; but see also Hagen & Laeng, 2016). More recently, Altman, Khislavsky, Coverdale, and Gilger (2016) have also shown that animals were detected more rapidly and accurately than inanimate objects in alternating scene presentations, even when they shared bottom-up features with the rest of the scene. Interestingly, the authors also found that the detection of changes to inanimates was hampered by the presence of animates. Animacy effects have also been observed in inattention blindness, with unexpected items being detected more frequently when they are animate than inanimate (Calvillo & Hawkins, 2016; Calvillo & Jackson, 2014), and in attentional blink (Guerrero & Calvillo, 2016; but see Hagen & Laeng, 2017). Finally, Yang et al. (2012) recently tracked participants' eye movements while they viewed pictures with animals and inanimate images as focal objects. Their findings showed that nonhuman animals were more likely to be attended to, and to be attended to for longer, than inanimate objects. Overall, the findings in these attentional tasks are consistent with the animate monitoring hypothesis (New et al., 2007), which assumes that animates attract attention more easily than inanimate objects because of their importance for fitness in ancestral environments.

In memory research, a novel finding has recently been reported, which we shall refer to as the *animacy effect in memory* (Bonin, Gelin, & Bugaiska, 2014; Nairne, VanArsdall, Pandeirada, Cogdill, & LeBreton, 2013; VanArsdall, Nairne, Pandeirada, & Blunt, 2013 see Nairne, VanArsdall, & Cogdill, 2017 for a review). It corresponds to the observation that animate stimuli are better remembered than inanimate stimuli. This finding is in line with the functionalist/evolutionary view of memory put forward by Nairne and co-workers (Nairne, 2010; Nairne & Pandeirada, 2008, 2010a, 2010b) whereby the human memory system has been tuned to solve critical adaptive problems (e.g., finding food and water, protection from predators, finding a mate for reproduction). This finding is particularly important since it reinforces the view that the human cognitive system is tuned not only to detect but also to remember animate things.

According to New et al.'s (2007) animate monitoring hypothesis, important features of the environment are captured quickly and automatically, and animacy is one such dimension that seems to be processed very quickly. Moreover, animates (words or pictures) may capture attention at the initial stages of encoding more readily than inanimates, which would (in part) account for the finding

that animates are better remembered than inanimates (Bonin et al., 2014; VanArsdall et al., 2013). We, therefore, developed an adapted version of the original Stroop (1935) paradigm,<sup>1</sup> referred to as the animacy Stroop task, in which participants had to categorise the colour of printed words that referred to either animate or inanimate concepts. If attention is captured faster and/or held longer by animate than inanimate words, then there should be more interference when processing the colours of animate words than inanimate words (e.g., it should take longer saying or categorising by means of button-responses *red* for the word *baby* printed in red than saying or categorising *red* for the word *mountain* printed in red).

It is worth stressing that the "animacy Stroop task" used here is very close to the emotional Stroop task that corresponds to the situation where colour words are replaced by emotional (e.g., *death*) or neutral word (e.g., *cup*) (for a review, Williams, Mathews, & MacLeod, 1996). The emotional Stroop effect, that is to say slower reaction times (RTs) to name the colour of emotional (e.g., *cancer*) than neutral words (e.g., *wall*), is generally observed when neutral and emotional words are presented in *separate* blocks of trials and rarely when presented mixed within a single block (e.g., Algom, Chajut, & Lev, 2004, Experiment 6; Ben-David, Levy & Algom, 2003). Because the animacy Stroop task in our study is very similar to the emotional Stroop task, we decided to use blocked presentation.

In this article, a second aim was to explore RT performance in the animacy Stroop task at the level of distributional characteristics (see Balota & Yap, 2011 for a brief review). The distributional characteristics of RTs have been investigated for instance in word recognition (e.g., Yap, Balota, Tse, & Besner, 2008), in object naming (e.g., Roelofs & Piai, 2017), in the classic (e.g., Spieler, Balota, & Faust, 2000) and semantic (White, Risko, & Besner, 2016) Stroop effect using ex-Gaussian analyses. These analyses characterise RT distributions by fitting RT data to an explicit model, the ex-Gaussian distribution. The ex-Gaussian distribution is a convolution of the normal (Gaussian) and exponential distributions. It contains three parameters: the mean of the normal distribution ( $\mu$ ), the variance of the normal distribution ( $\sigma$ ), and the mean and standard deviation of the exponential distribution ( $\tau$ ) (mathematically, the mean and standard deviation of the exponential distribution are identical). These parameters are useful to better understand if the mean difference comes from a shift of the RT distribution, reflected by differences in  $\mu$ , or from a change in their tails, reflected by differences in  $\tau$ , or from both of these aspects. Thus, we ran ex-Gaussian analyses for both experiments. We also completed distributional analyses of RTs by examining vincentiles per animacy condition.

To sum up, based on the research reported above suggesting that animates capture and maintain attention more readily than inanimates, a straightforward hypothesis was

that one should observe more interference for the former than for the latter words in an animacy Stroop task. The aim of this study was precisely to examine further this hypothesis, taking a novel approach based on the well-known Stroop paradigm.

## Experiment 1

### Method

**Participants.** Totally, 28 students (15 males, mean age 21.21 years) at the University of Bourgogne took part voluntarily in the experiment. All were native French speakers, had normal or corrected-to-normal visual acuity, and reported no colour blindness. None were taking medication known to affect the central nervous system. Given that no previous studies have investigated the influence of animacy in a Stroop task, and insofar as the effect we are seeking is closely related to the emotional Stroop effect, we determined the size of our sample on the basis of previous studies investigating emotional Stroop effects (Cisler et al., 2011; Williams et al., 1996). The size of our sample ( $N=28$ ) is therefore in line with most emotional Stroop studies. For example, in Williams et al.'s (1996) review, 40 out of 50 studies (80.77%) have a sample size between 10 and 28 participants.

**Stimuli.** The stimuli were the same as those used by Bonin et al. (2014, Experiment 1). A total of 56 nouns were selected from Snodgrass and Vanderwart's (1980) and Bonin, Peere-man, Malardier, Méot, and Chalard's (2003) databases. Each word referred to either an animate or an inanimate concept. The words were divided into two sets of 28 items matched for the surface variables of number of letters, number of syllables, and bigram frequency; the lexical variables of book frequency, subtitle frequency, age of acquisition, number of orthographic neighbours, and orthographic uniqueness point; and the semantic variables of imageability, image variability, concreteness, and emotional valence. The statistical characteristics of the controlled variables are presented in the Supplementary Materials (Table A1).

**Procedure.** The participants were tested individually in a dimly lit room. They were instructed to name the colour of the words as fast and as accurately as possible while disregarding the word's meaning, speaking into a Sennheiser external microphone. Each vocal response triggered an interrupt, and latency from stimulus onset to voice-activated interrupt was measured in milliseconds. An experimenter was sitting in the room to record the vocal responses on each trial but he had no visual contact with the participant (he followed the course of the experiment by means of a second screen).

Each trial began by a fixation cross displayed for 500 ms at the centre of the screen followed by a blank screen for

200 ms. The stimulus then appeared at the centre of the screen and disappeared as soon as the participant responded. The interval between the response and the next trial was 1 s. The trials were presented in two separate blocks of 28 trials each, one for animate words and one for inanimate words. The trials were pseudo-randomly ordered for each participant, excluding immediate repetitions of the same colour. The presentation of the two blocks was counterbalanced across participants with a self-paced break between the blocks. The words were presented in 72-point Chicago lowercase letters against a white background at a distance of approximately 60 cm. We used four prototypical colours of red, green, blue, and yellow. Each colour was randomly presented seven times per condition.

Before the experiment proper, the participants were trained using 8 words (4 animates and 4 inanimates; the four colours were presented for each category) that were not included in the main experiment. Following the experiment, the participants were debriefed and thanked for their participation.

### Results and discussion

The raw data can be found in the Supplementary Materials.

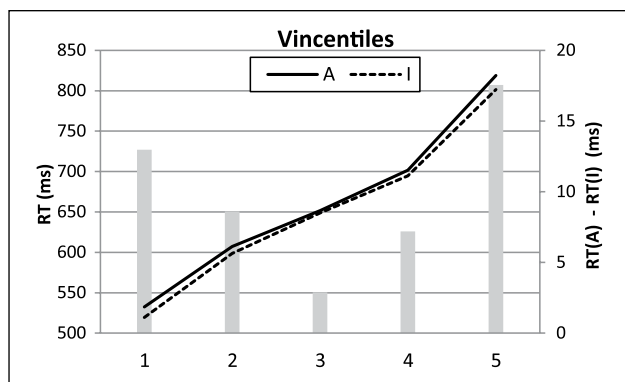
Due to error rates and microphone/speech failures, we excluded 3.44% and 4.46% of the data for animate and inanimate words, respectively. No reliable difference was observed between the two conditions,  $t(27)=0.82$ ,  $p=.419$ . Following Spieler et al. (2000), correct RTs were subjected to an outlier removal procedure in which RTs more than three standard deviations above or below the mean RT per participant, per condition, were excluded from all analyses. In this way, 0.99% of the remaining trials were removed.

Colour naming took significantly longer for animate words ( $M=667.55$  ms, standard deviation,  $SD=88.35$ ) than for inanimate words<sup>2</sup> ( $M=654.75$  ms,  $SD=87.42$ ),  $t(27)=2.28$ ,  $p=.031$ ,  $d=0.148$ , standardised mean change<sup>3</sup>=0.43). The finding on RTs thus exhibits an animacy Stroop effect and supports our prediction that it takes longer to name the colour of animate words (e.g., saying *red* for the word *baby* printed in red) than inanimate words.

### Distributional analysis

In order to explore how the animacy effect was distributed over the RT distributions, five vincentiles were computed (this number was limited to five because of the small numbers of words per participant in each animacy category). For each participant within each condition, RT data were thus first sorted from fastest to slowest, and the first 20% of the data were averaged, followed by the second 20%, and so on. These participants' vincentiles were then averaged across participants within each condition.

Figure 1 depicts averaged vincentiles per condition and the differences between the values for animates and



**Figure 1.** Vincentiles of Experiment 1. Division by five of the ordered individual distributions. The bars show the differences between the vincentiles obtained for animates and inanimates (right vertical scale)

inanimates. The figure suggests that the animacy effect is larger for both low and high RTs and somewhat reduced in the centre of the distributions.

### Ex-Gaussian analysis

Using maximum likelihood, parameters of ex-Gaussian distributions were estimated per participant and per condition using the function *timefit* of the *retimes* package of R. None of the means of the estimated parameters differed significantly between animates (A) and inanimates (I):  $\mu$ :  $M(A)=602.9$ ,  $M(I)=611.8$ ,  $t(27)=-.78$ ,  $p=.439$ ;  $\tau$ :  $M(A)=64.7$ ,  $M(I)=43$ ,  $t(27)=1.86$ ,  $p=.074$ ;  $\sigma$ :  $M(A)=69.8$ ,  $M(I)=79.8$ ,  $t(27)=-1.58$ ,  $p=.125$ . The test on  $\tau$  was marginally significant, which is in line with the larger difference found between animates and inanimates in the fifth vincentile (Figure 1). However, because the test on  $\tau$  is only marginally significant, this finding should be treated with caution.

In order to assess the robustness of the animacy Stroop effect, we decided to design a second experiment in which we used a manual Stroop effect (e.g., Augustinova & Ferrand, 2014; Macleod, 1991). Since we attempted a replication of our first study, we decided to increase the size of the samples of both participants and items (thus, including some new words). Thus, if the animacy stroop effect is robust, it would be present in this experiment.

## Experiment 2

### Method

**Participants.** Totally, 37 students (3 males, mean age 18.91 years) at the University of Bourgogne took part voluntarily in the experiment. Thus, based on Williams et al.'s (1996) review, the size of our sample of participants was now greater than most of the samples used to investigate

emotional Stroop effects (indeed, the samples in 96.15% of the studies investigating emotional Stroop effects reviewed by Williams et al. varied between 10 and 36 participants).<sup>4</sup> All were native speakers of French, had normal or corrected-to-normal visual acuity, and reported no colour blindness. None were taking medication known to affect the central nervous system.

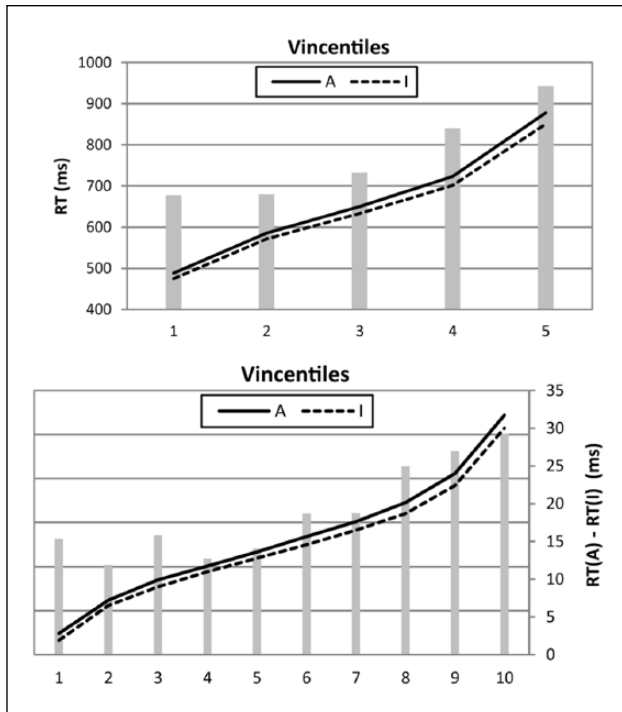
**Stimuli.** The stimuli were composed of 78 nouns that were selected from Snodgrass and Vanderwart's (1980) and Bonin et al.'s (2003) databases, with half animates and the other half inanimates. The same word characteristics as those described for Experiment 1 were matched between the two categories of words. The statistical characteristics of the controlled variables are provided in the Supplementary Materials (Table A2).

**Procedure.** The participants performed a manual animacy Stroop task in a group session. They were instructed to categorise—by pressing one of four buttons on a standard keyboard—the colour of the words as fast and as accurately as possible while disregarding the word's meaning. Each block began by a fixation cross displayed for 500 ms at the screen centre. Next, the stimulus was presented in the centre of the screen in red, green, blue, or yellow (font: Courier New, 26 points) in a different randomised order for each participant, against a black background, and it remained visible until the participant's response. The interval between the response and the next trial was set at 1 s. The trials were presented in two separate blocks of 39 trials each, one for animate words and one for inanimate words. The trials were pseudo-randomly ordered for each participant, excluding immediate repetitions of the same colour. The presentation of the two blocks was counterbalanced across participants with a self-paced break between the blocks. The same two blocks were then presented a second time, with the same counterbalanced order as in their initial presentation. The aim of this repetition was to obtain a larger set of data points per participant, ensuring greater reliability of the parameters estimated per participant, in particular for the ex-Gaussian analyses. Before the experiment proper, the participants were trained using 60 words differing from the experimental ones with visual feedback when the response was incorrect. Feedback was provided only for the practice trials. Following the experiment, the participants were debriefed and thanked for their participation.

### Results and discussion

The raw data can be found in the Supplementary Materials.

Error rates were low (2.91% and 3.56%, respectively, for animate and inanimate words) and the difference in error rates between the animate and inanimate conditions was not significant,  $t(36)=-1.39$ ,  $p=.172$ ,  $d=-.287$ .



**Figure 2.** Vincintiles of Experiment 2. Top = division by 5 of the ordered individual distributions; bottom = division by 10. The bars show the differences between the vincintiles obtained for animates and inanimates (right vertical scale).

RTs for correct responses above or below three standard deviations of the condition  $\times$  block  $\times$  participant mean were removed (1.2% of the remaining trials).

In a preliminary analysis, animacy and Block were treated as repeated factors in a by-participants<sup>5</sup> two-way analysis of variance (ANOVA). The animacy effect was significant, with colour categorising being longer for animate words ( $M=666.07$  ms,  $SD=79.86$ ) than for inanimate words ( $M=646.06$  ms,  $SD=74.49$ ),  $F(1,36)=8.42$ ,  $p=.006$ . The main effect of Block was also significant,  $F(1,36)=11.17$ ,  $p=.002$  (Block 1:  $M=646.26$ ,  $SD=11.99$ ; Block 2:  $M=665.87$ ,  $SD=13.12$ ). Importantly, the interaction effect between the animacy and Block factors was not reliable,  $F(1,36)=.24$ ,  $p=.628$ , and simple effects of the animacy variable were significant in both blocks: Block 1:  $F(1,36)=4.67$ ,  $p=.037$ ,  $M(A)=654.96$ ,  $M(I)=637.56$ ; Block 2:  $F(1,36)=5.86$ ,  $p=.021$ ,  $M(A)=677.18$ ,  $M(I)=654.56$ .

Given that the animacy effect was not modulated by the Block factor, and to bring the RT scores in line with those of Experiment 1 and with the results of the subsequent analyses on ex-Gaussian parameters, we took into account only the animacy factor in the analyses that follow. In this way, the animacy effect was significant in a paired  $t$ -test,  $t(36)=2.90$ ,  $p=.006$ ,  $d=.263$ , standardised mean change (see Footnote 1)=0.477, with animates ( $M=666.20$  ms,  $SD=79.80$ ) taking more time to categorise than inanimates ( $M=646.17$  ms,  $SD=74.39$ ).<sup>6</sup>

### Distributional analysis

Figure 2 depicts the means of the by-participants vincintiles for the two conditions. Starting from the left of the abscissa, the difference between animates and inanimates is roughly the same until (nearly) the centre of the distributions, and from there the difference tends to increase.

### Ex-Gaussian analysis

Analyses of the estimated parameters of ex-Gaussian distributions<sup>7</sup> revealed a marginal effect of animacy on  $\mu$ ,  $t(36)=1.99$ ,  $p=.055$ ;  $M(A)=569.57$ ,  $M(I)=557.34$ , and non-significant effects for both  $\tau$ ,  $t(36)=.81$ ,  $p=.425$ ;  $M(A)=96.63$ ,  $M(I)=88.83$ , and  $\sigma$ ,  $t(36)=.21$ ,  $p=.834$ ;  $M(A)=90.69$ ,  $M(I)=89.73$ .

To summarise, using partly new words and manual responses, the main finding of Experiment 2 is that it took longer to categorise the colour of animate than inanimate words, thereby establishing the robustness of the animacy Stroop effect.

### General discussion

The aim of this study was to examine further the hypothesis that animate items are processed by early attentional mechanisms. Indeed, as reviewed in the Introduction, a growing body of evidence in the perceptual domain strongly supports the idea that visual attention is captured more quickly and held longer by animate than inanimate stimuli (e.g., Yang et al., 2012). Moreover, in the domain of episodic memory, to account for the fact that animates are remembered better than inanimates, which is a new and important mnemonic effect, Nairne and colleagues put forward the hypothesis that animates may capture attention at the initial stages of encoding more readily than inanimates (Bonin et al., 2014; VanArsdall et al., 2013). According to an evolutionary account, the ability to detect animacy in the environment quickly and to remember animates better than inanimates probably aided the survival of our ancestors in the deep past. We submit that it is for this reason that we are equipped with such perceptual and memory processes. To test the hypothesis that animate words capture attention more quickly and hold it longer than inanimate words, we designed an adapted version of the original Stroop (1935) task in which participants had to categorise the colours of words that referred to either animate or inanimate concepts. The idea was that if animate words capture attention more quickly and hold it longer than inanimates, then we should observe what we have referred to as an animacy Stroop Effect. Thus, we predicted—and found—that processing the colour of words would take longer for words referring to animate than to inanimate entities. Indeed, an animacy Stroop effect was obtained in an oral and a manual animacy Stroop task with two sets of words.

A second aim of our research was to explore the distributional characteristics of the animacy Stroop effect. The ex-Gaussian analyses and vincentiles exploration of the data revealed an ambiguous pattern. In Experiment 1, the animacy interference effect was not reliable for  $\mu$ , and marginally significant for  $\tau$ . In line with the  $\tau$  parameter, descriptive statistics suggested that the difference between animates and inanimates was larger for the highest vincentile than the differences found in the other vincentiles. However, in Experiment 2, with more participants and experimental trials per animacy condition, a reverse pattern was observed, in other words, the animacy interference effect was marginally significant for  $\mu$ , and not reliable for  $\tau$ . However, the vincentiles suggest that the differences between animates and inanimates tended to increase after the centre of the distributions, with increasing RTs. Although the findings from the distributional analyses of RTs must be treated with caution given the discrepancy found between the two experiments, it is interesting to note that the results of Experiment 2 are in line with those of White et al. (2016) in their investigation of semantic Stroop effects (e.g., the word *blood* associated with blue ink), where they found an interference confined to  $\mu$ , and absent from  $\sigma$  and  $\tau$ . As noted by White et al. (2016), their findings differed from those typically observed in the standard Stroop effect (e.g., the word *blue* written in red ink) where effects on the three ex-Gaussian parameters ( $\mu$ ,  $\sigma$ , and  $\tau$ ) are found. According to White et al. (2016), response competition is thought to be a major component in the standard Stroop effect and to be associated with  $\tau$  (although semantic interference is also involved). By contrast, the semantic Stroop effect is mainly due to semantic interference (competition between the colour and the colour-carrier word, Spieler et al., 1996) and should not therefore be found on  $\tau$ . Our findings in the ex-Gaussian analyses of RTs in Experiment 2<sup>8</sup> suggest that similar mechanisms underpin the animacy Stroop effects found here (although, as stressed by Matzke and Wagenmakers (2009), one has to be careful when trying to assign cognitive mechanisms to ex-Gaussian parameters). To explore this issue in more depth, further studies are needed, with larger numbers of participants and trials. (Readers can find details in the Supplementary Materials about post hoc power analyses performed to ascertain the numbers of participants required to obtain significant results for the different parameters of ex-Gaussian analyses taken from our experiments.)

As described above, the animacy Stroop effect observed in this study corroborates previous studies on visual perception. However, our study extends those findings to verbal stimuli, since most previous studies made use of non-linguistic stimuli such as pictures (New et al., 2007; Öhman, Flykt et al., 2001; Öhman, Lundqvist et al., 2001) or artificial visual displays (Abrams & Christ, 2003). Our findings are in line with New et al.'s (2007)

animate monitoring hypothesis, which postulates that visual processes are tuned adaptively in such a way that important features of the environment—including animate entities—are captured quickly and automatically.

The fact that participants took longer to name the colour of animate than inanimate words suggests that the animacy dimension is an “intrinsic” property of concepts captured by attentional processes (VanArsdall et al., 2013) which results in more interference on the colour response. This may also partly explain why participants take the animacy dimension into account to remember words, even when they are not explicitly required to do so, with the result that animate words are remembered better than inanimates (e.g., Bonin, Gelin, Laroche, Méot, & Bugaiska, 2015, Study 1; Nairne et al., 2013). Overall, our study provides reasonable support for the idea that the mnemonic advantage of animate over inanimate words could be in part explained by an early attentional component (i.e., attentional capture, see Popp & Serra, 2015), although other proximate mechanisms are certainly involved (Bonin et al., 2015) in this mnemonic advantage.

Animacy is a composite dimension and humans have to take animates into account for various reasons depending on the context. Our study was not aimed at investigating a particular dimension of animacy. Our favoured interpretation of the current findings is that animates are generally given processing priority because their fitness value is greater than that of inanimates.

The perception of animates involves the mobilisation of early attentional processes allowing them to be detected rapidly. Animates also maintain attention because they often require a rapid decision. In the event of predators, the ability to respond appropriately is vital for survival (DeDora, Carlson, & Mujica-Parodi, 2011). It is important to stress, however, that evolutionary psychologists have clearly emphasised the *flexible nature of evolved processes*. Evolved processes are not always automatically prioritised. The way that they are triggered and used varies as a function of the immediate context in which individuals are placed.

Apart from evolutionary considerations, which were both the starting point and the main focus of this work, the animacy Stroop effect found here also provides further support for the interference account of Stroop effects competition (e.g., Augustinova & Ferrand, 2014). Indeed, it is difficult to explain how animate words can lead to more competition than inanimate words when processing their colours without assuming that the animacy dimension is automatically activated at the semantic/conceptual level.

To conclude, we have found evidence of a novel effect, the animacy Stroop effect. This effect manifests itself with greater interference for animate words than inanimate ones. This phenomenon adds to the growing body of evidence suggesting that animates have processing priority over inanimates.

## Acknowledgements

The authors thank Manuel Perea and two anonymous reviewers for their constructive comments on previous versions of the manuscript. Aurélie Bugaiska, Alain Méot and Patrick Bonin drafted the manuscript. Testing and data collection were performed by Laurent Grégoire, Anna-Malika Camblats, and Margaux Gelin. Alain Méot performed the data analyses. All authors provided feedback on different drafts of the manuscript. Finally, all authors approved the final version of the manuscript for submission.

## Declaration of conflicting interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

## Funding

The author(s) received no financial support for the research, authorship, and/or publication of this article.

## Supplementary material

Supplementary material is available at: [journals.sagepub.com/doi/suppl/10.1177/1747021818771514](http://journals.sagepub.com/doi/suppl/10.1177/1747021818771514).

## Notes

1. The Stroop (1935) task is widely used to investigate interference effects in several cognitive skills. It should be remembered that in Stroop's (1935) Experiment 2, colour words written in different coloured inks and coloured squares (control condition) were presented to participants who had to classify the colours. A key finding was that the categorisation of the colours took longer from words written in different colours than from the coloured squares. This interference effect has most often been interpreted as resulting from a competition during the categorisation process of the word meaning on the categorisation process (for a review, Macleod, 1991).
2. In this paired *t*-test and the following *t*-tests, Kolmogorov–Smirnov tests were run to check the normality of the distributions of the differences between scores for animates and inanimates. In all cases, the distributions were found to be normally distributed. This test was further complemented by bootstrapped *t*-tests with 10,000 subsamples to verify that the same patterns of results were obtained.
3. *d* was computed as the ratio of the difference between means and the square root of the mean of the variances (e.g., Rosnow, Rosenthal, & Rubin, 2000). The standardised mean change (e.g., Kline, 2013, p. 135) uses the standard deviation of the difference between scores as the denominator and is directly linked to power analysis.
4. Moreover, using a non-centrality parameter derived from the estimated standardised mean change reported in Experiment 1, post hoc power analysis revealed that, with such an effect size, 37 participants would lead to a power of .82 in a unilateral test (.72 in a bilateral test) at the alpha level of .05. As the direction of the impact of animacy can be predicted, a one-tailed test should be relevant in this case (see, for instance, Roelofs & Piai, 2017). However, to bring our results in line with both current approaches to reporting *p*-values and other analyses for which no precise predictions

were made, only two-tailed *p*-values are presented. As a one-tailed *p*-value is half that of the two-tailed test when observations fit the unilateral hypothesis, indicating one-tailed *p*-value is not necessary. However, for power analyses it is important to take the direction of effects into account.

5. It is noteworthy that the same results were obtained when using a by-items analysis with Animacy treated as a between-factor and Block as a within-factor or when using a mixed model on trials with random intercepts for participants and words.
6. The occasional discrepancies that can be seen for the main effect reported above are due to averaging over the blocks.
7. For each parameter, the absence of an interaction effect between Animacy and Block was first checked, and Kolmogorov–Smirnov tests were run to verify the normality of the distributions of the differences in scores for animates and inanimates. It is noteworthy that bootstrapped *t*-tests with 10,000 subsamples gave exactly the same pattern of results.
8. We are less confident about the findings obtained in Experiment 1 than those in Experiment 2 because of the lower number of trials per condition and per participant in the first experiment.

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