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The Lure of Seductive Details During Lecture Learning

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Research demonstrates that seductive details negatively impact learning from instructional materials such as textbooks and learning modules. Yet, anecdotally, teachers and students consider seductive details an enhancement to classroom lectures. We examined this apparent disconnect by exploring the impact of seductive details in mathematics lecture learning as a function of prior knowledge across 2 affective contexts: low-stakes learning and high-stakes learning. Undergraduate students viewed a video lecture on matrix algebra with or without seductive details either in a low-stakes or high-stakes learning environment. The high stakes were designed to mimic common classroom accountability for learning and were removed prior to the final test. On the final test, seductive details were generally detrimental in the low-stakes, but not high-stakes, learning environment. However, this effect was moderated by students' prior knowledge. Students with higher prior knowledge were not impacted by seductive details in either high- or low-stakes learning environments. In contrast, students with lower prior knowledge—those most in need of pedagogical assistance—learned more when seductive details were included in a high-stakes lecture environment. These results suggest that seductive details may not be as detrimental as previously concluded, and may even be beneficial in an incentivized learning environment for students who have the most to learn.

Educational Impact and Implications Statement

We examined how interesting but peripheral information in lecture instruction—known as "seductive details"—impacts students' lecture learning. In a low-stakes learning environment, we replicated previous findings showing that seductive details harm learning. However, when students were provided with a video lecture in a high-stakes learning environment, no learning decrements emerged. Furthermore, when prior knowledge was considered, low prior knowledge students surprisingly showed learning *gains* in a high-stakes environment with seductive details. These findings show that the common practice of using "interest catching devices" in the form of peripheral anecdotes and facts may be an effective pedagogical strategy for students who need the most assistance: those with low prior knowledge in high-stakes learning contexts.

Keywords: seductive details, pressure, mathematics, lecture instruction, learning

The inclusion of engaging yet unnecessary information in instructional materials is known in the psychological literature as "seductive details." By definition, seductive details are concrete and highly interesting, but tangential to the learning objectives (Garner, Brown, Sanders, & Menke, 1992; Garner, Gillingham, & White, 1989). Popular belief and empirical data indicate that teachers and students alike tend to believe that inserting interesting facts and anecdotes enhances instruction (Yue & Bjork, 2017). In contrast to conventional practice, however, the scientific literature shows that when seductive details are included in learning materials, there is a detrimental impact on students' overall comprehension of the important concepts (Rey, 2012). In the current study we investigate this disconnect between the practices of educators and the findings from research scientists. We ask: During lecture instruction in a classroom-like context, do seductive details impact student learning?

Seductive Details

The rationale behind including seductive details within instruction is that high-interest material will catch and sustain attention throughout the learning episode. Indeed, teacher education mate-

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rials explicitly promote the use of hooks (also known as "anticipatory sets" or "interest catching devices") to activate both prior knowledge and engagement at the outset of a lesson (Hunter, 1982; Lemov, 2015). In implementation, however, the lesson hook is often predominantly focused on generating engagement rather than activating specific prior knowledge (e.g., Burgess, 2012). In this way, including seductive details in instruction can be equated to the practice of "hooking" students into the lesson. Instructors may view a brief fascinating but peripheral story as a powerful tool to garner students' attention, particularly in today's classrooms where instructors must contend with technological devices, social media, and the Internet.

Educators often include seductive details in classroom instruction, online tutorials, and textbooks despite the research suggesting seductive details are detrimental to learning outcomes (Kintsch & Bates, 1977; Mayer, 1993, 2008; Pettersson, 1998; Pozzer & Roth, 2003). Seductive details—usually text or pictures inserted in short scientific text passages—have been found to interrupt students' processing of core material and reduce student learning when compared with materials without seductive details (Harp & Mayer, 1998; Lehman, Schraw, McCrudden, & Hartley, 2007; Sanchez & Wiley, 2006). For instance, in the classic seductive details studies conducted by Harp and Mayer (1997, 1998), participants were asked to read a passage about the process of lightning formation with or without the addition of seductive details in the form of captions, pictures, or both. When tested on measures of recall and problem solving after reading the text, participants who were exposed to the seductive details performed worse than those who received the text passage only. This finding has been consistent throughout the literature: one recent meta-analysis concluded that there is a small to medium negative effect size associated with the inclusion of seductive details on both retention and transfer performance in text-based and multimedia-based studies (Rey, 2012).

But not all students are equally harmed by the inclusion of seductive details. Some studies find that students low in working memory, spatial ability, or prior knowledge are the most harmed by seductive details placed within computer-based learning modules, whereas participants higher in these learner characteristics do not suffer the same learning decrements (Park, Korbach, & Brünken, 2015; Park, Moreno, Seufert, & Brünken, 2011; Sanchez & Wiley, 2006; Stitzman & Johnson, 2014). This pattern suggests that some individuals are unable to appropriately allocate attention to relevant information or handle the increased cognitive demand of the superfluous material. But considering that these studies took place in lab-based, low-stakes environments, the question remains as to how students of varying individual differences will be affected under more incentivized learning contexts. This question is particularly relevant for students with low levels of prior knowledge, at whom attention-getting hooks are likely aimed to increase interest in the learning material.

In summary, there is an apparent disconnect between what educators presumably believe about the benefits of seductive details in lecture instruction and the findings from learning science research about the harmful effects of seductive details in student materials. One possible reason for this discrepancy is that, surprisingly, the effects of seductive details have not been studied in lectures or in settings meant to approximate the high-stakes nature of a classroom lecture. The vast majority of studies on seductive details have been conducted using textbook passages, narrated multimedia modules, and in one case (Harp & Maslich, 2005), an audio-recording. Thus, it remains an open question as to whether seductive details during lecture-like instruction similarly damage learning outcomes.

The current study attempts to resolve this discrepancy by asking: What are the effects of seductive details on lecture learning when the affective context more closely approximates a classroom environment? Specifically, we assess whether making students feel accountable for their learning while delivering content through direct instruction alters the impact of seductive details. We also assess whether this context effect depends on students' prior knowledge.

Low-Stakes Learning

In the current study, the low-stakes learning context was incentivized similarly to a typical laboratory study exploring seductive details effects, in which students are instructed to process instructional materials and demonstrate what they have learned in exchange for course credit. Under conditions similar to previous research, it is likely that providing students with a video lecture on mathematics will yield similar results wherein seductive details are damaging to learning outcomes. Previous research has posed three hypotheses for the negative effects of seductive details: They distract attention away from core instruction, activate inappropriate prior knowledge, and disrupt integrated processing of relevant concepts (Harp & Mayer, 1998). For instance, when learning about the digestion system, presenting students with a story about the incredible feats of eating contest champions may catch students' interest but pull their attention away from the main content and instead lead them to ponder irrelevant ideas (e.g., "How do eating champions train for competitions?").

Ironically, despite having their attention distracted away from the core material, students may believe that they are learning the material more deeply because it is engaging. Hence, seductive details may also lead students to fall prey to their own faulty metacognition. Research suggests that students often exert inaccurate judgments of learning by taking current indicators of fluency as future predictors of ability, and thus anticipate that they will retain material better than they actually do (Benjamin, Bjork, & Schwartz, 1998; Koriat & Bjork, 2005). Despite their presumed belief that seductive details help learning, educators and students may instead be vulnerable to a fluency bias in which the interesting material—which is often inherently more concrete—makes the overall lesson seem easier to understand. There is extensive evidence that a fluency bias during learning occurs both in the laboratory and in the classroom (Alter, Oppenheimer, Epley, & Eyre, 2007; Finn & Tauber, 2015; Unkelbach & Greifeneder, 2013). Seductive details may contribute to a similar "illusion of comprehension" that belies students' actual understanding (Bjork, 1994).

A related explanation to account for the detrimental impact of seductive details during low-stakes learning contexts is that students are simply unmotivated to attend to the important information and allow their attention to wander to the irrelevant information. Classroom field research (Risko, Buchanan, Medimorec, & Kingstone, 2013) finds that students report greater off-task thinking during the second half of lecture when they are no longer motivated to learn (akin to a low-stakes learning environment). It is similarly possible that students in low-stakes learning contexts realize that seductive details are in fact irrelevant, yet they might feel suboptimal motivation to redirect their attention to the main lecture material. These students may lack sufficient incentive to refocus their cognitive efforts when faced with seductive details.

Observing an impact of seductive details under a low-stakes context would provide an important replication of previous findings but extend the effect to mathematics lecture learning. However, adjusting the learning backdrop to a high-stakes context might alter the impact of seductive details on students' affect, cognitive processes, and behavior.

High-Stakes Learning

With the advent of each successive educational policy emphasizing high-stakes standardized testing, seen most recently in Race to the Top (U.S. Department of Education, 2009) and the adoption of the Common Core standards (National Governors Association Center for Best Practices, Council of Chief State School Officers, 2010), there is renewed discussion of the impact of pressure on students' performance during high-stakes assessments. Previous research has found that during high pressure testing, students often perform below their actual ability, a phenomenon known as "choking under pressure" (Beilock, 2008). The most dominant account for the harmful impact of high-stakes pressure on student academic performance, specifically in mathematics, is that worries about the possibility of failure lead to distracted attention (Beilock, Kulp, Holt, & Carr, 2004; DeCaro, Thomas, Albert, & Beilock, 2011).

This focus on how pressure affects testing has been informative in helping us to understand the cognitive mechanisms underlying choking under pressure, but pressure during testing is only half of the story. Students commonly learn material under high-stakes contexts which are not typical of basic laboratory studies examining learning. In educational contexts, students face daily pressures to understand lecture material, complete assignments, prepare for class assessments, pass standardized tests, and maintain high grades. Students must also learn within a social context in which they work collaboratively in groups, present their thinking in front of classmates, and undergo evaluation by peers and instructors. In contrast, students typically get involved in research studies in exchange for course credit and are not otherwise accountable for their learning.

If the mechanism underlying high-stakes learning operates similarly to the mechanism at play in high-stakes testing, then we might expect high-stakes learning contexts to undermine what individuals encode during instruction. Furthermore, seductive details presented against a high-stakes learning backdrop might *further* distract from relevant instruction and exacerbate underperformance (Craik, Govoni, Naveh-Benjamin, & Anderson, 1996; Lindquist & McLean, 2011; Risko et al., 2013; Rohrer & Pashler, 2003; Smallwood & Schooler, 2006; Szpunar, Khan, & Schacter, 2013).

But not all students interpret high-stakes situations in the same way (Bellinger, DeCaro, & Ralston, 2015; Mattarella-Micke, Mateo, Kozak, Foster, & Beilock, 2011). The classic Yerkes-Dodson curve suggests that, at a moderate level, stress arousal can actually facilitate performance (Baumeister & Showers, 1986). High-stakes imposed during the learning period may serve to increase students' sense of accountability, but fall short of the harmful stress seen in previous studies examining performance under pressure. In this way, implementing high stakes during learning may serve to create an incentivized classroom context that facilitates rather than debilitates students' lecture learning by increasing students' motivation to learn.

Within a high-stakes learning context, where students are motivated to learn, the inclusion of seductive details might *aid* learning. This finding would be rather unexpected but not entirely unexplainable. Indeed, there are a number of accounts by which seductive details might help rather than harm learning specifically during a high-stakes learning context. First, in a learning setting with more at stake, seductive details may have an effect akin to what educators and students generally expect: they might increase interest, which in turn might foster cognitive attention to the relevant material. It is common for students to ask "Why do I need to know this?" (Mazzocco, Hanich, & Noeder, 2012). The inclusion of seductive details may provide students with increased utility-interest value for the material while the incentivized learning environment may encourage students to expend the effort to maintain focus on the relevant concepts. This possibility is in line with Kintsch's (1980) theory of emotional interest, which posits that affective arousal related to instructional material can positively influence cognitive processing.

Seductive details might have additional learning benefits by acting as breaks within relevant learning episodes. Previous research shows that interpolated break periods during lessons lead to sustained attention to lecture material, enhanced note taking, reduced anxiety, and increased problem-solving accuracy (Szpunar et al., 2013). Breaks also lead to memory consolidation (Dewar, Alber, Butler, Cowan, & Della Sala, 2012; Dewar, Alber, Cowan, & Della Sala, 2014; Dewar, Cowan, & Della Sala, 2007) and allow students to monitor their comprehension, refocus their attention, and guide subsequent study behavior (Metcalfe, 2009) as long as they are motivated to do so. Hence, the seductive details effect may hinge on the contextual or individual factors students experience in a learning context. Specifically, seductive details may be deleterious in instances where individuals are unable or otherwise unwilling to divert attention to the relevant information but beneficial when individuals are motivated and correspondingly more likely to exert cognitive control.

Current Study

The current study explored whether the impact of seductive details on learning from a lecture depends on the stakes involved in the learning context. We also examined the moderating role of the prior knowledge level of the learner. Although the moderating effect of learning context has not been examined in the seductive details literature, research has demonstrated that the impact of seductive details may depend upon individual differences in engagement and attention (Park et al., 2015; Sanchez & Wiley, 2006).

Students were assigned to watch a lecture on matrix algebra and then asked to complete several unrelated tasks before completing a final test on the material, which served as our primary learning measure. We attempted to approximate classroom instruction while also maintaining experimental control by testing these ideas using a video recorded lecture in a laboratory setting with groups of randomly assigned research participants.

Students in the low-stakes condition completed the study for research participation credit for an unrelated class, and thus were not further incentivized to learn the material—akin to previous studies testing the impact of seductive details (for a review, see Rey, 2012). Students in the high-stakes condition were incentivized using simulations of pressure typically experienced in a regular course: expert evaluation, social responsibility, and outcome incentives (e.g., Beilock, 2008; DeCaro et al., 2011). To mimic these respective stressors, we filmed students during learning for “professor observation,” told students that they would be required to demonstrate the mathematical procedures covered in the lecture in front of their peers after the lecture, and mandated a 100% pass rate for all students to receive monetary compensation. Thus, our manipulation was intended to reflect the incentives present in classroom settings (high-stakes condition) as well as traditional laboratory settings (low-stakes condition).

Because we were interested in the effects of seductive details and the stakes involved during learning, and not during testing, we isolated the effects of our high-stakes manipulation to the lecture phase. We accomplished this by measuring whether our high-stakes manipulation was successfully applied immediately following the lecture. We then “turned off” the manipulation (for students assigned to the high-stakes condition), using a procedure we describe below. After removing the high stakes, we assessed any residual effects of the manipulation by asking students to complete a working memory measure. We reasoned that if we successfully turned off the high-stakes manipulation, then students assigned to the high-stakes condition should perform just as well on the working memory task as those assigned to the low-stakes condition, per previous research (Beilock & Carr, 2005). Isolating the high stakes associated with learning in this way would allow all participants to be equivalent in affective state at the time of test despite the difference in affective state during lecture learning. This novel method would allow us to determine the cognitive effects of seductive details in learning environments in which students are more comparably motivated to classroom learning via increased task-value (Eccles et al., 1983) without contaminating the testing phase.

Additionally, we asked students to complete a self-report measure of individual differences in background (i.e., prior) knowledge. Prior knowledge has been shown to be a moderator of the impact of seductive details but has yet to be examined under more incentivized conditions such as the high-stakes manipulation we employ (Park et al., 2015; Sanchez & Wiley, 2006).

Lastly, we attempted to provide better clarity of results by asking students to take notes on the lesson as well as rate their lesson experience (i.e., judgments of learning, lesson quality, distractibility). We examined student notes for inclusion of relevant and seductive detail content as well as procedural thoroughness. Immediately following the video lecture, students provided judgments of learning, video quality, distractibility and felt pressure. We looked toward these measures to illuminate any significant change in affect brought about by seductive details, high-stakes pressure, or the combination of the two. We reasoned that seductive details or high-stakes conditions might differentially affect students’ interest, and this would be represented in their assessments of their own learning and the video quality of the lesson. Although students’ metacognition (Benjamin et al., 1998; Koriat & Bjork, 2005) and class ratings (Kornell & Hausman, 2016) have been shown to be poor predictors of long-term learning, at the very least these interest, distractibility, and quality measures might provide insight into students’ affective experience and allow for inferences about their motivational state.

By examining students’ prior knowledge and affective state associated with learning context, and the cognitive mechanisms associated with seductive details, we might better predict when capturing students’ attention with hooks might help or hinder learning in lecture instruction.

Method

Participants and Design

Undergraduate students ($N = 259$) were invited to participate in exchange for psychology course credit. Participants were assigned to one of four conditions, using a 2 (Seductive Details: Present, Absent) $\times$ 2 (Learning Stakes: Low, High) between-subjects design. Our goal was to test participants in groups of 10 in a classroom in order to approximate the social nature of a classroom environment. However, because participant attendance varied, experimental sessions ranged in size. A total of 41 sessions with an average student sample size of 6.32 ($SD = 2.08$) were run. Seventeen participants were removed from analyses because they indicated on a poststudy form that they had been informed by a friend about the nature of the study prior to participation (i.e., they knew about the high-stakes manipulation).

Materials

Prior knowledge survey. The prior knowledge survey posed five statements on matrix algebra (e.g., “I can calculate the inverse of a matrix using a determinant”) using a 5-point scale ranging from *not at all true of me* to *very true of me*. Prior knowledge scores were calculated as the average of the five items. A Likert-type scale was used in place of problem solving in order to more quickly assess the numerous matrix algebra skills of interest. Items were worded in as precise a way as possible to prevent participants from inflating their ability level while limiting the time necessary to measure prior knowledge. Previous research has demonstrated that self-assessments of this kind are generally accurate reflections of prior knowledge measured with more direct problem-solving questionnaires (Towler, 2009).

Video lesson. Participants were presented with a video lesson on matrix algebra designed to teach various mathematical properties of matrices including their form and how to add, subtract, multiply, divide, and calculate an inverse. In total, the lesson covered six topics within matrix algebra with 32 conceptual facts about matrices. The specific video featured a female instructor who taught using PowerPoint slides. Our goal in using a video lesson was to control for content across all sessions.

Two versions of the video lesson were used: one version with seductive details, and one without seductive details. The instruction in each video was identical. The seductive details video differed only in that it contained seven interesting facts irrelevant to the lesson objectives but peripherally related to matrix algebra. These facts were interspersed at the beginning, middle, and end of the instruction. In line with previous research, the seductive details were designed to be concrete, interesting, and noninstructive. For instance, one seductive detail stated that matrices can be used in genetics to predict physical traits, while participants viewed a striking photo of a young boy with one blue eye and one brown eye. Another seductive detail discussed how James Joseph Sylvester (the founder of matrix algebra) once supposedly stabbed a student for a perceived slight. The seductive details avoided being informative toward the lesson objectives. Pilot testing showed that each individual seductive detail slide was rated as significantly more interesting (the mean across all *SD* slides was $M = 4.97$, $SE = .30$) than relevant slides (the mean across all relevant slides was $M = 3.62$, $SE = .23$), Hedges' $g = -.86$, all ps $< .05$. The seductive details video was 14% longer: the running time of the video lesson without seductive details measured 15:31 min, and the running time of the video lesson with seductive details measured 18:00 min.

Postvideo lesson evaluation. Participants completed a survey measuring their attitudes and affective reactions to the video lesson. Survey items included a judgment of learning ("Please indicate how well you feel you have learned the content from the video lesson"), a lesson quality rating ("Please evaluate the quality of the video lesson instruction"), a measure of distraction ("I felt distracted and found it hard to pay attention"), and a high-stakes manipulation check ("Please indicate how much pressure you felt during the video lesson"). All responses were made using a 7-point scale from 1 (*not at all*) to 7 (*very high*).

Immediate postvideo test. The immediate postvideo test was composed of two items that tested material presented in the video. The first item asked "Below are two matrices. First, determine if the two matrices can be multiplied." The second item asked "What are the dimensions of the resulting matrix?" The questions were designed to be relatively easy to answer correctly. The main purpose of this "test" was to maintain the cover story we used to administer and then turn off the high-stakes manipulation, described in the Procedure section below.

Working memory assessment. A backward letter span task served as our measure of working memory (Ramirez, Gunderson, Levine, & Beilock, 2012). The letter span task requires participants to listen to series of consonants read aloud (i.e., R, M, Q, J, B) before immediately reporting the consonants back to the experimenter in a backward fashion (i.e., B, J, Q, M, R). A set consists of two lists of consonant series read aloud. Usually the task continues until a participant gets both lists within a span size set incorrect. However, because we tested all of the participants in the session at the same time, we made several modifications to this task. First, we asked participants to attempt both of the lists within a span size set even if they were unable to reproduce the first list. Second, we asked participants to report the consonants by writing them down on a piece of paper rather than saying them out loud. Experimenters were trained to monitor participants for any cheating (for instance, writing the letters down in a forward fashion but moving backward across the line). Lastly, to reduce the length of the session, we ended the task after the span size set of seven had been presented. Letter span scores were calculated by identifying the highest span score in which participants could accurately recall the two lists within a set. For instance, a span score of 6 indicates that the participant was able to accurately repeat (in a backward fashion) both lists of six letters that were presented during the six-letter span set.

Final test. The final test consisted of eight free-response matrix algebra problems of near and far transfer difficulty. Test problems were aligned to the lesson objectives and video content. Problems touched on identifying elements in a matrix, transposing a vector, creating a symmetrical matrix, adding and subtracting matrices, applying the rules for multiplying matrices, and setting up matrices to solve word problems. For example, one word problem posed: "Grades are being calculated at the end of the quarter. Stacy's quiz average was 89, her test average was 80, and her homework average was 90. Ben's quiz average was 94, his test average was 85, and his homework average was 70. If quizzes are weighted as 50% of the grade, tests as 30% of the grade, and homework as 20% of the grade, set up the matrices to find Stacy's and Ben's final grades. Note: You do not actually need to do the calculation." Each problem was worth one point, for a possible total of 8 points. Partial credit (0.5 points) was administered for answers that correctly addressed half the question or left some ambiguity in the response. Interrater reliability was at 88%.

Procedure

Participants came to a psychology laboratory that was set up to look like a university seminar classroom with 10 chairs arranged around a long oval desk. Upon arrival, participants were told that we were interested in understanding how students learn from lectures. Participants began by filling out the informed consent sheet and then were asked to complete the prior knowledge survey before receiving the learning stakes manipulation.

Participants in the *low-stakes condition* were informed they would be evaluating video lecture resources to help the university explore the use of learning media and that they should make an effort to behave as if they were in a real class. Participants in the *high-stakes condition* received a similar introduction with additional instructions designed to increase the stakes involved in learning. Participants were told that the university was interested in evaluating the effectiveness of video lectures through their performance. Participants were told that they would be awarded a financial bonus of $10 if they performed well on a test at the end of the video lesson (i.e., the immediate postvideo test), but that the financial bonus was contingent upon everyone in the group scoring 100%. We also informed participants that professors and researchers from the university would view their learning behaviors and thus participants would be filmed during the video lecture and postvideo test. At this point, the screen flashed the pictures of a selection of psychology professors in the department while research assistants set up three video cameras (two in the back of the room and one in the front of the room). Lastly, participants were informed that, after completing the test, they would be asked to individually stand at the board in the front of the classroom and explain how they arrived at the solution to a test problem for the other participants and the video cameras. Initial focus group interviews prior to the main study revealed that participants found the requirement to explain their answers in public as the most stressful component of our high-stakes instructions. Our intention in the high-stakes manipulation was to increase the stakes for learning in analogue to the incentives students may feel in a typical class. Because the laboratory inherently lacks the incentives of genuine classrooms, we attempted to mimic the pressure students feel around social comparison, expert evaluation, and outcome incentives (but in this case, using money rather than grades).

After administering our learning stakes manipulation, participants in all conditions were reminded to do their best and take notes as if they were in a real course lecture. Participants were given sheets of paper on which to take notes and viewed the video lesson on matrix algebra. Once the video ended, participants were asked to complete the video evaluation items. Participants were then asked to complete the immediate postvideo test, which was described at this time as the main learning assessment.

After completing the immediate postvideo test, participants in the low-stakes condition were thanked for their participation and effort. Participants in the high-stakes condition again received a different set of instructions. Specifically, the research assistants waited until everyone was done and then one researcher noted out loud that the experiment was running a little behind schedule. As such, the researchers would have to unfortunately forgo the explanation component of the study. The research assistants walked around the room to visually inspect everyone's accuracy on the two-item immediate postvideo test. Regardless of participants' actual accuracy, the research assistants announced that everyone answered the questions correctly. Thus, all participants in the high-stakes condition would receive the additional monetary bonus at the end of the study. The video cameras were then put away to remove the last source of salient pressure. Research assistants reminded participants in the high-stakes condition that, even though the "main test" was completed, they should still continue to try their best on the remaining study measures.

All participants were then informed that the remainder of the study would be comprised of several memory tests. Participants were then given 5 min to study their video notes and next directed to complete the backward letter span task and final test. The final test was introduced with the following set of instructions to ensure that participants did not experience performance pressure: "*In a moment, we'll begin our last measure. You will of course receive two research participation credits no matter how you perform so we just ask that you please try your best.*" Note that we did not introduce this test as an assessment, nor was it given a title indicating it to be an assessment of participants' ability. Because this final test was presented to participants as a low-stakes activity, students were not urged to complete items as quickly as possible. Participants were, however, informed that they had 10 min to complete the final test. Finally, participants filled out some demographic measures, were debriefed and, in the high-stakes condition, received the financial bonus.

Results

Initial analyses begin by examining students' postvideo evaluations (i.e., ratings of felt pressure, video lesson quality, judgments of learning, and distractibility during the lesson) as well as working memory performance. These initial analyses allow us to judge the efficacy of our pressure manipulation and better understand how our interaction of learning stakes and seductive details impacted participants' *perceptions* of the learning context. We next present results of final test performance to understand what impact the learning stakes and seductive details had on students' *actual* learning. We then attempt to understand the cognitive mechanisms that might be driving some of these effects with two approaches: by relating postvideo judgments to final test performance, and by examining the notes students took during the lesson. Finally, we assess whether the impact of learning context and seductive details on final test performance varies by participants' prior knowledge.

Unless noted otherwise, we examined the impact of seductive details and learning context using separate 2 (Learning Stakes: Low, High) × 2 (Seductive Details: Present, Absent) between-subjects factorial ANOVAs.

Postvideo Evaluation and Working Memory Results

Felt pressure. We begin by examining how participants' judgments of felt pressure varied across our manipulation of learning stakes and seductive details. We found a main effect of learning stakes: Participants reported experiencing more pressure during the video lesson in the high-stakes condition ($M = 4.11$ out of 7, $SE = 0.14$) than in the low-stakes condition ($M = 2.88$ out of 7, $SE = 0.14$), $F(1, 238) = 37.89$, $p < .001$. However, we did not find a main effect of seductive details or an interaction on participants' reports of pressure, Fs < 1. These analyses reveal that the high-stakes manipulation was successfully implemented (see Figure 1).

Working memory. To confirm that the effects of increasing learning stakes were successfully removed following the immediate postvideo test, we analyzed participants' performance on the working memory task. Because prior literature has shown that working memory is negatively impacted by high pressure situations (e.g., Beilock & Carr, 2005; Beilock & DeCaro, 2007; Gimmig, Huguet, Caverni, & Cury, 2006), a lack of observable difference in working memory scores between conditions following participants' release from the incentives would suggest that any negative effects of pressure, if experienced, were successfully alleviated. This is indeed what was found. Participants in the high-stakes condition ($M = 3.28$, $SE = 0.13$) performed just as well as those in the low-stakes condition ($M = 3.10$, $SE = 0.12$) on the working memory task, $F < 1$. We did not find a main effect of seductive details or an interaction, Fs < 1.

Video lesson quality. We next examined participants' impressions of the video lesson quality to explore the effects of seductive details and high-stakes learning on participants' evaluations of instructional value. Participants' ratings of the video lesson quality revealed no main effects of learning stakes or seductive details, Fs < 1. However, a significant interaction was found, $F(1, 238) = 7.49$, $p = .007$. In the low-stakes condition, participants who watched the video lesson with seductive details evaluated the video quality as marginally lower ($M = 5.05$, $SE = 0.17$) than those who watched the video lesson without seductive details ($M = 5.44$, $SE = 0.12$), $t(123) = 1.93$, $p = .056$, Hedges' $g = 0.34$. In contrast, for participants in the high-stakes condition, the trend reverses. Participants in a high-stakes context who watched the video with seductive details evaluated the video as marginally higher quality ($M = 5.41$, $SE = 0.13$) than those in the high-stakes without seductive details condition ($M = 5.02$, $SE = 0.15$), $t(115) = 1.94$, $p = .054$, Hedges' $g = 0.36$.

Judgments of learning. Results for judgments of learning revealed a main effect of learning stakes, $F(1, 237) = 6.62$, $p = .011$. Participants in the high-stakes condition reported that they learned less from the video overall ($M = 4.94$, $SE = 0.11$) compared with participants assigned to the low-stakes condition

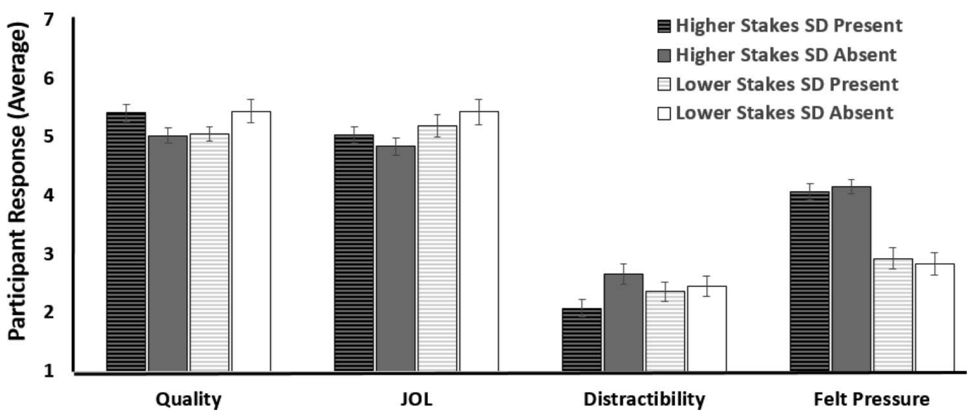

Figure 1. Participant responses to the video quality, judgment of learning, distractibility, and felt pressure ratings displayed as a function of learning stakes (low, high) and seductive details: (present, absent). Error bars represent standard errors.

(M = 5.32, SE = 0.10), $t(239) = -2.61$, $p = .010$, Hedges' $g = -0.34$. We did not find a main effect of seductive details or a significant two-way interaction, Fs < 1.

Distraction ratings. A main effect of seductive details emerged on the measure of participant distraction, $F(1, 238) = 4.08$, $p = .044$. Individuals with seductive details reported being *less* distracted ($M = 2.22$, $SE = 0.10$) than individuals without seductive details ($M = 2.55$, $SE = 0.13$), $t(240) = -1.98$, $p = .048$, Hedges' $g = 0.26$. Thus, the inclusion of engaging and emotional information in general served one of its presumed purposes—to keep students' minds on the lesson—at least by their own judgment of distractibility. We did not observe a main effect of learning stakes, $F < 1$, or interaction, $F(1, 238) = 2.03$, $p = .155$. Despite not obtaining a significant interaction, we noticed an interesting pattern for participants assigned to the high-stakes condition: Those who received seductive details reported lower distractibility than those who did not receive seductive details. Participants in the low-stakes condition did not reveal a similar pattern. But because the interaction term was not significant, we are limited in our ability to perform and interpret the simple effects.

Final Test Performance

Of central interest was students' performance on the final test. No main effects of learning stakes or seductive details on final test performance were found, for either participants' final average, Fs < 1, or adjusted average taking into account the number of problems attempted, Fs < 1. However, a significant interaction emerged for both final test average, $F(1, 238) = 4.40$, $p = .037$, and adjusted average, $F(1, 238) = 5.66$, $p = .018$. For all subsequent analyses, we rely on the adjusted average as a better indicator of participants' learning, due to the low-stakes final test instructions that de-emphasized performance. In the low-stakes condition, participants who received seductive details showed lower performance ($M = .75$, $SE = .03$) than participants who did not receive seductive details ($M = .83$, $SE = .03$), $t(123) = -2.09$, $p = .039$, Hedges' $g = -.372$. In contrast, participants in the high-stakes condition did not differ in performance when seductive details were included ($M = .82$, $SE = .03$) compared with when they were omitted ($M = .77$, $SE = .03$), $t(115) = 1.29$, $p = .198$, Hedges' $g = .238$ (see Figure 2).[1]

Given that students were nested within sessions, we also addressed whether there exists variation in performance across sessions and whether this variation accounts for the interaction reported above. We ran an empty model without any predictors to model the variability in adjusted test score accuracy across sessions. Results revealed that the variance in final test scores between sessions was very close to zero (Intercept = 2.01e-19 [1.50e-18]), indicating that it was not necessary to model the outcome using hierarchical linear modeling.

To glean insight into how seductive details may influence student learning outcomes under high and low stakes, we examined how the adjusted final test performance and postvideo evaluation ratings relate to one another in each of the four conditions. Participants in the high-stakes condition who received seductive details showed a significant positive relationship between quality of video lesson ratings and adjusted final test performance, $r(57) = .40$, $p = .002$. This relationship was not significant among participants in the high-stakes condition who did not receive seductive details, $r(56) = .00$, $p = .99$. These two correlations were significantly different in strength of association, $Z = 2.24$, $p = .025$. Participants in the low-stakes conditions showed no significant relationship between adjusted final test performance and video quality ratings regardless of whether they received seductive details (see Table 1).

A similar pattern of results emerged in participants' judgment of learning ratings. Among participants in the high-stakes condition, a positive correlation between judgment of learning and adjusted final test performance was present for those who received seductive details, $r(57) = .345$, $p = .007$, but was absent among those who did not receive seductive details, $r(56) = .142$, $p = .287$. However, these two correlation coefficients were not significantly different from each other, $Z = 1.14$, $p = .25$, indicating that the

[1] When we ran this same analysis but with prior knowledge as a covariate, we found that the Learning Stakes × Seductive Details interaction remained significant, $F(1, 237) = 4.96$, $p = .033$. We expand on the effects of prior knowledge at the end of the Results section.

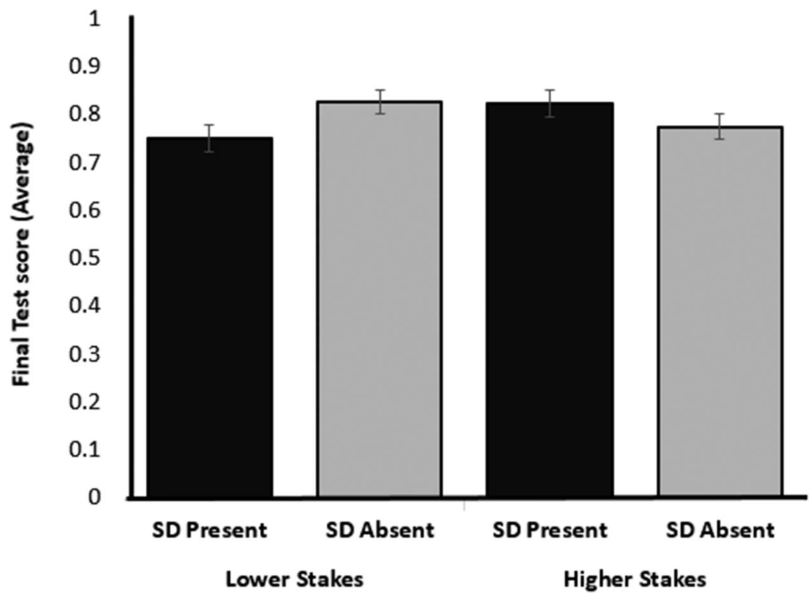

Figure 2. Adjusted final test performance for participants as a function of learning stakes and seductive details. Error bars represent standard errors.

two correlations are statistically the same. For the low-stakes condition, no relationship emerged between judgment of learning and performance in either seductive details condition (see Table 1). Participants' ratings of distractibility did not relate to performance in any of the four conditions, all *p*s $> .12$.

To summarize, only for participants who received seductive details during high-stakes lessons, ratings about the quality of lessons and judgments of learning were significantly correlated with final test performance. These findings suggest that learners may have better ability to judge their understanding of the lecture when seductive details are used in a high-stakes learning context, assuming that learners evaluate lesson quality by taking their comprehension into account. Ratings of distractibility were not significantly calibrated with final test scores in any of the four conditions.

Participant Notes

We next examined participant notes to gain insight into how the manipulation of learning stakes and seductive details may have affected lecture learning behaviors (i.e., note taking) during the video lesson. Participant notes were coded for three qualities: concept relevance, concept irrelevance, and procedural accuracy. Participant notes were coded by research assistants who were blind to condition assignment. Two research assistants coded 20% of the notes to establish interrater reliability (>90% agreement), and one research assistant coded the remaining notes.

Concept relevance and *irrelevance* were assessed by summing the number of important and seductive detail concepts recorded in note form, respectively. A concept checklist was applied to determine how many of the 32 important relevant concepts and seven irrelevant seductive detail concepts covered in the lesson were recorded.

Procedural accuracy was assessed by examining a subset of each participant's notes focusing on matrix multiplication. The subset was analyzed for procedural accuracy through a 3-point scale with the prompt "Using the student's notes, I could teach myself matrix by scalar and matrix by matrix multiplication." The scale was anchored by 1 at the low end ("I could not understand matrix multiplication based on the notes due to insufficient or inaccurate details") and 3 at the high end ("I could completely understand matrix multiplication with sufficient detail from the notes"). This scale was designed to assess how well participants captured the procedures involved in matrix calculations.

Table 1
Correlations With Final Test Performance Within Each of the Four Conditions

Calibration with final test performance	High-stakes		Low-stakes	
	SD Present	*SD* Absent	*SD* Present	*SD* Absent
Video lesson quality	$r(57) = .40^{**}$	$r(56) = .00$	$r(57) = .05$	$r(64) = .10$
Judgment of learning rating	$r(57) = .35^{**}$	$r(56) = .14$	$r(57) = .15$	$r(63) = .19$
Distractibility rating	$r(57) = -.14$	$r(56) = .14$	$r(57) = -.20$	$r(63) = -.07$

** $p < .01$.

Examining first the quantity of relevant concepts recorded in the notes, we found a main effect of learning stakes, $F(1, 238) = 8.54$, $p = .004$. Participants in the high-stakes condition captured more of the relevant lesson concepts ($M = 19.81$, $SE = 0.45$) than did participants in the low-stakes condition ($M = 17.81$, $SE = 0.46$), $t(240) = 2.99$, $p = .003$, Hedges' $g = 0.385$. A main effect of seductive details also emerged, $F(1, 238) = 8.84$, $p = .003$, such that participants who received seductive details captured more of the relevant lesson concepts ($M = 19.82$, $SE = 0.43$) than those who saw the video without seductive details ($M = 17.85$, $SE = 0.51$), $t(240) = 3.04$, $p = .003$, Hedges' $g = 0.39$. Participants in both the low-stakes, $F(1, 123) = 5.30$, $p = .023$, and high-stakes conditions, $F(1, 115) = 3.64$, $p = .059$, took more relevant notes when they received seductive details as a part of the lesson. See Table 2 for note scoring as a function of learning stakes and seductive details condition. No interaction was found, $F < 1$.

We next looked at the extent to which participants took notes on the irrelevant concepts (i.e., seductive details). This analysis was limited to participants who received seductive details during the video. Participants given high stakes did not differ from those given low stakes in the number of seductive details statements recorded in their notes, $p > .05$ (see Table 2). The average number of seductive detail statements recorded for all participants was 1.46 ($SD = 1.67$) out of 7. Note that the seductive details were highly concrete, comprehensible statements. Their omission from student notes suggests that students in all conditions recognized the irrelevance of this material or else considered it memorable enough that it was unnecessary to record. Thus, students did not appear confused about what information was important to capture in notes during the video lesson.

Examining students' clarity and thoroughness in procedural notes, no significant main effects or interaction were found in the content of participant notes relating to procedural accuracy, $F\text{s} < 1$. Across conditions, the average procedural score was 1.79 ($SD = 0.81$) out of 3. This score reflects that the average participant recorded notes which may be meaningful to the participant but were judged to lack the details needed for a naïve student to accurately perform both matrix multiplication procedures (i.e., matrix by scalar and matrix by matrix multiplication). These two types of multiplication were given equal weighting in the coding procedure.

Interaction With Prior Knowledge

Lastly, we addressed what role prior knowledge might play in our main performance results. We began by ensuring that participants across conditions were equitable in prior knowledge. Using prior knowledge as the outcome variable, we found no evidence for a main effect of learning stakes, seductive details, nor a Learning Stakes × Seductive Details interaction, $F\text{s} < 1$, suggesting that prior knowledge varied equally across conditions. We then asked whether the Learning Stakes × Seductive Details interaction might be further moderated by individual differences in prior knowledge. To address this possibility, we conducted a median split on prior knowledge ($M = 1.75$, $SD = 0.95$) and operationalized those with a score of 1 to 1.39 as lower prior knowledge ($M = 1.04$, $SD = 0.08$, $n = 118$) and those with a score of 1.40 to 5 as higher prior knowledge ($M = 2.43$, $SD = 0.90$, $n = 124$). We conducted an ANOVA with prior knowledge, learning stakes condition, and seductive details as between-subjects factors, and found a significant effect of prior knowledge, $F(1, 234) = 23.96$, $p < .001$, Learning Stakes × Seductive Details interaction, $F(1, 234) = 5.11$, $p = .030$, and the critical three-way interaction,[2] $F(1, 234) = 4.22$, $p = .041$. All other terms were not significant, $F\text{s} < 2$ (see Figure 3).

For participants with lower prior knowledge, we did not find main effects of learning stakes or seductive details, $F\text{s} < 1$, but did find that the Learning Stakes × Seductive Details interaction was significant, $F(1, 114) = 7.61$, $p = .007$. In the low-stakes condition, participants who received seductive details ($M = .67$, $SE = .04$) performed marginally, but not significantly, worse than those who did not receive seductive details ($M = .77$, $SE = .04$), $t(57) = -1.68$, $p = .098$, Hedges' $g = -.432$. (Note that the negative impact of seductive details in the low-stakes condition was significant when we ran this analysis generalizing across prior knowledge levels). In the high-stakes condition, in contrast, participants who received seductive details ($M = .80$, $SE = .04$) performed significantly *better* than those not given seductive details ($M = .68$, $SE = .04$), $t(57) = 2.25$, $p = .028$, Hedges' $g = .581$. (Note that the positive impact of seductive details was not significant when we ran this analysis generalizing across prior knowledge levels).

For participants with higher prior knowledge, no main effects or Learning Stakes × Seductive Details interaction were found, $F\text{s} < 2.5$. Participants with higher prior knowledge performed comparably regardless of whether learning stakes were high or seductive details were included.

Discussion

This study examined whether the effects of seductive details can be differentiated depending on the affective state induced by the learning context. Our results suggest that seductive details can indeed derail students' comprehension of core concepts when they are embedded within instruction in a low-stakes environment. Yet a starkly different pattern emerges during high-stakes learning—particularly for students with low prior knowledge.

Low-Stakes Condition

Among the general sample, participants assigned to the low-stakes condition who received seductive details during the matrix algebra lesson performed significantly worse on the final test than those who did not receive seductive details. This finding aligns well with the literature demonstrating that seductive details impair textbook learning under similar low-stakes conditions, in which students are not incentivized to learn but participate in the study only for research credit (Harp & Mayer, 1998; Lehman et al., 2007; Sanchez & Wiley, 2006). The current findings add to this literature by extending the seductive details literature to mathematics and video lecture learning.

Why did students underperform when the video lesson was accompanied by seductive details? In previous research, seductive

[2] We also ran this three-way model using regression. An inverse transformation was applied to prior knowledge but was otherwise run in the model as continuous variable without any splitting. A significant three way interaction was obtained ($B = 1.93$, $t = 2.10$, $p = .037$); $F(7, 241) = 5.80$, $p < .001$.

Table 2
Participant Note Averages for the Number of Relevant Concepts, Seductive Details, and Procedural Ratings as a Function of Learning Stakes (Low, High) and Seductive Details (Present, Absent)

Note scoring	High-stakes		Low-stakes	
	SD Present	*SD* Absent	*SD* Present	*SD* Absent
Relevant concepts: average number recorded (lesson total: 32)	20.64 (.67)	18.97 (.68)	19.00 (.67)	16.74 (.63)
Seductive details: average number recorded (lesson total: 7)	1.71 (.22)	—	1.22 (.22)	—
Procedural rating: average rating earned (1–3 scale)	1.90 (.11)	1.78 (.11)	1.83 (.11)	1.65 (.10)

Note. Standard errors are in parenthesis.

details have been argued to impact learning by capturing students' interest (Harp & Mayer, 1997; Kintsch, 1980) and activating inappropriate prior knowledge that detracts from processing of core concepts and leads to shallow learning of relevant material (Harp & Mayer, 1998). We did not find much evidence in favor of this interest account. Students actually took more notes on relevant material when they received the video lesson with seductive details. Students who watched the video in a low-stakes context also did not report being more distracted when they received seductive details than those who did not receive them as a part of the lesson.

An account that is better aligned with these data is that students in the low-stakes learning condition appropriately recognized the seductive details as irrelevant to the lesson objectives, which made the lesson feel incoherent but not distracting. Nevertheless, they may not have had the motivation or expectation of accountability to think deeply about the relevant material beyond engaging in low-level note taking activities to overcome what they perceived as an incoherent video lesson. This account explains why students in the low-stakes condition who received seductive details rated the lesson as lower in quality relative to those who did not receive seductive details: Perhaps they considered having to dismiss unnecessary (but not distracting) information the mark of a poor lesson. Furthermore, the finding that judgments of learning did not correlate with performance suggests that in the low-stakes conditions, students did not process information deeply and their metacognition was similarly shallow and subsequently inaccurate.

The bigger pattern of results suggests that when in a low-stakes learning setting (i.e., a traditional psychology experiment), seductive details do in fact harm video lecture learning. Perhaps this effect occurs because students feel neither pressure nor motivation to find the use of seductive details efficacious.

High-Stakes Condition

Considering the pattern of exam performance observed among participants in the low-stakes learning context, one might expect that students watching the video lesson under a high-stakes learning context would report the lesson as less efficacious and performance decrements would be even more exacerbated. However, in a high-stakes learning context, the inclusion of seductive details led participants to perform just as well as those who did not receive seductive details, with some noteworthy affective responses.

We found that participants in a high-stakes learning context who received seductive details actually reported higher video lesson

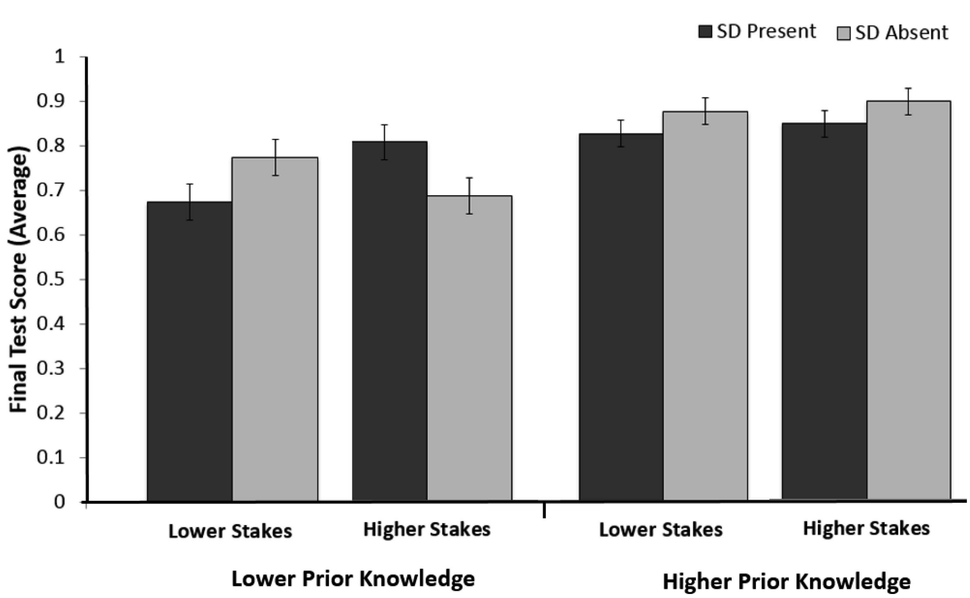

Figure 3. Final test performance for participants lower and higher in prior knowledge as a function of learning stakes and seductive details. Error bars represent standard errors.

quality ratings than those who did not receive seductive details. But of course, students are often overconfident about the benefits of various learning techniques (Bjork, Dunlosky, & Kornell, 2013) and their perceptions of learning techniques are often inversely related to their effectiveness (Godden & Baddeley, 1975; Smith, Glenberg, & Bjork, 1978). However, final test performance under high stakes was positively associated with participants' video lesson ratings—but only for those who received seductive details. Hence, these data suggest the inclusion of seductive details does *not* negatively impact student learning under high-stakes contexts—contrary to the general trend of previous findings. Instead, in addition to showing no detrimental effect on test performance, seductive details actually enhanced metacognition—a greater calibration between learning and perceptions of learning (Schacter & Szpunar, 2015).

Ideally, use of seductive details would create interest but not distract students' attention away from the relevant material. Within a high-stakes learning context, those who received seductive details did not report being more distracted by the video lesson than those who did not receive seductive details. We also observed that students assigned to watch the video lesson with seductive details under a high-stakes environment very rarely took notes on the seductive details, suggesting that participants recognized that seductive details were not relevant for the lesson goals. The pattern of results outlined thus far fit well with anecdotal reports from instructors and students that seductive details enhance learning by capturing students' attention using interesting information. Students likely appreciate instructor efforts to enhance lecture by including seductive details during high-stakes learning environments, but their appreciation does not hinder them from attending to and taking notes on the relevant material.

A second possibility is that seductive details may simply give students breaks from the video lesson, which provides opportunities to monitor their own learning when motivated to do so under high-stakes conditions. Students who received "breaks" via seductive details could have viewed these moments as opportunities to think more deeply about the material, which ultimately enhanced understanding. This monitoring account would help explain why higher lesson quality perceptions and judgments of learning were related to performance in the high-stakes, seductive details condition: Break periods during high-stakes learning may, in essence, give students more "think time," which allows for better monitoring of learning and calibration. In the current study, the seductive details provided an extra 2.5 min. Previous research suggests that even 3 s of think time breaks during question answer exchanges can go a long way to enhance student comprehension (Rowe, 1986; Tobin, 1987). This would be an especially valuable assistance for students with low prior knowledge.

In fact, among students lower in background knowledge, we found that the inclusion of seductive details significantly *enhanced* performance in the high-stakes condition but not the low-stakes condition. Participants with high prior knowledge generally performed well regardless of the seductive details or learning stakes. Our prior knowledge results suggest that seductive details are the most efficacious for students who are most at risk for underperformance (i.e., low-knowledge students who have high stakes riding on their learning). This outcome is inconsistent with previous laboratory research suggesting that it is students with high working memory and prior knowledge that most benefit from the inclusion of seductive details (Park et al., 2011, 2015; Sanchez & Wiley, 2006; Stitzman & Johnson, 2014).

Implications of Context-Dependent Findings for Researchers

Exposing students to a degree of accountability, more akin to a real-world classroom, was enough to significantly alter the effect of the seductive details manipulation. Whereas under low stakes, participants were harmed by the seductive details, under high stakes, participants were either unaffected or in some cases aided by their inclusion. Our results suggest that a critical moderator of the seductive details effect is the students' level of accountability brought on by the high- or low-stakes nature of the learning environment.

Our high-stakes manipulation was meant to mimic the accountability that students are commonly exposed to in a classroom lecture learning environment: social comparison, expert evaluation, and outcome incentives (cf. DeCaro et al., 2011). In this way, we could evaluate the joint effects of seductive details and high stakes on the input stages of learning. Students under high stakes reported higher perceptions of pressure, evaluated their judgments of learning as lower, and captured more relevant notes than students under low-stakes. These findings suggest that we were successful in manipulating a more high-stakes environment during the lecture portion of the study. We were also successful at extinguishing performance pressure once the lesson period was over, as participants in both low- and high-stakes conditions performed equally well on the working memory task. Hence, our procedure appears to have been successful at activating and isolating the effects of learning stakes to the learning phase of the research design.

We believe our findings and high-stakes manipulation procedure have important implications for laboratory studies attempting to unravel the processes of student learning. Students completing mandated research participation in a typical psychology experiment may be doing so under a default "low-stakes" environment, which is arguably ideal when studying basic cognitive processes. However, studies focused on generalizing findings beyond the laboratory should consider whether the designated environment is consistent with the affect that students experience in the natural environment. If participants do not feel like students, the mechanisms activated may not represent student learning as it happens in vivo. As a result, any measured outcomes may lack external validity. Although the current study included laboratory components artificial to a classroom (e.g., removing high stakes prior to the test), our findings still suggest that motivation is not to be overlooked when examining cognitive processes during instruction to generalize to the realm of education.

Implications for Educators

Taking the results in sum, the current study has important implications for teachers' instructional decisions in regard to lectures. Providing relatable, peripheral information alongside the more abstract conceptual information may provide students with the inclination to believe that the material is both learnable and worthy of being learned. Particularly in the math domain, it is common for students to believe that content is not useful for their lives outside of a school context (Mazzocco et al., 2012). There is ample evidence from the motivation literature that utility value is a significant motivating force influencing academic outcomes with demonstrated improvements in behaviors and achievement (Wigfield & Eccles, 1992, 2000). Providing interesting tangential information via seductive details to a rather abstract mathematical subject could help students relate the content back to their everyday knowledge—particularly for those students who are low in prior knowledge.

Although it is likely most desirable to engage students' interest in a lesson using information that is also *relevant* to the content, this is often a difficult feat when the content is abstract, procedural in nature, or is perceived to have little initial utility value. Developing appropriate anecdotes to bring material to life likely takes years of practice and requires an instructor to have significant expertise in the content domain. For novice instructors who are developing their own content and pedagogical knowledge as they teach a course, this study suggests that one feasible way to improve students' learning outcomes for those with low background knowledge is to—somewhat paradoxically—include seductive details. This may be even more advisable considering that those higher in prior knowledge were not affected negatively.

We feel one additional important caveat should be made: We are not advocating free rein when it comes to seductive details in terms of frequency or type. We are limited in our recommendations by our methodology, and in the current study we used a few seductive details placed during the transition of concepts so as not to interfere with concept instruction. It remains to be seen if seductive details are beneficial in real courses and whether the use of tangential seductive details are just as effective as relevant content anecdotes.

Limitations

Although we attempted to emulate an authentic classroom environment, one obvious and important limitation is that our findings are constrained by our laboratory paradigm. There are a number of ways in which our methodology is left wanting compared with authentic classrooms. First, the incentives we provided are approximations but not identical to those of a real classroom, no matter how motivated students became with our manipulation. As such, we can posit that seductive details may behave differently depending on motivational context as seen in the current study, but we cannot speak to classroom outcomes at the present time. Second, students did not get the chance to interact with the instructor or other students during the lesson. It is possible that providing collaborative opportunities would alter the effects of the seductive details. For instance, providing opportunities for students to discuss content may result in irrelevant discussion and reduced learning. Third, the lesson we presented was relatively brief (less than 20 min in both conditions) compared with a typical lecture, and students' exposure consisted of only one session. Longer-term effects of seductive details in lecture learning, such as changes in academic behaviors (e.g., studying time), were not assessed. Last, the final assessment took place under low-stakes conditions in order to examine solely how seductive details impact learning during transmission. This is inherently unlike a classroom environment in which students undoubtedly also experience great stress during testing. It remains for future research to determine the effects of seductive details in high-stakes test situations. Thus, at this time we cannot speak to dosage, type of seductive details, or how they may interact with high-stakes testing; however, based on our findings there is sufficient evidence to warrant additional research on seductive details and lecture learning.

Conclusion

This study examined the seductive details effect during a mathematics video lecture with either high or low stakes. Consistent with previous research, seductive details negatively affected learning during the low-stakes context. However, a manipulation to increase the high-stakes nature of the context resulted in a very different effect: students who were held accountable for their learning showed either no negative effects or even positive effects of receiving seductive details. The positive learning gains were seen particularly among students with low mathematics prior knowledge—the very students most in need of high-quality instruction. Important implications arise for researchers, for whom the current study suggests that context is not to be taken for granted in laboratory studies. These findings also have important implications for teachers, for whom the current study suggests that including seductive details in lecture instruction may be an effective way to assist students in achieving greater mastery of relevant content for those most likely to struggle because of insufficient prior knowledge.

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