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The Limited Effects of Prequestions on Learning from Authentic Lecture Videos

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Asking questions prior to learning enhances memory. Although this *prequestion effect* typically applies only to information that was prequestioned and not to other, non-prequestioned information, recent research using short videos found benefits to both prequestioned and non-prequestioned information. In the current study, students viewed authentic video-recorded lectures, each over 20 min, prepared for actual courses on signal detection theory (Experiment 1) and autobiographical memory (Experiment 2). Some students answered prequestions before viewing the videos (prequestion group) and some did not (control group). At final test the prequestion group outperformed the control group overall, as well as specifically for prequestioned information, but performance on non-prequestioned information was either not different from (Experiment 1) or only marginally better than (Experiment 2) the control group. The benefit of prequestions did not interact with subjective interest in the material. These results suggest positive but limited benefits of prequestions for educationally realistic lecture videos.

General Audience Summary

A powerful way to enhance students' memory for material they are trying to learn is to ask them questions about it. Asking questions prior to reading some to-be-learned information—i.e., prequestions—can significantly boost students' learning of that information. However, this effect tends to be specific to the information from the reading material that was relevant to the prequestions (i.e., prequestioned information), and does not usually occur for other portions of the material that were not relevant to the prequestions (i.e., non-prequestioned information). An important but neglected question is whether prequestions enhance learning from lectures and presentations. Preliminary data suggest that prequestions confer general benefits on learning of information from brief video presentations—enhancing both prequestioned and non-prequestioned information—but their effects on more authentic (longer and more complex) lecture-based learning are unclear. Students in the current study viewed lecture videos that had been prepared for actual classes on signal detection theory (Experiment 1) and autobiographical memory (Experiment 2). Some students answered prequestions before viewing the videos (prequestion group) and some did not (control group). On a later test over the lectures, the prequestion group scored higher than the control group. In Experiment 1, this advantage only occurred for the prequestioned information and not for the non-prequestioned information, whereas in Experiment 2 a marginal advantage

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occurred for the non-prequestioned information as well. These results suggest that under realistic lecture conditions, prequestions can enhance learning of upcoming information that is relevant to those questions, but do not consistently enhance learning of other, non-prequestioned information. Prequestions thus have positive, but limited, effects on authentic lecture-based learning.

Keywords: Prequestions, Testing, Retrieval, Learning, Memory

Research on student learning has revealed a number of techniques that can significantly enhance memory. One of the simplest yet most effective techniques is to provide students with questions over what they are trying to learn. Research on retrieval practice shows that answering questions about material that has just been presented, as opposed to restudying the same material, produces significant benefits on later memory for material such as new vocabulary (e.g., Finn & Roediger, 2011; Pyc & Rawson, 2010), reading passages (e.g., Butler, 2010; Hinze, Wiley, & Pellegrino, 2013), and lectures (Butler & Roediger, 2007).

Though comparatively less research has examined the effects of asking students questions *before* they learn something, such prequestions can also enhance memory. In one study (Rickards, 1976a), participants read a short passage about a fictitious African country called Mala. Some participants (the prequestion group) answered questions over the passage before reading it (e.g., "How many inches of rain fall per year in southern Mala?"), and others did not (the control group). On a later test requiring recall of the passage, the prequestion group outperformed the control group. Other studies have shown similar benefits (Little & Bjork, 2016; Peeck, 1970; Pressley, Tanenbaum, McDaniel, & Wood, 1990; Richland, Kornell, & Kao, 2009; Rickards, 1976b; Rickards, Anderson, & McCormick, 1976), suggesting that the opportunity to preview questions—even though participants often got them wrong and were not told the correct answers at the time—enhances learning of reading passages.

One explanation for the benefits of prequestions is enhanced attentional processing. Prequestions provide an idea of what information the to-be-learned material will contain, making that information more familiar and noticeable when it occurs (e.g., Hannafin & Hughes, 1986). Prequestions might also give students an impression that the prequestioned information is important to learn, or could make explicit to them the fact that the information is not already known, serving to arouse curiosity and stimulate efforts to read the passage more carefully (e.g., Berlyne, 1954, 1962). One or all of these possibilities increase the likelihood that students who receive prequestions will attend more to the reading passage—most likely the information relevant to the prequestions—than students who do not receive prequestions.

Consistent with this notion, prequestions usually produce greater benefits on memory for prequestioned information compared to non-prequestioned information. For example, in learning about Mala (Rickards, 1976a), students who were asked prequestions about the annual rainfall in Mala later remembered this information better than other information from the passage that was not prequestioned, such as information about Mala's social conditions. Other studies have shown this same effect, along with the tendency for the prequestion group to remember the non-prequestioned information no better than the control group (e.g., Bull & Dizney, 1973; Frase, 1968; Pressley et al., 1990; Richland et al., 2009).

However, there are circumstances under which prequestions might have both specific and general benefits. Whereas research on prequestions typically uses reading passages as stimuli, Carpenter and Toftness (2017) recently explored these effects on memory for video presentations. The prequestion group answered questions prior to viewing a brief video on the history of Easter Island (e.g., "How many families originally settled on the island of Rapa Nui?"), and the control group did not. On a test over the material from the video, the prequestion group outperformed the control group on both prequestioned and non-prequestioned information. The authors posited that video presentations or lectures (compared to reading passages) may be more likely to show these general benefits because students' attention may be more uniformly distributed. Unlike self-paced reading materials that allow learners to selectively focus their attention on prequestioned information and possibly ignore non-prequestioned information, videos provide instructor-paced information that would seem less likely to be subject to this selective processing.

These findings might offer a promising way to enhance students' learning from lectures and presentations. However, more research is needed to understand the role that prequestions play in learning from lectures. The study by Carpenter and Toftness (2017) is not highly representative of a real classroom lecture, as students were asked two fairly simple prequestions prior to viewing a brief 2-min video segment. Real classroom lectures are much longer and usually contain more complex information. If prequestions enhance learning because they encourage participants to devote more attentional processing to the video, then such processing would seem fairly easy to maintain over the course of a short video. When the lecture is longer or more complex, however, attentional resources may be limited and devoted more selectively to only some of the information. Under these conditions, priority may be given to the prequestioned information (relative to the non-prequestioned information) because it is more familiar. There are reasons to expect, therefore, that the effects of prequestions on lecture-based learning may be limited when the lectures are more educationallyrealistic. This has not yet been empirically tested within the known research on prequestions.

The purpose of the current study was to explore the effects of prequestions on memory for educationally realistic lecture videos. These videos were prepared for actual courses on signal detection theory (Experiment 1) and autobiographical memory

(Experiment 2) and contained visual graphics, animations, and the voice of an instructor explaining the content. In both experiments, all students viewed the video and then took a 20-item multiple-choice test over the contents. Some students (the prequestion group) answered questions about the video before viewing it, whereas others (the control group) did not. For the prequestion group, the 20-item test contained 10 questions that had previously appeared as prequestions (i.e., prequestioned information), and 10 that had not (i.e., non-prequestioned information).

Based on previous research (Carpenter & Toftness, 2017; Little & Bjork, 2016; Pressley et al., 1990; Richland et al., 2009), we expected that a learning advantage would result from having a chance to preview some of the test questions ahead of time. Given the complexity of the topic and length of the videos, however, we expected that this advantage may be specific rather than general. Due to limitations on attentional processing with educationally realistic videos, the benefits of prequestions were expected to occur for prequestioned information, but were expected to be weaker—and possibly eliminated—for non-prequestioned information.

Experiment 1

Participants

A total of 107 students from Iowa State University participated in exchange for partial course credit or a payment of $10.[1] The participants consisted of 68% ($n = 73$) females and 32% ($n = 34$) males. Participants completed the experiment individually on personal computers.

Materials

Participants viewed a video lecture on the topic of signal detection theory that had been prepared for an actual course. The video lasted 22 min 13 s and consisted of an animated slide show with graphics and voiceover of an instructor explaining the concepts. Twenty multiple-choice questions pertaining to the video material were created. Each question had four alternatives (A through D) with one correct answer. While there was some necessary topic overlap in the questions (e.g., more than one question pertained to the topic of ROC analysis), knowing the answer to any one question did not reveal the answer to any other question. Each of the 20 questions was based on factual, fairly verbatim information that was directly presented in the video (e.g., "Signal detection theory is a theory of:" with response options "A: memory," "B: decision-making," "C: problem-solving," "D: medical diagnosis").

Design and Procedure

Participants were first presented with instructions on the computer informing them that the objective of the study was to understand how people learn from lectures. Participants were informed that they would be viewing a video-recorded lecture about 20 min in length and that later they would be given a memory test over the contents of the lecture. Before proceeding, the instructions informed participants to put on the headphones that were provided.

Participants were randomly assigned to either the prequestion group ($n = 53$) or the control group ($n = 54$). Manipulated between groups was the presence (or absence) of ten prequestions, randomly selected and randomly ordered for each participant from the entire set of 20 questions. Participants in the prequestion group were informed that they would answer some questions about the video before viewing it. For each of these prequestions, participants were required to offer their best guess as to the correct answer by pressing a letter key corresponding to one of the four options. Participants responded at their own pace, and feedback was not provided after these prequestions. Immediately after answering all prequestions, participants in the prequestion group pressed a button to begin viewing the video. Participants in the control group did not see any prequestions before proceeding to view the video. For both groups, the lecture video was presented in one continuous play-through (the pause, rewind, and fast forward functions were disabled) with no breaks.

Upon completion of the video, all participants engaged in a distractor task in which they were asked to answer 28 trivia questions unrelated to the video topic. They were given unlimited time to provide an open-ended response using the keyboard. The correct answer to each trivia question was displayed for seven seconds immediately after the question was answered. This task was inserted to provide some delay (approximately 5 min) between the learning and test phases to encourage final test responses based on learning rather than immediate recognition from the just-seen video.

Following the distractor task, all participants answered all 20 questions about the information presented in the video. For participants in the prequestion group, 10 of these questions were previously seen as prequestions (i.e., prequestioned information), and 10 were never-before-seen questions from the video (i.e., non-prequestioned information). For the control group, the 20 questions were necessarily all over non-prequestioned information. As on the pretest, each question had one correct answer to be selected from the four options (A-D). For the final test, however, a fifth option was added (E) to indicate "I do not know." This option was not included on the pretest in order to encourage participants to think about the questions and answers. On the final test, however, participants' tendencies to select "I do

[1] We did not conduct a formal a priori power analysis to determine sample size. Given the differences in design between the current study and that of Carpenter and Toftness (2017), the expected effect sizes for the current design were not well-informed by previous research. The sample sizes to obtain the same effects observed by Carpenter and Toftness (using G*Power 3.1.5; Faul, Erdfelder, Buchner, & Lang, 2009) were estimated at 34 for the overall effect of prequestions, 110 for the between-subjects general effect of prequestions (showing an advantage for non-prequestioned information in the prequestion group vs. control group), and 27 for the advantage of prequestioned information over non-prequestioned information within the prequestion group. We did not use these rather variable estimates to determine sample size, but rather aimed for a sample size larger than in Carpenter and Toftness. The current data show that the effects are smaller than what was observed by Carpenter and Toftness, which helps contribute understanding of the true effect size in this limited research so far.

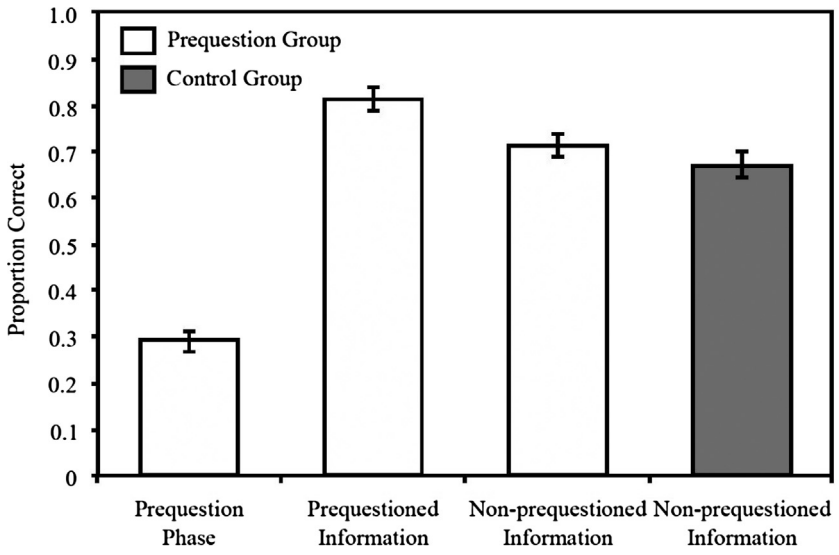

Figure 1. Proportion of correct responses for the prequestion group and control group. On the final test, the prequestion group outperformed the control group, but this benefit was specific to the prequestioned information. For non-prequestioned information, the prequestion group did not score significantly higher than the control group. Error bars represent standard errors.

not know" are informative, as this reflects a true wrong response unobscured by correct guessing. For all participants, the final test questions were presented one at a time in a pre-determined order, separated by a one-second delay, consistent with the order in which the information appeared in the video. Participants responded at their own pace by pressing a single key, and no feedback was provided.

Following the final test, instructions on the computer prompted participants to report if they had any prior knowledge of the information presented in the video before participating in the experiment. The response options were: "A: No, I did not have detailed prior knowledge of this information," "B: I have heard of it before, but did not know the details until today," "C: I may have learned this information before, but I did not remember the details," and "D: I learned this information before, and I remembered the details before coming to today's experiment." After answering this question, participants were informed that the study was complete. They were then debriefed, granted credit or paid, and thanked for their participation.

Results

Data from eight participants were excluded due to computer malfunctions that prevented the video from displaying properly, from one participant whose final test score was more than three standard deviations below the group mean, and from one participant who reported already knowing the material in the video prior to the experiment (i.e., chose Option D when queried about prior knowledge).[2] The following analyses are based on the remaining 97 participants (47 participants in the prequestion group and 50 in the control group).

Figure 1 shows performance during all phases of the study for the prequestion group and the control group. During the prequestion phase, participants answered 29% of the questions correctly ($SD = 15\%$). On the final test, participants answered 81% of these same questions correctly ($SD = 16\%$). This represents a significant improvement in knowledge of the content in the video before and after viewing it, $t(46) = 17.14$, $p < .001$, $d = 2.50$. Participants in the prequestion group also performed higher on the final test for prequestioned information ($M = 81\%$, $SD = 16\%$) compared to non-prequestioned information ($M = 71\%$, $SD = 17\%$), $t(46) = 4.11$, $p < .001$, $d = .60$.

On the final test, overall performance was greater in the prequestion group ($M = 76\%$, $SD = 14\%$) than in the control group ($M = 67\%$, $SD = 20\%$), $t(95) = 2.58$, $p = .011$, $d = .52$, revealing a significant "prequestion effect." However, further analyses showed that this effect was specific to prequestioned information. The prequestion group performed better than the control group on final test questions that had previously appeared as prequestions, $t(95) = 3.80$, $p < .001$, $d = .76$, but not for final test questions that had not appeared as prequestions, $t(95) = 1.11$, $p = .269$.

[2] Ratings of self-reported prior knowledge coincided with objective scores on the prequestions. In Experiment 1, the participant who chose Option D for prior knowledge ("I learned this information before, and I remembered the details before coming to today's experiment") scored 70% on the prequestions, which was significantly higher than prequestion accuracy for participants in the prequestion group who chose Option A ("I did not have any detailed prior knowledge of this information," $n = 43$, $M = .28$, $SD = .15$, $p < .001$), or Option B ("I have heard of it before, but did not know the details until today," $n = 4$, $M = .37$, $SD = .15$, $p = .02$). No significant differences occurred in prequestion accuracy for those who chose Option A vs. Option B, $p = .24$, and in Experiment 1 no participants in the prequestion group chose Option C ("I may have learned this information before, but I did not remember the details"). Similarly, in Experiment 2 the participant in the prequestion group who chose Option D scored 60% on the prequestions, which was significantly higher than prequestion accuracy for those who chose Option A ($n = 27$, $M = .30$, $SD = .15$, $p < .001$), Option B ($n = 7$, $M = .34$, $SD = .17$, $p = .007$), or Option C ($n = 11$, $M = .44$, $SD = .18$, $p = .01$), with no significant differences in prequestion accuracy for those who chose Options A–C, $F(1, 42) = 2.64$, $p = .083$. Thus, in both experiments only data from participants who chose Option D were excluded from further analyses.

To directly compare the specific effect of prequestions (on prequestioned information) to the general effect of prequestions (on non-prequestioned information), we conducted an analysis to examine the potential interaction between group (prequestion vs. control) and type of information tested (prequestioned vs. non-prequestioned). Because the control group did not receive prequestions, we randomly assigned 10 of the 20 questions for each participant in the control group as prequestioned information and 10 as non-prequestioned information. A 2 × 2 (Group: prequestion vs. control × Type of Information: prequestioned vs. non-prequestioned) mixed ANOVA revealed a significant main effect of group, $F(1, 95) = 6.67$, $p = .011$, $\eta^2 = .066$. The main effect of type of information was significant, $F(1, 95) = 9.72$, $p = .002$, $\eta^2 = .093$. Finally, a significant interaction occurred, indicating a stronger effect of prequestions on prequestioned information than on non-prequestioned information, $F(1, 95) = 6.51$, $p = .012$, $\eta^2 = .064$.

Discussion

Experiment 1 revealed a significant prequestion effect with video lectures. Unlike previous research using short videos, however (Carpenter & Toftness, 2017), the overall effect from Experiment 1 was weaker and restricted to prequestioned information. This finding is consistent with the reasoning that prequestions are less likely to be effective over longer and more authentic lecture durations. In addition to the length of the videos, however, the content also differed markedly between the 2-min video on Easter Island used in the study by Carpenter and Toftness, compared to the 22-min video on signal detection theory used in Experiment 1. It is possible that participants find the former topic more interesting than the latter. Participants' level of subjective interest in the material, independently from the length of the lecture video, may drive the attention they devote to the video, and in turn be an important contributor to the general effects of prequestions. These potential effects cannot be determined from Experiment 1. Thus, Experiment 2 was conducted to address the role that subjective interest in the lecture topic might play in the prequestion effect.

Experiment 2

Experiment 2 was designed to replicate and extend Experiment 1, and to determine whether participants' subjective interest in the topic contributes to the prequestion effect. Using the same basic procedure from Experiment 1, students in Experiment 2 viewed a different lecture video of similar duration (24 min) on the topic of autobiographical memory. Based on the experiences of the instructor who created both lecture videos, the topic of autobiographical memory was expected to be more interesting to participants than signal detection theory.

To explore the potential role of subjective interest, participants in Experiment 2 (both prequestion and control groups) were asked to rate their level of interest in the video based on a brief description of the topic before viewing it. If subjective interest contributes to the prequestion effect, then the benefits of prequestions on later memory should be stronger for participants who express greater interest in the topic.

Participants

A total of 102 students from Iowa State University (a sample size comparable to that of Experiment 1) participated in exchange for partial course credit or a payment of $10. The participants consisted of 63% ($n = 64$) females and 37% ($n = 38$) males. Participants completed the experiment individually on personal computers.

Materials

The video on autobiographical memory was created by the same instructor who created the Experiment 1 video on signal detection theory and consisted of the same basic delivery style with graphics, animations, and voiceover. The video duration was 24 min 2 s. As before, 20 multiple-choice questions were created from the video material, each having four alternatives (A through D) and one correct answer. As in Experiment 1, the questions were designed to be independent such that knowing the answer to any one question did not reveal the answer to another. Most of the questions were based on factual, fairly verbatim information directly presented in the video (e.g., "The first method to scientifically study autobiographical memory was called:" with response options "A: the diary technique," "B: the word cueing technique," "C: the interview technique," "D: the reminiscence technique"), and others were based on factual information but sometimes worded differently from the way the concept was described in the video. For example, the "reminiscence bump" was described in the video as the ability for adults to recall more from the second and third decades of life than from other periods, but the test question over this concept was phrased differently: "the reminiscence bump refers to the phenomenon that people have particularly good memory for: A: early life events, B: events during the school years, C: young adulthood, D: events that happened most recently."

Design and Procedure

The basic design and procedure were identical to Experiment 1. Participants were randomly assigned to either the prequestion group ($n = 51$) or the control group ($n = 51$), and the same procedure from Experiment 1 was followed. One new design feature was added to Experiment 2. For both the prequestion and control groups, before viewing the video participants were given the prompt: "Today, we are interested in how people learn information from lectures. You will be viewing a lecture on the topic of Autobiographical Memory. This refers to the scientific study of memory for life events. Based on this description, how interested do you think you will be in the information covered in this video?" Participants were asked to press a number key (1, 2, 3, or 4) to indicate their interest level (1 = *not at all interested*, 4 = *very interested*) and continue to the next phase of the experiment. In the prequestion group, the interest rating was followed immediately by the 10 prequestions and then the video, whereas in the control group the interest rating was followed immediately by the video. As in Experiment 1, both groups completed the same trivia distractor task after viewing the video. They then completed the 20-item multiple-choice test, followed by the

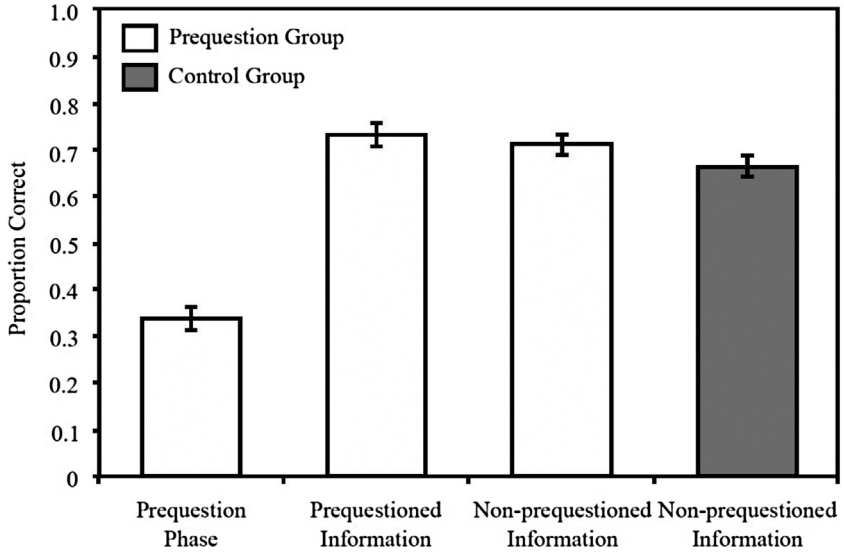

Figure 2. Proportion of correct responses for the prequestion group and control group. On the final test, the prequestion group outperformed the control group on prequestioned information. For non-prequestioned information, the prequestion group marginally outperformed the control group. Error bars represent standard errors.

self-reported rating of prior knowledge. All participants were then granted credit or paid, thanked, and debriefed.

Results

Data from 6 participants were excluded due to computer malfunctions that prevented the video from displaying properly, from two participants who were observed using their phones during the experiment, from one participant whose final test score was more than three standard deviations below the group mean, and from two participants who reported already knowing the material in the video prior to the experiment (i.e., chose Option D when queried about their prior knowledge).[2] The following analyses are based on the remaining 91 participants (45 participants in the prequestion group and 46 in the control group).

Effects of prequestions. Figure 2 shows performance during all phases of the study for the prequestion group and the control group. During the prequestion phase, participants answered 34% of the questions correctly ($SD = 17\%$). On the final test, participants answered 73% of these same questions correctly ($SD = 17\%$). As in Experiment 1, this represents a significant improvement in knowledge of the content in the video before and after viewing it, $t(44) = 14.13$, $p < .001$, $d = 2.11$.

As in Experiment 1, overall performance was greater in the prequestion group ($M = 73\%$, $SD = 12\%$) than in the control group ($M = 67\%$, $SD = 15\%$), $t(89) = 2.21$, $p = .030$, $d = .44$, revealing a significant "prequestion effect." The prequestion group performed better than the control group on prequestioned information, $t(89) = 2.02$, $p = .047$, $d = .37$, and showed a marginally significant advantage for non-prequestioned information as well, $t(89) = 1.78$, $p = .078$. Unlike in Experiment 1, participants in the prequestion croup did not perform significantly better on the final test for prequestioned information compared to non-prequestioned information, $t(44) = 0.26$, $p = .795$.

Table 1
Number of Participants Giving Subjective Interest Ratings 1–4 in Experiment 2

	Subjective interest rating			
	1	2	3	4
Prequestion group	0(0%)	14 (31%)	23 (51%)	8 (18%)
Control group	2(4%)	16 (35%)	25 (54%)	3 (7%)

As in Experiment 1, we directly compared the specific effect of prequestions (on prequestioned information) to the general effect of prequestions (on non-prequestioned information), with an analysis examining the potential interaction between group (prequestion vs. control) and type of information tested (prequestioned vs. non-prequestioned). Because the control group did not receive prequestions, we randomly assigned 10 of the 20 questions for each participant in the control group as prequestioned information and 10 as non-prequestioned information. A 2 × 2 (Group: prequestion vs. control × Type of Information: prequestioned vs. non-prequestioned) mixed ANOVA revealed a significant main effect of group, $F(1, 89) = 4.89$, $p = .030$, $\eta^2 = .052$. However, unlike in Experiment 1, the main effect of type of information was not significant, $F(1, 89) = .002$, $p = .960$. Finally, unlike in Experiment 1, an interaction did not occur—indicating that the effect of prequestions on prequestioned information was not stronger than the effect on non-prequestioned information—$F(1, 89) = .105$, $p = .746$.

Effects of subjective interest. We conducted further analyses to explore the potential effects of subjective interest on learning from prequestions. Participants' ratings of subjective interest did not differ significantly between groups, with an average rating of 2.87 ($SD = .69$) in the prequestion group and 2.63 ($SD = .68$) in the control group, $t(89) = 1.64$, $p = .104$. As shown in Table 1, most participants reported fairly high levels of subjective interest in the topic of autobiographical memory, with the most common response being a 3 out of 4.

Effects of subjective interest were examined by dividing participants into those who expressed lower-than-average interest (i.e., a rating of 1 or 2) vs. higher-than-average interest (i.e., a rating of 3 or 4). A 2 × 2 (Group: prequestion vs. control × Interest Level: high vs. low) between-subjects ANOVA was then conducted separately for prequestioned information and non-prequestioned information. The analysis on prequestioned information revealed a significant main effect of group, $F(1, 87) = 4.00$, $p = .049$, $\eta^2 = .044$, in that the prequestion group ($M = 73\%$, $SD = 17\%$) outperformed the control group ($M = 66\%$, $SD = 16\%$). The main effect of subjective interest was not significant, $F(1, 87) = 3.21$, $p = .077$, nor was the interaction between group and subjective interest, $F(1, 87) = .482$, $p = .489$. The same 2 × 2 ANOVA for non-prequestioned information revealed no significant main effect of group, $F(1, 87) = 3.39$, $p = .069$, or subjective interest, $F(1, 87) = 2.67$, $p = .106$, and no interaction, $F(1, 87) = .802$, $p = .373$.

Discussion

The results of Experiment 2 are consistent with those of Experiment 1 in showing an overall benefit of prequestions, and further showed that level of subjective interest in the topic did not significantly interact with the effects of prequestions. Unlike in Experiment 1, within the prequestion group there was no significant difference in final test performance between prequestioned and non-prequestioned information. The prequestion group showed a marginally significant advantage over the control group on non-prequestioned information, suggesting that in Experiment 2 the benefit of prequestions appeared to be more general than in Experiment 1. The presence of a significant interaction between group and type of information in Experiment 1, but the absence of that interaction in Experiment 2, further indicates that the effects of prequestions were specific to prequestioned information in Experiment 1 but not in Experiment 2.

General Discussion

The current study provides new insight into the effects of prequestions on learning from lecture videos. Though several studies have shown that prequestions enhance learning (Bull & Dizney, 1973; Little & Bjork, 2016; Peeck, 1970; Pressley et al., 1990; Richland et al., 2009; Rickards et al., 1976), these studies have used reading materials as stimuli and leave open the question of whether prequestions enhance learning from lectures.

Carpenter and Toftness (2017) recently explored the effects of prequestions on learning from brief 2-min video presentations, and found that prequestions enhanced memory for both the prequestioned and the non-prequestioned information. This finding is different from the typical finding observed in studies using reading passages, which have shown that prequestions enhance memory for prequestioned information but not for non-prequestioned information (Bull & Dizney, 1973; Frase, 1968; Pressley et al., 1990; Richland et al., 2009). Carpenter and Toftness reasoned that the "spill-over" benefit in video learning is due to enhanced attentional processing. Relative to a reading passage where students can selectively focus on some parts of the passage more than others (i.e., recognizing, focusing on, and possibly rereading portions of the passage that are relevant to the prequestions, and possibly skimming over other parts that are less relevant), the contents of a video presentation are not learner-paced and available all at once, leading students to process more of the entire video and ultimately leading to benefits on both prequestioned and non-prequestioned information.

However, the current study showed that these general benefits of prequestions do not necessarily hold with longer lecture videos. When learning from a 22-min lecture video on signal detection theory (Experiment 1), the benefits of prequestions were specific to prequestioned information and not to non-prequestioned information. When learning from a 24-min video on autobiographical memory (Experiment 2), the benefits of prequestions were not specific to prequestioned information. However, nor did prequestions produce strong benefits on non-prequestioned information, as observed in the study by Carpenter and Toftness (2017). Overall, the benefits of prequestions were smaller in the current study ($d = 0.52$ in Experiment 1, $d = 0.44$ in Experiment 2) that in the previous study by Carpenter and Toftness ($d = 1.00$).

We reasoned that participants' subjective interest in the material may play a role in the prequestion effect, such that a higher degree of interest may be more likely to arouse the attentional mechanisms believed to underlie learning from prequestions. However, results of Experiment 2 showed that level of subjective interest did not interact with the effect of prequestions. Though we cannot account for all of the factors that might have influenced the larger effect observed by Carpenter and Toftness (2017) relative to the current Experiment 1 and Experiment 2, the common element among the latter two experiments is that the videos were much longer (over 20 min). A viable candidate explanation for the weaker effects of prequestions in the current study, therefore, is the length of the lecture videos.

Why might longer lectures result in weaker effects of prequestions? It may have to do with the amount of information processing that is required. Longer lectures contain more information, and this places extra processing demands on the learner. In order to benefit from prequestions (when feedback is not provided right after the prequestions), participants must remember the prequestions while viewing the video, notice the information in the video that is relevant to those questions, and successfully discover (and later remember) the answers to those questions. Learning from prequestions therefore requires multiple steps and the formation of explicit connections between the prequestions and the ensuing content that may be harder to make as the lecture duration increases. With longer lectures, participants may forget some of the prequestions after the lecture begins, or they may discover the answers to the prequestions during the lecture but have difficulty remembering those answers because of the amount of additional information presented. When learning from shorter videos (Carpenter & Toftness, 2017), it may be easier to remember the prequestions themselves, and easier as well to connect the prequestions to the content that follows.

To date, we know of only two classroom studies examining the effects of prequestions. One has shown that prequestions

enhance learning from introductory psychology lectures (approximately 90 min in duration), but this benefit—much like in Experiment 1 of the current study—was specific to the prequestioned information (Carpenter, Rahman, & Perkins, 2018). Exploring the effects of prequestions over delayed time intervals, McDaniel, Agarwal, Huelser, McDermott, and Roediger (2011) observed some benefits of prequestions on quizzes administered at the end of a lesson in a middle school science class. However, no effects of prequestions were observed on delayed assessments such as reviews prior to exams, or on the exams themselves.

Thus, the effects of prequestions on lecture-based learning appear to be limited under realistic conditions. To the extent that the duration of the lecture influences the effects of prequestions, it may be that prequestions are most likely to benefit learning of brief lectures, or segmented portions of a lecture, rather than a full lecture of traditional classroom duration. Future research could more directly examine the potential moderating effects of lecture duration by administering prequestions prior to a shorter versus longer lecture on the same topic. Collecting measures of attentional processing during lectures—such as the degree to which participants can correctly identify content that was queried in the earlier prequestions, or participants' likelihood of mind wandering during portions of the lecture relevant to prequestions—may also reveal key insights into the ways that learners process lecture-based information following prequestions.

Other important questions for future research include the generality of the prequestion effect and the type of prequestions used. Do prequestions enhance learning only when the same questions are repeated on the later test? Or, would prequestions benefit later performance on non-identical questions that assess learning of the same concepts? Are some types of prequestions more beneficial than others? Some previous research on retrieval practice has shown that short-answer questions sometimes produce better learning than multiple-choice questions (Kang, McDermott, & Roediger, 2007), but comparisons of question types have not yet been systematically explored in the prequestion literature.

Importantly, the research to date has revealed no evidence that prequestions do any harm to lecture-based learning. This is different from some studies using reading passages that have sometimes observed a detrimental effect of prequestions on non-prequestioned information (Peeck, 1970; Rickards, 1976a; Sagaria & Di Vesta, 1978). The most likely explanation for these findings is that with reading passages, participants have the opportunity to selectively focus on the prequestioned information at the expense of the non-prequestioned information. Due to the instructor-paced nature of lectures, it would seem harder to selectively ignore portions of the information. While it is certainly possible that participants could "tune out" and "tune back in" during a lecture, text-based processing may afford greater opportunity for this, as participants can decide when to slow down, speed up, ignore, or repeat any portion of the material. Such selective processing is more likely a matter of degree than all-or-nothing, and could depend upon how the information is presented in both text- and lecture-based learning.

In summary, prequestions appear to be a beneficial tool for enhancing learning of lecture presentations. However, depending on the length and complexity of the lecture, these benefits may not be large. Further research is encouraged that can shed light on potential ways of optimizing the benefits of prequestions in realistic educational settings.

Conflict of Interest Statement

The authors declare no conflict of interest.

Author Contributions

Alexander Toftness and Shana Carpenter conceived the idea for the study. Laura Mickes provided the materials. Alexander Toftness programmed the experiments, and Alexander Toftness and Sierra Lauber collected and analyzed the data. All authors contributed to the writing and final editing of the manuscript.

References

Berlyne, D. E. (1954). An experimental study of human curiosity. *British Journal of Psychology*, *45*, 256–265.

Berlyne, D. E. (1962). Uncertainty and epistemic curiosity. *British Journal of Psychology*, *53*, 27–34.

Bull, S. G., & Dizney, H. F. (1973). Epistemic-curiosity-arousing prequestions: Their effect on long-term retention. *Journal of Educational Psychology*, *65*, 45–49.

Butler, A. C. (2010). Repeated testing produces superior transfer of learning relative to repeated studying. *Journal of Experimental Psychology: Learning, Memory, & Cognition*, *36*, 1118–1133.

Butler, A. C., & Roediger, H. L., III. (2007). Testing improves long-term retention in a simulated classroom setting. *European Journal of Cognitive Psychology*, *19*, 514–527.

Carpenter, S. K., & Toftness, A. R. (2017). The effect of prequestions on learning from video presentations. *Journal of Applied Research in Memory & Cognition*, *6*(1), 104–109.

Carpenter, S. K., Rahman, S., & Perkins, K. (2018). The effects of prequestions on classroom learning. *Journal of Experimental Psychology: Applied*, *24*, 34–42.

Faul, F., Erdfelder, E., Buchner, A., & Lang, A.-G. (2009). Statistical power analyses using G*Power 3.1: Tests for correlational and regression analyses. *Behavior Research Methods*, *41*, 1149–1160.

Finn, B., & Roediger, H. L., III. (2011). Enhancing retention through reconsolidation: Negative emotional arousal following retrieval enhances later recall. *Psychological Science*, *22*, 781–786.

Frase, L. T. (1968). Effect of question location, pacing, and mode upon retention of prose material. *Journal of Educational Psychology*, *59*, 244–249.

Hannafin, M. J., & Hughes, C. W. (1986). A framework for incorporating orienting activities in computer-based interactive video. *Instructional Science*, *15*, 239–255.

Hinze, S. R., Wiley, J., & Pellegrino, J. W. (2013). The importance of constructive comprehension processes in learning from tests. *Journal of Memory & Language*, *69*, 151–164.

Kang, S. H. K., McDermott, K. B., & Roediger, H. L., III. (2007). Test format and corrective feedback modify the effect of testing on long-term retention. *European Journal of Cognitive Psychology*, *19*, 528–558.

Little, J. L., & Bjork, E. L. (2016). Multiple-choice pretesting potentiates learning of related information. *Memory & Cognition*, *44*, 1085–1101.

McDaniel, M. A., Agarwal, P. K., Huelser, B. J., McDermott, K. B., & Roediger, H. L., III. (2011). Test-enhanced learning in a middle school science classroom: The effects of quiz frequency and placement. *Journal of Educational Psychology*, *103*, 399–414.

Peeck, J. (1970). Effect of prequestions on delayed retention of prose material. *Journal of Educational Psychology*, *61*, 241–246.

Pressley, M., Tanenbaum, R., McDaniel, M. A., & Wood, E. (1990). What happens when university students try to answer prequestions that accompany textbook material? *Contemporary Educational Psychology*, *15*, 27–35.

Pyc, M. A., & Rawson, K. A. (2010). Why testing improves memory: Mediator effectiveness hypothesis. *Science*, 330.

Richland, L. E., Kornell, N., & Kao, L. S. (2009). The pretesting effect: Do unsuccessful retrieval attempts enhance learning? *Journal of Experimental Psychology: Applied*, *15*, 243–257.

Rickards, J. P. (1976a). Interaction of position and conceptual level of adjunct questions on immediate and delayed retention of text. *Journal of Educational Psychology*, *68*, 210–217.

Rickards, J. P. (1976b). Type of verbatim question interspersed in text: A new look at the position effect. *Journal of Reading Behavior*, *8*, 37–45.

Rickards, J. P., Anderson, M. C., & McCormick, C. B. (1976). Processing effects of common-word and number questions inserted in reading materials. *Journal of Educational Research*, *69*, 274–277.

Sagaria, S. D., & di Vesta, F. J. (1978). Learner expectations induced by adjunct questions and the retrieval of intentional and incidental information. *Journal of Educational Psychology*, *70*, 280–288.

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