# How a noisy classroom affects learning: The effect of background noise on memory, listening, and logic skills

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Math senior seminar
May 2026

**Abstract**

The purpose of this study was to evaluate whether background noise affects one's cognitive abilities in a classroom. Previous research has shown that although noise exposure may slow down one’s efficiency, it may or may not ultimately result in a decrease in accuracy. We hypothesized that when exposed to noise, one's memory, logical reasoning, and auditory comprehension would be worse than in a silent environment. We asked participants to complete logic puzzles, memory games, and listening tasks twice, once in silence and once in an environment with 65 decibels of recorded cafeteria noise, to test whether noise negatively affects cognitive ability. We found that ordinary people who participated in activities in noisy environments often scored higher than those who worked in silence. Our data suggest that noise isn’t necessarily bad and sometimes can improve one's cognitive ability, although some methodological limitations may have impacted our results.

**Introduction**

Different background noises can affect the way a person interprets information (1). Noise might make it more difficult to focus on certain tasks (2). Research suggests that, on average, high school classrooms' decibel level was 65 decibels, but they ultimately could reach up to 95 decibels (3). Being exposed to these decibel levels over a long period of time can cause hearing loss (1). Research suggests that exposure to background noise in an environment can affect someone's concentration and cognitive performance (2). This is important because if certain noises affect one's concentration in a classroom, students and teachers should know so they can be more aware of their effects in class. In our study, we tested three types of cognitive abilities: memory, auditory comprehension, and logical reasoning, with various tests being administered when exposed to different levels of noise and silence.

There are four main types of cognitive abilities: attention, memory, logic, and auditory reasoning (*4*). **Attention** is the ability to stay focused on a task while being distracted by another opposing source. Attention is present throughout the entire project due to it being the background noise that our prospects will hear. Attention is related to memory because if a person can not pay attention, they will not remember. **Memory** is the ability to retain information for a long period of time or for a short period of time. Short-term memory can be seen through remembering someone's name or a phone number, and long-term memory is remembering questions for a test. **Logical processing** is the ability to see a problem and find a solution; an example of this can be seen in someone who solves a mystery or a puzzle like a crossword or Sudoku. **Auditory** processing is the ability to understand information through sound. Examples of this are the ability to draw what someone is saying or manipulate an image in one's mind based on verbal directions. In our project, we evaluated these cognitive abilities and saw how they are affected by background noise. In this next section, we evaluate how background noise affects someone's cognitive ability.

When studying for a test, background noise can be a significant factor, especially in large open rooms like schools. Braat-Eggen et al. performed an experiment to see if the influence of intelligibility of background speech plays a role in distracting someone when studying for a test (2). There are three background noise scenarios, where each scenario includes varying sounds of speech and room acoustics. Two groups had absorbing sounds, and one group had reverberant sounds. The hypothesis was not supported in this source. Although there was a little decline in performance, there wasn't enough evidence to prove otherwise. The group that did the worst was the group with the clearest voices: 3 voices in an absorbing setting. Although the reverberant group with 14 voices was seen as the most distracting, this did not show up as a significant result in student performance.

The influence of irrelevant sound effects could play a role in an elementary school student's ability to process information. Imhof et al. performed an experiment where they tested to see if background noise would have a negative impact on elementary students' ability to process information(5). In this experiment, they used 50 fourth-grade students and assigned them to two tasks: listening and copying. Students completed the tasks twice, once in silence and once with background noise that mimicked a classroom at a volume of 65 decibels. The

hypothesis was partially supported. The effect of background noise will slow one's ability to finish a task, but it will ultimately not result in a decline in error rates. The effects of noise affect a student's ability to get their work done on time, but it does not affect someone's ability to answer questions correctly. Our study will investigate one's ability to finish a task in a high school setting, where tasks might be more complex and require sustained attention.

Similar to Imhof et al, other researchers have found that noise slows down reaction processing speed. In this experiment, Lauf et al. conducted a 2-back memory test to see if people's memory would be influenced by traffic noise (6). Participants would be presented with various images and asked to see if they could properly spot the pattern from two prior cards when being exposed to stimulating noise that caused stress, and when being exposed to silence. Whenever it came to the number of errors, there was no clear relationship. *In terms of reaction speed, people took longer to respond when surrounded by louder noise than in silence. This shows that* being exposed to noise will not influence accuracy, but it will influence the speed at which the task is finished. In the current study, we will also examine the number of errors and the time to finish tasks.

Other research suggests chronic noise influences cognitive performance, but it may also affect one's motivation. Dohmen et al. conducted a pilot study of 3 adults and 2 elementary-aged students who were assigned randomly to two groups (background noise and quiet groups) (1). Participants took a Stroop test, which measures one's ability to understand conflicting information, and did a simple short-term memory test. They also completed a motivation puzzle where participants were asked to solve impossible puzzles to measure how many times they attempted the puzzle. *The hypothesis was partially supported,* with children having a faster reaction time with less background noise, but mixed results for the memory and puzzle tests. The effect of background noise might have an effect on one's solving skills, but ultimately, we cannot decide due to the small sample size of this study. In our study, we plan to test memory and focus, but with a larger sample.

Overall, this research says that memory and reasoning are not solely dependent on background noise; however, noise does make reaction time slower when given a task (B, C, F). This study adds to the understanding that background noise will negatively affect one's memory, listening ability, and visuals. In our study, we plan on giving people a logic test, a memory test, and a listening test, all while they are being exposed to stress-inducing sounds.

We hypothesize that one's memory (H1), listening ability (H2), and logical processing (H3) will be affected by noise. This is because research suggests differing findings on how it affects accuracy, but it does show that people tend to act more slowly (C, F).

**Materials and Methods**

In this study, twenty-six 11th graders were evaluated. Their ages ranged from 15 to 17 years old. All of the participants were identified as black or African American. . The participants were given several cognitive tests that were based on logic, memory, and auditory perception. First, they were given the task in silence, then they were given the task while being exposed to noises that ranged from around 65. For the logic test, the participants were given two logic grid puzzles that they had to complete in a given time, and then their scores and the time taken to complete them were recorded. The logic puzzles contain a series of clues and ask participants to conclude. For example, “Peter's birthday is in April, and the 8-year-old’s birthday is in April,” therefore, Peter is 8 years old. The total number of conclusions correct was recorded as a score out of 14.

For our memory test, we gave the contestants a list of numbers projected on a screen that they had to read in 20 seconds. Once the time was up, the list was removed, and then the participants had to write down as many numbers as possible. And finally, for auditory comprehension, the participants were to listen to the speaker and draw what the speaker was saying. Then they would be graded on how many details they were able to draw accurately. For example, if the speaker listed 4 details and the participant drew only 2 in response, they would receive a score of 2/4. The auditory task had a total of 12 details to be drawn.

First, we went to classes in our high school and gave the participants a consent form they would sign if they chose to participate. On the consent form, it would be stated that they would be required to complete various logic puzzles, and later, we will be able to record their results. Afterward, the participants were given the various logic puzzles in silence and then scored. Later, the participants were given the same kind of puzzles while being exposed to stress-inducing sounds that originated from our school cafeteria and were at 65db. The participants' first test was compared to their second test to see if the sound played a role in their performance.

Differences in performance were measured using a t-test for correlated samples. The abbreviation M is the mean, and SD is the standard deviation. All tests were calculated using vassarstats.net with a 0.05 significance threshold.

**Results**

The main goal of this project was to determine whether noise affected a person's cognitive abilities. We took 26 students and exposed them to three different cognitive tests for a total of two times, once in silence, and the other with background noise recorded from a cafeteria played at 65 decibels.

For our first cognitive task, we asked a group of people to look at a board with a total of 42 numbers and remember as many as possible in a particular timeframe. Afterward, they would write down as many numbers as possible to test their memory. We hypothesized that people would remember fewer words/numbers when exposed to noise. We conducted a t-test for correlated samples, where we found a significant difference in one's ability to answer questions correctly when being exposed to silence and noise ($t = 2.3$, $p = 0.03$). People who worked in noise had a higher mean score of ($M=3.7$, $SD=1.2$ compared to the silence condition ($M=2.7$, $SD= 2.1$).

For our next test, we wanted to test people's listening ability and memory when exposed to sound. Our test consisted of taking a group of people and having them draw 13 different things that the reader lists off while being exposed to silence and noise. We hypothesized that more errors would be made on the drawing when exposed to noise. A t-test showed a difference in people's ability to remember different objects when having them read out and while surrounded by noise and being surrounded by silence ($t= -3.15$, $p= 0.0034$). The mean value for people when being surrounded by noise came out to be $m=8.2$, $sd= 3.9$ For people being surrounded by silence, their mean score was ($m=4.9$, $sd=2.1$). Students drew more of the picture correctly when exposed to background noise.

For our last test, we wanted to test a person's deductive reasoning and cognitive abilities while being exposed to silence and noise. We gave different people logic grid puzzles and asked them to finish them in silence and while surrounded by noise. We hypothesized that more errors would transpire as a result of being surrounded by noise. We conducted a t-test where we found a difference in people's ability to complete logic grid puzzles while surrounded by noise and being surrounded by silence ($t=-5.05$, $p= .0001$). As a result of the p-value being less than .05 this allows us to have reason to believe that there is a significant change. People who worked in noise had a mean score of ($m=11.3$, $sd=3.1$) compared to people who worked while being in silence, who had a mean score of ($m=6.7$, $sd=2.3$).

| | Silence | Noise | Significant Difference? |
|---|---|---|---|
| Memory | M=2.7, SD= 2.1 | M=3.7, SD=1.2 | Noise > Silence |
| Listening | M=4.9, SD=2.1 | M=8.2, SD= 3.9 | Noise > Silence |
| Logical Processing | M=6.7, SD=2.3 | M=11.3, SD=3.1 | Noise > Silence |

***Table 1. Memory, listening, and logic scores in silence and with background noise.*** *Dependent t-tests found, in each test, that the noise condition outperformed silence ($p<0.05$).*

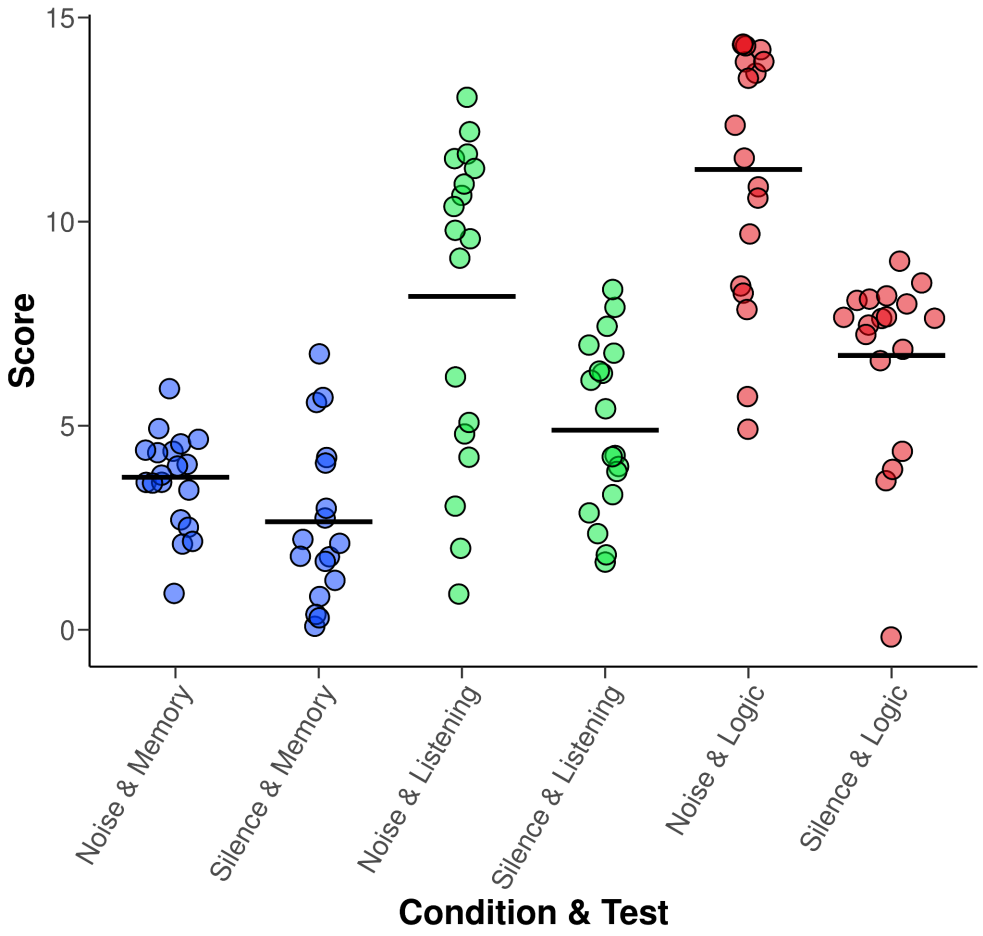


***Figure 1. There is a difference between one's cognitive abilities under sound and noise conditions.*** *A total of 26 students completed three different cognitive tests for a total of two times, once in silence, and the other with background noise recorded from a cafeteria played at 65 decibels. Afterward, we conducted a t-test for dependent samples and found there was a significant difference between noise and silence ($p<0.05$).*

**Discussion**

In this study, we determined whether one's cognitive ability was influenced by classroom noise. For our first hypothesis, we believed that people would remember fewer words/numbers when exposed to noise. However, this was not supported, as people tend to remember more when exposed to noise (Figure 1, Table 1). Our second hypothesis was that one's listening ability would be hindered as a result of being exposed to noise. This was not supported because people often got more answers correct on the listening test when being exposed to noise (Figure 1, Table 1). Our third hypothesis was that one's logical reasoning would be hindered as a result of being exposed to noise. But this was not the case, for people got more answers correct on a logic grid puzzle when exposed to noise than in silence.

Our results are consistent with studies from Lauf et al (6). Lauf found that noise did not play a significant enough role in altering one's memory (6). However, he did find that there was a significant difference in one's efficiency when being exposed to noise, with participants often finishing faster when in silence than when in noise, but still maintaining the same score. Our findings found something similar in that noise didn't hurt one's ability to remember more things, although we did not measure efficiency. On average, people trying to remember things in noise scored higher than people trying to remember things in silence. Although we didn't record one's time, it is rational to say that noise isn't harmful for one's memory based on our findings and Lauf et al's findings.

Similar to Lauf et al, Imhof et al. found that one's listing ability was not based on the noise level (6). In their study, they found that noise didn't play a significant enough role in one's ability to accurately complete a task, but it did slow down the rate at which a person was able to complete a task. In our findings, we did not record the time it took our participants to complete a task; however, we did see that there was no correlation between one's accuracy and noise. The mean score for someone working in noise was higher than the mean score for someone working in silence (Figure 1, Table 2). This leads us to believe that noise isn't necessarily bad; however, it could slow down one's progress.

Dohmen et al. conducted a pilot study to measure individuals' logical reasoning and willingness to give up when faced with an impossible task. What he found was that people often finished faster with less noise, but whenever it came to the accuracy with which people were finishing, there was no significant difference (1). In our research, we found that people scored higher when being surrounded by noise compared to being in a silent environment (Figure 1, Table 3). With this now known, we can conclude that noise may be less likely to harm one's logical reasoning than other research suggests.

One reason why we see an increase in one's accuracy through noise might be explained in an article from Flinders University. In this article they saw that people with ADHD often benefited more with white and pink noise due to it helping them reach the part of their brain that is responsible for focusing. Although we didn't test to see if our participants had ADHD, there might have been similar characteristics within our participants that ultimately lead to us getting our results.

Throughout the course of this project, we experienced minimal limitations that have played a part in my project. However, there was one thing that could have possibly altered my data. The fact that we had our participants take our test a total of two times could have given the participants a better understanding of the test and ultimately improved their scores. For next time, I believe that we should have had our participants only do some tests and not have them repeat the same test. Another thing that could have improved our project is that we could have had the participants do our test, but make them take it in different orders. For example, one class could have started in silence and then worked in noise, while the other class worked in noise to start off and then in silence. Doing this could have limited the margin of error and given us a stronger project.

Based on our research and that of other sources, having a noisy environment at the very least doesn't hurt one's cognitive ability. Throughout our research, we have seen that a noisy environment may slow down one's efficiency, but ultimately it will not harm their accuracy. What this entails is that when in a classroom environment, sometimes having noise present can help students. While total silence might be useful for some situations in a classroom, we believe teachers should not be afraid of general background noise during their lessons.

**Work Cited**


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