The effect of stimulus duration on directed forgetting for pictures

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Author Note

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Abstract

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What is memory?

What is memory and how is it altered? Memory is often inaccurately defined as the ability to encode, store and retrieve information. A more accurate definition separates memory into two separate processes. Process one is characterized by remembering information and is defined as successfully encoding, storing and retrieving information. Process two is characterized by forgetting information. This definition allows for the conceptual introduction of intentionally controlling ones memory by selectively forgetting information details. The process by which information is forgotten can be explored using a directed forgetting procedure.

What is Directed Forgetting?

The directed forgetting procedure instructs participants to selectively remember or forget specific events and measures the accuracy with which participants are able to do so (for reviews see, X, X, X). The design of a directed forgetting procedure consists of an encoding phase and a testing phase. The encoding phase presents participants with a series which is then followed by the presentation of instructional cues, directing participants to either remember or forget the previously presented stimulus. After the participants have been presented with all available stimuli, the testing phase begins. This testing phase then presents the same stimuli of the encoding phase against previously unseen stimuli, and tasks participants to accurately identify the stimulus presented in the encoding phase. Significantly lower accuracy in the recognition of forget-cued encoding stimuli is an indication of the presence of a phenomenon known as the directed forgetting effect.

A classic demonstration of directed forgetting

Bjork (1972) provides a description of traditional directed forgetting procedures. Generally, these procedures present participants with a series of items and cues. There are a

number of ways to cue various item sets, including intraserial cuing, postinput cuing and pre-input cuing. The most common method of cuing item sets throughout traditional directed forgetting procedures is intraserial cuing. Intraserial cuing sequentially presents participants with a set of items and directs them to either forget or remember said item using the cue's instruction. Though the item presented during such experiments may vary, traditional directed-forgetting procedures discussed throughout this paper use word stimuli as the presented items. Traditional directed forgetting procedures also determine the presence and magnitude of a directed forgetting effect using either recognition or recall based testing conditions. Testing conditions which operationalize the directed forgetting effect as the accurate recall of "Forget-cued" stimuli do so by having participants recall as many wordage items as possible, without regard to the cue instructions. Previous research employing this recall-based directed forgetting procedure has identified a directed forgetting effect of 10-15% for F- cued wordage stimuli, compared to the R- cued wordage stimuli (Weiner & Reed, 1969). Testing conditions which operationalize the directed forgetting effect as the accurate recognition of "Forget-cued" stimuli do so by having participants identify as many previously seen wordage items as possible, without regard to the cue instructions.

What do we empirically know about directed forgetting?

Mcleod (1998) has identified 38 factors with the potential to influence the directed-forgetting effect. This paper will specifically focus on 4 of these 38 factors. These 4 factors include cue presentation time, stimulus presentation time, stimulus detail and stimulus type.

Wetzel and Hunt (1977) used a directed forgetting procedure to explore the effects of cue duration on the participant recall accuracy of word stimuli. This exploration required the manipulation of both the stimuli presentation duration and the cue presentation duration during the encoding phase, creating two separate experimental conditions. These experimental conditions are known as the long delay condition and the short delay condition.

The long-delay condition presents the word stimuli for a duration of 2, 4 or 8 seconds and the cue for a duration of 1 second, while the short-delay condition presents the word stimuli for a duration of 1 second and the cue for a duration of 2, 4 or 8 seconds. The result of this experiment indicates that short delay conditions, specifically conditions with short stimulus duration and long cue duration lead to an increased directed forgetting effect. These results serve as a motivation for the factorial manipulation of stimuli presentation duration within my experiment.

Ahmad et al (2019) used a directed forgetting procedure which explored the effects of stimuli details on accuracy of participant recognition of encoding phase stimuli. This was done through the introduction of novel testing conditions and exemplar conditions into the testing phase. Novel conditions present the same stimuli from the encoding phase against previously unseen stimuli, completely different to that of the encoding stimuli. Exemplar conditions present the same stimuli from the encoding phase against previously unseen stimuli similar to that of the encoding stimuli. Both conditions task participants to accurately identify the stimulus presented in the encoding phase. The results of this experiment indicate the existence of a significantly lower directed forgetting effect for novel testing conditions. This indication of significantly higher accuracy in participant recognition for novel testing conditions than exemplar testing conditions serves as a motivation for my experiment.

Traditional directed forgetting experiments employed both recall-based testing procedures and verbage stimuli to determine the existence of a directed forgetting effect amongst participants. Epstein (1972) defines the directed forgetting effect from the more traditional perspective as a significant decrease in participant ability to accurately recall the verbage stimuli presented during the encoding phase from memory. The issue with recall-based directed forgetting procedures, is that they fail to consider inherently more memorable stimuli. Standing (1973) shows that people possess the ability to remember

thousands of pictures, along with the object details within said pictures (MacLeod, 1998). Ahmad et al. (2017) considers this in his experiment through the use of a recognition-based directed forgetting procedure and pictorial stimuli throughout the encoding phase. The results of this experiment indicate that although directed forgetting for pictures and their objects, its effects are extremely small. These results and the memorable ability of images as opposed to word stimuli serves as the motivation for the use of image stimuli throughout my experiment.

Experiment 1

Experiment 1 quite similarly resembles the traditional directed forgetting procedural technique used by Bjork (XXXX) to explore participant recognition of previously seen encoding stimuli when randomly presented with distractors throughout the testing phase. Deviations from the procedure observed in Bjork's experiment include (1) the factorial manipulation of stimuli presentation duration by 500 milliseconds, 1 second and 2 seconds (2) the randomized presentation of novel and exemplar distractors throughout the testing phase (3) the use of inherently more memorable stimuli -images- throughout both the encoding and testing phase, instead of word stimuli.

Method

Participants. All participants in this experiment were undergraduate students in the City University of New York (CUNY) Brooklyn College. In total, XXXX subjects participated in experiment 1. Subjects received course credit for participation in this experiment. All procedures issued by the Brooklyn College Institutional Review Board were followed and consent was received from all subjects throughout each phase of this experiment.

Stimuli and Apparatus. There were 120 images from a total of 16 categorical scenes presented throughout the encoding phase of this experiment. These sixteen categorical scenes were further classified as being either outdoor scenes or indoor scenes. The eight of sixteen outdoor visual scenes consisted of settings which included bedrooms,

churches, classrooms, offices, dining rooms, conference rooms, hair salons & empty rooms. The eight of sixteen indoor visual scenes consisted of settings such as airports, bridges, beaches, castles, cemeteries, houses, tents and playgrounds. These 120 images were of the same database of 320 total images of 24 different categorical scenes created by Xiao et al (2010). Konkle et al (2010b) and Ahmed, Tan & Hockley (2016) made similar use of this image dataset in earlier experiments.

Alongside the initial 120 images presented during the encoding phase, another 120 images were selected as distractors throughout the testing phase. Sixty of these images were of the same visual scene categories as the images presented during the encoding phase. These images were presented as exemplar distractor testing conditions. The other half of the 120 distractor images were of completely new visual scene categories as the images presented throughout the encoding phase. These distractor images were presented as novel distractor testing conditions. This experiment was programmed in JavaScript using Jspsych and was served onto the web using Jatos. The results of this experiment were analyzed using Rcode.

Design. This experiment consisted of a 2x2x3 completely within-subjects experimental design, with the manipulated variables including the Distractor Test, Cue & picture encoding time. The distractor testing condition variable possessed two distinct manipulations, being novel testing conditions and exemplar testing conditions. Novel testing conditions display images with previously unseen or unrelated visual scene categories as distractors during the testing phase. Exemplar testing conditions display images with similar visual scene categories as distractors during the testing phase. The picture presentation time variable possessed three distinct manipulations to the duration of images presented during the encoding phase of the experiment. These three manipulations included durations of 500 milliseconds, 1 second and 2 seconds. The cue presentation variable possessed two distinct manipulations. These two manipulations included the “Remember” cue and the “Forget” cue. The Remember cue instructs participants to remember the upcoming image stimuli, while the “Forget” cue instructs participants to selectively forget the upcoming image stimuli.

Procedure.

Participants used the (XXXX) site to access the experiment. As stated earlier, there are two major phases of the experiment. These phases are the encoding phase and the testing phase. Prior to the encoding phase however, participants were presented with a consent form. Upon completion of the consent form, they were presented with encoding phase instructions.

During the encoding phase, participants are presented with the cue instructions followed by the images. The cues instruct participants to either selectively remember or selectively forget the upcoming image stimuli at random. There are a total of 120 cue instructions, which are presented for a duration of (XXXX) seconds. The image stimuli presented during the encoding phase are composed of the 120 images from a total of 16 categorical scenes subsetted from the larger database of 320 images with a total of 24 categorical scenes. These 120 images are presented at random at durations of either 500 milliseconds, 1 second or 2 seconds. The presentation times of the images will also be displayed at random. Seeing as how the presentation of a single cue instruction followed by a single image consists of a single trial, and there are 120 cue instructions and 120 images to be presented, then there will be 120 trials throughout the encoding phase of this experiment. Upon completion of the encoding phase, participants were then taken to the testing phase. Similarly to the encoding phase, during the beginning of the testing phase participants were given instructions of completing the testing phase. During the testing phase, participants are given a series of trials where they are shown either an exemplar distractor image or a novel distractor image alongside an image previously seen during the encoding phase and are tasked with selecting the encoding image. There are 60 novel distractor images and 60 exemplar distractor images, each of which were presented at random throughout the testing procedure.

Results

We used R (Version 4.1.0; R Core Team, 2021) and the R-packages *dplyr* (Version 1.0.7; Wickham, François, Henry, & Müller, 2021), *forcats* (Version 0.5.1; Wickham, 2021a), *ggplot2* (Version 3.3.5; Wickham, 2016), *jsonlite* (Version 1.7.2; Ooms, 2014), *pacman* (Version 0.5.1; Rinker & Kurkiewicz, 2018), *papaja* (Version 0.1.0.9997; Aust & Barth, 2020), *purrr* (Version 0.3.4; Henry & Wickham, 2020), *readr* (Version 2.0.2; Wickham & Hester, 2021), *stringr* (Version 1.4.0; Wickham, 2019), *tibble* (Version 3.1.6; Müller & Wickham, 2021), *tidyr* (Version 1.1.4; Wickham, 2021b), *tidyverse* (Version 1.3.1; Wickham et al., 2019), and *tinylabels* (Version 0.2.1; Barth, 2021) for all our analyses. We collected five subjects worth of pilot data. For each subject we computed mean recognition accuracy in each condition of the design. Figure 1 shows mean recognition accuracy in each condition, collapsed across each subject.

Discussion

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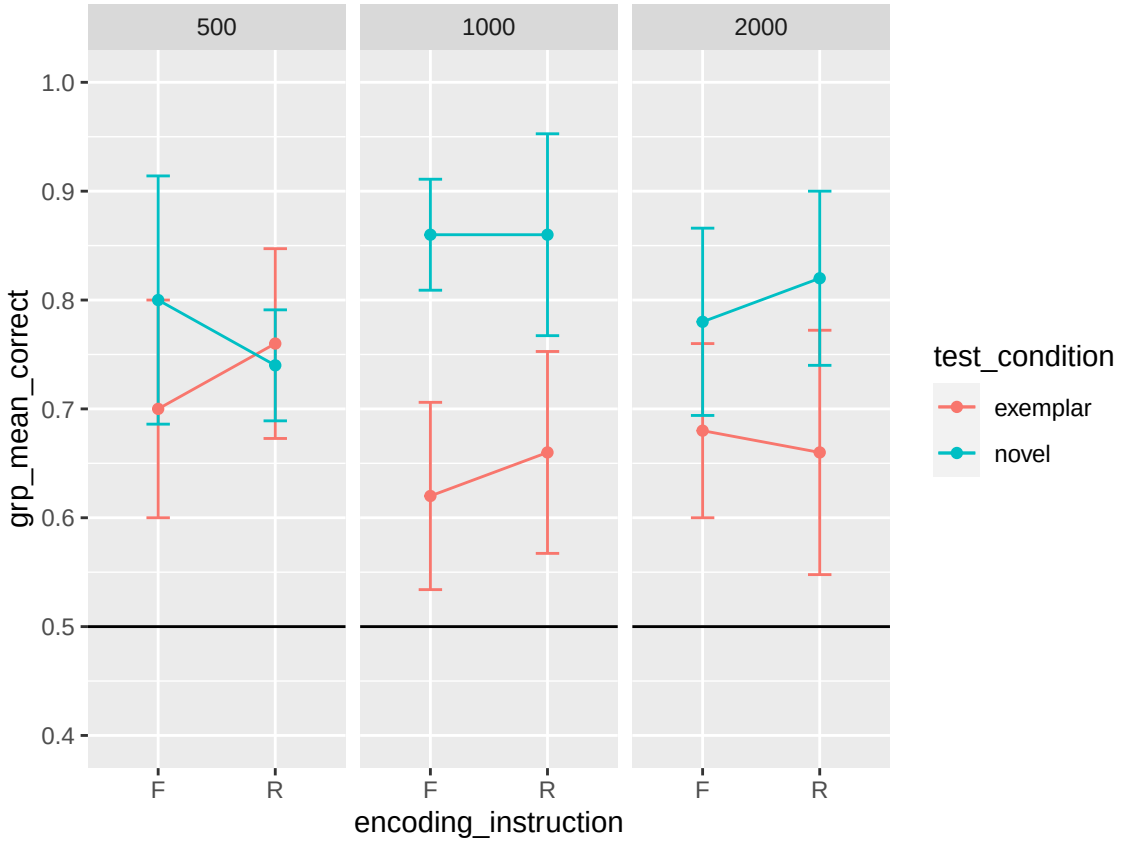

Figure 1. Mean recognition accuracy for each condition in the Pilot experiment