

The Role of Practice Testing and Presentation Style on Undergraduate Students' Retention of Information

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Abstract—Previous research on the testing effect has demonstrated that practice testing, whether open or closed book, is similarly effective in promoting long-term retention of information over non-testing (Agarwal, Karpicke, Kang, Roediger, & McDermott, 2008). Furthermore, the way in which information is presented (e.g., text vs. video) influences information retention (Merkt, Weigand, Heier, & Schwan, 2011). The current study extends previous research by examining the independent and interactive role of practice testing (i.e., open-book, closed-book, or no test) and presentation style (i.e., text or video) on undergraduate students' retention of information. A total of 149 students learned new information through video or text mediums and then completed an open-book practice test, closed-book practice test, or did not complete a practice test (control). Following a distractor task, participants completed a test of knowledge retention. The text medium and an open-book practice test both (independently) promoted greater retention of information.

Keywords: testing effect, learning, knowledge retention

With the exception of the past two decades, textbooks have served as the primary form of educational aid. However, with the emergence of the digital age, pictures, videos, and audio clips are increasingly accompanying conventional textbooks (Issa, Cox, & Killingsworth, 1999), and less conventional instructional tools such as websites and interactive games are becoming commonplace. Educators who employ the less conventional instructional tools question whether the tools contribute to increasing students' retention of information over conventional texts. Recent research suggests learning from less conventional tools (e.g., interactive videos) efficiently aids the learning process (Merkt, Weigand, Heier, & Schwan, 2011), but this learning may depend on the learners' expectancies concerning how their knowledge will be tested (i.e., open-book or closed-book testing; Agarwal, Karpicke, Kang, Roediger, & McDermott, 2008; Agarwal & Roediger, 2011). The purpose of the current study was to examine whether presentation style (i.e., text or video)

independently or in combination with practice testing (i.e., open-book, closed-book, or no test) promotes retention of information among university students.

The "testing phenomenon" (Glover, 1989, p. 392), also known as the "testing effect" (Agarwal & Roediger, 2011, p. 836), states the process of retrieving and applying knowledge through repeated testing opportunities positively impacts long-term retention of information (Glover, 1989). In fact, research has demonstrated knowledge retention is contingent on the amount of mental processing dedicated to particular information, with the greater number of "retrieval events" (p. 392) associated with greater final knowledge retention. In an examination of the testing effect, Glover examined individuals' retention of trivial facts or diagrams while manipulating the number of practice tests (i.e., no practice test, one practice test, more than one practice test) and type of recall (i.e., free-recall, cued-recall). Results revealed, for both free-recall and cued-recall, participants given

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one or more practice tests outperformed participants given no practice test. These findings support the notion that repeated opportunities to retrieve information increases individuals' retention of information.

Karpicke and Roediger (2007) found additional support for the testing effect when examining the effectiveness of study-testing patterns on students' retention of word lists. Specifically, Karpicke and Roediger randomly assigned participants to one of three study-test pattern conditions: alternating study sessions with practice tests (STST), three consecutive study sessions followed by one practice test (SSST), and one study session followed by three consecutive practice tests (STTT). A final test of retention, for all groups, was administered one week following the last practice test. Karpicke and Roediger predicted repeated practice tests would promote greater knowledge retention on the final test of knowledge. Results were consistent with the prediction; the repeated practice test conditions enhanced students' retention relative to repeated studying, with alternating the study and testing trials producing the greatest retention. These findings suggest repeated testing is an effective strategy to promote learning.

Closed- and open-book testing are two common educational practices used to assess students' learning. During closed-book testing, students recall or retrieve information without the aid of notes, textbooks, or electronic resources. In contrast, during open-book testing, students are allowed to consult their notes, textbook, or electronic resources. Research on the effectiveness of open- and closed-book testing is beginning to receive empirical attention. For example, Agarwal et al. (Study 1, 2008) examined whether open- or closed-book testing differentially effects retention of information. Specifically, participants were randomly assigned to study prose passages and then re-study or take an (initial) open- or closed-book test. One week after exposure to the prose passages, participants completed a short answer final test assessing their retention of the information. The results of the initial test revealed the open-book testing condition led to better performance than the closed-book testing condition, but this effect did not last, with both

open- and closed-book testing conditions equally promoting learning (relative to the re-studying control condition) on the final test. Therefore, the testing effect emerges for both open- and closed-book tests.

Although open- and closed-book tests may be equally effective in promoting long-term retention of information, students' expectancies concerning open- and closed-books tests (e.g., difficulty) may affect their learning. Examining the role of students' expectancies on the testing effect using open- and closed-book tests, Agarwal and Roediger (2011) asked participants to read passages, derived from the Graduate Record Exam, where they were told to expect no test, an open-book test, or a closed-book test. Results revealed participants spent less time studying and learned less when expecting an open-book test (compared to a closed-book test). However, both open- and closed-book testing conditions led to better performance than the no test (study only) condition. Overall, it seems that students' expectancies regarding the type of testing influence their learning.

In addition to traditional classroom assessment activities (i.e., tests), many students engage in some kind of content immersive activity in order to further their grasp of course concepts. Often this learning is achieved through the viewing of informational videos. In fact, researchers (e.g., Issa et al., 1999) have reported self-paced multimedia learning has a positive impact on high school and college students' learning, with retention being 21-28% better when using self-paced multimedia resources relative to traditional classroom lecture. Thus, the way in which information is presented also influences individuals' learning.

Merkt et al. (2011) compared students' retention of educational information about the political and economic situation in Germany after World War II across three types of presentation style: an enhanced video, a common video, and a content-equivalent illustrated textbook. The enhanced video contained "micro-level as well as macro-level activities" (p. 692), which included a start/stop button, a timeline navigation tool, a table of contents, and an index of key terms. The common video contained only micro-level

activities, “analogous to the features of a regular VHS tape, with a start/stop-, and a forward and a rewind button” (p. 692). The illustrated textbook served as a control condition and was a verbatim transcription of the video’s audio with accompanying screen shots. Merkt and colleagues hypothesized participants viewing the enhanced video would outperform participants in the common video group, and albeit somewhat surprisingly, retention for the illustrated textbook would be equivalent to that of the enhanced video (because enhanced video and text both afford micro and macro level features). Secondary school students from Germany were randomly assigned to one of the three presentation style conditions. Knowledge acquisition was assessed through the identification of facts, derived from the informational content, on an essay test. Results revealed the print medium was as effective as both video conditions in promoting retention; unexpectedly, the common video outperformed the enhanced video. These results suggest that, contrary to what students may expect, textbook reading is an effective tool, at least equally as effective as videos, for promoting retention of information.

Although text appears to be an effective medium to promote learning, it is possible some educational content may be easier to learn through print. Consequently, in a study examining memory for less traditional educational content (i.e., violent news stories presented in the media), college students were exposed to stories in either audiovisual, audio, or print mediums. Subsequently, participants completed a 20-item questionnaire assessing their memory for the stories. Results revealed a significant difference among all three mediums, with the print medium yielding the greatest recall and the audiovisual medium yielding the worst recall (Furnham & Gunter, 1987). Thus, text appears to be a reliable medium for promoting the learning of even less traditional education information as well.

Current Study

The present study examined the independent and interactive role of practice testing (i.e., open-book practice test, closed-book practice test, or no practice test) and presentation style (i.e.,

text or video) on individuals’ retention of information. Consistent with the research by Merkt et al. (2011), as well as Furnham and Gunter (1987), it was predicted that participants using a traditional text to learn novel content would outperform participants who use videos on a test of retention. Furthermore, consistent with the research by Agarwal and Roediger (2011), it was predicted that, on a final test of knowledge retention, participants informed of and given a closed-book practice test would outperform peers informed of and given an open-book practice test. Lastly, as an extension of previous research, the current study examined the combination of presentation style and practice testing on students’ retention of information, where the closed-book testing of text content was expected to yield the best overall retention of information compared to any other presentation-testing condition.

Method

Participants

A sample of 149 undergraduate students (51 male, 97 female, 1 preferred not to respond) from a small, Catholic university participated in exchange for course credit. The majority of students were advanced standing (third or fourth year of study; 60%), Caucasian (81%), and female (65%). Students from all three colleges at the university were represented in the study (53.3% College of Professional Sciences, 25.5% Arts and Sciences, 19.6% College of Business, 1.6% Undecided). Participant age ranged from 18 to 29 years old ($M = 20.18$, $SD = 1.38$).

Materials

Video or text presentation style. To assess the effectiveness of video- versus text-based mediums in promoting learning, two videos totaling 7:26 mins were obtained via YouTube, detailing the neurological phenomenon of synesthesia. A text version of the videos (see Appendix A) was created by precisely transcribing the video’s content and including accompanying still-framed photographs from the videos.

Practice and final tests. Parallel 59-item variable-style practice and final tests of knowledge about synesthesia were created for this study (see Appendix B for final test). Items on the practice

and final tests were derived by the first author by identifying the factual content described in the videos about the neurological phenomenon of synesthesia. The second author reviewed the videos to verify the factual content presented on the practice and final tests. Correct responses on the final test of knowledge were summed, after hand scoring participants' tests with higher scores reflecting better retention of information. Scores on the practice and final tests were significantly correlated ($r = .78, p < .001$).

Procedure

The study was conducted in small groups of 8 to 15 students as a 2 x 3 between-subjects factorial design, in which participants were randomly assigned to learn about synesthesia via a video or text medium and participate in an open-book practice test, a closed-book practice test, or no practice test.

University IRB approval was obtained prior to conducting the present study. Upon beginning the study, participants completed an informed consent document and responded to demographic questions assessing their age, gender, race, academic year, and previous exposure to information about synesthesia (see Appendix C). After describing the purpose of the study, but prior to viewing the video- or text-based content, one third of the participants were informed to anticipate an open-book practice test, another third of participants were informed to anticipate a closed-book practice test, and the final third of participants were not informed of (nor provided) a practice test. As an incentive for active participation in the study, participants were also told that scoring over 60% on a final comprehension test would qualify them for entry into a drawing for a \$30 gift card (all participants were, in fact, entered into the drawing regardless of performance on the final test). After this information was provided, participants were presented with the brief, factual content concerning the neurological phenomenon of synesthesia in the form of either video or text. Participants were instructed to study the content at their own pace and were then invited to complete an open-book practice test, a closed-book practice test, or were not invited to complete a

practice test. Although the time taken by each participant to review the material was not recorded, the first author observed participants took more time to review the material in the open-book compared to the closed-book practice-test conditions. Participants in the closed-book practice test condition were not permitted to refer back to their content during the test, whereas, in contrast, participants in the open-book practice test condition were allowed to actively refer to the content to confirm and/or search for correct answers. Subsequently, all participants were exposed to a distractor task, involving participating in an unrelated study and then asked to complete the final, self-paced, closed-book test measuring their retention of information about synesthesia. At the end of the study, participants were thanked and debriefed.

Results

Participants' previous knowledge of synesthesia was unrelated to their practice ($r = .10, p > .05$) and final ($r = .12, p > .05$) test scores and, therefore, was not controlled for in subsequent analyses. To test the prediction that closed-book testing of information presented through a text medium would yield the best overall retention of information compared to the other presentation-testing conditions, a 2 (presentation style: video, text) x 3 (practice test: open, closed, no) between-subjects analysis of variance (ANOVA) was conducted on the number of correct items on the final test of knowledge retention. The interaction between practice test and presentation style was not significant, $F(2, 143) = 0.73, p > .05, \eta_p^2 = .10$. However, the main effect of presentation style was significant, $F(1, 143) = 12.76, p < .001, \eta_p^2 = .08$, revealing individuals learning through text ($M = 12.21, SD = 1.79$) outperformed individuals learning through video ($M = 11.17, SD = 1.79$) on the final test of knowledge retention. Furthermore, the main effect of practice test was significant, $F(2, 143) = 3.81, p < .05, \eta_p^2 = .05$. Follow-up post-hoc tests, using a Bonferroni correction, revealed participants given an open-book practice test ($M = 12.22, SD = 1.88$) outperformed individuals who did not receive a practice test ($M = 11.28, SD = 1.71$) on the final test of knowledge retention. No differences emerged between open-book practice

($M = 12.22$, $SD = 1.88$) and closed-book practice ($M = 11.63$, $SD = 1.89$) tests or closed-book practice and no practice test ($M = 11.28$, $SD = 1.71$).

Discussion

Extending previous research on the factors influencing students' retention of information, the present study examined the independent and interactive role of practice testing (i.e., open-book, closed-book, or no test) and presentation style (i.e., text or video) on undergraduate students' retention of information. Results revealed learning information through text and participating in an open-book practice test both (independently) promoted greater retention of information. In general, the present findings yield valuable information about the ways educators can promote the retention of information among college students, as well as questions that provide important directions for future research on the topic.

The current investigation adds further support to prior research (see Furnham & Gunter, 1987; Sundar, Narayan, Obergon, & Uppal, 1998) demonstrating learning through text is superior to learning through video when attempting to recall facts mentioned in the mediums. This finding suggests the way in which information is presented plays a role in how well information is absorbed and retained. One possible reason for this difference is the cognitive effort expended in order to understand the content (see Mayer, Hegarty, Mayer, & Campbell, 2005). Sundar and colleagues (1998), as well as Furnham and Gunter (1987), contend print content (relative to video content) may innately contribute to greater retention, most likely due to the greater demand of mental energy the text medium requires. In the present study, participants may have actively engaged with the text content, interacting more meaningfully with the content in this medium, whereas participants may have passively received or reviewed the content in the video. However, an alternative explanation for this effect may be that video requires greater cognitive load than print, because the learner must hold the information in memory without the memory aid provided by print.

One of the primary purposes of the present study was to examine if participants who

anticipate and complete a closed-book practice test would outperform peers who anticipate and complete an open-book practice test. Contrary to prediction, completing an open-book practice test did not enhance performance on a final knowledge test relative to a closed-book practice test. The only significant difference to emerge for the role of practice testing on retention of information was that an open-book practice test promoted greater retention of information compared to no practice test. Although inconsistent with prediction, the result supports research by Agarwal et al. (2008), who found recall of learned facts was higher for an open-book initial (or first) test compared to no test or a closed-book initial test (however, this difference did not last for a final test, occurring one week after exposure to the information). Consequently, this finding suggests retention of information practiced with open-book tests may initially be more successful than retention of information practiced with closed-book tests. It is possible that because open-book tests rely less on drawing from long-term memory than closed-book tests, performance on open-book tests may be superior. In future studies, manipulating the number of open- and closed-book practice tests, as well as the time between practice and final tests, may reveal the most effective strategy for using practice tests to increase long-term retention of information.

Limitations and Future Directions

The present findings contribute to the understanding of the role of presentation style (i.e., text or video) and practice testing (i.e., open-book, closed-book, or no test) on undergraduate students' retention of information. The brief discussion presented next describes three important directions for future research on the topic.

Although utilizing a college student sample was a strength of the current study, individuals in this particular age group may be adept learners, as evidenced by their acceptance into a four-year university. However, because today's college students grew up in an educational system where media in the classroom was increasingly encouraged, the results of the current study may not generalize to other age groups. Additional

research should take a cross-sectional methodological approach to studying the role of presentation style (and practice tests) on individuals' long-term retention of information, as this research may reveal that the degree to which each generation has been immersed in technology may influence the effectiveness of learning through video versus text mediums.

Furthermore, although the current study found learning about the neurological phenomenon of synesthesia through text was more effective than learning through video, one possible explanation for this difference is the "interactivity" (Merkt et al., 2011, p. 687) of the mediums. Text, relative to video, allows for greater interaction between the reader and the content (see arguments by Merkt et al., 2011), as the reader can stop to reflect on difficult concepts, re-read an interesting passage, and/or backtrack to make connections between or among ideas. Consequently, the more interactive and engaging the medium, the more information processing that may occur and the better the long-term retention of the information (Furnham & Gunter, 1987; Merkt et al., 2011). With this idea in mind, future research should examine if the relationship between a medium's interactivity and learning is moderated by the amount of control learners exert over their information processing. For students who exert relatively high control over their information processing (i.e., enjoying thinking about difficult content), maybe text and video would equally promote content retention. Finally, with new interactive educational content being developed every day, the current study should be conducted in more naturalistic settings, testing students' memory for actual classroom content.

Finally, the finding that open-book practice tests contribute to greater retention of information compared to no practice tests provides a direction for future research. Specifically, future research could examine if the difficulty of a learning task (i.e., cognitive effort expended) influences the effectiveness of practice tests on retention of information. Such research may reveal that greater cognitive effort explains why practice tests are effective relative to no practice tests.

Conclusion

In sum, the present study demonstrates learning information through text and providing open-content practice tests both (independently) promote greater retention of information among college students. Despite the limitations of the present study, the findings have implications for educational settings, as educators can be assured that assigned text-based readings are beneficial to students' knowledge acquisition and retention. Furthermore, educators can be confident that open-book practice tests encourage learning relative to not providing a practice tests. Future research should investigate the long-term retention of information based on the varied presentation styles and practice opportunities that exist in higher education. Further, additional research is needed with regard to the effectiveness of closed-book practice tests to promote retention of information in order to evaluate its merit. Finally, the acquisition of knowledge in different academic areas, such as mathematics or history, may rely on different types of presentation methods. Therefore, continued research examining the importance of presentation style and practice testing for specific academic areas is needed.

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