Investigating the Effects of Doodling on Learning Performance:

The Daydream Reduction Hypothesis

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Abstract

Previous studies have reported a positive relationship between doodling and working attention and memory processes (Andrade, 2009; Boggs et al., 2017; Kercood & Banda, 2012). The present study aims to investigate why this positive dual-task relationship exists through empirical testing of the Daydream Reduction Hypothesis; stating that doodling improves learning performance due to its ability to reduce daydreaming. In order to test this hypothesis, a close replication of Andrade (2010) was conducted, with an additional shadowing component that manipulated the participants' ability to daydream. A significant negative relationship was found between shadowing and attention, suggesting that the shadowing component impaired participants' performance. Results between doodling and attention and memory were found to be non significant. If the shadowing component were substituted for a task less cognitively demanding, it is possible that we would be able to replicate the results of Andrade (2010), and discover why doodling has been observed to improve learning performance.

Introduction

As time progresses during a classroom lecture, students are likely to daydream and mind wander instead of effectively processing the presented information. Past research has demonstrated that doodling while simultaneously monitoring an auditory message results in better attention towards and memory of information presented in the message (Andrade, 2009; Boggs et al., 2017; Kercood & Banda, 2012). The purpose of this experiment was to further investigate the beneficial effects doodling on attention and memory, as it is especially unique compared to typical occurrences involving dual-task performances. Generally, past research has demonstrated that performing two tasks simultaneously (relative to performing either task one at a time) results in either an impairment in task performance, or no effect on task performance (Strayer & Johnston, 2001). Interestingly, the doodling effect is the one of the few, if not only, existing findings where a dual-task activity results in the improvement of performance.

A concept that potentially explains the effectiveness of dual-task activity is one raised by Morey and Cowan (2004). Their study suggested that if information being processed during the two simultaneously performed tasks exceed working memory/attention processing capacities, then dual-task interference will be evident. However, if the information being processed while performing two tasks together does not exceed working memory/attention capacity, then no interference will occur.

As previously stated, before discovering the effect of doodling on attention and memory, there had been little to no findings on dual performance resulting in the improvement of one of the two tasks. Thus, the improving effect of doodling on attention and memory is not only of potential interest to educators who wish to understand techniques of improving students' retention of information in the classroom, but may also be of theoretical interest to cognitive psychologists who aim to understand the consequences of dual-task performance.

Related Research

How have the beneficial effects of doodling on memory and/or attention been established, and what are the conditions under which doodling has the greatest benefit? Andrade (2009) led the first study to demonstrate that doodling improves learning performance. She recruited participants that had only just finished participating in an unrelated experiment, (so that they had time to already grow bored), and they were asked if they wouldn't mind participating in another short experiment. Andrade's intention was to measure attention and memory through use of a 2.5 minute recorded phone call. All participants were asked to monitor the message recorded by an individual who was planning a party, and write down any names of people who claimed they were going to be in attendance. Attention was measured by the amount of correctly written down names, and memory was measured using the score of the surprise recall test given at the completion of the phone message.

The participants of this experiment were split into two conditions: doodling and non-doodling. The participants of the doodling condition were given further instructions to use a pencil to shade in shapes that were printed on paper by sets of ten, each row alternating between squares and circles. A 4.5cm wide margin was open on the left side of the paper and was intended to be used as a space for doodling participants to take notes of the monitored information. The non-doodling group was given a lined piece of paper to write down any of the targeted information.

At the completion of the tape, the researcher engaged participants in conversation for one minute before administering a surprise memory test. Half were asked to recall the names of those attending the party, followed by the places mentioned, and the other half were asked to first recall the places mentioned, followed by the attending guests.

Post-analysis findings showed that those in the doodling group performed significantly better than those in the control group. Participants in the doodling condition correctly recalled 29% more information than those in the non-doodling group. As for the use of note-taking to measure attention, it was found that those in the doodling group correctly wrote down a mean of

7.8 (SD = 0.4) of the 8 names, compared to those in the control group who correctly wrote down a mean of 7.1 (SD = 1.1) of the 8 names. This was the first evidence to suggest doodling improves learning performance.

Boggs (2017) decided to further investigate Andrade's (2009) findings in order to understand if there is a significant difference in performance among different types of doodling strategies. In Andrade's study there were only 2 groups, participants either structurally doodled (shaded in printed shapes) or merely listened to the tape. In contrast, Boggs (2017) assigned participants into one of four conditions: (a) a structured doodling group who were asked to shade in printed shapes while listening to the message, (b) an unstructured doodling group used for participants to doodle anything wanted while listening to the message, (c) a non-doodling, note-taking condition who were simply asked to take notes on the message they were exposed to, and (d) a non-doodling a control group who were instructed to only listen and pay attention to the message they were exposed to.

The 5-minute phone conversation Boggs used was recorded between two friends about a couples' vacation to Hawaii. After listening to the recording, participants were then asked to turn over their papers and were given a forewarned test consisting of 13 short answer questions regarding information from the phone conversation.

Significant differences in memory and attention were found among the four groups. Those in the structured group (M=7.67, SD= 1.72) were reported to have performed better on the 13-question recall quiz compared to those in the unstructured group (M=5.43, SD= 2.14), who interestingly performed significantly worse than the control group (M=6.56, SD=1.72). Overall, it was reported that the note-taking condition (M= 8.55, SD= 2.84), performed best on the 13-question test, and were observed to score significantly better than those in the control group (M=6.56, SD=1.72).

Boggs's (2017) findings were interesting because they were the first establish that the structured doodling technique improves performance in regards to working memory and attention, rather than unstructured doodling shown to inhibit performance. This difference found in doodling techniques in relation to working memory and attention could be explained by the previously mentioned concept suggested by Morey and Cowan (2004). Morey and Cowan (2004) theorized that if one were to exceed their limits of processing capacities while performing two tasks simultaneously, interference would occur resulting in failure to complete one or both tasks effectively. Furthermore, it is possible that unstructured doodling while monitoring information may cognitively exceed these processing capacities, thus resulting in an inhibition of both attention and memory; making structured doodling a much more interesting focus due to its opposite effect.

Daydream Reduction Hypothesis

Why does structured doodling improve attention and memory for information presented in an auditory message? Andrade (2009) hypothesized that the beneficial effects of structured doodling found in her study could be due to doodling's ability to reduce or eliminate the distraction of daydreaming, thus resulting in better attention and memory. Later, Boggs (2017) further establishes this theory, as he theorized in his study that doodling uses minimal cognitive resources whilst maintaining stimulation, whereas daydreaming uses a much higher amount of cognitive resources. Therefore, doodling whilst processing information can be beneficial for attention and memory; however, his findings suggest that the doodling activity itself mustn't be an attentional demanding task and exceed working memory and attention processes.

Boggs's (2017) findings suggest that unstructured doodling may be considered an attentional demanding task, as it is found to impair performance while structured doodling improves performance. The contrasting performance effects of these two techniques are interesting because it shows that there's a difference in processing; unstructured doodling is suspected to use a higher amount of processing because it requires more thought on what to doodle and how, whereas structured doodling is less thought-provoking and simply requires repetitive motions of shading.

This balance of stimulation and attention is also mentioned by researchers Suneeta Kercood and Devender Banda, whose study focused on the effects of additional physical activity on learning performance (2012). In their experiment, they studied four students between the ages of 10 and 12, two of which were diagnosed with attention problems. A single subject alternating treatments design was used that required participants listen to a short story followed by a multiple choice assessment in each condition. Each participant experienced four conditions: (a) the baseline condition, where they simply listened to the short story, (b) an intervention-doodling condition where they freely doodled while listening to the short story, (c) an intervention-exercise ball condition where they sat on a bouncy exercise ball and listened to the short story, and (d) a reversal condition where they repeated the baseline condition and merely listened to the short story. It was observed that all four students scored higher and showed improved performance accuracy during both of the intervention conditions (doodling and exercise ball), compared to their assessment scores for both the baseline and reversal conditions.

Keercod and Banda (2012) suggest their findings could be related to a theory they mention known as the Optimal Stimulation Theory. Similar to the daydream reduction hypothesis, this theory suggests that physical activity, like doodling, whilst processing information can be beneficial because it allows individuals to achieve an optimal stimulatory state that could be described as homeostasis. If one reaches the state they require, but do not exceed it, it is likely for them to actively attend to the task and reduce distractions such as mind wandering or daydreaming.

Current Research Goal

The hypothesis that structured doodling improves attention and memory via reduction of daydreaming has not yet been empirically tested as no prior study has assessed the effects of doodling on attention and memory under a condition where individuals are prevented from day-dreaming. This experiment aims to replicate Andrade's (2009) experiment in addition to extending it via the addition of a second manipulation that is intended to completely prevent the possibility that participants day-dream while monitoring the message. Specifically, in addition to randomly assigning participants to doodle or not while monitoring the message, participants were further randomly assigned to verbally shadow or not shadow the message as it was presented in real-time. This shadowing technique required that participants repeat the auditory information aloud, word-for-word as they were listening to the exposed message. By adding this component, it was assumed that shadowing would use a substantial amount of cognitive resources, enough to eliminate the possibility for the participant to day dream.

With the additional shadowing component, a 2x2 between-subjects factorial design was created consisting of four conditions. All participants were asked to monitor a message, similar to the experiment reported by Andrade (2009) . The first group doodled but did not shadow, the second both doodled and shadowed, the third shadowed but did not doodle, and the final group as the control neither doodled nor shadowed.

If the daydreaming reduction hypothesis were correct, the data would reveal that the daydream-eliminating conditions (the doodling condition, the shadowing condition, and the combined shadowing and doodling condition) would all perform equally better than the control group, whose condition was expected to perform the worst as it does not have any daydream eliminating activity. However, if the results indicated that the doodling condition is the only condition to show improved performance compared to the control condition, or that the combined doodling and shadowing condition is the only condition shown to improve performance compared to the control group, then we would have evidence to suggest that the benefits of doodling on attention and memory is due to something beyond daydream reduction.

Method

Participants

Participants of this study consisted of undergraduate college students (N=95) enrolled at Stockton University, selected by the university's Psychology Research pool. 80 female students and 15 male students signed up to participate using the Stockton's SONA system and in return received course credit.

Materials

The task administered before the experiment was intended to bore participants so that they may be more likely to daydream. A program, similar to one used by van Tilburg and Igou (2012), played on the computer screen for ten minutes. Each trial flashed a series of 5 to 15 squares; lined in a row sized at 2.5 cm^2 and spaced at 2 mm apart. At the end of each trial the computer prompted, "Approximately how many squares did you just see?" and allowed participants to respond using their keyboard.

The mock telephone message played for participants lasted 5 minutes, and contained a similar script to the one used in Andrade (2009). The only difference in the script was a change in places mentioned as they were changed to American cities rather than cities in the United Kingdom (Andrade 2009). The recorder spoke in a reasonably monotone voice and at a slower pace so that participants in the shadowing conditions would be able to perform appropriately. The audio file was played at a comfortable listening volume through headphones. Throughout the script were 8 names of people attending the party, 8 place names, and the names of 3 people and a cat who could not attend (along with much unrelated information).

Participants selected to be in the doodling conditions used a pencil to shade shapes printed on white computer paper. The shapes were sized to be approximately 1 cm in diameter, and were printed by 10 shapes per row, each row alternating between squares and circles. A 4.5 cm wide margin was made available on the left side of the paper, to allow doodling participants to effectively monitor and note any of the targeted information. Those in the non-doodling conditions received a lined piece of paper to write down any of the targeted information.

Procedure

In consideration of replicating Andrade (2009) as closely as possible, participants first completed an unrelated task before focusing on the analyzed portion of the experiment. The unrelated task involved administering participants the program that requires them to make estimations about the visual stimulation. Before the program played researchers instructed the following: "I am going to play you a program that will flash a series of squares. After a few flashes the program will ask you to make an estimated guess about the amount of squares you previously saw. Do your best to estimate correctly; however, errors do not significantly count against you."

After finishing the boredom task, participants were told the following: "I am going to play you a tape. I want you to pretend that the speaker is a friend who has telephoned you to invite you to a party. During the phone message the speaker will name people who are and who are not attending the party. Your job is to pay attention to the names of those going to the party, and to write down the names as the message plays. The recording is rather dull but that's okay because I don't want you to remember any of it. Just write down the names of the people who will definitely or probably be coming to the party (excluding yourself). Ignore the names of those who can't come. Do not write down anything else."

Participants in the doodling, non-shadowing condition were also asked to shade in the shapes while listening to the tape, they were told "It does not matter how neatly or how quickly you do this, it is just something to help relieve the boredom".

Participants in the shadowing condition received further instruction to shadow the message as it played for them through noise-cancelling headphones. They were told, "Do your best to effectively repeat the message aloud, word for word, as it plays through your headphones".

Participants selected to both doodle and shadow were told, "Do your best to effectively repeat the message aloud, word for word, as it is being presented to you through your headphones, while doing so please shade in the printed shapes. It does not matter how neatly or quickly you shade, it is just something to help relieve boredom"

Participants in the control group did not receive any further instruction as they neither doodled nor shadowed, but merely listened to the auditory message and wrote down any of the targeted information on their lined piece of paper.

All participants listened to the recording, and at its completion researchers collected their paper, and engaged the participant in conversation for 1 minute, including an apology for misleading them about the memory test to follow. At that point researchers asked half of the participants to recall the names of those attending the party, and then asked of the places mentioned. For the other half of participants, researchers first asked of the places mentioned, and then asked them to recall the names of those going to the party.

Data Analysis

This project focused on two dependent variables, message-monitoring and message-memory. The first variable, message-monitoring, was intended to be used as a measure of attention. As explained, participants were asked to monitor the message as it plays, and to write down the names of attending party guests. The amount of correctly written names minus the amount of incorrectly written names were used as a score of attention. The more names a participant correctly wrote down, the higher the score they received for message-monitoring, and vice versa.

The second variable, message-memory, was measured by the amount of correctly recalled names and places during the surprise memory test. The amount of correctly recalled names minus the amount of incorrectly recalled names was used as a score of message-memory. Participants who correctly recalled more names and places received a higher score for message-memory, and vice versa.

The two independent variables being studied were doodling and shadowing, each consisting of two conditions: doodling and non doodling, and shadowing and non shadowing, respectively. This formation resulted in a 2x2 between-subjects factorial design consisting of four groups. After data collection, three two-way ANOVAs were conducted to test the effects that doodling and shadowing have on message-monitoring and message-memory. If the daydream-reduction hypothesis were correct, the results would have shown a doodling-shadowing interaction that indicated doodling improved performance compared to non-doodling under conditions of non-shadowing, further, it would have also indicated that both doodling and non-doodling conditions performed equally under shadowing conditions.

Results

Three two-way ANOVAs were conducted in the interest of analyzing the effects of doodling (doodling, non-doodling) and shadowing (shadowing, non-shadowing) on a measure of attention, a measure of memory for target names, and a measure of memory for places. All three measures were calculated as a number of correct responses minus number of incorrect responses.

Effects on Attention (Table1). First, a main effect of shadowing on attention was found, $F(1, 91) = 8.594$, $p < .05$; participants who shadowed ($M = 6.98$, $SD = 1.05$) scored significantly lower on the attention task than those who did not shadow ($M = 7.54$, $SD = .80$). This indicates that shadowing significantly impairs attention. Further, the main effect of doodling on attention was not significant, $F(1, 91) = 2.032$, $p > .05$. There was non-significant interaction between doodling and shadowing with respect to their effects on the attention measure, $F(1, 91) = .101$, $p > .05$.

Table 1

Means and Standard Deviations on the Measure of Attention Score

Shadow Condition	Doodle Condition	*M*	*SD*	*N*
Non-shadow	Doodle	7.40	1.00	24
	Non-doodle	7.71	0.60	24
Shadow	Doodle	6.90	1.12	24
	Non-doodle	7.10	1.00	23

Effects on Memory for Target Names (Table 2). There were no significant main effects of shadowing, F(1, 91) = .689, p > .05, or doodling, F(1, 91) = 1.195, p > .05, on memory for target names. There was non-significant interaction between doodling and shadowing with respect to their effects on memory for target names, F(1, 91) = .021, p > .05.

Table 2

Means and Standard Deviations on the Measure of Name Memory Score

Shadow Condition	Doodle Condition	*M*	*SD*	N
Non-shadow	Doodle	3.83	1.17	24
	Non-doodle	4.21	1.91	24
Shadow	Doodle	3.62	1.50	24
	Non-doodle	3.91	1.20	23

Effects on Memory for Places (Table 3). There were no significant main effects of shadowing, F(1, 91) =1.226, p > .05, or doodling, F(1, 91) = .968, p > .05, on memory of places. There was non-significant interaction between doodling and shadowing with respect to their effects on memory for places, F(1, 91) = .045, p > .05.

Table 3

Means and Standard Deviations on the Measure of Places Memory Score

Shadow Condition	Doodle Condition	*M*	*SD*	*N*
Non-shadow	Doodle	1.80	1.38	24
	Non-doodle	1.50	1.38	24
Shadow	Doodle	2.04	1.40	24
	Non-doodle	1.83	1.27	23

Discussion

The purpose of this study was to investigate pre-existing evidence that supported doodling having a positive effect on working attention and memory (Andrade, 2009; Boggs et al., 2017; Kercood & Banda, 2012). This study specifically aimed to explore why the observed relationship between doodling and learning performance exists through close replication of Andrade (2009). With the addition of the shadowing variable, the daydream reduction hypothesis was generated; theorizing that doodling's positive effect on memory and attention is due to doodlings ability to reduce daydreaming.

If the daydream reduction hypothesis were correct, the data would have revealed that the conditions designed to promote daydream reduction (the doodling, shadowing, and combination conditions) would all perform equally better than the control condition. However, this was not the case and so the daydream reduction hypothesis remains unproven.

The only significant relationship found between the three ANOVA analyses existed between shadowing and attention; a relationship observed to go in a negative direction. It was initially anticipated that participants selected to be in the shadowing conditions would use enough cognitive processes to reduce daydreaming, while maintaining the ability to focus on the target information. However, data analysis suggests that participants could possibly have been overwhelmed by the unfamiliar instruction to shadow information, consequently affecting their performance negatively (Morey & Cowen, 2004). This suggestion can be supported by comments of multiple participants at the conclusion of the experiment, who claimed that their focus was more on shadowing correctly rather than the target information.

An alternative method that could promote daydream reduction more effectively would be to substitute shadowing with finger tapping, as previous studies have found a positive relationship between finger tapping and improved memory and attention (Rabinowitz & Lavner, 2014). Theoretically, this task would provide enough stimulation to reduce daydreaming and would be less cognitively taxing than shadowing.

Interestingly, there were no significant findings between doodling on attention and memory processes; previously observed results showing the positive effects of doodling on learning performance were not replicated (Andrade, 2009; Boggs et al., 2017; Kercood & Banda, 2012). Furthermore, certain limitations may have influenced the results.

Participants were given three scores ranging from 1 to 8. Each score was generated based on the participant's responses for the attention task, and both parts of the memory task. Data analyses suggest that averages for each group could be non-significant due to the participants' inability to score within a wider range. Because participants could only score within a 1 to 8 range, there may have not been enough target information given to properly measure each participant's performance; ensuring little variability between scores.

The recording administered during the attention task could be a factor in why we were unable to replicate the significant results found by Andrade (2009) between doodling and learning performance. Although the same script from Andrade (2009) was used, the message our participants monitored took twice the amount of time to play. This was a necessary change to ensure that participants in the shadowing conditions would not become overwhelmed following the message; however, this change could have had an unexpected impacted participants' performance. It is possible that the message was too slow for participants to completely engage in, or that the extended time could have been challenging for participants to continuously shade and execute their instructions accordingly.

A third limitation exists within the design of the boredom task administered to participants before the attention task. Although it was not the first time a similar estimation task was used to bore participants (van Tilburg and Igou, 2012), researchers observed the boredom task to have differing effects on participants. For example, some participants responded expectedly, and appeared to be effectively bored during the task; however, a portion of the participants tested seemed to engage so much with the task, that they did not experience the desired boredom effect. Thus, variability may have existed between participants, resulting in an unreliable dataset and consequently, the inability to replicate Andrade (2009).

In order to better measure the relationship between doodling on attention and memory processes, participants should be given a longer attention task with more target information, allowing them to score within a wider range. The recording administered during the attention task should be spoken at a normal pace to promote effectual processing of information. Further, an alternative boredom task should be distributed that more successfully bores participants. As a substitute for the shadowing condition, a finger tapping condition should be used as a method to prevent daydreaming.

With these changes, we would refine the control of our method and the ability to investigate whether the positive relationship found between doodling and learning performance is due to daydream reduction. To understand why this relationship exists would allow cognitive psychologists to gain perspective in how similar working attention and working memory processes are conducted, as well as dual-task processing. In addition, to understand doodling's positive effects could lead to discussions on why doodling is an impactful tool in the classroom.

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