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The Effect of Visual Aids in Online Learning

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Abstract

Research has demonstrated the potential for increased distraction and decreased comprehension for material presented digitally (Gerow et al., 2010). Given the continued shift toward digital content and increase in online-only learning, examining ways to improve comprehension are important. Prior work has shown that visual aids can improve comprehension of material for learners, and thus may be a valuable tool to redress digital comprehension deficits (Bransford & Johnson, 1972; Majidi & Aydinlu, 2016). The present study examined the effect of visual aids in online reading comprehension. A between-subject experimental survey (N = 60) evaluated memory and comprehension in undergraduate students in one of three conditions: an image related to the text, one unrelated to the text or no image. It was hypothesized that the related image group would perform the best, followed by control and then distracting image groups. Contrary to expectation, the related image group performed the worst. The results are discussed in light of the study's limitations and suggestions for future research are outlined.

Keywords: visual aids, reading comprehension, online learning

The Effects of Visual Aids in Online Learning

Over the past twenty years, researchers have highlighted that online readers retain information less than print readers (Ackerman & Goldsmith, 2008; Ackerman & Lauterman, 2012; Delgado, et al., 2018). While simultaneously, the use of technology in the classroom, including e-texts, continues to increase (Cortez, 2017). In addition, recent work has also found that distractions increase when students are allowed to use the internet, often resulting in lower comprehension and memory for to-be-learned material (Behnke, et al., 1981; Gerow, et al., 2010). As technology becomes more readily available to students, and more necessary due to COVID-19, it is important to understand the cause of these impairments in order to find ways to improve comprehension of material. Visual aids may be one key variable to improve digital learning, as studies have found that they are beneficial to reading comprehension for students (Bransford & Johnson, 1972; Majidi & Aydinlu, 2016).

With the increased use of digital reading, especially in schools, researchers have become interested in comparing the comprehension levels for readers of online materia compared to print material. Ackerman and Lauterman (2012) examined the effects of text comprehension with online and print readers across varied conditions, where participants were under a time pressure or free regulation during the study. They found that online readers resulted in lower comprehension when under the time pressure condition, and that self-assessment of information learned was more accurate among participants who were assigned to print reading (Ackerman & Lauterman, 2012). Hou and Rashid (2017) conducted an experiment examining how two theories could explain why print readers typically comprehend more than online readers. The first theory, the Cognitive Map Mechanism, implicates that it is more difficult for online readers to make a spatial representation of the information presented to them, which can impair recall and reading

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comprehension. The second theory, the Medium Materiality Mechanism, suggests that the tangibility of printed text creates stronger sensorimotor engagement than online text.

However, not all research has shown deficits in online reading comprehension. Kemp and Grieve (2014) found little differences between online and print test performance. They suggest that these results are possible because students of higher education (undergraduate or graduate) have had more exposure to online activities and are therefore more comfortable with them (Kemp & Grieve, 2014). For older age groups, students consistently showcased more self-control against online distractors, such as IM messages, internet ads, video games and the accessibility to other resources (Kemp & Grieve, 2014). What can be inferred from this work is that age and experience can influence a person's ability to comprehend text presented online at the same rate of printed text.

Whereas the studies above demonstrate the differences in comprehension between print and online reading, researchers like Gerow and his colleagues (2010) have examined how distractions become more likely when learning virtually. Their research suggests that an increase in distractions can also decrease the amount of information retained by students (Gerow et al., 2010). Another study, examining the use of internet technology in education, found that switching between competing activities was highly distracting for graduate student participants (Winter et al., 2010). Both studies suggest that virtual multitasking in the classroom can be distracting for students, ultimately risking their comprehension of material. Understanding how comprehension levels of virtual learning are impacted by distractions is essential to the current research study. This is also important in determining the role visual aids play in online learning, and how they can either enhance or distract learners.

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A number of studies have already examined these variables, finding that text enhancements can improve retention and comprehension levels of students. Researchers have explored the use of visual aids in reading comprehension and memory, finding that the use of images can enhance comprehension of text and activities (Bransford & Johnson, 1972; Rakes, et al., 1995; Gorman & Eastman, 2000). Visual aids offer an outline of the narrative in a way that can improve their results on a memory recall test (Bransford & Johnson, 1972). For students particularly, visual aids can benefit their organization and active involvement in learning, leading to increased retention levels (Rakes, et al., 1995).

The use of visual aids can improve reading and writing skills because they are processed differently from text (Gorman & Eastman, 2000). One study found that visual aids offer an outline of the narrative in a way that can improve memory recall (Bransford & Johnson, 1972). For students particularly, visual aids can benefit their organization and active involvement in learning, leading to increased retention levels as well (Rakes, et al., 1995). Mayer and colleagues (1999) have promoted a theory of multimedia design, which states that materials, such as animations, used to promote prior-knowledge activation are beneficial. However, researchers who have examined this theory found few differences in student performance (Sperling et al., 2003). More recent studies have examined the use of visual aids particularly for reading comprehension exams for high school students (Majidi & Aydinlu, 2016). The success of participant retention was influenced by the context of the visual to the text (Majidi & Aydinlu, 2016). From this research it is clear that the use of text enhancements can benefit students academically. Yet, it is less clear how these results can be impacted when participants are given a reading comprehension test online.

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In light of the mixed evidence on the role of images in text retention and comprehension, the aim of the present study is to further investigate the role that visual aids play in on-screen learning. Specifically, the study will explore whether a related or distracting image influences comprehension and memory for a passage compared to the absence of an image. It is expected that the participants in the related image condition will have the highest performance on the comprehension exam, and those assigned to the distracting image condition will have the lowest performance rate.

Methods

Participants

Undergraduate student participants (47 female, 13 males, 3 unidentified, $M = 22.67$, $SD = 5.71$ age range: 17-45 years) from both a small private and public community college were recruited with an email of the anonymous link to the survey. Participation was voluntary and students were offered 1-point extra credit for participating. Out of the 65 participants, 22 identified as White/Caucasian, 20 as Hispanic/Latinx, 7 as Asian, 4 as Black/African American, 2 as Hawaiian Native/Pacific Islander and 7 as “other”. The academic class standings were as follows: 6 first-year undergraduates, 30 sophomores, 16 juniors, and 9 seniors; 44 were full-time students and 18 were part-time students.

Materials

Passage

Participants were presented with a passage on invasive brown anole lizards in Florida which was taken from a PSAT exam found online (IvyGlobal). The passage discussed the toe-pad differences between green anole lizards who have adapted to sharing their habitat with the

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brown anole species (Stuart, 2014). The passage was chosen because the material was likely new to most participants and included enough detail for memory and comprehension evaluations.

Images

The distracting image, as seen in Figure 1, was a graphic of different popular lizard species seen in Florida. The image was brightly colored and although it included a drawing of the green anole lizard it included many other lizards not mentioned. As shown in Figure 2, the relating image was a comparison between the larger toepads of the green anole and the smaller toepads of the brown anole. The diagram illustrated the main topic of the passage. The images appeared onscreen at the top of the text for both groups.

Dependent Variables

Participants were asked a total of 12 questions after reading the passage. Five comprehension questions, taken from the Practice SAT exam used for the passage (Pike, n.d.), were asked in order to examine participants' understanding of the material (e.g., Based on the passage, which choice best describes the relationship between brown anoles and green anoles in Florida?) An additional 7 memory questions were constructed to determine participants' level of recall of the text (e.g., What other species, mentioned in the passage, benefit from large toepads?). These two types of questions were selected to assess surface and deeper understanding (Majidi & Aydinlu, 2016).

Procedure

Students participated on their own time by using the Qualtrics link that was provided by the researcher. The survey began with a consent form that all participants had to agree to in order to continue with the survey. This was followed by a total of 8 demographics questions asking primarily of their education background, undergraduate level, gender and age. They were then

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randomly assigned to one of the three conditions: no image, related image, or distracting image. After reading the same passage, they answered the memory and comprehension questions. Responses were recorded on Qualtrics and were later analyzed with SPSS. The survey was open for a total of 25 days.

Results

Participants' scores on the memory and comprehension questions were calculated separately, with one point assigned for a correct response. One question was removed because of a mistake noted in the answer options. A one-way ANOVA comparing memory scores across the three conditions yielded a statistically significant difference, $F(2, 42) = 7.59, p = 0.002$. Analysis of the means revealed a pattern inconsistent with expectation. The distracting image group ($M = 4.27, SD = 1.53$) had significantly higher scores than the related image group ($M = 2.47, SD = 1.33$), $p = 0.003$. The control group ($M = 4.08, SD = 1.44$) also had significantly higher scores than the related image group, $p = 0.011$, as seen in Figure 3. Contrary to expectation, there were no significant findings in the results comprehension scores, $F(2, 42) = 0.42, p = 0.658$.

Discussion

The present study was designed to assess the impact of visual images on learning, with the prediction that a related image would help, and a distracting image would hinder retention and comprehension. Contrary to hypotheses, the results indicated that the related image impaired scores relative to the other two groups on memory, with inconclusive findings for the comprehension questions.

Although the results suggest that visual aids have a significant effect on performance of a reading comprehension exam, the scores were the opposite of what was predicted. Participants in the 'relating image' group were outperformed by the 'distracting image' group and the control

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group. The reduced scores of the comprehension questions from all condition groups may be in part of the survey being conducted unsupervised and online. The variation in time it took for each participant to complete the survey suggests some may have skimmed through the narrative, only remembering surface level information. Based on previous research concerning online learning, it is possible that the comprehension scores were lower in comparison to the memory scores because of reduced retention levels.

Limitations of the study design could also have contributed to the mixed findings. First, the images used for the survey were taken from the internet, and their difference in design could have introduced uncontrolled variability (e.g., color, organization, number of objects) to affect results. The visual aids in the image conditions were placed at the top of the page with the narrative underneath. Previous research has indicated that the context of the image in relation to the text plays a major role in how it affects the participants comprehension (Majidi & Aydinlu, 2016). This suggests that the placement used for the present study could have impacted participants' performance. A replicated study examining image placement in relation to text would further examine this theory.

A second limitation has to do with the inability to monitor participants as they took the survey. The average time it took for participants to complete the survey was 2.4 hours, with a median time of 6 minute. This suggests high variability in attention and suggests further that some participants may have been distracted after accessing the study. Further, the uncontrolled setting within which participants completed the survey could have introduced a number of variables that affected the results. Correcting these limitations is important for future work.

Given that prior work has shown beneficial effects of visual aids, future research focused on image placement and design as well as with students of different age groups is warranted.

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Creating visual aids, rather than using ones from the internet, is one way to eradicate any confounding variables associated with the images that were used in this study. As mentioned in previous research, undergraduate students are less likely to be affected by virtual distractions in a learning environment (Kemp & Grieve, 2014). Therefore, conducting a similar study with a younger population group (e.g., elementary students) may be helpful in understanding more fully the influence of visual aids in online learning.

In sum, the present study evaluated the impact of different types of visual images on reading comprehension and memory during digital presentation. Although the results were inconclusive, continuation of such explorations is important, as much of education has shifted to digital format and this trend seems unlikely to decrease.

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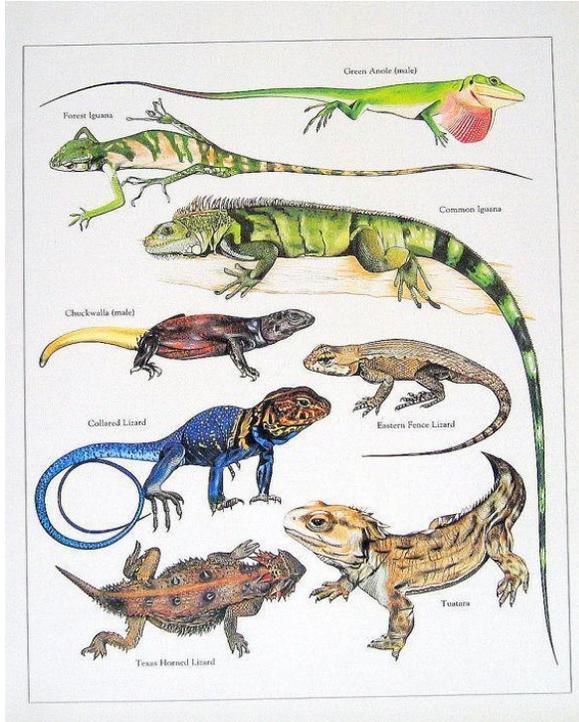
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Figure 1

Image presented to participants in the 'distracting image' group.



Note. This figure is a diagram of different lizard species that was given to participants in the distracting image condition group (DuCharme, n.d.).

Figure 2

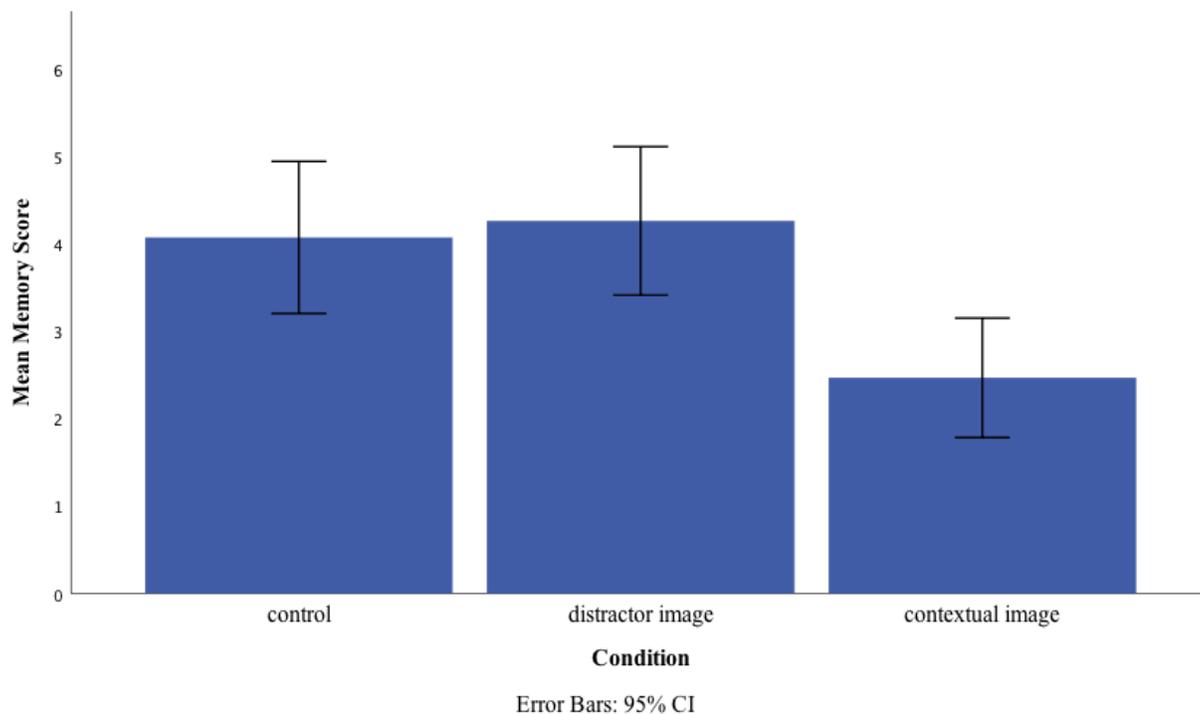
Image presented to participants in the 'relating image' group.



Note. This figure showcases the toepad differences between Green Anole lizards and Brown Anole lizards that was presented to participants in the contextual image condition group (Wasserman, F., & Blumenrath. (n.d.).

Figure 3

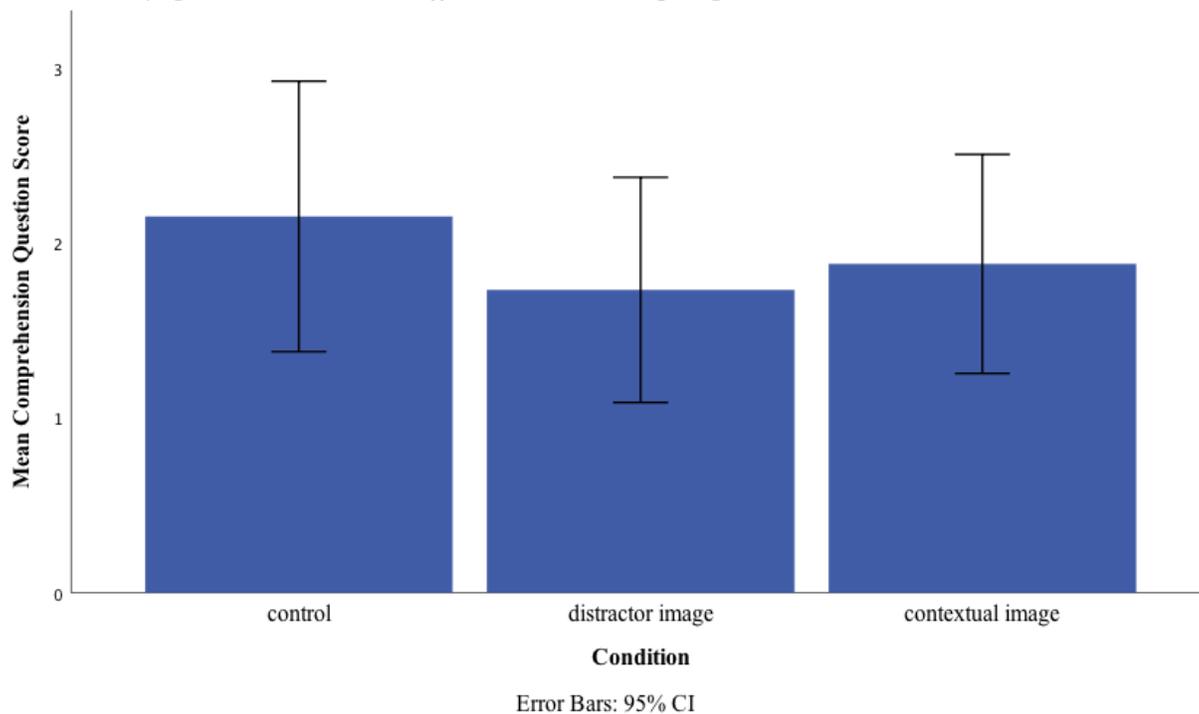
Scores of the memory questions between the three different condition groups.



Note. This figure demonstrates the differences in scores between the three condition groups (relating image, control group, and distracting image) of the memory question scores. Their scores were out of a total of 7 questions. Error bars represent 95% confidence intervals.

Figure 4

Scores of the memory questions between different condition groups.



Note. This figure represents the mean scores of the comprehension questions. Participants' scores were out of 5 total questions. Error bars represent 95% confidence interval.