Memory

Routledge
Taylor & Francis Group

ISSN: (Print) (Online) Journal homepage: https://www.tandfonline.com/loi/pmem20

Selective remembering and directed forgetting are influenced by similar stimulus properties

Dillon H. Murphy & Alan D. Castel

To cite this article: Dillon H. Murphy & Alan D. Castel (2022) Selective remembering and directed forgetting are influenced by similar stimulus properties, Memory, 30:9, 1130-1147, DOI: 10.1080/09658211.2022.2092152

To link to this article: https://doi.org/10.1080/09658211.2022.2092152

Published online: 22 Jun 2022.

MEMORY
2022, VOL. 30, NO. 9, 1130–1147
https://doi.org/10.1080/09658211.2022.2092152

Routledge
Taylor & Francis Group

Selective remembering and directed forgetting are influenced by similar stimulus properties

Dillon H. Murphy and Alan D. Castel

Department of Psychology, University of California, Los Angeles, CA, USA

ABSTRACT
Do the properties of to-be-remembered events influence the ability to remember, and also intentionally forget, these events in similar ways? Prior work has examined how the font size, animacy, emotionality, concreteness (the degree to which a word denotes something perceptible), frequency (how often a word appears in language), and length of to-be-remembered words influence memory. However, it was previously unclear whether the forgetting of information is also influenced by these characteristics. In six experiments, we used an item-method directed forgetting task where we presented participants with to-be-remembered and to-be-forgotten words varying in font size (large or small), animacy (animate or inanimate), emotionality (negative or neutral), concreteness (high or low), frequency (high or low), and word length (long or short). Results revealed that animacy, emotionality, concreteness, frequency, and word length (but not font size) influenced both remembering and forgetting. Together, the present findings indicate that the characteristics of presented words can influence remembering as well as directed forgetting, providing further evidence that the remembering and forgetting processes are governed by similar properties.

ARTICLE HISTORY
Received 14 February 2022
Accepted 14 June 2022

KEYWORDS
Directed forgetting; selective rehearsal; stimulus properties; memory; recall

Much of memory research focuses on how to improve learning but there are also instances where we might want to forget information. For example, a judge sometimes instructs a jury to forget certain evidence or instructors might mistakenly present incorrect information and tell their students to disregard what was just said. Additionally, forgetting can be beneficial to allow for the recall of other essential events and details (see Anderson & Hanslmayr, 2014; Bjork & Bjork, 1996; Fawcett & Hulbert, 2020); thus, it is important to know whether certain features that influence remembering have similar or different effects on the wilful ability to forget information. Specifically, some item characteristics can influence remembering but directed forgetting may affect this process in different ways. Although a considerable amount of research has examined how the properties of to-be-remembered events influence the ability to remember, it is less clear how these properties influence the ability to intentionally forget.

Directed forgetting tasks measure one's ability to strategically forget certain information by presenting learners with both to-be-remembered and to-be-forgotten information (see Bäuml et al., 2020; Johnson, 1994; MacLeod, 1998; Sahakyan et al., 2013 for reviews), and participants have demonstrated the ability to forget certain information in various types of directed forgetting paradigms. For example, in the item-method of directed forgetting, participants are presented with a list of words with each word followed by a cue either to remember or to forget the word (e.g., Gardiner et al., 1994). Participants are then asked to recall all words, regardless of the cues to either remember or forget them. Additionally, participants often complete a surprise recognition test whereby they are presented with the studied words (both to-be-remembered and to-be-forgotten words) as well as words that were not presented (lures), and participants' objective is to identify whether each word had been presented in the encoding phase.

Compared to controls where learners try to remember all presented information, memory for information that learners expected to be tested on (remember words) is generally enhanced and memory for information that learners did not expect to be tested on (forget words) tends to be poorer, illustrating the benefits of forgetting (see Foster & Sahakyan, 2012). Specifically, although memory is worse for items learners are told to forget, this forgetting results in enhanced memory for target words by allowing the learner to focus on a subset of the studied items rather than trying to remember all the words. Moreover, this intentional forgetting may be an effortful process (see

CONTACT Dillon H. Murphy dmurphy8@ucla.edu Department of Psychology, University of California, Los Angeles, CA 90095, USA
The experiments reported in this article were formally preregistered and the stimuli and data have been made available on the Open Science Framework here.

Fawcett & Taylor, 2010, 2012; Taylor, 2005; Taylor & Fawcett, 2011; Thompson et al., 2014) that can also degrade memory for other details of information even when the target information is retrieved (Fawcett et al., 2016), suggesting that the initial forgetting process may influence what is later remembered.

Differences in memory for to-be-remembered and to-be-forgotten words in the item-method (but not the list method) of directed forgetting are frequently attributed to selective rehearsal. According to selective rehearsal accounts, presented words are maintained in working memory until participants are given the cue to either remember or forget the word (Bjork, 1970, 1972; Johnson, 1994; MacLeod, 1975; Sahakyan & Foster, 2009; Tan et al., 2020). If participants are instructed to remember the word, participants engage in more elaborative study strategies to encode the word into long-term memory; if instructed to forget the word, rehearsal of that word is ceased, leading to an increased likelihood of forgetting. However, according to the selective rehearsal account, the to-be-forgotten information still receives some rehearsal/encoding before the cue is presented. Thus, since to-be-forgotten information receives some rehearsal, this information should be subject to the same fundamental properties influencing memory for to-be-remembered information. Specifically, if to-be-forgotten information receives some rehearsal and subsequent encoding before the cue to forget the word, the properties of the word that influence remembering should impact the forgetting of these words as well, although the effects may be reduced when cued to forget the word. There also may be effortful or active forgetting mechanisms that influence directed forgetting, and these processes could influence how attentional resources are withdrawn from to-be-forgotten information to limit unwanted processing (Anderson & Hulbert, 2021).

In contrast to selective rehearsal, inhibitory accounts of directed forgetting suggest that to-be-forgotten information is inhibited, although when inhibition occurs may depend on the method of directed forgetting. Specifically, inhibition occurs during encoding in the item method (see Anderson & Hanslmayr, 2014; Basden et al., 2003; Fawcett & Taylor, 2008; Geiselman & Bagheri, 1985) but during retrieval in the list method (Basden et al., 1993; Basden & Basden, 1998; Bjork, 1989; Bjork & Bjork, 1996; Sahakyan et al., 2013; Weiner & Reed, 1969). Others have argued for context change (Delaney et al., 2010; Sahakyan et al., 2008; Sahakyan & Delaney, 2003; Sahakyan & Kelley, 2002), but these accounts primarily support the list-method directed forgetting effect (see Hubbard & Sahakyan, 2021 for a discussion of how context change and forget cues may operate differently in item-method directed forgetting). In item-method directed forgetting, there has been some support for the cognitive load hypothesis (Lee, 2012; Lee & Lee, 2011; see also Taylor & Ivanoff, 2021). According to the cognitive load account, the allocation of attentional resources towards a secondary task can enhance the directed forgetting effect by reducing the extent to which to-be-forgotten items receive unwanted encoding, somewhat similar to selective rehearsal accounts.

In sum, in the item-method of directed forgetting, the effects are largely driven by selective encoding processes (i.e., more rehearsal given to to-be-remembered items than to to-be-forgotten items or ceased processing of to-be-forgotten items such that to-be-remembered items are selectively rehearsed over to-be-forgotten items) as well as effortful or strategic forgetting that may be influenced by similar stimulus characteristics (see MacLeod, 1998; Murphy & Castel, 2021). As a result, directed forgetting effects may be influenced by similar characteristics that guide selective encoding and effortful forgetting. Specifically, stimulus properties may similarly influence the encoding processes for to-be-remembered and to-be-forgotten words before the onset of the cue to remember or forget a word.

Previous work has demonstrated a plethora of characteristics of studied words that can influence memorability. For example, a large font sometimes produces a small memory benefit (Chang & Brainerd, 2022; Luna et al., 2018), animate words are better remembered than inanimate words (Nairne et al., 2017), emotionally valenced words tend to be better remembered than neutral words (e.g., Buchanan et al., 2006), concrete words (the degree to which a word denotes something perceptible) are better remembered than abstract words (Paivio, 1966, 1971, 2013), frequent words (the incidence rate of a word) are better remembered than less frequent words (Hall, 1954), and short words (number of letters) are better remembered than long words (Baddeley et al., 1975).

In terms of how these characteristics affect directed forgetting, prior work suggests that neither the loudness of audibly presented words nor the font size of visually presented words affects directed forgetting (Foster & Sahakyan, 2012; Sahakyan & Foster, 2016; see also Foster, 2012). Some prior work has found a reduced directed forgetting effect using emotionally valenced images (e.g., Nowicka et al., 2011) while others have not found emotionally valenced images to impact directed forgetting (e.g., Yang et al., 2012). When using word lists, some studies have found a reduced directed forgetting effect for emotional words (see Bailey & Chapman, 2012) while other work has found a stronger directed forgetting effect for negatively valenced items (Brandt et al., 2013). Ye et al. (2019) present some evidence that word frequency does not interact with directed forgetting but acknowledge that the impact of word frequency on directed forgetting remains unclear. Thus, in the present study, we aimed to better elucidate whether the forgetting of words is also influenced by word properties. Specifically, according to selective rehearsal accounts, large words, animate objects, emotionally valenced words, highly concrete words, highly frequent words, and longer words may be differentially forgotten compared with small words, inanimate objects, neutral words, less concrete words, low-frequency words, and shorter words.

The current studies

Some prior work suggests that although remembering and forgetting may follow similar principles, certain variables can impact remembering and forgetting in different manners (cf. Cepeda et al., 2008; Rowland, 2014). In contrast to incidental forgetting, directed forgetting tasks may produce different results from those of other memory studies. Specifically, examining how memory and forgetting may or may not be influenced by similar stimuli characteristics can further elucidate how we intentionally remember and forget.

In the current studies, we were interested in how different stimulus properties that are known to influence memory and widely examined in psychological research – font size, animacy, emotionality, concreteness, frequency, and word length – influence the directed forgetting effect. Specifically, if forgetting is not purely under the wilful control of the participant (i.e., if forgetting is influenced by factors other than a learners' goals), then some stimulus properties may still similarly influence remembering and directed forgetting. In each experiment, we presented participants with words followed by a cue indicating whether the word should be remembered (RRRR) or should be forgotten (FFFF). Participants were then asked to recall all words, regardless of the cue.

Consistent with prior work, we expected that words in large font, animate objects, negative words, highly concrete words, low-frequency words, and shorter words to be better remembered, even when cued to forget, than words in small font, inanimate objects, neutral words, less concrete words, high-frequency words, and longer words, indicating that the stimulus properties that can influence remembering can also affect forgetting. Specifically, since learners process to-be-remembered and to-be-forgotten words before the cue denoting whether the word should be remembered or forgotten (according to the selective rehearsal account), memory for all words should be governed by the same principles. Thus, we expected stimulus characteristics to affect to-be-remembered and to-be-forgotten words similarly, consistent with a selective rehearsal account, although the effect of some variables may be slightly more pronounced for to-be-remembered items, as these items would receive additional later rehearsal opportunities (or perhaps deeper processing, such as imagery) for to-be-remembered items.

Experiment 1a – font size

Since font size can be indicative of the importance of information (see Luna et al., 2019) and can sometimes influence later remembering (see Chang & Brainerd, 2022; Halamish, 2018; Luna et al., 2018), the ability to forget information may be affected by its font size. For example, tangential information is often placed in a footnote using a small font size while newspaper headlines are presented in large fonts designed to capture attention and convey importance. Most prior research has focused on how font size influences remembering or predictions about memory (e.g., Murphy et al., 2021; Rhodes & Castel, 2008, 2009) but prior work suggests that neither the loudness of audibly presented words nor the font size of visually presented words affects directed forgetting (Foster & Sahakyan, 2012; Sahakyan & Foster, 2016; see also Foster, 2012). In Experiment 1a, we aimed to replicate this prior work and further elucidate how the font size of to-be-remembered and to-be-forgotten words influences the recall of this information. Participants studied to-be-remembered and to-be-forgotten words in large and small font before completing a recall test. We expected participants to demonstrate a slight recall advantage for large to-be-remembered words compared to small to-be-remembered words (see Chang & Brainerd, 2022; Luna et al., 2018), and for this effect to hold for to-be-forgotten words.

Experiment 1b – animacy

Rather than external characteristics like the font size, more intrinsic qualities of a word may also influence memory. For example, animate objects (i.e., living things that can think and move independently) tend to be better remembered than inanimate objects (Bonin et al., 2014, 2015; Leding, 2019; Nairne et al., 2013; Popp & Serra, 2016, 2018; Serra, 2021; VanArsdall et al., 2015; see Nairne et al., 2017 for a review). This effect is generally attributed to adaptive memory views such that animate objects are more important to remember as these are likely to be prey, predators, or mates (see Nairne, 2016). However, it is unclear how the animacy of a word affects its ability to be intentionally forgotten. In Experiment 1b, we presented participants with animate (e.g., horse) and inanimate (e.g., lamp) items. We expected a memory advantage for animate items compared with inanimate items, regardless of the cue to remember or forget each item, as the processing of the words prior to the cue to remember or forget should influence memorability even if learners attempt to forget it.

Experiment 1c – emotionality

Emotionally valenced words tend to be better remembered than neutral words (e.g., Buchanan et al., 2006; Doerksen & Shimamura, 2001; Kensinger & Corkin, 2003; Kleinsmith & Kaplan, 1963; LaBar & Phelps, 1998; Rubin & Friendly, 1986; see also Buchanan & Adolphs, 2002; Murphy & Isaacowitz, 2008). This effect may be attributable to increased semantic relatedness of emotional words (Talmi & Moscovitch, 2004) or to increased arousal resulting from the emotional stimuli (Bradley et al., 1992; Kensinger & Corkin, 2004). Prior work has yielded mixed findings on the effects of emotional valence on item-method directed forgetting (e.g., Bailey & Chapman, 2012; Brandt et al., 2013), and in Experiment 1c, we aimed to elucidate how emotional valence affects remembering and forgetting. When presented with negative (e.g., murder) and neutral (e.g., cloth) to-be-remembered and to-be-forgotten words, we expected a recall advantage for negative words compared with neutral words.

Experiment 1d – concreteness

Concreteness is another word characteristic that has been shown to affect memory. Specifically, highly concrete words tend to be better remembered than words low in concreteness (Paivio, 1966, 1971, 2013; see also Begg et al., 1989; Hertzog et al., 2003; Schwanenflugel et al., 1988). For example, highly concrete words (e.g., chair) are theorised to activate perceptual memory more than abstract words (e.g., hope) and are subsequently easier to remember (e.g., Begg et al., 1989; Hertzog et al., 2003; Tauber & Rhodes, 2012). Thus, the more concrete a word is, the easier it may be to utilise effective encoding strategies such as imagery, sentence generation, and grouping (see Hertzog et al., 1998; Richardson, 1998; Unsworth, 2016) leading to better performance on a later memory test. In Experiment 1d, we presented participants with highly concrete and less concrete words. In addition to a memory advantage for concrete to-be-remembered words, we expected highly concrete to-be-forgotten words to be more likely to be remembered, even if cued to forget, than to-be-forgotten words low in concreteness such that highly concrete words will be more frequently recalled compared with less concrete words.

Experiment 1e – frequency

Word frequency can also influence memory (see Popov & Reder, in press for a review). For example, research suggests that highly frequent words (e.g., apple) are better recalled than less frequent words (e.g., aardvark; Hall, 1954; McDaniel & Bugg, 2008), but only when manipulated between-subjects and using a pure list manipulation (Bousfield & Cohen, 1955; Shepard, 1967; Underwood et al., 1965). As such, in a within-subject or mixed list design, word frequency has little effect on recall (e.g., Duncan, 1974; Gregg, 1976; see also MacLeod & Kampe, 1996; but see Mendes et al., 2020, 2021). In contrast to recall tests, on recognition tests, less frequent words are better recognised than more frequent words (Benjamin, 2003; Coane et al., 2011; DeCarlo, 2007; Glanzer & Adams, 1985, 1990; Glanzer & Bowles, 1976; Gorman, 1961; Schwartz & Rouse, 1961; Shepard, 1967) whether tested via yes-no recognition (e.g., Balota & Neely, 1980) or forced-choice recognition (e.g., Glanzer & Bowles, 1976). Thus, word frequency can affect the memorability of studied words, although this may depend on how participants are tested.

In Experiment 1e, we examined how word frequency affects memory for to-be-remembered and to-be-forgotten words. However, rather than a within-subject, mixed list design (as in Experiments 1a-d), we opted to use a between-subjects, pure list design since prior work suggests that word frequency effects do not arise in within-subject or mixed list designs (e.g., Duncan, 1974; Gregg, 1976). Specifically, participants completed an item-method directed forgetting task containing either only low- or high-frequency words. Although the directed forgetting effect may be greater for low-frequency items than for high-frequency items (see Sahakyan et al., 2013), we expected to-be-forgotten words high in frequency to be better recalled than less frequent to-be-forgotten words.

Experiment 1f – length

The last word characteristic that we investigated was word length. Word length has been shown to affect memorability such that shorter words are better remembered than long words (i.e., the word length effect; see Baddeley et al., 1975; see also Barton et al., 2014; New et al., 2006). However, the word length effect also depends on whether a pure- or mixed-list design is used. Specifically, Hulme et al. (2004) demonstrated that in pure lists, short words are better remembered than long words, but short and long words were similarly recalled in mixed lists (see also Jalbert, Neath, Bireta, et al., 2011). The word length effect is often attributed to the increased complexity of longer items (see Neath & Nairne, 1995) and longer rehearsal time for longer words (Baddeley, 1986; Burgess & Hitch, 1999; Page & Norris, 1998). Additionally, the word length effect may be attributable to orthographic and phonological neighbourhood size (i.e., words with larger neighbourhoods are better recalled than words with small neighbourhoods; see Jalbert, Neath, Bireta, et al., 2011; Jalbert, Neath, and Surprenant, 2011). Regardless of the mechanism, it remains unclear how word length influences the ability to intentionally forget certain words. In Experiment 1f, we presented participants with short (e.g., disc) and long (e.g., depression) words that were also high or low in orthographic and phonological neighbourhood size, respectively. Similar to Experiment 1e, we opted to use a between-subjects, pure-list manipulation since the word length effect is strongest in pure lists (e.g., Hulme et al., 2004). We expected a recall advantage for short words compared with long words whether instructed to remember or forget them.

General method

Participants

The number of participants (after exclusions), their demographic information, and the number of exclusions in each experiment can be seen in Table 1. Participants were

Table 1. Descriptive statistics for the participants in each experiment.

	n	M_{age}	SD_{age}	Number of exclusions
Experiment 1a	100	20.40	2.59	1
Experiment 1b	101	20.28	2.43	1
Experiment 1c	100	20.50	3.00	1
Experiment 1d	105	20.71	2.44	0
Experiment 1e	216	20.19	1.82	3
Experiment 1f	210	20.43	2.64	3

recruited from the University of California Los Angeles Human Subjects Pool. Participants in each experiment were tested online (participants received a study link and then completed the study on their own) and received course credit for their participation. Participants were excluded from analysis (we used the same exclusion criteria in each experiment) if they admitted to cheating (e.g., writing down answers) in a post-task questionnaire (they were told they would still receive credit if they cheated). Per our preregistration, in each experiment, in Experiments 1a-d, we aimed to collect around 100 participants. The sample size was selected based on prior exploratory research and the expectation of detecting a medium effect size. Additionally, a power analysis indicated that for a 2 × 2 repeated-measures ANOVA, assuming a medium correlation (r = .50) between repeated measures, alpha = .05, power = .80, 100 participants would be needed to reliably detect a small effect size (η_p^2 = .02). In Experiments 1e and 1f, we aimed to collect around 200 participants. A power analysis indicated that for a 2 × 2 mixed ANOVA, assuming a medium correlation (r = .50) between repeated measures, alpha = .05, power = .80, 194 participants would be needed to reliably detect a small effect size (η_p^2 = .03).

Materials

In each experiment, words were matched to vary in item characteristics. Specifically, animacy scores[1] (with greater scores indicating the item is more animate), emotional valence (with lower values indicating more negatively valence and higher values indicating more positive valence), concreteness (with lower values indicating lower concreteness and higher values indicating higher concreteness), log-transformed Hyperspace Analogue to Language (log-HAL) frequency (with lower values indicating lower frequency in the English language and higher values indicating higher frequency), mean word length (number of letters) as well as orthographic and phonographic neighbourhood size for the words used in each experiment are shown in Table 2. Words were classified according to the English Lexicon Project website (Balota et al., 2007). Additionally, p-values resulting from

Table 2. Descriptive statistics as well as p-values from independent samples t-tests comparing the characteristics of each word set for the words used in each experiment.

	Animacy	Emotional Valence	Concreteness	Frequency	Length	Orthographic neighbourhood size	Phonographic neighbourhood size
Experiment 1a – Small Words	–	5.43	4.42	9.04	4.78	–	–
Experiment 1a – Large Words	–	5.27	4.36	9.18	4.68	–	–
Experiment 1a – p-value of difference	–	.485	.723	.680	.605	–	–
Experiment 1b – Inanimate Words	518.28	5.80	4.83	8.15	5.00	–	–
Experiment 1b – Animate Words	1626.28	5.79	4.86	8.05	4.98	–	–
Experiment 1b – p-value of difference	<.001	.929	.700	.491	.888	–	–
Experiment 1c – Neutral Words	–	4.59	7.98	4.01	5.00	–	–
Experiment 1c – Negative Words	–	2.34	7.93	3.93	5.10	–	–
Experiment 1c – p-value of difference	–	<.001	.895	.687	.591	–	–
Experiment 1d – Low Concreteness Words	–	5.66	2.67	10.05	4.95	–	–
Experiment 1d – High Concreteness Words	–	5.74	4.61	9.99	4.93	–	–
Experiment 1d – p-value of difference	–	.760	<.001	.794	.904	–	–
Experiment 1e – Low Frequency Words	–	5.40	4.50	7.81	4.85	–	–
Experiment 1e – High Frequency Words	–	5.43	4.47	10.00	4.81	–	–
Experiment 1e – p-value of difference	–	.886	.732	<.001	.783	–	–
Experiment 1f – Short Words	–	5.25	4.15	8.04	3.54	14.96	25.48
Experiment 1f – Long Words	–	5.22	4.11	8.05	9.13	.24	.28
Experiment 1f – p-value of difference	–	.824	.728	.952	<.001	<.001	<.001

independent samples *t*-tests comparing the characteristics of each word set are also shown in Table 2.

Procedure

Participants were informed that they would be presented with a list of words for a later test but that they only needed to remember some of them. Specifically, after each word was presented, a cue indicated whether the participant should try to remember the word (RRRR) or try to forget the word (FFFF). Participants were presented with a total of 40 words and each word was preceded by a 1 s fixation cross, then appeared on the screen, one at a time, in random order, for 5 s followed by the cue for an additional 3 s. For each participant, half of the words were randomly designated as to-be-remembered words and half were designated as to-be-forgotten words.

In Experiment 1a, half of the words were presented in a large (48 point) font, and half were presented in a small (12 point) font (see Murphy et al., 2021; Rhodes & Castel, 2008 for work using similar font sizes). In all subsequent experiments, all words were presented in regular font (30 point). In Experiment 1b, half of the words were animate and half were inanimate. In Experiment 1c, half the words were negatively valenced and half were neutral. In Experiment 1d, half of the words were highly concrete and half of the words were low in concreteness. In Experiment 1e, we utilised a between-subjects, pure list design where participants completed an item-method directed forgetting task similar to Experiments 1a-d. Participants were randomly assigned to a condition using either just low-frequency words ($n = 108$) or just high-frequency words ($n = 108$). Finally, in Experiment 1f, we again utilised a between-subjects, pure list design where participants were randomly assigned to a condition using either just short words ($n = 104$) or just long words ($n = 106$).

In all experiments, the cue indicating whether participants should try to remember or forget the word was presented in a neutral size (30 point) font. After the presentation of all 40 words, participants were given an immediate 3 min free recall test in which they were asked to recall *all* of the words from the just-presented list. Following the recall test, participants completed a surprise recognition test; participants were shown the words from the just-presented list (in 30 point font) as well as 40 lures (in random order) and asked to indicate whether each item was on the list of presented items. Participants also indicated their confidence in their responses on a scale from 0 to 100 (with 0 being not at all confident and 100 being very confident) and were given as much time as they needed for this portion of the task. Since the recall test precedes the recognition test, there may be carryover effects (i.e., the free recall test should strengthen the recalled items, which should subsequently produce greater recognition and confidence for those items). Thus, we do not report analyses of the recognition test (but these analyses generally reflected the same trends as the recall test). Both the recall and recognition data can be accessed on OSF.

Results

Descriptive statistics in each experiment are shown in Table 3. Recall performance as a function of cue and each stimulus characteristic (as a categorical variable) is shown in Figures 1, 2, 4, 6, 8, and 10. Additionally, the probability of recall as a function of cue and each stimulus characteristic (as a continuous variable) is shown in Figures 3, 5, 7, 9, and 11. In Experiments 1a-d, we conducted 2 (cue: remember, forget) × 2 (stimulus type) repeated-measures ANOVAs on recall performance.[2] In Experiments 1e and 1f, we conducted 2 (cue: remember, forget) × 2 (stimulus type) mixed ANOVAs on recall performance. These results can be seen in Table 4. To examine the strength of the evidence for each effect, we also computed a Bayes Factor (a ratio of the marginal likelihood of the null model and a model suggesting group differences) compared to a null model using JASP (Love et al., 2019). We provide BF_{01} when inferential statistics favour the null hypothesis (which would be supported by a large BF_{01}) and BF_{10} when inferential statistics favour the alternative hypothesis (which would be supported by a large BF_{10}; for more information on interpreting Bayes factors, see Kass & Raftery, 1995).

To further elucidate how stimulus characteristics influence remembering and forgetting, we also examined animacy, emotional valence, concreteness, frequency, and length as continuous variables. To determine whether these stimulus characteristics (examined as a continuous variable) predict recall, we computed multilevel models (MLMs) whereby we treated the data as hierarchical or clustered (i.e., multilevel) with items nested within individual participants. Since recall at the item level was binary (correct or incorrect), we conducted logistic MLMs to examine memory. In these analyses, the regression coefficients are given as logit units (i.e., the log odds of correct recall). We report exponential betas (e^B), and their 95% confidence intervals, which give the coefficient as an odds ratio (i.e., the odds of correct recall divided by the odds of not recalling a word).

Table 3. Means and standard deviations (in parentheses) for recall as a function of cue in each experiment.

	FFFF recall	RRRR recall
Experiment 1a – Small words	.11 (.12)	.51 (.24)
Experiment 1a – Large words	.12 (.14)	.53 (.24)
Experiment 1b – Inanimate words	.12 (.15)	.51 (.25)
Experiment 1b – Animate words	.17 (.19)	.58 (.27)
Experiment 1c – Neutral words	.12 (.15)	.43 (.23)
Experiment 1c – Negative words	.14 (.14)	.47 (.24)
Experiment 1d – Low concreteness words	.10 (.13)	.51 (.27)
Experiment 1d – High concreteness words	.21 (.19)	.59 (.27)
Experiment 1e – Low frequency words	.10 (.11)	.51 (.24)
Experiment 1e – High frequency words	.15 (.15)	.58 (.24)
Experiment 1f – Short words	.12 (.09)	.45 (.22)
Experiment 1f – Long words	.09 (.10)	.42 (.22)

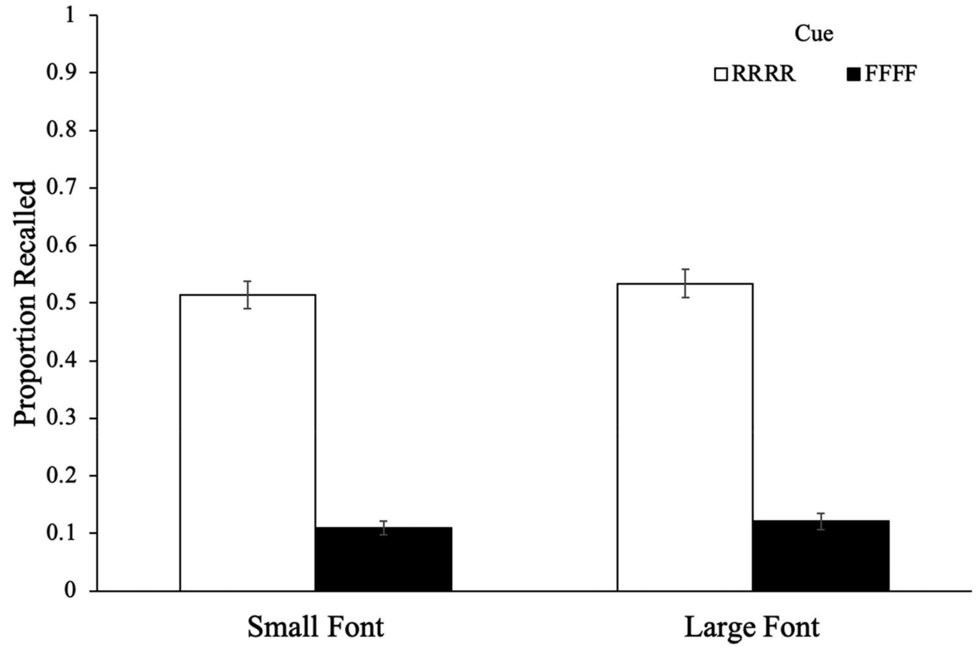

Figure 1. Recall performance as a function of font size and cue in Experiment 1a. Error bars reflect the standard error of the mean.

Thus, e^B can be interpreted as the extent to which the odds of recalling a word changed. Specifically, values greater than 1 represent an increased likelihood of recall while values less than 1 represent a decreased likelihood of recall. Since we manipulated frequency and length between subjects, we did not use MLMs with items nested within individual participants. Rather, we used a general linear model (still at the item level) with recall accuracy predicted by frequency/length and cue. These results are summarised in Table 5.

In these analyses, we did not include any random slopes, only random intercepts (allowing the intercept to vary for each participant). We only allowed for random intercepts across participants since we expected participants to vary in performance and how they interpreted items, but we did not expect the words to vary. This approach allows us to account for individual differences across participants; we did not want to account for the variance between words as that is the effect that we were interested in. While we acknowledge that these models

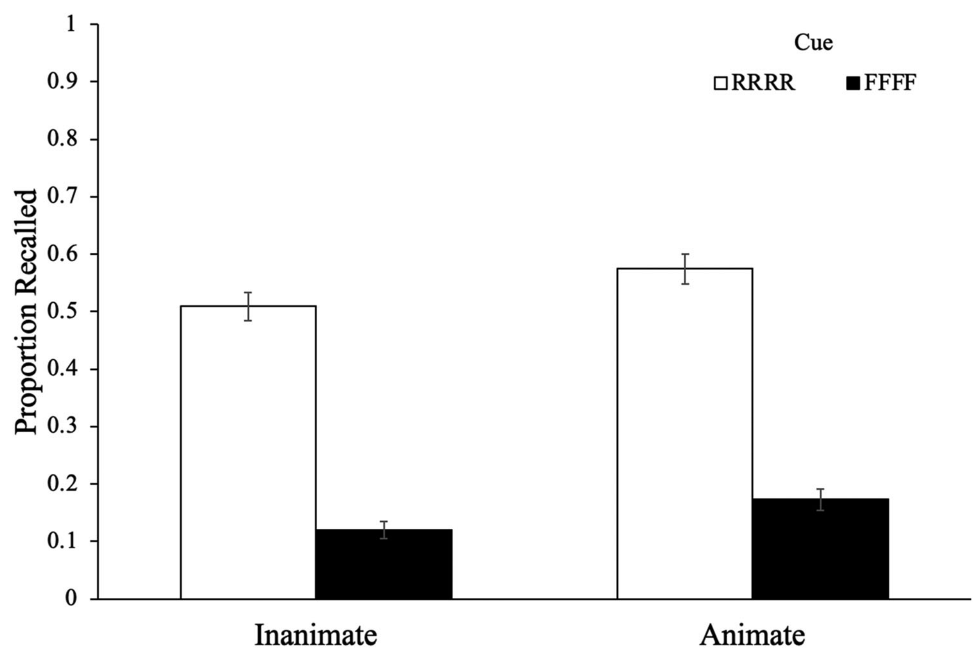

Figure 2. Recall performance as a function of animacy and cue in Experiment 1b. Error bars reflect the standard error of the mean.

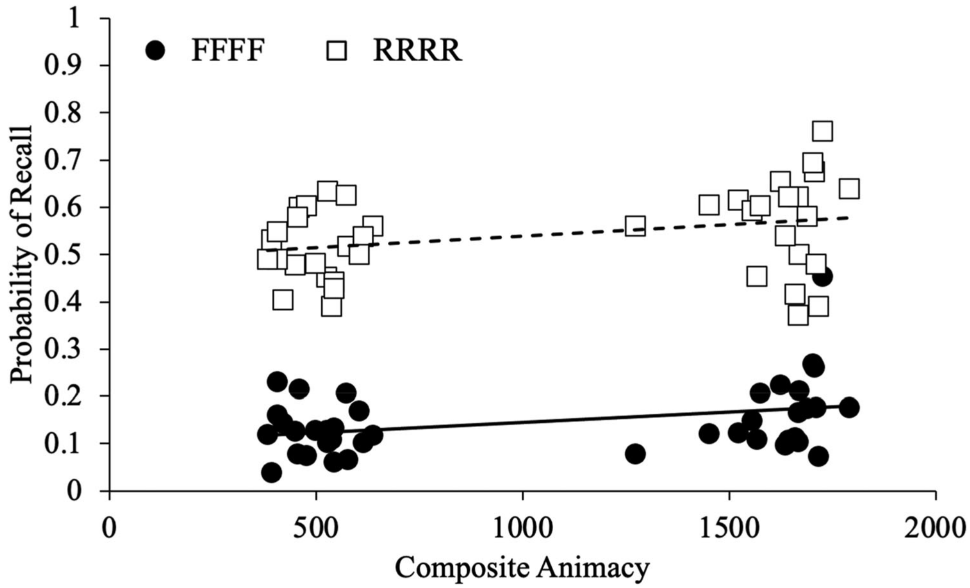

Figure 3. Probability of recall as a function of cue and animacy with regression lines in Experiment 1b.

are not independent of the ANOVAs, they serve as a way of verifying that the results do not change under different assumptions.

In each experiment, we observed a directed forgetting effect such that words cued as to-be-remembered were better recalled than words cued as to-be-forgotten. Additionally, in our categorical analyses, there was a recall advantage for words high in animacy, negatively valenced words, highly concrete words, and high-frequency words (although Bayes Factor provided equivocal evidence for the effect of animacy, emotional valence, and frequency). However, font size and length did not significantly predict memory. In these analyses, there were no significant interactions between cue and stimulus type. These results were generally corroborated in our continuous analyses. However, there was a significant effect of length such that shorter words were better recalled than longer words. Additionally, we observed an interaction between cue and word concreteness. Specifically, an analysis of the simple effects revealed that concreteness was a better predictor of recall for to-be-forgotten words [$e^B = 1.38$, $CI_{95\%} = 1.23–1.56$, $z = 5.24$, $p < .001$] than to-be-

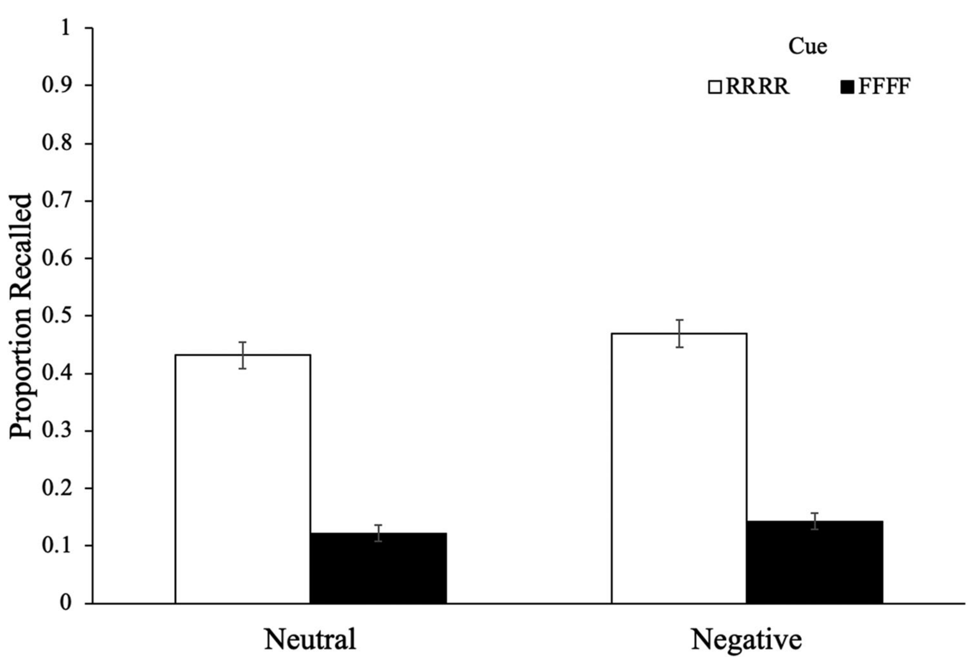

Figure 4. Recall performance as a function of emotionality and cue in Experiment 1c. Error bars reflect the standard error of the mean.

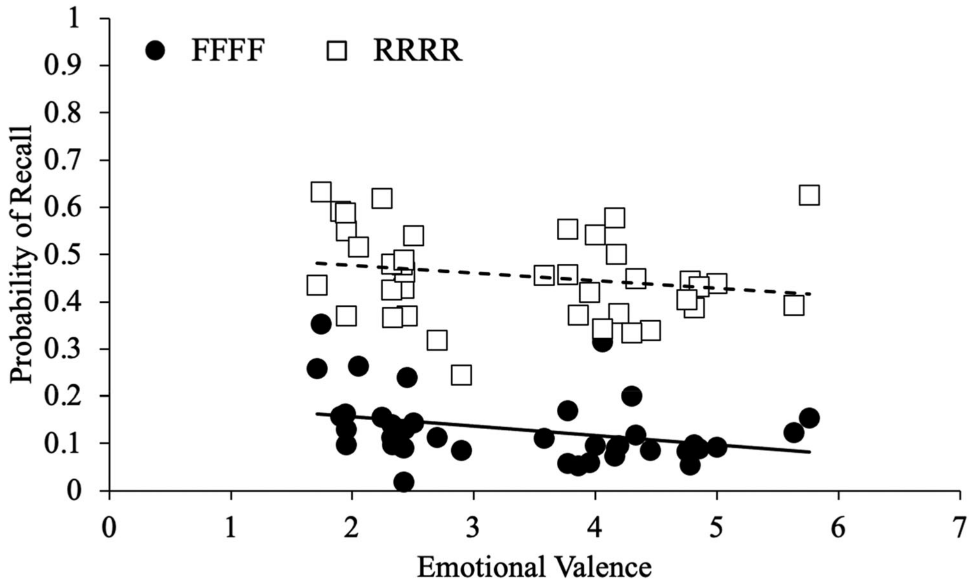

Figure 5. Probability of recall as a function of cue and emotional valence with regression lines in Experiment 1c.

remembered words [$e^B = 1.14$, $CI_{95\%} = 1.05–1.24$, $z = 3.03$, $p = .002$].

General discussion

We are sometimes presented with information that we need to forget. For example, in the courtroom, juries are sometimes told to forget what they heard if a judge determines that some information was presented unlawfully. In the lab, previous work using directed forgetting tasks has revealed that participants are generally able to implement top-down control mechanisms to successfully recall or recognise the information they are told to remember while simultaneously forgetting information they were told to forget (Basden & Basden, 1998; Bjork, 1998; MacLeod, 1998). However, it was previously unclear how the intrinsic qualities of this information affect learners' ability to selectively remember and intentionally forget information, and whether the same principles apply to encoding as well as to the wilful forgetting of target information.

In the current study, we presented participants with to-be-remembered and to-be-forgotten words that varied in font size, animacy, emotionality, concreteness, frequency,

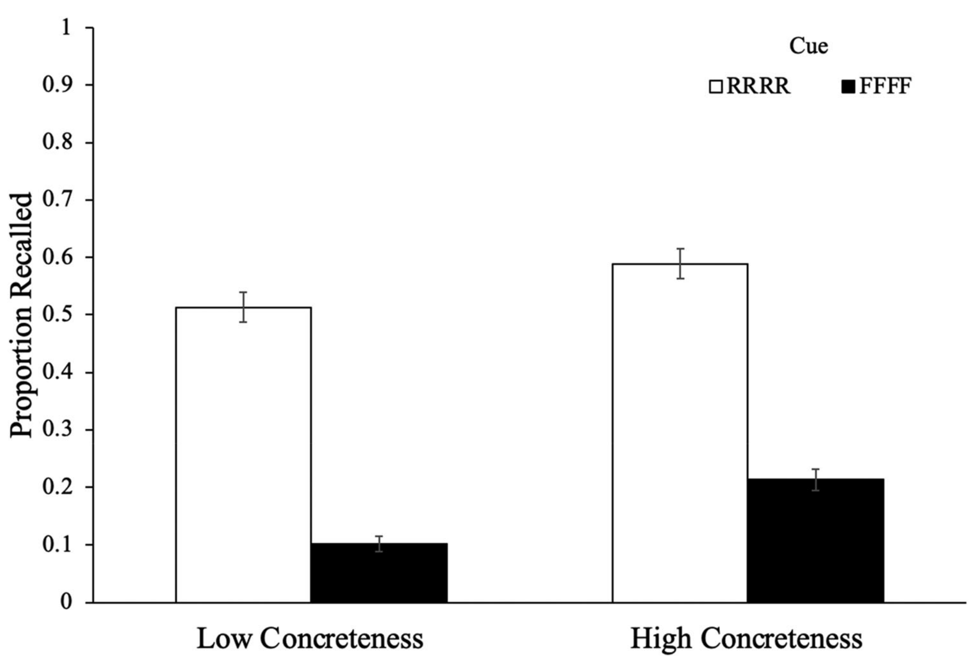

Figure 6. Recall performance as a function of concreteness and cue in Experiment 1d. Error bars reflect the standard error of the mean.

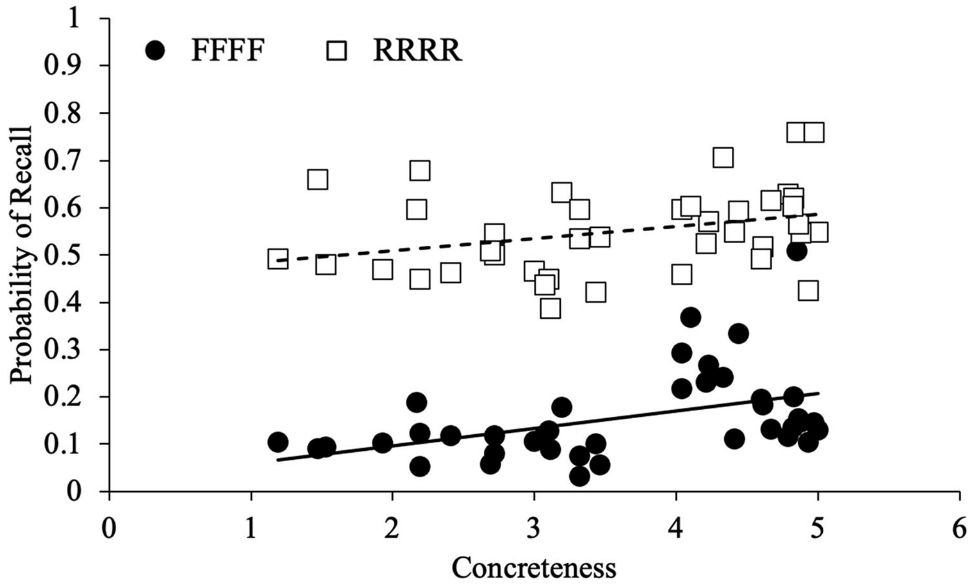

Figure 7. Probability of recall as a function of cue and concreteness with regression lines in Experiment 1d.

and length. Results revealed that participants were consistently sensitive to the cue to either remember or forget the word, regardless of the stimulus characteristics. In terms of font size, previous work suggests that the effect of font size (if any) is small (Chang & Brainerd, 2022; Luna et al., 2018) and in the current study, font size did not significantly influence learners' ability to remember or forget information, replicating prior work (see Foster & Sahakyan, 2012; Sahakyan & Foster, 2016 for discussion of volume and font size; see also Foster, 2012). Furthermore, consistent with prior work, animacy, emotionality, concreteness, frequency, and length all influenced memory (although the effect of length was only observed when analyzed as a continuous variable). Specifically, animate items, negatively valenced words, and highly concrete words were better recalled than inanimate items, neutral words, or words low in concreteness. Moreover, when analyzed as a continuous variable, concreteness interacted with cue such that concreteness had a greater impact on forgetting than remembering, potentially indicating that concreteness may influence some spontaneous imagery prior to the cue (as opposed to just rehearsal), although additional research that examines this issue in more detail is needed. In terms of frequency and length, highly frequent and

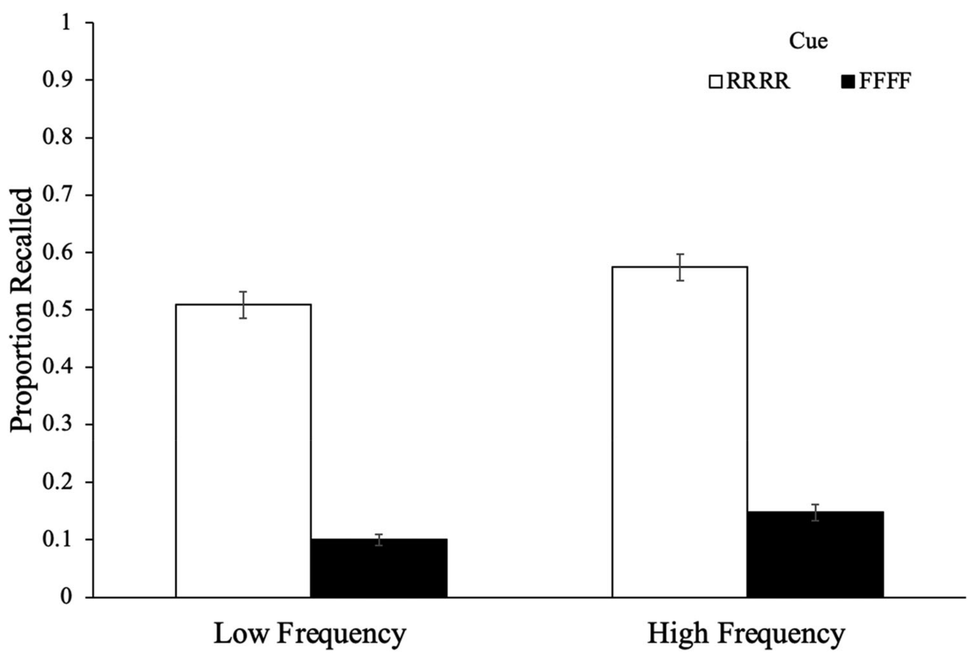

Figure 8. Recall performance as a function of frequency and cue in Experiment 1e. Error bars reflect the standard error of the mean.

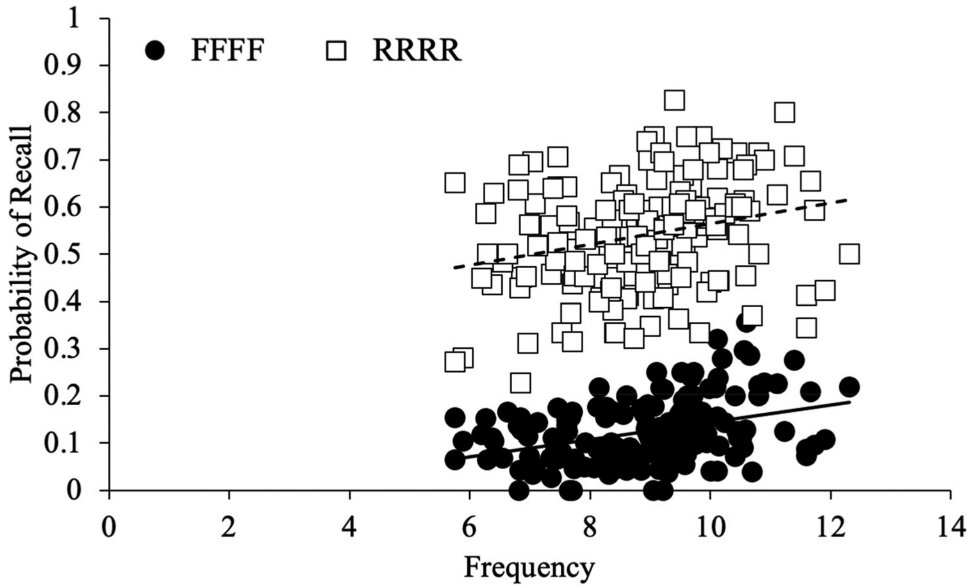

Figure 9. Probability of recall as a function of cue and frequency with regression lines in Experiment 1e.

short words were better recalled than low-frequency and long words. Critically, these effects persisted regardless of the cue to either remember or forget each word, indicating that many of the stimulus properties that influence the ability to remember goal-relevant information also impacts the ability to remember goal-irrelevant information.

The present study revealed that while some intrinsic qualities of a word can influence memory for to-be-remembered words, some of these qualities can also influence memory for to-be-forgotten information. Specifically, if presented with words high in animacy, emotional valence, concreteness, frequency, or with few letters, this information is more likely to be recalled even if forgetting is attempted. In an applied context, if you were to read a news headline that contained animate items, was highly negative, used concrete, frequent, or short words, and you were to find out that this headline came from an unreputable source and you should forget this information, it may be more difficult to forget than if the headline had included inanimate items, neutral words, less concrete, less frequent, or longer words. In

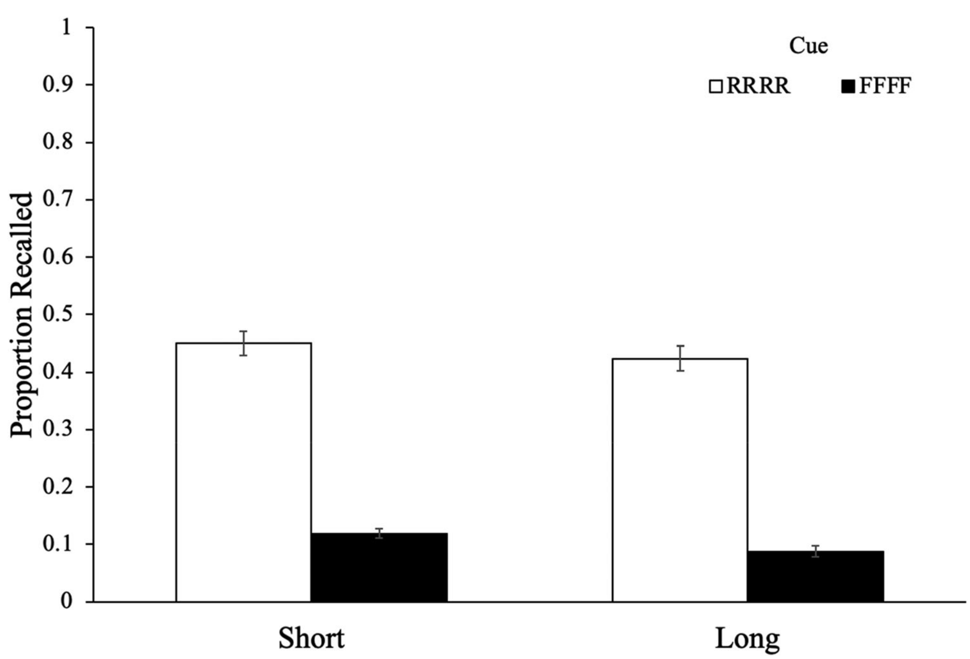

Figure 10. Recall performance as a function of length and cue in Experiment 1f. Error bars reflect the standard error of the mean.

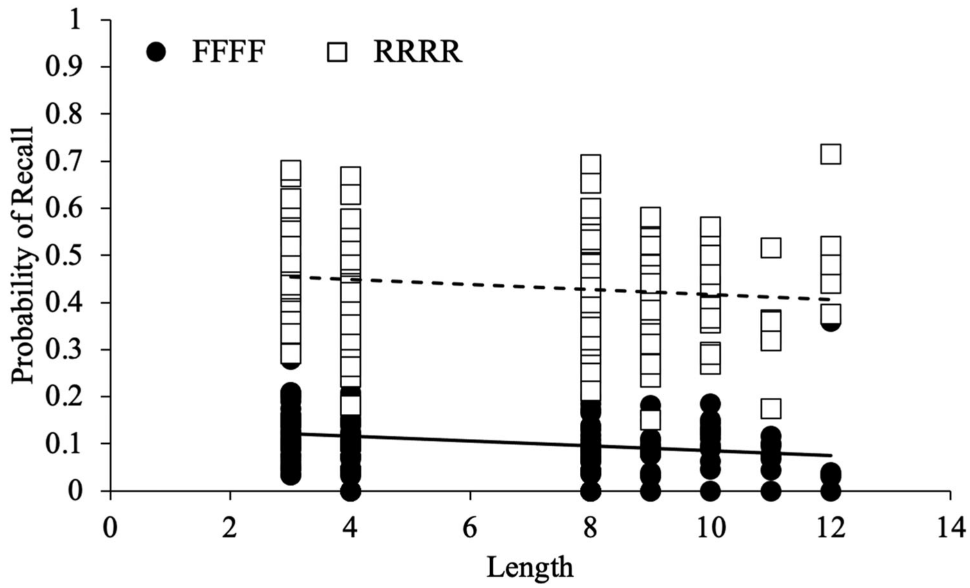

Figure 11. Probability of recall as a function of cue and word length with regression lines in Experiment 1f.

the present study, our demonstration that the fundamental aspects of remembering can manifest in one's ability to forget may shed light on how false or fabricated information can be difficult to forget and potentially later influence decision-making and beliefs, potentially contributing to misinformation effects (see Lewandowsky et al., 2005).

In terms of the mechanisms benefitting memory for each of these characteristics, compared to inanimate items, animate items may be more important to remember as these items are often prey, predators, or mates (see Nairne, 2016). Compared to neutral words, negatively valenced words may increase arousal leading to a memory benefit (Bradley et al., 1992; Kensinger & Corkin, 2004). Highly concrete words may activate perceptual memory more than abstract words (e.g., Begg et al., 1989; Hertzog et al., 2003; Tauber & Rhodes, 2012). Highly frequent words may be easier to encode as a result of more prior exposure and potential retrieval paths (Popov & Reder, in press). Finally, longer words may be more complex (see Neath & Nairne, 1995) and take longer to rehearse, leading to poorer recall (Baddeley, 1986; Burgess & Hitch, 1999; Page & Norris, 1998); however, the results of Experiment 1f are more consistent with accounts suggesting that the word length effect arises

Table 4. Results of 2 (cue: remember, forget) × 2 (stimulus type) ANOVAs in each experiment.

	Effect of Cue	Effect of Stimuli	Interaction
Experiment 1a	$F(1, 99) = 288.24$, $p < .001$, $\eta_p^2 = .74$, $BF_{10} > 100$	$F(1, 99) = 1.16$, $p = .284$, $\eta_p^2 = .01$, $BF_{01} = 7.82$	$F(1, 99) = .16$, $p = .694$, $\eta_p^2 < .01$, $BF_{01} > 100$
Experiment 1b	$F(1, 100) = 233.93$, $p < .001$, $\eta_p^2 = .70$, $BF_{10} > 100$	$F(1, 100) = 24.57$, $p < .001$, $\eta_p^2 = .20$, $BF_{10} = 1.02$	$F(1, 100) = .27$, $p = .604$, $\eta_p^2 < .01$, $BF_{01} = 6.15$
Experiment 1c	$F(1, 99) = 225.09$, $p < .001$, $\eta_p^2 = .70$, $BF_{10} > 100$	$F(1, 99) = 5.63$, $p = .020$, $\eta_p^2 = .05$, $BF_{10} = .25$	$F(1, 99) = .41$, $p = .522$, $\eta_p^2 < .01$, $BF_{01} = 5.47$
Experiment 1d	$F(1, 104) = 279.10$, $p < .001$, $\eta_p^2 = .73$, $BF_{10} > 100$	$F(1, 104) = 60.53$, $p < .001$, $\eta_p^2 = .37$, $BF_{10} = 33.37$	$F(1, 104) = 2.33$, $p = .130$, $\eta_p^2 = .02$, $BF_{01} = 4.19$
Experiment 1e	$F(1, 214) = 649.76$, $p < .001$, $\eta_p^2 = .75$, $BF_{10} > 100$	$F(1, 214) = 8.07$, $p = .005$, $\eta_p^2 = .04$, $BF_{10} = .75$	$F(1, 214) = .34$, $p = .563$, $\eta_p^2 < .01$, $BF_{01} = 5.91$
Experiment 1f	$F(1, 208) = 476.20$, $p < .001$, $\eta_p^2 = .70$, $BF_{10} > 100$	$F(1, 208) = 2.57$, $p = .110$, $\eta_p^2 = .01$, $BF_{01} = 4.68$	$F(1, 208) = .03$, $p = .869$, $\eta_p^2 < .01$, $BF_{01} = 6.67$

Table 5. Results of models with cue and stimulus characteristics (as a continuous variable) predicting recall in each experiment.

	Effect of cue	Effect of stimuli	Interaction
Experiment 1a	–	–	–
Experiment 1b	eB = 1.00, CI: 1.00–1.00, $z = 4.35$, $p < .001$	eB = 8.95, CI: 7.57–10.59, $z = 25.57$, $p < .001$	eB = 1.00, CI: 1.00–1.00, $z = -1.01$, $p = .314$
Experiment 1c	eB = .89, CI: .83 – .95, $z = -3.29$, $p < .001$	eB = 6.35, CI: 5.37–7.50, $z = 21.71$, $p < .001$	eB = 1.04, CI: .90–1.20, $z = .53$, $p = .594$
Experiment 1d	eB = 1.26, CI: 1.17–1.35, $z = 6.06$, $p < .001$	eB = 9.02, CI: 7.65–10.65, $z = 26.06$, $p < .001$	eB = .82, CI: .71 – .95, $z = -2.61$, $p = .009$
Experiment 1e	$\beta = .06$, $t = 6.02$, $p < .001$	$\beta = .89$, $t = 46.04$, $p < .001$	$\beta = .01$, $t = .56$, $p = .576$
Experiment 1f	$\beta = -.04$, $t = -3.47$, $p < .001$	$\beta = .75$, $t = 37.19$, $p < .001$	$\beta = -.00$, $t = -.14$, $p = .892$

from differences in orthographic set size, not rehearsal (Jalbert, Neath, Bireta, et al., 2011; Jalbert, Neath, & Surprenant, 2011). Specifically, assuming differential rehearsal of to-be-remembered and to-be-forgotten words accounts for the item-method directed forgetting effect, word length and cue should not interact if the word length effect is attributable to orthographic neighbourhood size (and there were no significant differences in orthographic neighbourhood size between to-be-remembered and to-be-forgotten words). In sum, stimulus characteristics influencing remembering and forgetting in the present study may be consistent with selective rehearsal accounts of directed forgetting such that each word receives some processing and encoding prior to the cue to remember or forget the word, with these mechanisms contributing to memorability for both to-be-remembered and to-be-forgotten words; however, more work directly examining rehearsal processes may be needed to attribute these findings to selective rehearsal.

Previous work using item-method directed forgetting tasks has suggested that directed forgetting effects largely result from selective encoding (Bjork, 1972; MacLeod, 1975; Sheard & MacLeod, 2005; Tan et al., 2020) such that participants selectively rehearse to-be-remembered information while ceasing rehearsal for to-be-forgotten information. However, according to selective rehearsal models, the to-be-forgotten information still receives some rehearsal/encoding. Therefore, to-be-forgotten information should be subject to the same fundamental properties influencing memory as to-be-remembered words (but with a weaker memory trace, see Thompson et al., 2011) due to the rehearsal and subsequent encoding of information before the cue to remember or forget the word.

Although to-be-forgotten words may be less rehearsed than to-be-remembered words, leading to stimulus characteristics still affecting memory for these words, some prior work has argued for distinct processes occurring during forget trials that are not observed during remember trials, particularly involving incidental forgetting versus successful intentional forgetting (Rizio & Dennis, 2013). Therefore, successful intentional forgetting may be a more complex process than simply less rehearsal and the factors that affect to-be-remembered words should not necessarily similarly affect to-be-forgotten words. However, the present results did not reveal interactions between stimulus properties and directed forgetting (except for a small effect with concreteness), suggesting that generally, remembering and forgetting are not differentially impacted by stimulus properties.

The results of the current study are also consistent with the cognitive load hypothesis of directed forgetting (Lee, 2012; Lee & Lee, 2011). The cognitive load hypothesis suggests that increased cognitive load reduces the unwanted processing of to-be-forgotten words, enhancing the directed forgetting effect. Thus, this theory suggests that in the absence of a secondary task during encoding, to-be-remembered and to-be-forgotten items are being processed similarly. For example, Taylor and Ivanoff (2021) manipulated the perceptual quality of presented words in an item-method directed forgetting task but the perceptual quality of the words did not impact the directed forgetting effect. In the present study, there was not a secondary task during encoding, likely resulting in to-be-forgotten words receiving some unwanted processing. As such, each word's characteristics similarly influenced memory regardless of the cue to remember or forget it, providing further evidence that the remembering and forgetting processes are governed by similar properties and supporting both the cognitive load and selective rehearsal accounts of directed forgetting; additional research using a secondary task could better differentiate between these two accounts.

While we focus on the selective rehearsal mechanisms, there are likely also effortful or active forgetting mechanisms that guide directed forgetting which could influence how attentional resources are withdrawn from to-be-forgotten information to limit unwanted processing (see Anderson & Hulbert, 2021). These effortful or strategic forgetting processes may also be influenced by similar stimulus characteristics that could allow for the optimal memory of goal-relevant information (see MacLeod, 1998; Murphy et al., 2022; Murphy & Castel, 2021). However, further research is needed to understand how effortful forgetting is influenced by guiding attention in goal-directed memory, as well as the degree to which people may be aware (i.e., metacognition) of how these stimulus characteristics could influence directed forgetting (Friedman & Castel, 2011).

Although we employed an item-method directed forgetting paradigm to investigate how intrinsic qualities of words influence remembering and forgetting, future work should investigate remembering and forgetting of similar words in other methods of directed forgetting. For example, in the list method of directed forgetting, the intrinsic qualities of to-be-remembered and to-be-forgotten information may affect memory differently since the directed forgetting effect may be attributable to inhibition (Basden et al., 1993; Basden & Basden, 1998; Bäuml et al., 2020; Bjork, 1989; Geiselman et al., 1983; Geiselman & Bagheri, 1985; Weiner & Reed, 1969; see Sahakyan et al., 2013 for a review) or changes in context (Sahakyan, 2004; Sahakyan et al., 2008; Sahakyan & Kelley, 2002) rather than selective encoding. Furthermore, future research could employ a point value manipulation of directed forgetting (see Castel et al., 2007) to further elucidate how manipulating the intrinsic qualities of words, as well as the value of to-be-remembered and to-be-forgotten information, influences remembering and forgetting. Specifically, although animacy, emotionality, concreteness, frequency, and length can influence remembering and forgetting, the effects of value on remembering (see Knowlton & Castel, 2021; Madan, 2017) may reduce this effect as learners tend to prioritise value over other cues (e.g., Murphy et al., 2021). Additionally, the effects of these variables may be different if the cue is presented during or before the word is presented, as that may then guide more goal-driven processes to ignore to-be-forgotten words, and this may be more difficult for words that are influenced by variables that may be more difficult to ignore.

While we believe that the effects of word characteristics on item-method directed forgetting are largely driven by selective encoding processes, future work could examine whether the impact of stimulus properties differentially affects words as a function of the amount of rehearsal dedicated to each word. For example, future research could compare the present findings to a procedure in which some words are more rehearsed than others such as providing participants more study time for some words or a procedure that includes changing one's mental context or encourages mind wandering on a subset of the trials.

In sum, the present study revealed that while certain characteristics of presented information influence remembering, they generally do not impact directed forgetting. Specifically, animacy, emotionality, concreteness, frequency, and length predicted recall for both to-be-remembered and to-be-forgotten words, but font size did not significantly predict recall. The present work shows how intrinsic qualities of information can influence learners' ability to both selectively remember and as well as intentionally forget information, suggesting that similar principles may apply to encoding as well as the wilful forgetting of target information, which may have important implications for clinical treatments and consumer behaviour. For example, consumers may need to be wary of certain stimulus characteristics, as when given information turns out to be from an unreputable source, fabricated, or false, this information may be more difficult to forget and could subsequently influence beliefs and decision making. In contrast, if the goal is to enhance memory for information, important information should be presented using animate items, emotionally valenced, concrete, highly frequent, and short terminology. Given the results from the present work, these may be useful future directions to examine in an applied context.

Notes

1. Animate items consisted of various animals while inanimate items included clothing, furniture, instruments, and tools. Stimuli were taken from VanArsdall and Blunt (2021); they provided scores for each word in terms of being alive, the ability to think, and the ability to move and we calculated a composite score for each word and these values were used to create the word lists.
2. In addition to subject-level analyses, we also computed item-analyses in each experiment. Although not reported in the present manuscript, these results generally corroborated the subject-level analyses.

Acknowledgments

We would like to thank Lily Kiamanesh for assistance generating stimuli and Yuning Chen for assistance preparing the data sets. We also thank Mary Whatley for helpful comments regarding the analyses and Catherine Sandhofer for her helpful comments regarding the manuscript.

Disclosure statement

No potential conflict of interest was reported by the author(s).

ORCID

Dillon H. Murphy http://orcid.org/0000-0002-5604-3494
Alan D. Castel http://orcid.org/0000-0003-1965-8227

References

Anderson, M. C., & Hanslmayr, S. (2014). Neural mechanisms of motivated forgetting. *Trends in Cognitive Sciences*, *18*(6), 279–292. https://doi.org/10.1016/j.tics.2014.03.002

Anderson, M. C., & Hulbert, J. C. (2021). Active forgetting: Adaptation of memory by prefrontal control. *Annual Review of Psychology*, *72* (1), 1–36. https://doi.org/10.1146/annurev-psych-072720-094140

Baddeley, A. D. (1986). *Working memory*. Oxford University Press.

Baddeley, A. D., Thomson, N., & Buchanan, M. (1975). Word length and the structure of short-term memory. *Journal of Verbal Learning and Verbal Behavior*, *14*(6), 575–589. https://doi.org/10.1016/S0022-5371(75)80045-4

Bailey, K., & Chapman, P. (2012). When can we choose to forget? An ERP study into item-method directed forgetting of emotional words. *Brain and Cognition*, *78*(2), 133–147. https://doi.org/10.1016/j.bandc.2011.11.004

Balota, D. A., & Neely, J. H. (1980). Test-expectancy and word-frequency effects in recall and recognition. *Journal of Experimental Psychology: Human Learning and Memory*, *6*(5), 576–587. https://doi.org/10.1037/0278-7393.6.5.576

Balota, D. A., Yap, M. J., Cortese, M. J., Hutchison, K. A., Kessler, B., Loftis, B., Neely, J. H., Nelson, D. L., Simpson, G. B., & Treiman, R. (2007). The English lexicon project. *Behavior Research Methods*, *39*(3), 445–459. https://doi.org/10.3758/BF03193014

Barton, J. J., Hanif, H. M., Eklinder Björnström, L., & Hills, C. (2014). The word-length effect in reading: A review. *Cognitive Neuropsychology*, *31*(5-6), 378–412. https://doi.org/10.1080/02643294.2014.895314

Basden, B. H., & Basden, D. R. (1998). Directed forgetting: A contrast of methods and interpretations. In J. M. Golding & C. M. MacLeod (Eds.), *Intentional forgetting: Interdisciplinary approaches* (pp. 139–172). Lawrence Erlbaum Associates.

Basden, B. H., Basden, D. R., & Gargano, G. J. (1993). Directed forgetting in implicit and explicit memory tests: A comparison of methods. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *19*(3), 603–616. https://doi.org/10.1037/0278-7393.19.3.603

Basden, B. H., Basden, D. R., & Morales, E. (2003). The role of retrieval practice in directed forgetting. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *29*(3), 389–397. https://doi.org/10.1037/0278-7393.29.3.389

Bäuml, K. H. T., Abel, M., & Kliegl, O. (2020). Inhibitory processes in episodic memory. In M. Eysenck & D. Groome (Eds.), *Forgetting: Explaining memory failure* (pp. 125–146). Sage.

Begg, I., Duft, S., Lalonde, P., Melnick, R., & Sanvito, J. (1989). Memory predictions are based on ease of processing. *Journal of Memory and Language*, *28*(5), 610–632. https://doi.org/10.1016/0749-596X(89)90016-8

Benjamin, A. S. (2003). Predicting and postdicting the effects of word frequency on memory. *Memory & Cognition*, *31*(2), 297–305. https://doi.org/10.3758/BF03194388

Bjork, E. L., & Bjork, R. A. (1996). Continuing influences of to-be forgotten information. *Consciousness and Cognition*, *5*(1-2), 176–196. https://doi.org/10.1006/ccog.1996.0011

Bjork, R. A. (1970). Positive forgetting: The noninterference of items intentionally forgotten. *Journal of Verbal Learning and Verbal Behavior*, *9*(3), 255–268. https://doi.org/10.1016/S0022-5371(70)80059-7

Bjork, R. A. (1972). Theoretical implications of directed forgetting. In A. W. Melton & E. Martin (Eds.), *Coding processes in human memory* (pp. 217–235). Winston.

Bjork, R. A. (1989). Retrieval inhibition as an adaptive mechanism in human memory. In H. L. Roediger & F. I. M. Craik (Eds.), *Varieties of memory and consciousness: Essays in honour of endul tulving* (pp. 309–330). Erlbaum.

Bjork, R. A. (1998). Intentional forgetting in perspective: Comments, conjectures, and some directed remembering. In J. M. Golding & C. M. MacLeod (Eds.), *Intentional forgetting: Interdisciplinary approaches* (pp. 453–481). Lawrence Erlbaum Associates.

Bonin, P., Gelin, M., & Bugaiska, A. (2014). Animates are better remembered than inanimates: Further evidence from word and picture stimuli. *Memory & Cognition*, *42*(3), 370–382. https://doi.org/10.3758/s13421-013-0368-8

Bonin, P., Gelin, M., Laroche, B., Méot, A., & Bugaiska, A. (2015). The 'how' of animacy effects in episodic memory. *Experimental Psychology*, *62*(6), 371–384. https://doi.org/10.1027/1618-3169/a000308

Bousfield, W. A., & Cohen, B. H. (1955). The occurrence of clustering in the recall of randomly arranged words of different frequencies of usage. *The Journal of General Psychology*, *52*(1), 83–95. https://doi.org/10.1080/00221309.1955.9918346

Bradley, M. M., Greenwald, M. K., Petry, M. C., & Lang, P. J. (1992). Remembering pictures: Pleasure and arousal in memory. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *18*(2), 379–390. https://doi.org/10.1037/0278-7393.18.2.379

Brandt, K. R., Nielsen, M. K., & Holmes, A. (2013). Forgetting emotional and neutral words: An ERP study. *Brain Research*, *1501*, 21–31. https://doi.org/10.1016/j.brainres.2013.01.019

Buchanan, T. W., & Adolphs, R. (2002). The role of the human amygdala in emotional modulation of long-term declarative memory. In S. C. Moore & M. Oaksford (Eds.), *Emotional cognition: From brain to behaviour* (pp. 9–34). Amsterdam.

Buchanan, T. W., Etzel, J. A., Adolphs, R., & Tranel, D. (2006). The influence of autonomic arousal and semantic relatedness on memory for emotional words. *International Journal of Psychophysiology*, *61*(1), 26–33. https://doi.org/10.1016/j.ijpsycho.2005.10.022

Burgess, N., & Hitch, G. J. (1999). Memory for serial order: A network model of the phonological loop and its timing. *Psychological Review*, *106*(3), 551–581. https://doi.org/10.1037/0033-295X.106.3.551

Castel, A. D., Farb, N., & Craik, F. I. M. (2007). Memory for general and specific value information in younger and older adults: Measuring the limits of strategic control. *Memory & Cognition*, *35*(4), 689–700. https://doi.org/10.3758/BF03193307

Cepeda, N. J., Vul, E., Rohrer, D., Wixted, J. T., & Pashler, H. (2008). Spacing effects in learning: A temporal ridgeline of optimal retention. *Psychological Science*, *19*(11), 1095–1102. https://doi.org/10.1111/j.1467-9280.2008.02209.x

Chang, M., & Brainerd, C. J. (2022). Association and dissociation between judgments of learning and memory: A meta-analysis of the font size effect. *Metacognition and Learning*, 1–34. https://doi.org/10.1007/s11409-021-09287-3

Coane, J. H., Balota, D. A., Dolan, P. O., & Jacoby, L. L. (2011). Not all sources of familiarity are created equal: The case of word frequency and repetition in episodic recognition. *Memory & Cognition*, *39*(5), 791–805. https://doi.org/10.3758/s13421-010-0069-5

DeCarlo, L. T. (2007). The mirror effect and mixture signal detection theory. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *33*(1), 18–33. https://doi.org/10.1037/0278-7393.33.1.18

Delaney, P. F., Sahakyan, L., Kelley, C. M., & Zimmerman, C. A. (2010). Remembering to forget: The amnesic effect of daydreaming. *Psychological Science*, *21*(7), 1036–1042. https://doi.org/10.1177/0956797610374739

Doerksen, S., & Shimamura, A. P. (2001). Source memory enhancement for emotional words. *Emotion*, *1*(1), 5–11. https://doi.org/10.1037/1528-3542.1.1.5

Duncan, C. P. (1974). Retrieval of low-frequency words from mixed lists. *Bulletin of the Psychonomic Society*, *4*(2), 137–138. https://doi.org/10.3758/BF03334222

Fawcett, J. M., & Hulbert, J. C. (2020). The many faces of forgetting: Toward a constructive view of forgetting in everyday life. *Journal of Applied Research in Memory and Cognition*, *9*(1), 1–18. https://doi.org/10.1016/j.jarmac.2019.11.002

Fawcett, J. M., Lawrence, M. A., & Taylor, T. L. (2016). The representational consequences of intentional forgetting: Impairments to both the probability and fidelity of long-term memory. *Journal of Experimental Psychology: General*, *145*(1), 56–81. https://doi.org/10.1037/xge0000128

Fawcett, J. M., & Taylor, T. L. (2008). Forgetting is effortful: Evidence from reaction time probes in an item-method directed forgetting task. *Memory & Cognition*, *36*(6), 1168–1181. https://doi.org/10.3758/MC.36.6.1168

Fawcett, J. M., & Taylor, T. L. (2010). Directed forgetting shares mechanisms with attentional withdrawal but not with stop-signal inhibition. *Memory & Cognition*, *38*(6), 797–808. https://doi.org/10.3758/MC.38.6.797

Fawcett, J. M., & Taylor, T. L. (2012). The control of working memory resources in intentional forgetting: Evidence from incidental probe word recognition. *Acta Psychologica*, *139*(1), 84–90. https://doi.org/10.1016/j.actpsy.2011.10.001

Foster, N. L. (2012). *Beliefs about item memorability affect metacognitive control in item-method directed forgetting*. The University of North Carolina at Greensboro.

Foster, N. L., & Sahakyan, L. (2012). Metacognition influences item-method directed forgetting. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *38*(5), 1309–1324. https://doi.org/10.1037/a0027868

Friedman, M. C., & Castel, A. D. (2011). Are we aware of our ability to forget? Metacognitive predictions of directed forgetting. *Memory & Cognition*, *39*(8), 1448–1456. https://doi.org/10.3758/s13421-011-0115-y

Gardiner, J. M., Gawlik, B., & Richardson-Klavehn, A. (1994). Maintenance rehearsal affects knowing, not remembering; elaborative rehearsal affects remembering, not knowing. *Psychonomic Bulletin & Review*, *1*(1), 107–110. https://doi.org/10.3758/BF03200764

Geiselman, R. E., & Bagheri, B. (1985). Repetition effects in directed forgetting: Evidence for retrieval inhibition. *Memory & Cognition*, *13*(1), 57–62. https://doi.org/10.3758/BF03198444

Geiselman, R. E., Bjork, R. A., & Fishman, D. L. (1983). Disrupted retrieval in directed forgetting: A link with posthypnotic amnesia. *Journal of Experimental Psychology: General*, *112*(1), 58–72. https://doi.org/10.1037/0096-3445.112.1.58

Glanzer, M., & Adams, J. K. (1985). The mirror effect in recognition memory. *Memory & Cognition*, *13*(1), 8–20. https://doi.org/10.3758/BF03198438

Glanzer, M., & Adams, J. K. (1990). The mirror effect in recognition memory: Data and theory. *Journal of Experimental Psychology: Learning, Memory, & Cognition*, *16*(1), 5–16. https://doi.org/10.1037/0278-7393.16.1.5

Glanzer, M., & Bowles, N. (1976). Analysis of the word-frequency effect in recognition memory.. *Journal of Experimental Psychology:*

Human Learning & Memory, *2*(1), 21–31. https://doi.org/10.1037/0278-7393.2.1.21

Gorman, A. N. (1961). Recognition memory for names as a function of abstractness and frequency. *Journal of Experimental Psychology*, *61*(1), 23–29. https://doi.org/10.1037/h0040561

Gregg, V. (1976). Word frequency, recognition, and recall. In J. Brown (Ed.), *Recall and recognition* (pp. 183–216). Wiley.

Halamish, V. (2018). Can very small font size enhance memory? *Memory & Cognition*, *46*(6), 979–993. https://doi.org/10.3758/s13421-018-0816-6

Hall, J. F. (1954). Learning as a function of word-frequency. *The American Journal of Psychology*, *67*(1), 138–140. https://doi.org/10.2307/1418080

Hertzog, C., Dunlosky, J., Robinson, A. E., & Kidder, D. P. (2003). Encoding fluency is a cue used for judgments about learning. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *29*(1), 22–34. https://doi.org/10.1037/0278-7393.29.1.22

Hertzog, C., McGuire, C. L., & Lineweaver, T. T. (1998). Aging, attributions, perceived control, and strategy use in a free recall task. *Aging, Neuropsychology, and Cognition*, *5*(2), 85–106. https://doi.org/10.1076/anec.5.2.85.601

Hubbard, R. J., & Sahakyan, L. (2021). Separable neural mechanisms support intentional forgetting and thought substitution. *Cortex*, *142*, 317–331. https://doi.org/10.1016/j.cortex.2021.06.013

Hulme, C., Suprenant, A. M., Bireta, T. J., Stuart, G., & Neath, I. (2004). Abolishing the word-length effect. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *30*(1), 98–106. https://doi.org/10.1037/0278-7393.30.1.98

Jalbert, A., Neath, I., Bireta, T. J., & Surprenant, A. M. (2011). When does length cause the word length effect? *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *37*(2), 338–353. https://doi.org/10.1037/a0021804

Jalbert, A., Neath, I., & Surprenant, A. M. (2011). Does length or neighborhood size cause the word length effect? *Memory & Cognition*, *39*(7), 1198–1210. https://doi.org/10.3758/s13421-011-0094-z

Johnson, H. M. (1994). Processes of successful intentional forgetting. *Psychological Bulletin*, *116*(2), 274–292. https://doi.org/10.1037/0033-2909.116.2.274

Kass, R. E., & Raftery, A. E. (1995). Bayes factors. *Journal of the American Statistical Association*, *90*(430), 773–795. https://doi.org/10.1080/01621459.1995.10476572

Kensinger, E. A., & Corkin, S. (2003). Memory enhancement for emotional words: Are emotional words more vividly remembered than neutral words? *Memory & Cognition*, *31*(8), 1169–1180. https://doi.org/10.3758/BF03195800

Kensinger, E. A., & Corkin, S. (2004). Two routes to emotional memory: Distinct neural processes for valence and arousal. *Proceedings of the National Academy of Sciences*, *101*(9), 3310–3315. https://doi.org/10.1073/pnas.0306408101

Kleinsmith, L. J., & Kaplan, S. (1963). Paired-associate learning as a function of arousal and interpolated interval. *Journal of Experimental Psychology*, *65*(2), 190–193. https://doi.org/10.1037/h0040288

Knowlton, B. J., & Castel, A. D. (2021). Memory and reward-based learning: A value-directed remembering perspective. *Annual Review of Psychology*, *73*(1), 25–52. https://doi.org/10.1146/annurev-psych-032921-050951

LaBar, K. S., & Phelps, E. A. (1998). Arousal-mediated memory consolidation: Role of the medial temporal lobe in humans. *Psychological Science*, *9*(6), 490–493. https://doi.org/10.1111/1467-9280.00090

Leding, J. K. (2019). Adaptive memory: Animacy, threat, and attention in free recall. *Memory & Cognition*, *47*(3), 383–394. https://doi.org/10.3758/s13421-018-0873-x

Lee, Y. S. (2012). Cognitive load hypothesis of item-method directed forgetting. *Quarterly Journal of Experimental Psychology*, *65*(6), 1110–1122. https://doi.org/10.1080/17470218.2011.644303

Lee, Y. S., & Lee, H. M. (2011). Divided attention facilitates intentional forgetting: Evidence from item-method directed forgetting. *Consciousness & Cognition*, *20*(3), 618–626. https://doi.org/10.1016/j.concog.2010.09.008

Lewandowsky, S., Stritzke, W. G. K., Oberauer, K., & Morales, M. (2005). Memory for fact, fiction, and misinformation. *Psychological Science*, *16*(3), 190–195. https://doi.org/10.1111/j.0956-7976.2005.00802.x

Love, J., Selker, R., Marsman, M., Jamil, T., Dropmann, D., Verhagen, J., Ly, A., Gronau, Q. F., Šmíra, M., Epskamp, S., Matzke, D., Wild, A., Knight, P., Rouder, J. N., Morey, R. D., & Wagenmakers, E. J. (2019). JASP: Graphical statistical software for common statistical designs. *Journal of Statistical Software*, *88*(2), 1–17. https://doi.org/10.18637/jss.v088.i02

Luna, K., Martín-Luengo, B., & Albuquerque, P. B. (2018). Do delayed judgements of learning reduce metamemory illusions? A meta-analysis. *Quarterly Journal of Experimental Psychology*, *71*(7), 1626–1636. https://doi.org/10.1080/17470218.2017.1343362

Luna, K., Nogueira, M., & Albuquerque, P. B. (2019). Words in larger font are perceived as more important: Explaining the belief that font size affects memory. *Memory (Hove, England)*, *27*(4), 555–560. https://doi.org/10.1080/09658211.2018.1529797

MacLeod, C. M. (1975). Long-term recognition and recall following directed forgetting. *Journal of Experimental Psychology: Human Learning and Memory*, *1*(3), 271–279. https://doi.org/10.1037/0278-7393.1.3.271

MacLeod, C. M. (1998). Directed forgetting. In J. Golding & C. M. MacLeod (Eds.), *Intentional forgetting: Interdisciplinary approaches* (pp. 139–172). Erlbaum.

MacLeod, C. M., & Kampe, K. E. (1996). Word frequency effects on recall, recognition, and word fragment completion tests. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *22*(1), 132–142. https://doi.org/10.1037/0278-7393.22.1.132

Madan, C. R. (2017). Motivated cognition: Effects of reward, emotion, and other motivational factors across a variety of cognitive domains. *Collabra: Psychology*, *3*(1), 24. https://doi.org/10.1525/collabra.111

McDaniel, M. A., & Bugg, J. M. (2008). Instability in memory phenomena: A common puzzle and a unifying explanation. *Psychonomic Bulletin & Review*, *15*(2), 237–255. https://doi.org/10.3758/PBR.15.2.237

Mendes, P. S., Luna, K., & Albuquerque, P. B. (2020). Experience matters: Effects of (in)congruent prompts about word frequency on judgments of learning. *Zeitschrift fur Psychologie*, *228*(4), 254–263. https://doi.org/10.1027/2151-2604/a000423

Mendes, P. S., Luna, K., & Albuquerque, P. B. (2021). Word frequency effects on judgments of learning: More than just beliefs. *The Journal of General Psychology*, *148*(2), 124–148. https://doi.org/10.1080/00221309.2019.1706073

Murphy, D. H., & Castel, A. D. (2021). Responsible remembering and forgetting as contributors to memory for important information. *Memory & Cognition*, *49*(5), 895–911. https://doi.org/10.3758/s13421-021-01139-4

Murphy, D. H., Huckins, S. C., Rhodes, M. G., & Castel, A. D. (2021). The effect of perceptual processing fluency and value on metacognition and remembering. *Psychonomic Bulletin & Review*. https://doi.org/10.3758/s13423-021-02030-8

Murphy, D. H., Schwartz, S. T., & Castel, A. D. (2022). Serial and strategic memory processes in goal-directed selective remembering. *Cognition*, *225*, 105178. https://doi.org/10.1016/j.cognition.2022.105178

Murphy, N. A., & Isaacowitz, D. M. (2008). Preferences for emotional information in older and younger adults: A meta-analysis of memory and attention tasks. *Psychology and Aging*, *23*(2), 263–286. https://doi.org/10.1037/0882-7974.23.2.263

Nairne, J. S. (2016). Adaptive memory: Fitness-relevant "tunings" help drive learning and remembering. In D. C. Geary & D. B. Berch (Eds.), *Evolutionary perspectives on child development and education* (pp. 251–269). Springer International Publishing.

Nairne, J. S., VanArsdall, J. E., & Cogdill, M. (2017). Remembering the living: Episodic memory is tuned to animacy. *Current Directions in*

Psychological Science, *26*(1), 22–27. https://doi.org/10.1177/0963721416667711
Nairne, J. S., VanArsdall, J. E., Pandeirada, J. N. S., Cogdill, M., & LeBreton, J. M. (2013). Adaptive memory: The mnemonic value of animacy. *Psychological Science*, *24*(10), 2099–2105. https://doi.org/10.1177/0956797613480803
Neath, I., & Nairne, J. S. (1995). Word-length effects in immediate memory: Overwriting trace decay theory. *Psychonomic Bulletin & Review*, *2*(4), 429–441. https://doi.org/10.3758/BF03210981
New, B., Ferrand, L., Pallier, C., & Brysbaert, M. (2006). Reexamining the word length effect in visual word recognition: New evidence from the English Lexicon project. *Psychonomic Bulletin & Review*, *13*(1), 45–52. https://doi.org/10.3758/BF03193811
Nowicka, A., Marchewka, A., Jednorog, K., Tacikowski, P., & Brechmann, A. (2011). Forgetting of emotional information is hard: An fMRI study of directed forgetting. *Cerebral Cortex*, *21*(3), 539–549. https://doi.org/10.1093/cercor/bhq117
Page, M. P. A., & Norris, D. (1998). The primacy model: A new model of immediate serial recall. *Psychological Review*, *105*(4), 761–781. https://doi.org/10.1037/0033-295X.105.4.761-781
Paivio, A. (1966). Latency of verbal associates and imagery to noun stimuli as a function of abstractness and generality. *Canadian Journal of Psychology*, *20*(4), 378–387. https://doi.org/10.1037/h0082953
Paivio, A. (1971). *Imagery and verbal processes*. Holt, Rinehart, & Winston.
Paivio, A. (2013). Dual coding theory, word abstractness, and emotion: A critical review of Kousta et al. (2011). *Journal of Experimental Psychology: General*, *142*(1), 282–287. https://doi.org/10.1037/a0027004
Popov, V., & Reder, L. (in press). Frequency effects in recognition and recall. In E. Tulving & F. I. M. Craik (Eds.), *The Oxford handbook of memory*. Oxford University Press.
Popp, E. Y., & Serra, M. J. (2016). Adaptive memory: Animacy enhances free recall but impairs cued recall. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *42*(2), 186–201. https://doi.org/10.1037/xlm0000174
Popp, E. Y., & Serra, M. J. (2018). The animacy advantage for free recall performance is not attributable to greater mental arousal. *Memory (Hove, England)*, *26*(1), 89–95. https://doi.org/10.1080/09658211.2017.1326507
Rhodes, M. G., & Castel, A. D. (2008). Memory predictions are influenced by perceptual information: Evidence for metacognitive illusions. *Journal of Experimental Psychology: General*, *137*(4), 615–625. https://doi.org/10.1037/a0013684
Rhodes, M. G., & Castel, A. D. (2009). Metacognitive illusions for auditory information: Effects on monitoring and control. *Psychonomic Bulletin & Review*, *16*(3), 550–554. https://doi.org/10.3758/PBR.16.3.550
Richardson, J. T. E. (1998). The availability and effectiveness of reported mediators in associative learning: A historical review and an experimental investigation. *Psychonomic Bulletin & Review*, *5*(4), 597–614. https://doi.org/10.3758/BF03208837
Rizio, A. A., & Dennis, N. A. (2013). The neural correlates of cognitive control: Successful remembering and intentional forgetting. *Journal of Cognitive Neuroscience*, *25*(2), 297–312. https://doi.org/10.1162/jocn_a_00310
Rowland, C. A. (2014). The effect of testing versus restudy on retention: A meta-analytic review of the testing effect. *Psychological Bulletin*, *140*(6), 1432–1463. https://doi.org/10.1037/a0037559
Rubin, D. C., & Friendly, M. (1986). Predicting which words get recalled: Measures of free recall, availability, goodness, emotionality, and pronunciability for 925 nouns. *Memory & Cognition*, *14*(1), 79–94. https://doi.org/10.3758/BF03209231
Sahakyan, L. (2004). Destructive effects of “forget” instructions. *Psychonomic Bulletin & Review*, *11*(3), 555–559. https://doi.org/10.3758/BF03196610
Sahakyan, L., & Delaney, P. F. (2003). Can encoding differences explain the benefits of directed forgetting in the list method paradigm? *Journal of Memory & Language*, *48*(1), 195–206. https://doi.org/10.1016/S0749-596X(02)00524-7
Sahakyan, L., Delaney, P. F., Foster, N. L., & Abushanab, B. (2013). List-method directed forgetting in cognitive and clinical research: A theoretical and methodological review. In B. H. Ross (Ed.), *The psychology of learning and motivation* (Vol. 59, pp. 131–190). Academic Press.
Sahakyan, L., Delaney, P. F., & Goodmon, L. B. (2008). Oh, honey, I already forgot that: Strategic control of directed forgetting in older and younger adults. *Psychology and Aging*, *23*(3), 621–633. https://doi.org/10.1037/a0012766
Sahakyan, L., & Foster, N. L. (2009). Intentional forgetting of actions: Comparison of list-method and item-method directed forgetting. *Journal of Memory and Language*, *61*(1), 134–152. https://doi.org/10.1016/j.jml.2009.02.006
Sahakyan, L., & Foster, N. L. (2016). The need for metaforgetting: Insights from directed forgetting. In J. Dunlosky & S. Tauber (Eds.), *Oxford handbook of metacognition* (pp. 341–356). Oxford University Press.
Sahakyan, L., & Kelley, C. M. (2002). A contextual change account of the directed forgetting effect. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *28*(6), 1064–1072. https://doi.org/10.1037/0278-7393.28.6.1064
Schwanenflugel, P. J., Harnishfeger, K. K., & Stowe, R. W. (1988). Context availability and lexical decisions for abstract and concrete words. *Journal of Memory and Language*, *27*(5), 499–520. https://doi.org/10.1016/0749-596X(88)90022-8
Schwartz, F., & Rouse, R. O. (1961). The activation and recovery of associations. *Psychological Issues*, *3*(Whole No. 9), 140.
Serra, M. J. (2021). Animate and inanimate words demonstrate equivalent retrieval dynamics despite the occurrence of the animacy advantage. *Frontiers in Psychology*, *12*, 2027. https://doi.org/10.3389/fpsyg.2021.661451
Sheard, E. D., & MacLeod, C. M. (2005). List method directed forgetting: Return of the selective rehearsal account. In N. Ohta, C. M. MacLeod, & B. Uttl (Eds.), *Dynamic cognitive processes* (pp. 219–248). Springer.
Shepard, R. N. (1967). Recognition memory for words, sentences, and pictures. *Journal of Verbal Learning and Verbal Behavior*, *6*(1), 156–163. https://doi.org/10.1016/S0022-5371(67)80067-7
Talmi, D., & Moscovitch, M. (2004). Can semantic relatedness explain the enhancement of memory for emotional words? *Memory & Cognition*, *32*(5), 742–751. https://doi.org/10.3758/BF03195864
Tan, P., Ensor, T. M., Hockley, W. E., Harrison, G. W., & Wilson, D. E. (2020). In support of selective rehearsal: Double-item presentation in item-method directed forgetting. *Psychonomic Bulletin & Review*, *27*(3), 529–535. https://doi.org/10.3758/s13423-020-01723-w
Tauber, S. K., & Rhodes, M. G. (2012). Measuring memory monitoring with judgements of retention (JORs). *Quarterly Journal of Experimental Psychology*, *65*(7), 1376–1396. https://doi.org/10.1080/17470218.2012.656665
Taylor, T. L. (2005). Inhibition of return following instructions to remember and forget. *The Quarterly Journal of Experimental Psychology Section A*, *58*(Erratum in 58A, 1343), 613–629. https://doi.org/10.1080/02724980443000115
Taylor, T. L., & Fawcett, J. M. (2011). Larger IOR effects following forget than following remember instructions depend on exogenous attentional withdrawal and target localization. *Attention, Perception, & Psychophysics*, *73*(6), 1790–1814. https://doi.org/10.3758/s13414-011-0146-2
Taylor, T. L., & Ivanoff, J. (2021). Forgetting under difficult conditions: Item-method directed forgetting under perceptual processing constraints. *Memory & Cognition*, *49*(6), 1101–1118. https://doi.org/10.3758/s13421-021-01149-2
Thompson, K. M., Fawcett, J. M., & Taylor, T. L. (2011). Tag, you're it: Tagging as an alternative to yes/no recognition in item method

directed forgetting. *Acta Psychologica*, *138*(1), 171–175. https://doi.org/10.1016/j.actpsy.2011.06.001

Thompson, K. M., Hamm, J. P., & Taylor, T. L. (2014). Effects of memory instruction on attention and information processing: Further investigation of inhibition of return in item-method directed forgetting. *Attention, Perception, & Psychophysics*, *76*(2), 322–334. https://doi.org/10.3758/s13414-013-0584-0

Underwood, B. J., Ekstrand, B. R., & Keppel, G. (1965). An analysis of intralist similarity in verbal learning with experiments on conceptual similarity. *Journal of Verbal Learning and Verbal Behavior*, *4*(6), 447–462. https://doi.org/10.1016/S0022-5371(65)80042-1

Unsworth, N. (2016). Working memory capacity and recall from LTM: Examining the influences of encoding strategies, study time allocation, search efficiency, and monitoring abilities. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *42*(1), 50–61. https://doi.org/10.1037/xlm0000148

VanArsdall, J., & Blunt, J. (2021, May 28). *Animacy normative data*. Retrieved from osf.io/4t3cu

VanArsdall, J. E., Nairne, J. S., Pandeirada, J. N., & Cogdill, M. (2015). Adaptive memory: Animacy effects persist in paired-associate learning. *Memory (Hove, England)*, *23*(5), 657–663. https://doi.org/10.1080/09658211.2014.916304

Weiner, B., & Reed, H. (1969). Effects of the instructional sets to remember and to forget on short-term retention: Studies of rehearsal control and retrieval inhibition (suppression). *Journal of Experimental Psychology*, *79*(2, Pt.1), 226–232. https://doi.org/10.1037/h0026951

Yang, W., Liu, P., Xiao, X., Li, X., Zeng, C., Qiu, J., & Zhang, Q. (2012). Different neural substrates underlying directed forgetting for negative and neutral images: An event-related potential study. *Brain Research*, *1441*, 53–63. https://doi.org/10.1016/j.brainres.2011.10.042

Ye, J., Nie, A., & Liu, S. (2019). How do word frequency and memory task influence directed forgetting: An ERP study. *International Journal of Psychophysiology*, *146*, 157–172. https://doi.org/10.1016/j.ijpsycho.2019.10.005