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The effects of preconceptions on directed forgetting - the example of e-learning

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Abstract
This study used the item-based legal forgetting paradigm to investigate the effects of preconception type and material type on directed forgetting, and further explored the effects of preconception on directed forgetting of specific and gist memories through 2 experiments using static textual images and selected dynamic videos as experimental material in a simulated online teaching environment. The results showed that positive preconceptions induced directed forgetting of specific memory, while negative preconceptions enhanced directed forgetting of gist memory only. At the same time, static materials showed a directional forgetting effect, while dynamic materials did not show a directional forgetting effect. Static materials improve individual learning more than dynamic materials.

Keywords Preconceptions/antecedent views · Directed forgetting · General/gist memory · Specific memory · Type of material

Introduction

With the popularity of online classes, more and more teachers are using software such as Zoom and Tencent Meeting to complete their teaching tasks remotely. It is well known that students are susceptible to antecedent view about teachers when taking classes offline. Students' emotional efficacy is related to the level of interpersonal relationships between teachers and students (Visser et al., 2013), as students admire authoritative teachers more than novice teachers. When I like the teacher, I am willing to take the class, and vice versa. So, with the rise of online teaching, will this effect disappear with online compartmentalization? Or, do students' antecedent view about teachers affect their learning status in online teaching? This is the question that this study wants to explore.

Directed forgetting (DF) to filter old information in time for effective recall. In the experiment, participants were presented with either a to-be-remembered (TBR) or a to-be-forgotten (TBF) instruction after learning a single item (item-method) or a series of study items (list-method) and were told to remember or forget the specified material (Joslyn & Oakes, 2005). The directed forgetting affects occurs when recall or recollection performance on TBF is significantly lower than that on TBR. Therefore, in our study, we concluded that when participants showed the directed forgetting effect, it indicated that they had a better learning effect, mastering the so-called 'key content' and forgetting the irrelevant information. The mechanism by which the directed forgetting effect occurs varies somewhat in terms of volition and the allocation of attentional resources depending on the form of the task. Inhibitory control of the extraction of information previously encoded in TBF pairs occurred in list method. In the item method experiments, not only does extraction inhibition occur, but attentional resources are consciously used to encode only the recapitulation of TBR pairs to ensure that the remembered segment can enter long-term memory (Bjork, 1970; Depue et al., 2006; Pastötter & Haciahmet, 2022a; Pastötter & Haciahmet, 2022b; Sahakyan & Foster, 2009; Taylor & Ivanoff, 2021). In the current study, we will use the item method procedure to explore consciously forgetting unimportant information in learned content.

Most previous studies have verified the effect of emotion on directed forgetting. Wessel and Merckelbach (2006) examined that emotional and non-emotional words can be

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directed to forgetting at the same rate. Both positive and negative emotional words were able to show an orienting forgetting effect compared to neutral emotional words (Barnier et al., 2007; Keith Payne & Corrigan, 2007). However, inducing negative emotions in individuals prior to the experiment eliminated the directed forgetting effect (Bäuml & Kuhbandner, 2007, 2009). The elimination may be based on the Affect-As-Cognitive Feedback account(AACF) that emotional state influences the final choice of processing strategy. In the holistic focus condition, positive-minded individuals use holistic processing (low distraction) and negative-minded individuals use local processing (high distraction); whereas in the local focus condition, the above correspondence is reversed (Corenblum et al., 2020). All of the above experiments used verbal stimuli as experimental materials, including words, sentences, and prose (Bailey & Chapman, 2012; Pastötter & Haciahmet, 2022a), as well as nonverbal stimuli such as emotional pictures (Nowicka et al., 2011), faces (Kissler & Hauswald, 2022)have also found directed forgetting effects induced by different emotional valences of information. There are results where emotional state does not affect directed forgetting effects (Corenblum et al., 2020; Dougal & Rotello, 2007; Hauswald et al., 2011). This may be due to the fact that participants processed only the conceptual meaning of the emotional material without producing the corresponding emotional experience(Keith Payne & Corrigan, 2007). The Mood Congruency Effect states that when individuals are in an emotional state it is beneficial to capture positive information and to process and recall it, while a negative emotional state is more beneficial to capture negative information (Kim & Pekrun, 2014). Not surprisingly, most of the aforementioned materials, have been studied using static information such as words, faces, and pictures, and fewer studies have used dynamic stimuli to explore the effects of directed forgetting. Despite the existence of the above theories to explain the effect of emotions on directed forgetting. We also speculate that the different results triggered may be due to the different forms of experimental materials. Crucially, most of the events we are exposed to in our daily lives are continuous events, so it is necessary to use dynamic continuous events for the study. Fawcett et al. (2013a, 2013b) used dynamic videos for their exploration and found that participants performed significantly better in remembered segments than forgotten segments. Cognitive load theory holds that when an individual processes information, if the individual's total psychological resources are less than the total psychological resources required to process the knowledge, psychological load will be induced (Sweller et al., 1998). Specifically, individual who use the material are overloaded with working memory due to the animation and other redundant information in the video, resulting in increased cognitive load. Conversely, the cognitive load was lower for static materials because it is easier and more efficient to access information (Wang et al., 2020). Hence, this study attempted to simulate the 'online teaching' format by using static pictures and dynamic videos to verify whether dynamic videos can induce the directed forgetting effect, and hypothesized that static materials would produce better learning effects.

Current research demonstrates that perception exists before emotional contagion and regulates the final effect of emotional contagion. Antecedent view, as a form of emotional contagion, are extracted by the perceiver in an unconscious form (Bhullar, 2012; Sritharan et al., 2010), enhancing or diminishing the perceiver's emotional contagion and influence one's own emotional experience. Thus, antecedent views can be divided into positive and negative(Qiyong & Jiamei, 2015). Accordingly, we hypothesized that antecedent views could enhance or weaken students' emotional experiences, thus influencing the occurrence of the directed forgetting effect. Most previous studies on antecedent views have focused on the service industry and less on other domains, so this study chose to simulate teaching activities. As antecedent view are usually reflected in classroom activities where students admire authoritative teachers more than novice teachers. Students' emotional experience is related to the level of interpersonal relationships between teachers and students (Visser et al., 2013). Are students' evaluations of teachers extracted in an unconscious form, so that they perceive authoritative teachers as showing more realistic emotions? Does this lead to a greater emotional experience for students, which in turn have an impact on the effectiveness of classroom learning? It is likely that the 'learning-based' online model of teaching and learning will diminish the extent to which teachers can influence the learning process. However, the isolation of the online environment and students' lack of self-control still allow for interpersonal interactions between teachers and students to influence student learning. In other words, we hypothesized that the online model is a setting where antecedent view can play a role in directed forgetting, and that two different presentations, static and dynamic, are used.

The effects of emotion on different memory types are selective. People have different levels of memory for different types of information: gist memory and specific memory. Gist memory refers to the main plot of an event and the conceptual information about the event; specific memory refers to specific information related to the central event or background information unrelated to the central event (Burke et al., 1992). The gist/specific trade-off effect states that emotions increase the likelihood of remembering the main idea of an event and decrease the likelihood of remembering specifics leading to forgetting (Adolphs et al., 2005). However, the specific trade-off effect was only seen for remembering segments of instructions, which was associated with the inhibition of extraction of forgotten segments. A trade-off between gist and visually specific information also arises in some encoding tasks, but this trade-off occurs only when memory for the non-emotional context of the scene is evaluated. That is, negative emotions can enhance memory for specifics directly associated with emotional stimuli, but have no effect on gist memory (Kensinger et al., 2005, 2006, 2007).

In this study, two types of teacher identity information, 'authoritative' and 'novice' teachers, were designed to examine the effect of antecedent views on directed forgetting in different forms of online teaching materials through a tutorial. Experiment 1 explored three main questions. First, whether antecedent view as a form of emotionally contagious conditioning can induce an directed forgetting effect. Second, previous studies have used dynamic materials less frequently. There is a lack of data to support whether they can induce a stable directed forgetting effect. Therefore, Experiment 1 was set up as a control group when positive/negative antecedent views were introduced. An attempt was made to verify that dynamic materials could elicit a directed forgetting effect. Given that different memory types can experience different levels of forgetting. A final question was to explore whether the differences between memory types corroborated the previous results when two newer experimental variables were used. We expected that antecedent views would induce a directed forgetting effect. And it is feasible to use dynamic materials for memory studies. Although scientific studies aim to verify the reproducibility of novelty experimental materials to previous findings. However, it is necessary to compare the experimental materials and explore whether different formats have an effect on the experimental results. In conjunction with actual online teaching activities, teachers mostly use static materials. Therefore, Experiment 2 further explored whether the form of the materials had an effect on the experimental results based on the verification that dynamic materials can induce directed forgetting. It provides data to support the selection of materials for future directed forgetting studies and the development of online teaching activities. According to previous claims, the cognitive load of the static form is smaller compared to the dynamic form (Wang et al., 2020). Therefore, we predict that the static format elicits a greater directed forgetting effect.

Experiment 1

Method

Participants

Considering the sample size, to validate whether ours was appropriate, we conducted a priority G*power analysis by adopting the G*power 3.1 software. For the mixed design ANOVA used in this study, the total sample size predicting a 90% level of power at the significance level $\alpha = 0.01$ and an effect size ($f = 0.25$) was at least fifty-one. Thus, ninety effective participants in the current experiment met such requirement obviously (51 female and 39 male participants; 30 in the positively antecedent view, 30 in the negatively antecedent view, 30 in the neutral). Their ages ranged from 18 to 23 years. Participants were all native Chinese speakers, and they all were righthanded. All had normal visual acuity, and none reported any history of neurological impairments or color vision disorders.

Design

This experiment used a 3 (type of antecedent view: positive, negative, neutral) × 2 (DF: remember, forget) × 2 (type of memory: gist-only memory, specific memory) mixed experimental design. The type of antecedent view was a between-subjects variable, DF and the type of memory were within-subjects variables. The dependent variables were the correct responses and RTs of gist-only memory and specific memory.

Materials

The experimental task used a directed-forgetting paradigm of item-method developed in the Empire 3.0 (Ren et al., 2019).

Study materials Three teaching videos depicting Physical knowledge were retrieved from the public domain video sharing website. Thirty undergraduate participants were requested to rate each video on three dimensions using a 7-point rating scale. The dimensions included valence (1 = nervous/fear, 7 = happy/lively), arousal (1 = few, 7 = strongly), and difficulty (1 = very easy, 7 = very difficult). According to the results, one video that was too easy was excluded. Comparison of the remaining videos revealed significant differences in valence ($t(58) = 2.63$, $p < 0.05$) and arousal ($t(58) = 2.03$, $p < 0.05$), while the difficulty ($p > 0.05$) was not significant. Finally, one neutral video (valence = 4.00 ± 0.91, arousal = 3.63 ± 0.93, difficulty = 3.57 ± 1.19) was selected as the experimental

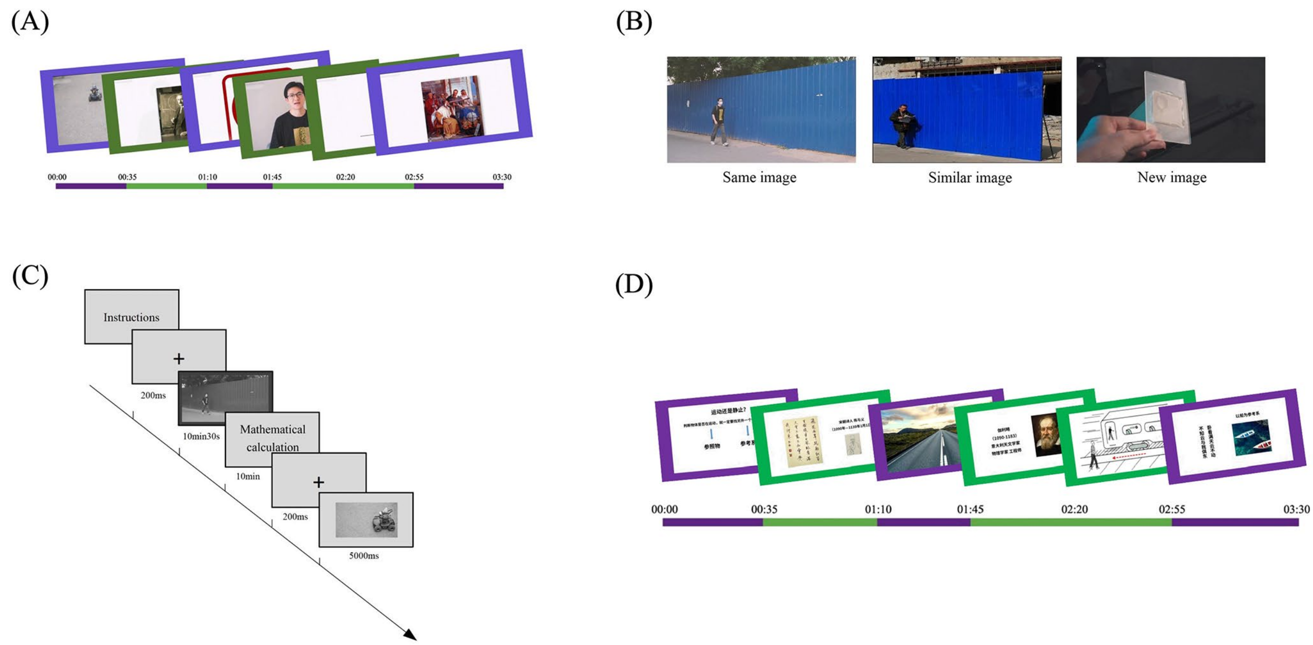

Fig. 1 (A) The sequence of events during study dynamic material phase. (B) Recognition test materials: same image; similar image; new image. (C) The sequence of events during an experiment trial. (D) The sequence of events during study static material phase

material. According to the method of Fawcett et al. (2013a, 2013b), the color border (purple and green) representing the DF was inlaid on the periphery of the video with a resolution of 1280 × 720 pixels, a total duration of 10 min and 30s. Each segment lasted 35s. Each video had 18 segments, including 9 remembered segments and 9 forgotten segments, as shown in Fig. 1 A.

Test materials According to Kensinger et al. (2007), the recognition material was divided into three categories: same images, similar images, and new images. The same image was the screenshot of the video played in the experiment stage. The similar image was shared with the same gist information but different specifics. The new image was completely different from the same image in both gist information and specifics, as shown in Fig. 1B. A total of 120 images were recognized, including 48 same images, 48 similar images and 24 new images respectively. The same and similar images were balanced within participants to ensure that only one of the same images and the similar images that matched them would be presented to the participants, divided into two versions randomly presented between participants (Ren et al., 2019).

Procedure

The experiment was divided into four parts, see Fig. 1 C. The first part was to guide the participants to establish positively or negatively antecedent view in their brains with the following instructions (Qiyong & Jiamei, 2015): 1. You are about to see a video of a middle school special grade teacher from a middle school in Haidian District, Beijing, who graduated from the physics department of Peking University in 2006 with a postgraduate degree and was qualified as a middle school special grade teacher only four years after joining the profession. The video of his lecture has been reproduced online more than a million times and he has been named by netizens as the most gifted teacher. 2. What you are about to see below is a video of a new teacher who graduated from a private college in 2013 with a college degree in physics and is now employed by a after-school training institution. The neutral group will not accept the input of the first part of the tutorial and will start the second part directly.

In the second part of the study phase, participants viewed an educational video and were instructed that the green border represented the 'remember' and the purple border represented the 'forget' instruction. The border color varied randomly between segments and the order in which the same color borders appeared using ABBA design. Care was also taken to ensure that the same material was presented as remembered and forgotten segments in different participants.

The third part of the session consisted of a 10-minute interference task at the end of the previous part, in which participants had to perform a simple mathematical calculation.

Table 1 Mean proportion and standard of specific and gist-only recognition from different antecedent view in the remember and forget conditions

		Positive (n = 30)		Negative (n = 30)		Neutral (n = 30)	
		Remember	Forget	Remember	Forget	Remember	Forget
Specific recognition	*M*	0.824	0.700	0.766	0.777	0.775	0.646
	SD	0.144	0.138	0.128	0.220	0.185	0.287
Gist-only recognition	*M*	0.225	0.257	0.217	0.211	0.237	0.251
	SD	0.106	0.095	0.915	0.098	0.097	0.097

The fourth part was a test phase in which 72 images were presented, 24 same, 24 similar, and 24 new. Participants were asked to compare the video they had just watched with each of the images presented and to make a judgment. If the image presented was exactly the same as the video, it was 'same'; if the image presented had the same gist information but different specifics, it was 'similar'; If the image presented did not match the video at all, it was 'new'. All of them are selected by tapping the only keyboard number, '8' stands for 'same', '9' stands for 'similar' and '0' stands for 'new'.

Data analysis

According to the statistical method of Kensinger et al. (2007), the correct responses of specific recognition and gist-only recognition were calculated based on the participants keystroke responses to the 'same' images. (1) Specific recognition: the 'same' response to the 'same' images, which means that the participants have a more precise and specific memory of the video; (2) Gist-only recognition: Gist-only recognition was calculated from the 'similar' responses made by participants to the 'same' images. The original data were corrected according to the method from Snodgrass and Corwin (1988) (original data + 0.5/N + 1, 'N' is the number of different types of images). Correct responses and RTs were counted using IBM SPSS Statistics v18. Correct responses and RTs were analyzed with a 3 (type of antecedent view: positive, negative, neutral) × 2 (DF: remember, forget) × 2 (type of memory: gist-only memory, specific memory) mixed design ANOVA and general conclusions were drawn to test the hypotheses.

Results

Analyses for the correct responses of recognition

A 3 (type of antecedent view: positive, negative, neutral) × 2 (DF: remember, forget) × 2 (type of memory: gist-only memory, specific memory) mixed design ANOVA (Table 1) was conducted on the correct responses of recognition and found that a significant interaction of the type of antecedent view between DF and the type of memory in recognition ($F(2, 87) = 4.678$, $p < 0.05$, $\eta^2_p = 0.097$). Simple effect tests for the three-way interaction demonstrated that (1) in the positively antecedent view condition, showing much higher correct responses for the fragment of remembering the specific than for gist-only ($p < 0.001$, 95% CI = [0.530, 0.669]); (2) in the neutral condition, indicating much higher correct responses for the fragment of remembering the specific than for gist-only ($p < 0.001$, 95% CI = [0.468, 0.607]); (3) in the negatively antecedent view condition, the correct responses for the fragment of remembering the specific were much greater for gist-only ($p < 0.001$, 95% CI = [0.480, 0.618]); (4) in the positively antecedent view condition, showing much higher correct responses for the fragment of forgetting the specific than for gist-only ($p < 0.001$, 95% CI = [0.352, 0.534]); (5) in the neutral condition, indicating much higher correct responses for the fragment of forgetting the specific than for gist-only ($p < 0.001$, 95% CI = [0.304, 0.485]); (6) in the negatively antecedent view condition, the correct responses for the fragment of forgetting the specific was much greater for gist-only ($p < 0.001$, 95% CI = [0.475, 0.657]); (7) in the positively antecedent view condition, the correct responses of specific recognition were significantly higher for the remembered segment than for the forgotten segment ($p < 0.01$, 95% CI = [0.052, 0.199]) see Fig. 2 A; (8) in the neutral condition, the remembered segment had a significantly higher responses of correct specific recognition than the forgotten segment ($p < 0.01$, 95% CI = [0.056, 0.203]) see Figs. 2B and (9) in the negatively antecedent view condition, there was no directed forgetting effect in the responses of correct specific recognition ($p > 0.05$); (10) in the positively antecedent view condition, there was no directed forgetting effect in the responses of correct gist-only recognition ($p > 0.05$); 11) in the neutral condition, there was no significant difference between the remembered and forgotten segments in terms of the correct responses of the gist-only ($p > 0.05$); 12) in the negatively antecedent view condition, there was no significant difference between the remembered and forgotten segments in terms of the correct responses of the gist-only ($p > 0.05$).

Analyses for the RTs

A 3 (type of antecedent view: positive, negative, neutral) × 2 (DF: remember, forget) repeated measures ANOVA at

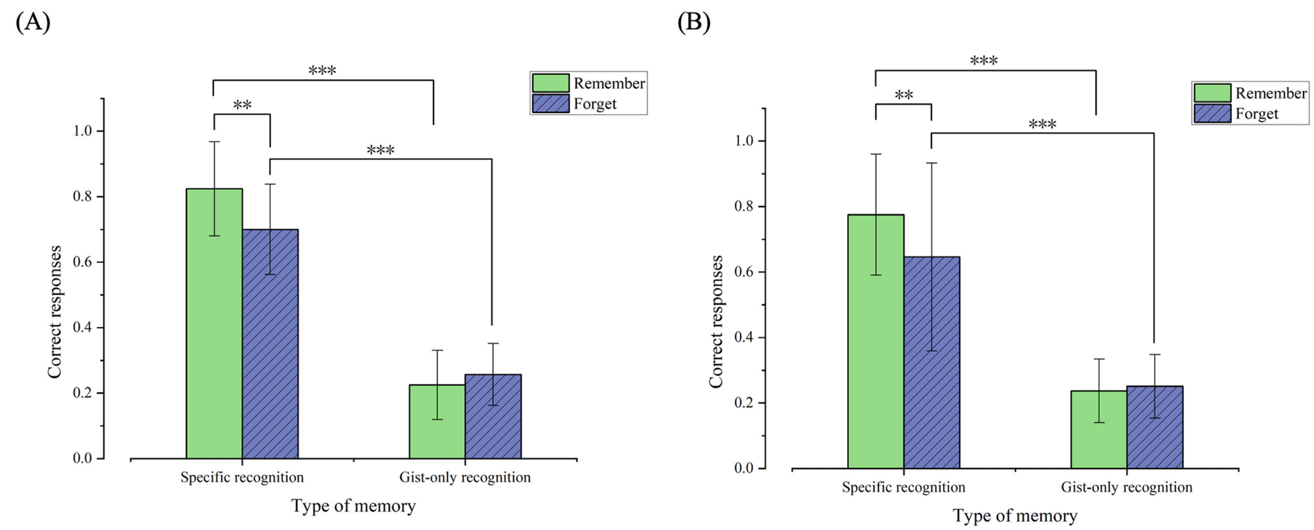

Fig. 2 (A) In the positively antecedent view condition, the correct responses of specific and gist-only recognition in the remembered and forgotten segment. (B) In the neutral condition, the correct responses of specific and gist-only recognition in the remembered and forgotten segment. *$p<0.05$; **$p<0.01$; ***$p<0.001$

Table 2 RTs and standard deviation (ms) of DF under the type of antecedent view

		Positive (n = 30)	Negative (n = 30)	Neutral (n = 30)
Remember	*M*	1667.67	1574.43	1761.63
	SD	446.59	522.79	550.95
Forget	*M*	1581.77	1681.43	1764.30
	SD	350.01	670.79	686.41

RTs (Table 2) revealed a non-significant main effect for DF ($F(1, 87)=0.023$, $p=0.880$), a non-significant main effect for antecedent view ($F(2, 87)=0.773$, $p=0.465$). There was no significant interaction ($F(2, 87)=1.113$, $p=0.327$).

Discussion

The results of Experiment 1 showed that participants were significantly better at recalling specific of the remembered fragments than those of the forgotten fragments in the positively antecedent view. In the neutral condition, there was also a reliable DF effect of specific. However, there was no directed forgetting effect in the responses of correct specific recognition in the negatively antecedent view condition. At the same time, the correct recall rate for the forgotten fragments of negatively antecedent view tended to be better than that of the neutral group, while there was no difference in the correct recall rate for the remembered fragments. This was consistent with the findings of Ren et al.(2019), which may be due to the fact that negatively antecedent view enhanced participants' recall of specifics of the forgotten segments. Kensinger (2009) suggested that when it comes to remembering specifics of emotional events, negative emotions may lead to enhanced specific memory, while positive emotions did not play a role in improving memory accuracy. Therefore, the directed forgetting effect was observed in the positively antecedent view specific recollection. The directed forgetting effect did not occur in the gist-only recollection, which may be due to the fact that participants could make inferences about the presented images and thus weaken the directed forgetting effect.

In Experiment 1, we verified that different antecedent view induced different directed forgetting effects in the dynamic video. Participants unconsciously extracted positive preconceptions, which enhanced their positive emotional experience, and the directed forgetting effect of specific memory emerged. In the measure of recognition, negative emotions eliminate the directed forgetting effect of specific recognition. However, there was no effect of emotion on gist-only. The results of Experiment 1 validated this view. At the same time, it has been shown that directed forgetting of gist-only recognition is susceptible to the effects of event continuity (Ren et al., 2019). Participants influenced the direction of the directed forgetting effect by guessing the content of the memory. In contrast to dynamic video material, static material consists of a single picture and text. It lacks a certain degree of continuity (Wang et al., 2020). Given the effect of controlling for the additional variable of event continuity, Experiment 2 excluded the gist-only recollection condition. In summary, to further investigate whether dynamic and static materials could elicit different directed forgetting effects, Experiment 2 extended the experimental design of Experiment 1 with the addition of the between-subjects variable of material. Given that gist-only recollection was not significant in Experiment 1, Experiment 2 was explored in specific memory recollection only.

Experiment 2

Method

Participants

According to G*power 3.1 software, if an effect size of $f=0.25$ and the power $=0.90$ were expected, the analysis demonstrated that a total sample size of eighty-four was required. Thusly, one hundred and twenty undergraduate university students in the current experiment met such requirement obviously (69 female and 51 male participants; 30 in the positive antecedent view and dynamic materials, 30 in the positive antecedent view and static materials, 30 in the negative antecedent view and dynamic materials, 30 in the negative antecedent view and static materials). Their ages ranged from 18 to 23 years. The participants were all native Chinese speakers, and all were righthanded. All had normal visual acuity, none reported any history of neurological impairments and color vision disorders.

Design

This experiment used a 2 (type of antecedent view: positive, negative) × 2 (DF: remember, forget) × 2 (material: dynamic, static) mixed experimental design. The type of antecedent view and material were between-subjects variable, DF was a within-subjects variable. The dependent variables were the correct responses and RTs of specific information.

Materials

Study materials the dynamic materials were consistent with Experiment 1, while the static materials were transform into images and text according to the original video, presented in the form of PowerPoint, with the same sound as well as playback duration as the original video, see Fig. 1D. The color border (purple and green) representing the DF was inlaid on the periphery of the video. Each segment lasted 35s. Each video had 18 segments, including 9 remembered segments and 9 forgotten segments.

Test materials The test materials for the dynamic group were the same as those in Experiment 1, while the static group were recreated based on the new studying materials, and the production method and its classification were the same as those in Experiment 1.

Table 3 Mean proportion and standard of specific recognition from different antecedent view and material in the remember and forget conditions

		Positive (n = 60)		Negative (n = 60)	
		dynamic	static	dynamic	static
Remember	*M*	0.772	0.731	0.753	0.717
	SD	0.161	0.173	0.089	0.123
Forget	*M*	0.797	0.617	0.828	0.644
	SD	0.194	0.153	0.165	0.171

Procedure

The dynamic group viewed the dynamic material and the static group viewed the static material. The rest of the experimental steps were the same as in Experiment 1.

Data analysis

According to the statistical method of Kensinger et al. (2007), the correct responses of specific recognition were calculated based on the participants' keystroke responses to the 'same' images: the 'same' response to the 'same' images, which means that the participants have a more precise and specific memory of the video. Correct responses and RTs were counted using IBM SPSS Statistics v18. Correct responses and RTs were analyzed with a 2 (type of antecedent view: positive, negative) × 2 (DF: remember, forget) × 2 (material: dynamic, static) mixed design ANOVA and general conclusions were drawn to test the hypotheses.

Results

Analyses for the correct responses of recognition

Referring to Ren et al.(2019), a mixed design ANOVA of a 2 (type of antecedent view: positive, negative) × 2 (DF: remember, forget) × 2 (material: dynamic, static) was conducted on the recall rates (Table 3), and the results showed that the main effect of antecedent view was not significant ($p > 0.05$). No significant differences were found in the accuracy of recall between antecedent view, material and the DF ($p > 0.05$). However, there was a significant interaction between DF and material ($F(1, 116) = 17.760$, $p < 0.001$, $\eta^2_p = 0.133$). We further analyzed the interaction effect: (1) in the forgotten segment, the recall specific rates was significantly higher for the dynamic material than for the static material ($p < 0.001$, 95% CI = [0.120, 0.244]), (2) in the remembered segment, no significant differences were

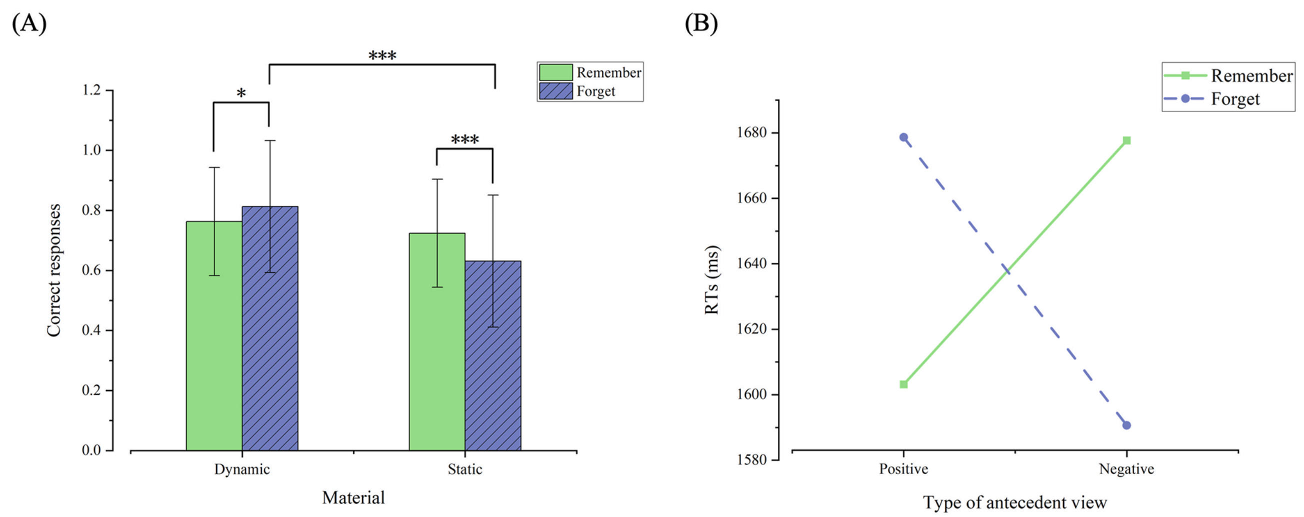

Fig. 3 (A) The correct responses of specific recognition from different materials and DF. (B) RTs of specific recognition from different materials and antecedent views. *$p<0.05$; **$p<0.01$; ***$p<0.001$

Table 4 RTs and standard deviation (ms) of type of antecedent view and type of material under the DF.

		Positive (n = 60)		Negative (n = 60)	
		dynamic	static	dynamic	static
Remember	*M*	1528.09	1665.49	1670.14	1666.49
	SD	356.25	418.60	382.28	334.95
Forget	*M*	1582.61	1745.09	1518.38	1694.22
	SD	438.54	425.93	245.50	318.31

found in the rate of recalling the specific between dynamic material and static material ($p>0.05$), (3) in the static material condition, the DF effect significantly affected recall specific rates ($p<0.001$, 95% CI = [0.046, 0.141]), (4) in the dynamic material condition, the correct specific recall rate was significantly higher for the forgotten segment than for the remembered segment ($p<0.05$, 95% CI = [0.003, 0.097]) see Fig. 3 A.

Analyses for the RTs

A 2 (type of antecedent view: positive, negative) × 2 (DF: remember, forget) × 2 (material: dynamic, static) mixed design ANOVA at RTs (Table 4) revealed that the interaction between DF and antecedent view was significant ($F(1, 115)=7.816$, $p=0.006$). Further simple effects analyses revealed that, (1) the RTs of the forgotten segment was much faster than for the remembered segment in the negative condition ($p=0.023$, 95% CI = [-0.162, -0.121]), (2) the RTs of the remembered segment was much faster than for the forgotten segment in the positive condition ($p=0.052$, 95% CI = [-0.152, 0.001]), see Fig. 3B.

Discussion

The results of Experiment 2 showed a stable directed forgetting effect in the static condition. However, this was not shown in the dynamic condition, and even the correct rate of forgotten segments was significantly higher than the remembered segments. Because the total mental load required to process the static material was lower than that of the dynamic material. When participants were selectively retelling and extracting inhibition, the static group absorbed the key information more efficiently and blocked out the irrelevant information set out in the experiment. This also confirms the cognitive load theory (Sweller et al., 1998). In the forgotten segments, the recall rate of the dynamic material was higher than that of the static material, which we believe is related to the nature of the material itself. In the remembered segments, there was no significant difference between them. Compared to static material, dynamic material is interesting and contains a lot of redundant information. Participants are likely to pay more attention to this type of content (Wang et al., 2020). Further analysis of the mean responses revealed that participants processed the task as a whole (low distraction) in a positive condition. Attentional resources were consciously used for learning when selecting retelling, resulting in a rapid response during the extraction phase. This is consistent with the AACF.

General discussion

Positive antecedent view on different memory types of the DF Effect

Experiment 1 used a directed forgetting paradigm to investigate the effect of DF in online teaching situations by physics videos with neutral emotional valence and appropriate difficulty level. The results showed a significant difference between the participants' correct recollection of the remembered segments and forgotten segments. This was in line with previous research (Fawcett et al., 2013a, b). In the positive antecedent view condition, participants recalled the remembered items correctly at a significantly higher rate than the forgotten items. According to mood congruency effect (Kim & Pekrun, 2014), positive information is captured when individuals are in a positive emotional state. Given that the material did not have positive valence, the positive antecedent view did not capture more of the content of TBF pairs and allocated attentional resources to encoding TBR pairs. In specific memory, the positive antecedent view elicited a directed forgetting effect in participants, but gist-only memory did not appear to be systematically the case. This is consistent with investigators' (Adolphs et al., 2001) suggestion that emotions influence memory, possibly only in gist memory. The physics instructional video itself was somewhat logical and the selected participants were already mature in their thinking skills. In the experiment, even when the forgetting instruction occurred, the participants could still guess and make inferences about the picture material presented, based on the context of the video material. Compared to gist memory, specific memory is more difficult to infer and guess. Also, when participants were in a positive emotional state, they were more inclined to adopt holistic processing, focusing their attention on gist information (Corenblum et al., 2020). The experiment simulated an online teaching environment, changing the human interaction to a human-machine interaction, but the situation of "Liking the class because I liked the teacher." still occurred and seemed to carry over from offline to online. As online teaching is not directly supervised by the teacher and is limited by the equipment. The student's attention to the content presented on the screen is more comprehensive. In conjunction with the online teaching context, it is possible to divide the remembered and forgotten segments into priority and non-priority content.

Negative antecedent view on different memory types of the DF Effect

Our study found that the negative antecedent view weakened the directed forgetting effect, which supported the idea that negative emotions might impair source memory. Emotions dissipate when induced prior to encoding, but appear to affect memory when induced prior to retrieval (Goernert et al., 2021; Otani et al., 2012). According to emotional coherence theory, prior evoked emotions lead to more efficient cognitive processing of learning materials with the same properties than other materials. Although we measured arousal and emotional valence of the physical video prior to the experiment, we did not exclude the additional circumstance that it was a negative material for the participants. When participants were in a negative mood, experimental material of the same nature were preferentially processed. In addition to Kensinger's(2009) explanation of emotional events. Researchers conducting meta-analyses of the literature on DF using item-based methods have found that emotional memories tend to be more resistant to intentional forgetting than neutral memories, although further research is needed to describe how these differences occur (Hall et al., 2021). In previous studies using evoked emotions, there have been two results as to whether negative emotions can elicit a stable directed forgetting effect. The reason for this may be the presence of two emotional variables, one being the participant's own emotional state and the other being the emotional nature of the learning material. Researchers explored the interaction between the two and found that individuals with depressive tendencies had difficulty inhibiting memory encoding of negative words, which may result from inefficient memory inhibition and early selective attention (Xie et al., 2018). Second, negative antecedent view did not cause individuals to experience orienting forgetting in specific memory, but they enhanced memory for gist information, contrary to previous research (Kensinger et al., 2006, 2007). Some data suggest that negative arousal may increase attention to specific memory, thus making it more difficult to be forgotten (Kensinger et al., 2006). The above studies used static material with valence. In Experiment 1, we used dynamic video material. Combined with the fact that the participants themselves had some scientific literacy, it was possible for them to make speculations about the recalled content based on the material, thus improving the memory of the gist information. Ren et al. (2019) randomly disrupted the order in which the video content were presented in an experiment that broke the relevance of the information, and directed forgetting occurred for gist-only memory, and there was an effect of continuity and relevance of gist-only memory to content. In addition, the sequential nature of the memorized material leads to a certain degree of inability to remember efficiently. However, knowledge itself is somewhat systematic and logical, and disrupting the structure to deliver knowledge to students is not conducive to students forming their own knowledge system. In order to improve students' efficient retention of knowledge, a fragmented presentation is only counterproductive.

Different presentation formats of learning materials on DF

Different materials can have different effects on directional forgetting (Chen et al., 2022; Kissler & Hauswald, 2022; Pastötter & Haciahmet, 2022b; Quinlan et al., 2010). The results of Experiment 2 showed that the static presentation of the material enhanced learning more than the dynamic. The static condition group remembered the fragments correctly at a significantly higher rate than the forgotten fragments, which is consistent with previous experiments in which numerous researchers used static pictures and text as learning materials (Barnier et al., 2007; Keith Payne & Corrigan, 2007; Taylor et al., 2018). The magnitude of the directed forgetting effect in the item approach depends on the extent to which participants manipulate items while encoding. Directed forgetting involves bottom-up selective attention as well as top-down inhibition of extraction, and stopping unwanted TBF item rehearsals requires limited attentional resources in the short term, but may eventually release these attentional resources for further TBR item processing and rehearsal in the long term (Hourihan & Taylor, 2006; Rubinfeld et al., 2019). Compared to the redundancy of dynamic material, static material has clearer information and is better matched to the task goal. This will reduce the cognitive load that arises when individuals engage in attention allocation, resulting in a much higher directed forgetting effect (Chen et al., 2021; Quinlan et al., 2010; Wang et al., 2020). As the learning material becomes richer and more interesting, the active cognitive process of forgetting requires more mental resources from the learner. It is more difficult to forget a video clip than to remember it (Fawcett et al., 2013a, b). In general, static material is more conducive to improved learning outcomes. This has implications for the future of online teaching and learning. In the current model of online teaching in China, the text-and-picture PowerPoint format is more common. However, the use of animations, videos and other dynamic materials requires careful production design of content, and once there is too much irrelevant content, students' memory of the key content will be impaired when learning.

Limitations and future directions

This study verified that dynamic materials can cause a stable directional forgetting effect Based on this, explored the differences induced by static and dynamic materials to provide input for the form of multimedia use for online instruction. To a certain extent, this study provides data support for the cognitive load theory, where static materials have less cognitive load and their lead to a more pronounced directed forgetting effect. Second, the results demonstrate that emotional state affects individuals' final processing strategies, supporting the AACF.

The current study leaves room for improvement in the following areas. First, only the video materials were rated when the experimental materials were assigned, and the altered static learning materials were not rated for valence and arousal. Nor were the reidentified picture materials rated the same or similar, leading to some bias in the experimental results. Second, in the dynamic physics instructional video, alternating animations of the teacher and tutorial comprehension were used. The effect of the presentation of the teacher image on the directed forgetting effect was not discussed separately in the experiment and can be compared in subsequent studies. Last but not least, the form of input for antecedent views needs to be explored, and this type of extrinsic emotion design requires some degree of emotion measurement of the participants after the elicitation to make the experimental results more scientifically valid.

Conclusion

In summary, the current study demonstrates several novel implications: (a) In online teaching situations, positive antecedent views induce the directed forgetting effect, while negative antecedent views weaken it; (b)There was a difference in the effect of antecedent views on memory type, with positive views causing directed forgetting of specific memories, while negative views did not cause directed forgetting and even improved memory for gist-only information; (c) Reliable DF effect suggests the pivotal roles of static material, while dynamic material did not. Compared to dynamic materials, static materials were more effective in enhancing learners' learning. Static materials, which are more focused and produce less cognitive load. Although dynamic materials are more interesting, they also tend to include a lot of irrelevant content, which affects the learning effect.

Authors' contributions Baolin Huang conceived the study and designed the trial;Lele Fang and Baolin Huang supervised the conduct of the trial, data collection, provided statistical advice on study design and analyzed the data. Baolin Huang drafted the manuscript, and all authors contributed substantially to its revision. Lele Fang took responsibility for the paper as a whole.

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Availability of data and material The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Informed consent Informed consent was obtained from all individual participants included in the study.

Ethics approval This study was approved and consented by the Ethics Committee of The School of psychology of Liaoning Normal University.

Conflict of interest The authors have no relevant financial or non-financial interests to disclose.

References

Adolphs, R., Denburg, N. L., & Tranel, D. (2001). The amygdala's role in long-term declarative memory for gist and detail. *Behavioral Neuroscience*, *115*(5), 983–992. https://doi.org/10.1037//0735-7044.115.5.983

Adolphs, R., Tranel, D., & Buchanan, T. W. (2005). Amygdala damage impairs emotional memory for gist but not details of complex stimuli. *Nature Neuroscience*, *8*(4), 512–518. https://doi.org/10.1038/nn1413

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

Barnier, A. J., Conway, M. A., Mayoh, L., Speyer, J., Avizmil, O., & Harris, C. B. (2007). Directed forgetting of recently recalled autobiographical memories. *Journal Of Experimental Psychology: General*, *136*(2), 301–322. https://doi.org/10.1037/0096-3445.136.2.301

Bäuml, K. H., & Kuhbandner, C. (2007). Remembering can cause forgetting–but not in negative moods. *Psychological Science*, *18*(2), 111–115. https://doi.org/10.1111/j.1467-9280.2007.01857.x

Bäuml, K. H., & Kuhbandner, C. (2009). Positive moods can eliminate intentional forgetting. *Psychonomic Bulletin & Review*, *16*(1), 93–98. https://doi.org/10.3758/pbr.16.1.93

Bhullar, N. (2012). Relationship between mood and susceptibility to emotional contagion: is positive mood more contagious? *North American Journal of Psychology*, *14*, 517–529.

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

Burke, A., Heuer, F., & Reisberg, D. (1992). Remembering emotional events. *Memory & Cognition*, *20*(3), 277–290. https://doi.org/10.3758/BF03199665

Chen, Y., Liu, C., Du, Y., Zhang, J., Yu, J., & Xu, H. (2022). Machine learning classification model using Weibo users' social appearance anxiety. *Personality and Individual Differences*, *188*, 111449. https://doi.org/10.1016/j.paid.2021.111449

Chen, Y., Xu, H., Liu, C., Zhang, J., & Guo, C. (2021). Association Between Future Orientation and Anxiety in University Students During COVID-19 Outbreak: The Chain Mediating Role of Optimization in Primary-Secondary Control and Resilience. *12*. https://doi.org/10.3389/fpsyt.2021.699388

Corenblum, B., Goernert, P. N., & Watier, N. N. (2020). Directed forgetting of emotionally valenced faces. *Acta Psychol (Amst)*, *206*, 103077. https://doi.org/10.1016/j.actpsy.2020.103077

Depue, B. E., Banich, M. T., & Curran, T. (2006). Suppression of emotional and nonemotional content in memory: effects of repetition on cognitive control. *Psychological Science*, *17*(5), 441–447. https://doi.org/10.1111/j.1467-9280.2006.01725.x

Dougal, S., & Rotello, C. M. (2007). "Remembering" emotional words is based on response bias, not recollection. *Psychonomic Bulletin & Review*, *14*(3), 423–429. https://doi.org/10.3758/bf03194083

Fawcett, J. M., Taylor, T. L., & Nadel, L. (2013a). Event-method directed forgetting: forgetting a video segment is more effortful than remembering it. *Acta Psychol (Amst)*, *144*(2), 332–343. https://doi.org/10.1016/j.actpsy.2013.07.005

Fawcett, J. M., Taylor, T. L., & Nadel, L. (2013b). Intentional forgetting diminishes memory for continuous events. *Memory (Hove, England)*, *21*(6), 675–694. https://doi.org/10.1080/09658211.2012.748078

Goernert, P. N., Corenblum, B., & Watier, N. (2021). Mood states effect retrieval not encoding in item-method directed forgetting. *Journal of Cognitive Psychology*, *33*(4), 424–438. https://doi.org/10.1080/20445911.2021.1903013

Hall, K. J., Fawcett, E. J., Hourihan, K. L., & Fawcett, J. M. (2021). Emotional memories are (usually) harder to forget: a meta-analysis of the item-method directed forgetting literature. *Psychonomic Bulletin & Review*, *28*(4), 1313–1326. https://doi.org/10.3758/s13423-021-01914-z

Hauswald, A., Schulz, H., Iordanov, T., & Kissler, J. (2011). ERP dynamics underlying successful directed forgetting of neutral but not negative pictures. *Soc Cogn Affect Neurosci*, *6*(4), 450–459. https://doi.org/10.1093/scan/nsq061

Hourihan, K. L., & Taylor, T. L. (2006). Cease remembering: control processes in directed forgetting. *Journal Of Experimental Psychology: Human Perception And Performance*, *32*(6), 1354–1365. https://doi.org/10.1037/0096-1523.32.6.1354

Joslyn, S. L., & Oakes, M. A. (2005). Directed forgetting of autobiographical events. *Memory & Cognition*, *33*(4), 577–587. https://doi.org/10.3758/bf03195325

Keith Payne, B., & Corrigan, E. (2007). Emotional constraints on intentional forgetting. *Journal of Experimental Social Psychology*, *43*(5), 780–786. https://doi.org/10.1016/j.jesp.2006.07.005

Kensinger, E. A. (2009). Remembering the details: Effects of emotion. *Emotion Review*, *1*(2), 99–113. https://doi.org/10.1177/1754073908100432

Kensinger, E. A., Garoff-Eaton, R. J., & Schacter, D. L. (2006). Memory for specific visual details can be enhanced by negative arousing content. *Journal of Memory and Language*, *54*(1), 99–112. https://doi.org/10.1016/j.jml.2005.05.005

Kensinger, E. A., Garoff-Eaton, R. J., & Schacter, D. L. (2007). Effects of emotion on memory specificity: memory trade-offs elicited by negative visually arousing stimuli. *Journal of Memory and Language*, *56*(4), 575–591. https://doi.org/10.1016/j.jml.2006.05.004

Kensinger, E. A., Piguet, O., Krendl, A. C., & Corkin, S. (2005). Memory for contextual details: effects of emotion and aging. *Psychology And Aging*, *20*(2), 241–250. https://doi.org/10.1037/0882-7974.20.2.241

Kim, C., & Pekrun, R. (2014). Emotions and motivation in Learning and Performance. In J. M. Spector, M. D. Merrill, J. Elen, & M. J. Bishop (Eds.), *Handbook of Research on Educational*

Communications and Technology (pp. 65–75). New York, NY: Springer New York.
Kissler, J., & Hauswald, A. (2022). Different ways to forget: electrophysiological mechanisms underlying item-method directed forgetting of angry and neutral faces. *Frontiers In Behavioral Neuroscience*, *16*, 957227. https://doi.org/10.3389/fnbeh.2022.957227
Nowicka, A., Marchewka, A., Jednoróg, 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
Otani, H., Libkuman, T. M., Goernert, P. N., Kato, K., Migita, M., Freehafer, S. E., & Landow, M. P. (2012). Emotion, directed forgetting, and source memory. *British Journal Of Psychology*, *103*(3), 343–358. https://doi.org/10.1111/j.2044-8295.2011.02078.x
Pastötter, B., & Haciahmet, C. C. (2022a). Can people intentionally and selectively forget prose material? Frontiers In Psychology, 13, 928533. https://doi.org/10.3389/fpsyg.2022.928533
Pastötter, B., & Haciahmet, C. C. (2022b). Can People Intentionally and Selectively Forget Prose Material?, 13. https://doi.org/10.3389/fpsyg.2022.928533
Qiyong, Z., & Jiamei, L. U. (2015). The Regulation Effect of Antecedent View on Emotional Contagion: with examples of teaching activities. *Acta Psychologica Sinica*, *47*(6), 797–806.
Quinlan, C. K., Taylor, T. L., & Fawcett, J. M. (2010). Directed forgetting: comparing pictures and words. *Canadian Journal Of Experimental Psychology*, *64*(1), 41–46. https://doi.org/10.1037/a0016569
Ren, X., Li, Y., Mao, W., & Geng, Q. (2019). The effect of emotion on directed forgetting for continuous events. *Acta Psychologica Sinica*, *51*(3), 269–279. https://doi.org/10.3724/sp.J.1041.2019.00269
Rubinfeld, L. M., Taylor, T. L., & Hamm, J. P. (2019). Selection for encoding: no evidence of better endogenous orienting following forget than following remember instructions. *Attention, Perception, & Psychophysics*, *81*(1), 237–252. https://doi.org/10.3758/s13414-018-1587-7
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
Snodgrass, J. G., & Corwin, J. (1988). Perceptual identification thresholds for 150 fragmented pictures from the Snodgrass and Vanderwart picture set. *Perceptual And Motor Skills*, *67*(1), 3–36. https://doi.org/10.2466/pms.1988.67.1.3
Sritharan, R., Heilpern, K., Wilbur, C. J., & Gawronski, B. (2010). I think I like you: spontaneous and deliberate evaluations of potential romantic partners in an online dating context. *European Journal of Social Psychology*, *40*(6), 1062–1077. https://doi.org/10.1002/ejsp.703
Sweller, J., van Merrienboer, J. J. G., & Paas, F. G. W. C. (1998). Cognitive Architecture and Instructional Design. *Educational Psychology Review*, *10*(3), 251–296. https://doi.org/10.1023/A:1022193728205
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
Taylor, T. L., Quinlan, C. K., & Vullings, K. C. H. (2018). Decomposing item-method directed forgetting of emotional pictures: equivalent costs and no benefits. *Memory & Cognition*, *46*(1), 132–147. https://doi.org/10.3758/s13421-017-0751-y
Visser, V. A., van Knippenberg, D., van Kleef, G. A., & Wisse, B. (2013). How leader displays of happiness and sadness influence follower performance: emotional contagion and creative versus analytical performance. *The Leadership Quarterly*, *24*(1), 172–188. https://doi.org/10.1016/j.leaqua.2012.09.003
Wang, C., Fang, T., & Gu, Y. (2020). Learning performance and behavioral patterns of online collaborative learning: impact of cognitive load and affordances of different multimedia. *Computers & Education*, *143*, 103683. https://doi.org/10.1016/j.compedu.2019.103683
Wessel, I., & Merckelbach, H. (2006). BRIEF REPORT forgetting "murder" is not harder than forgetting "circle": Listwise-directed forgetting of emotional words. *Cognition and Emotion*, *20*(1), 129–137. https://doi.org/10.1080/02699930500260195
Xie, H., Jiang, D., & Zhang, D. (2018). Individuals with depressive tendencies experience difficulty in forgetting negative material: two mechanisms revealed by ERP data in the directed forgetting paradigm. *Scientific Reports*, *8*(1), 1113. https://doi.org/10.1038/s41598-018-19570-0