What We Hear Without Listening: Partial Processing of Unattended Information in Auditory Tasks

Attenuation Theory vs Filter Theory: To what extent is unattended auditory information processed during dichotic listening tasks?

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I. Introduction

In an age of constant connectivity and sensory overload, the ability to focus on one information stream while ignoring others is more challenged than ever. From classrooms filled with digital distractions to households where multitasking has become the norm, our attention is constantly split. Understanding how selective attention works offers valuable insight into how humans manage, filter, and respond to overlapping stimuli. Research into selective attention can reveal whether our brains can tune out irrelevant stimuli or whether seemingly "ignored" inputs continue to influence our thoughts, emotions, and actions.

For more than six decades, researchers have studied dichotic memory and selective attention processing, helping us understand the extent to which unattended audio streams are processed and remembered. The implications of this research are far-reaching. If we can determine how and when the brain processes unattended information, we can design environments, tools, and strategies that better support focus and memory.

This study aims to answer the question: Attenuation Theory vs Filter Theory: To what extent is unattended auditory information processed during dichotic listening tasks? By analyzing key research on this topic, this paper will explore differing opinions among researchers regarding whether the processing of an unattended stream is possible.

II. Literature Review

A. Published research exploring the relationship between attention and auditory processing

Research into auditory selective attention began with Colin Cherry, who pioneered dichotic listening experiments in 1953, introducing the technique of presenting different auditory messages to each ear and asking participants to shadow one.[1] Cherry found that, while subjects could accurately reproduce the attended message, they could not report any content from the unattended stream. Even repeated words or changes in language in the ignored ear went unnoticed, leading Cherry to conclude that selective auditory attention functions as a filtering mechanism that blocks irrelevant stimuli from conscious processing.

Building upon Cherry's findings, in 1958, Donald Broadbent proposed the Filter Theory of Attention.[2] In his early experiments, participants received simultaneous digit sequences in each ear and were asked to recall them. Most subjects reported digits ear-by-ear rather than in the order heard, suggesting that information is filtered early in the perceptual process based on physical characteristics such as location or pitch. Broadbent's model posited a single-channel bottleneck: only one information stream can be processed at a time, while all other inputs are entirely blocked.

[1] Cherry, E. Colin. "Some experiments on the recognition of speech, with one and with two ears." *APA PsycNet*. (1953).
[2] Broadbent, Donald. *Perception and Communication*. London: Pergamon Press, (1958).

However, this rigid filtering model was soon challenged by Anne Treisman in 1960, who conducted additional dichotic listening experiments that led her to propose Attenuation Theory.[3] Treisman found that participants sometimes switched ears mid-task if the unattended message began to make contextual sense, such as when a sentence split between both ears retained grammatical coherence. This suggests that unattended messages are not completely blocked but weakened, allowing meaningful content to break through if it matches expectations or context.

Neville Moray confirmed Cherry's original findings in 1959 by demonstrating that participants were unable to recall content from the unattended message, even when it consisted of repeated simple words or digits.[4] However, Moray added a critical dimension: personally significant information, e.g., a participant's own name, often penetrated the attentional barrier. This suggests that, while most irrelevant auditory stimuli are filtered or attenuated, certain affective cues can override the filter. These results support Treisman's Attenuation Theory, indicating that unattended messages are not fully suppressed and may undergo limited semantic processing.

Subsequent research shifted focus from attentional filtering to the cognitive mechanisms underlying memory encoding, particularly the role of the phonological loop in verbal retention. Phillip Landry and Carl Bartling examined the impact of articulatory suppression—a process in which participants repeat irrelevant sounds such as "1, 2" while attempting to memorize verbal information—on the phonological loop in 2011.[5] The experimental group, which engaged in articulatory suppression, demonstrated significantly lower recall accuracy. Landry and Bartling concluded that competing auditory stimuli can impair attention and recall by interrupting the brain's ability to selectively retain verbal input, especially when auditory distractions inhibit internal rehearsal processes.

In 2014, Jessica Spurgeon, Geoff Ward, and William J. Matthews further examined the role of the phonological loop in memory performance by comparing immediate serial recall (in order) with immediate free recall (any order).[6] They found that concurrent articulation made recall more difficult, particularly for serial recall, and that phonological similarity between words reduced recall accuracy. Interfering auditory stimuli, especially those that share phonological features, can affect the structure and efficiency of memory retrieval, as the data suggests.

B. Points of Contention

Foundational studies provide competing theories: Broadbent's Filter Theory suggests a rigid perceptual bottleneck, while Treisman's Attenuation Theory offers a more flexible model. More recent cognitive research examines how auditory interference impacts memory and attention, supporting Treisman's theory that unattended information is not entirely blocked but may be weakened or disrupted.

[3] Treisman, Anne M. "SELECTIVE ATTENTION IN MAN." *Oxford Academic*. (1960).[4] Moray, Neville. "Attention in Dichotic Listening: Affective Cues and the Influence of Instructions." *Quarterly Journal of Experimental Psychology*, (1959).
[5] Landry, Phillip, and Carl Bartling. "The Phonological Loop and Articulatory Suppression." *American Journal of Psychological Research*. (2011).
[6] Spurgeon, Jessica, Geoff Ward, and William J. Matthews. "Examining the relationship between immediate serial recall and immediate free recall: common effects of phonological loop variables but only limited evidence for the

phonological loop." *National Library of Medicine*. (2014).

Despite the considerable body of research, debate remains about whether the brain fully filters out irrelevant auditory input or merely reduces its intensity. Some findings, such as Moray's observation that subjects can detect personally significant information in an unattended stream, appear to validate Treisman's model. However, very little testing has been done to distinguish the threshold at which unattended stimuli begin to penetrate awareness. Given this gap, our study used controlled dichotic listening experiments to test whether information from the secondary auditory channel is partially processed or completely ignored. Notably, prior dichotic listening research has relied primarily on adult populations; the study extends that work by testing adolescents, a group whose attentional systems are still developing. In doing so, the study aims to clarify whether Attenuation Theory more accurately accounts for the nuances of selective attention than the earlier Filter Theory, offering updated insight into auditory cognition and information processing.

III. Methodology

A. Research method

This study used a mixed-methods approach, combining a laboratory experiment (the primary research method) with interviews (the secondary method). Laboratory experiments, which involve manipulating an independent variable in a controlled environment, are ideal for testing causal relationships due to their high internal validity and use of standardized procedures. However, their artificial settings may reduce ecological validity, and participants' awareness of being observed can introduce bias.

To complement the experiment, qualitative interviews were conducted to gather deeper insight into participants' experiences. Interviews allowed for open-ended responses that reveal perspectives not always captured by quantitative data. While rich in detail, interviews can be influenced by bias and lack the consistency of more structured methods. By integrating both methods through triangulation, this study provides a more complete understanding of the relationship between selective attention and auditory processing.

B. Sampling method

This study used stratified random sampling to ensure equal representation and enhance generalizability. Sixty Menlo High School students were contacted by email, with fifteen randomly selected from each grade. Of those contacted, thirty responded and were randomly assigned to the control or experimental group, with fifteen participants in each group.

Stratified sampling helped reduce bias and account for potential differences in cognitive development across age groups, allowing the study to better isolate the effect of dichotic listening on recall. However, because participation was voluntary, self-selection bias is a limitation: the final sample may reflect students who are more interested in cognitive research, limiting the external validity of the findings.

Additionally, random sampling was used to select interview participants post-experiment, with

five students chosen from each group to provide qualitative insights.

C. Ethical considerations

Before participation, all students signed a consent form.[7] The form clearly outlined the purpose, procedures, risks, and benefits of the study. Participants were informed that their responses would be used solely for research purposes.

Participants were notified, both verbally and in writing, that they could withdraw at any time without penalty. This was stated clearly in the consent form and was verbally told to the participants before they participated.[8]

All participant information was anonymized. Survey data and interview transcripts were stored in a password-protected form and deleted after data compilation. Audio recordings of the interviews conducted were deleted after transcription.

Steps were taken to minimize potential distress. The task was deemed low-risk, but participants were reminded of their ability to withdraw their data and stop the experiment at any time.

These measures ensured that the study was conducted ethically, protecting participants' rights and well-being.

D. Procedure

1. Participant Selection:
    a. Email 40-50 Menlo High School students, ~10 from each grade.[9]
    b. Randomly assign 15-20 participants to the control group and 15-20 to the experimental group. Around 60 students were contacted; 30 responded.
2. Experimental Setup:
    a. Conduct the experiment in a quiet, controlled environment. This was conducted in the library.
    b. Use noise-canceling headphones to deliver auditory stimuli.
    c. Prepare two sets of audio tracks:
        i. Control Group: Listening to both audio tracks, one after the other. Both passages are the primary passages.
        ii. Experimental Group: Two separate audio tracks, one in each ear. Both headphones contain a different passage. One is the primary passage.
        iii. The following tracks were used:
            1. Primary audio: How do dinosaurs choose their pets?[10]
            2. Secondary audio: Clifford's Happy Easter[11]

[7] See Appendix B
[8] See Appendix B for informed consent form and Appendix L for procedure scripts
[9] See Appendix C-F for email scripts

[10] See Appendix M for transcript
[11] See Appendix N for transcript

3. Task Procedure:[12]
    a. Participants sign the consent form.[13]
    b. Instruct all participants to listen to the primary audio, then answer comprehension questions. [14]
4. Data Collection:
    a. Record participants' answers to the comprehension questions. [15]
    b. Compare correct responses across groups to determine if the secondary audio was entirely ignored or partially processed.
5. Secondary Research Method: Post-Experiment Interviews:
    a. Conduct interviews with some participants (randomly select 10 participants - 5 from each group).[16]
    b. Analyze subjective reports to assess selective attention mechanisms.[17]
6. Analysis:
    a. If the experimental group retains no information from the secondary audio, Broadbent's Filter Theory is supported.
    b. If partial recall occurs, Treisman's Attenuation Theory is supported.

E. Hypotheses

Hypothesis 1: Unattended auditory information is not processed during dichotic listening tasks; participants will not recall the unattended stream, supporting Broadbent's Filter Theory. [18]

Hypothesis 2: Unattended auditory information is partially processed during dichotic listening tasks; participants will recall key or meaningful content from the unattended stream, supporting Treisman's Attenuation Theory. [19]

Null Hypothesis: Unattended auditory information is not processed beyond a basic sensory level during dichotic listening tasks; it does not affect recall or recognition.

IV. Results

This study set out to investigate the extent to which unattended auditory information is processed during dichotic listening tasks. Specifically, it aimed to test the validity of Donald Broadbent's Filter Theory versus Anne Treisman's Attenuation Theory.

[12] See Appendix L for full script
[13] See Appendix B for informed consent form
[14] See Appendix K for quiz questions
[15] See Appendix A for raw data
[16] See Appendix G and H for interview questions
[17] See Appendix I and J for interview transcripts

[18] Broadbent, Donald. *Perception and Communication*. (1958).
[19] Treisman, Anne M. "SELECTIVE ATTENTION IN MAN." (1960).

There were two competing hypotheses: Hypothesis 1, aligned with Broadbent's Filter Theory, and Hypothesis 2, consistent with Treisman's Attenuation Theory. The null hypothesis asserted that unattended information would not be processed and would have no effect on memory recall.

A. Data

Table 1 - Answer Accuracy for Each Group Per Question

Audiobook	How Many People Answered The Question Correctly (Out of 15)				
	Question	Control Group	Percent of Group That Answered Correctly	Experimental Group	Percent of Group That Answered Correctly
Primary	Question 1	2	13.33%	2	13.33%
	Question 2	4	26.67%	0	0.00%
	Question 3	2	13.33%	3	20.00%
	Question 4	2	13.33%	2	13.33%
Secondary	Question 1	9	60.00%	1	6.67%
	Question 2	15	100.00%	9	60.00%
	Question 3	14	93.33%	7	46.67%
	Question 4	11	73.33%	4	26.67%

Figure 1 - How many people got each question right for the primary audiobook

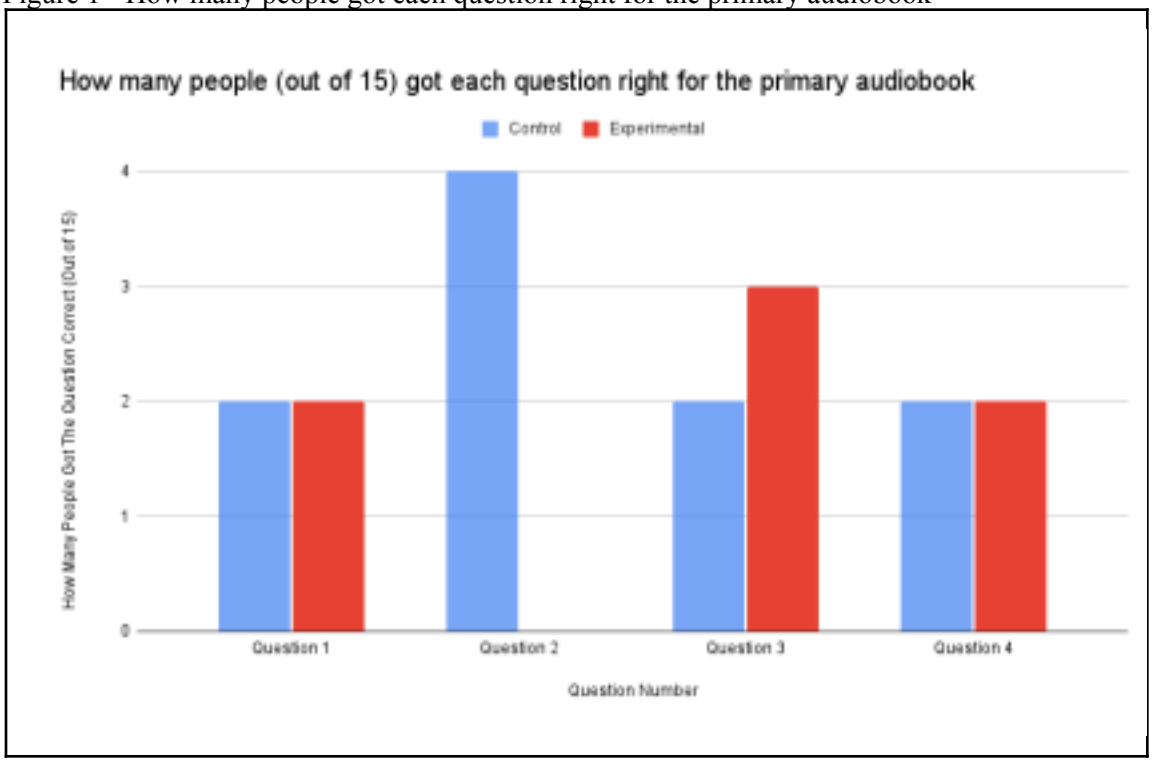


Figure 2 - How many people got each question right for the secondary audiobook

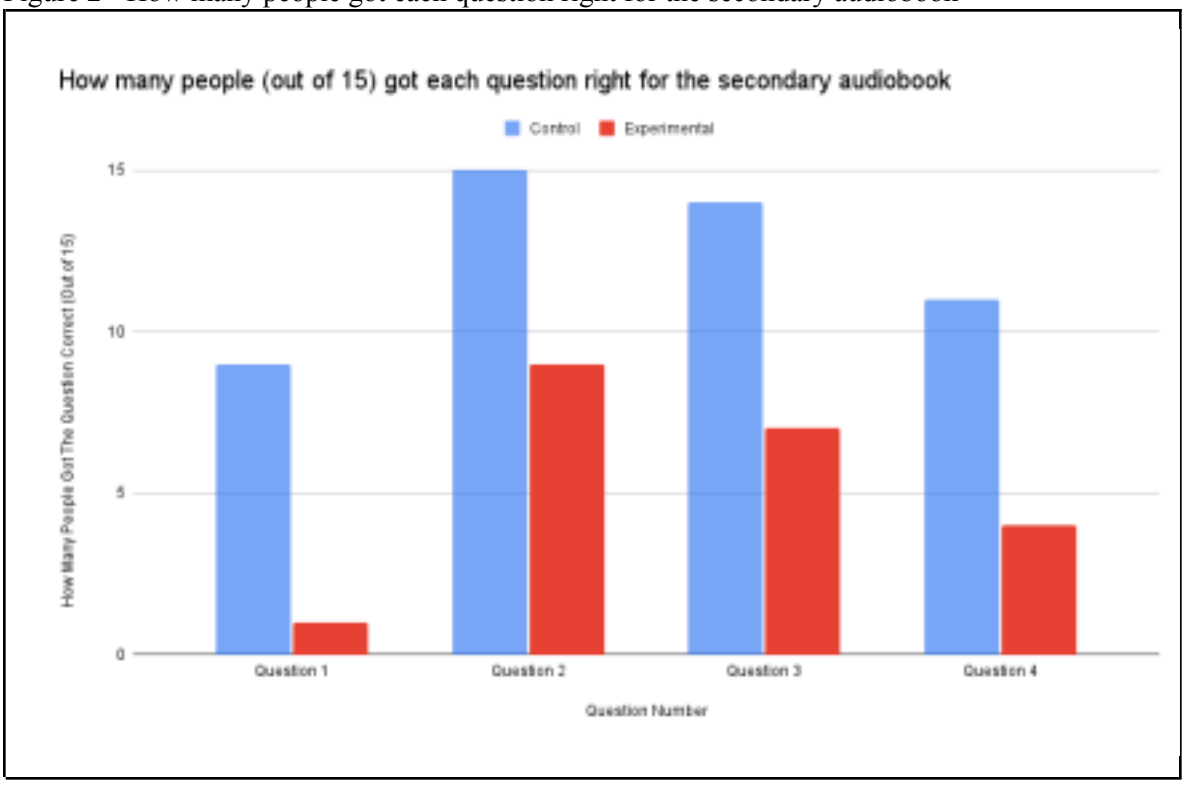
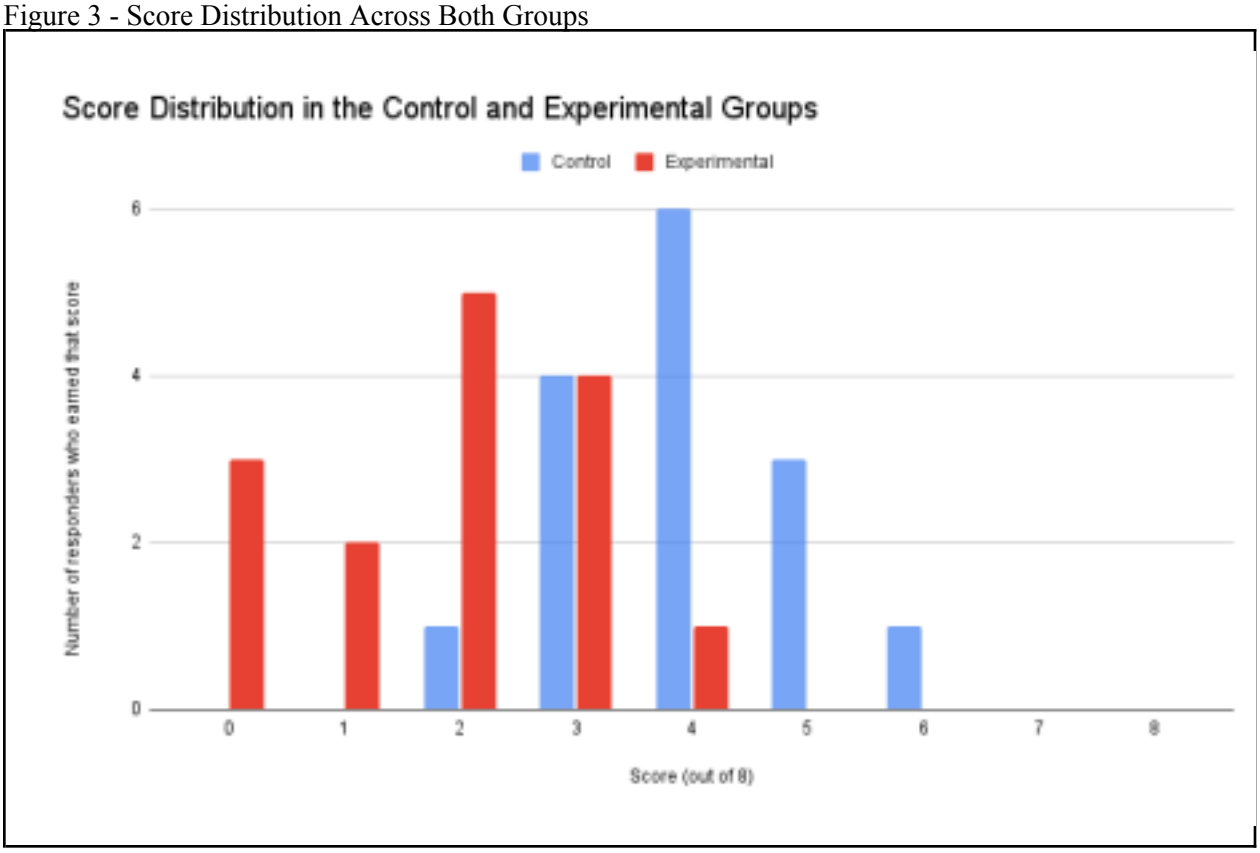


Figure 3 - Score Distribution Across Both Groups



B. Description

The results support Hypothesis 2 and Treisman's Attenuation Theory, rejecting the null hypothesis. While the experimental group scored lower than the control group on comprehension questions about the unattended stream, their partial accuracy indicates some processing occurred. A Chi-Square Test of Independence confirmed statistical significance.

Figure 1 shows comparable performance between groups on the primary audiobook, with no significant difference on Question 2 ($p = 0.109$), suggesting that focused attention enabled effective comprehension. In contrast, Figure 2 highlights significantly lower performance by the experimental group on all four secondary audiobook questions, with p-values of 0.004, 0.016, 0.028, and 0.036, indicating partial but impaired processing.

Figure 3 illustrates the score distributions: control group scores clustered between 4 and 6, while experimental group scores ranged from 0 to 3. The presence of non-zero scores in the experimental group reinforces the idea that unattended information was not fully filtered out, but attenuated, aligning with Treisman's theory.

C. Analysis

The data suggest that unattended auditory input is not completely blocked; rather, key details from the secondary stream are retained when they are meaningful or salient. Four of five experimental participants interviewed recalled the phrase "Clifford turned green," a detail from the unattended audio stream, showing that even when focus is directed elsewhere, emotionally resonant information can still break through. This supports Treisman's Attenuation Theory, which posits that unattended input is attenuated rather than removed.[20] Evolutionarily, this filtering mechanism may have enabled early humans to remain alert to threats while focusing on tasks, increasing their chances of survival. Quantitative data support this: Questions 2 ($p = 0.031$) and 3 ($p = 0.003$) of the secondary audio showed significant performance differences between groups, indicating impaired—but not absent—recall in the experimental group. These findings point to partial processing rather than full filtering.

Divided attention also reduced comprehension and participant confidence. Experimental group members reported difficulty focusing, with one adding, "I felt less confident because I was listening to both at the same time."[21] These effects align with Alan Baddeley's working memory model and the limits of the phonological loop, which handles auditory input.[22] Competing audio streams overloaded cognitive capacity. Quantitative results mirror this: on Question 2 of the secondary passage, 100% of control participants answered correctly, compared with only 60% in the experimental group ($p = 0.009$); on Question 3, scores were 93.3% and 46.7%, respectively ($p = 0.009$). These score drops illustrate how divided attention impairs retention.

Not all unattended content is processed equally. Experimental participants most often recalled vivid or emotionally charged phrases such as "Clifford turned bright green" or "red, white, and blue," because they reminded them of America. This supports the Levels of Processing theory, which suggests that semantically rich material is more likely to be remembered.[23] These findings echo Cherry's cocktail party effect—salient background details often bypass attentional filters.[24] While differences in recall were minimal for less distinctive content, frequent recollection of vivid elements shows how selective attention favors semantic meaning.

Overall, these results support Treisman's Attenuation Theory over Broadbent's Filter Theory. The ability to recall unattended but salient details contradicts the idea that irrelevant input is completely blocked, as Broadbent suggested.[25]Instead, the data show that attention functions flexibly, allowing semantically meaningful distractions to be processed when relevant.[26] This blend of qualitative and quantitative evidence suggests attention is selective and adaptive, designed to prioritize important stimuli in complex, multi-sensory environments.

[20] Treisman, A. M. *Selective attention in man*. (1960).
[21] See Appendix J for full interview transcripts
[22] Baddeley, Alan. "Working Memory." *Science 255*, no. 5044 (1992): 556–559.
[23] Craik, Fergus I. M., and Robert S. Lockhart. "Levels of Processing: A Framework for Memory Research." *Journal of Verbal Learning and Verbal Behavior* 11, no. 6 (1972): 671–684.
[24] Cherry, "Some Experiments on the Recognition of Speech, with One and with Two Ears." (1953).
[25] Broadbent, Donald. *Perception and Communication*. (1958).
[26] Treisman, Anne M. "SELECTIVE ATTENTION IN MAN." (1960).

D. Methodological Analysis

One strength of this study was the use of random assignment, which ensured that participants had an equal chance of being assigned to the control or experimental group. This minimized selection bias and strengthened the study's internal validity by balancing individual differences, helping to isolate the effect of the independent variable on recall accuracy.

Another strength was the procedure standardization. All participants used the same type of headphones, listened to identical audio recordings, and were tested in the same location. This consistency reduced the influence of extraneous variables and improved reliability, ensuring that observed differences were due to the manipulated auditory conditions rather than inconsistencies in setup.

Additionally, the inclusion of a control group provided a clear baseline for comparison. This allowed the study to test selective attention specifically rather than general comprehension, thereby enhancing construct validity.

Despite these strengths, the study had notable limitations. The artificial setting—listening to audio through noise-canceling headphones in a library—may not reflect real-world auditory conditions, limiting ecological validity. Furthermore, participant awareness of the study's purpose may have led to response bias, especially in the experimental group, where students may have tried harder to ignore the secondary audio or anticipated the study's aim.

Time constraints prevented testing all participants at the same time of day. As a result, some sessions took place in noisier conditions. This inconsistent testing environment may have affected participants' ability to focus during the experiment and influenced their reflections during interviews, with some noting that it was harder to focus due to background noise.

To strengthen future research, the study should be conducted in more naturalistic environments, such as classrooms, and use quieter, better-controlled testing spaces to minimize external distractions and enhance the reliability and generalizability of results.

V. Implications

A. Educators

This study's findings are relevant to teachers and educational administrators because they reveal how competing auditory stimuli, such as background noise, music, or overlapping voices, can interfere with students' ability to focus and retain information. In particular, when students are exposed to multiple auditory inputs, they may still process unattended stimuli.[27] This partial processing, however, often comes at the cost of reduced comprehension and lower confidence in retaining targeted material. These findings align with research on cognitive load, which suggests that excessive simultaneous stimuli can hinder learning by overloading students' working memory.[28]

[27] Treisman, A. M. *Selective attention in man*. (1960).
[28] Sweller, J. *Cognitive load during problem solving: Effects on learning.* (1988).

Educators should take steps to minimize auditory distractions during instruction. Specifically, they should implement structured classroom environments by limiting background noise, using clear and direct speech, and designing lessons with minimal competing audio sources. For instance, when using multimedia tools in a lesson, teachers should avoid layering narration with music or other effects unless necessary. Research by Klatte, Bergström, and Lachmann supports this approach, showing that even low-level background noise in classroom settings negatively affects children's speech comprehension and memory.[29] By creating a mindful learning environment, educators can foster deeper engagement and improve information retention, equipping students with better attentional control.

B. Parents

This study's findings are relevant to parents because they show how easily children can become distracted by auditory stimuli in their surroundings, even when they appear focused. Background noise—e.g., a sibling watching television or a parent talking on the phone—may still be processed by the brain, even if the child is trying to concentrate on a task.[30] As a result, the child's comprehension of primary material may suffer, which can lead to reduced retention and academic frustration.

To support their child's cognitive performance, parents should prioritize creating structured, quiet spaces for learning. This includes turning off televisions and music, avoiding loud conversations in study areas, and helping children develop strategies to minimize distractions. Establishing a routine for homework in a distraction-free environment can improve focus and memory. Research by Shield and Dockrell found that high levels of background noise negatively affect children's ability to process speech and recall verbal information, particularly during complex learning tasks.[31] Given that even partial auditory distraction was sufficient to impair recall in this study, minimizing competing stimuli at home may meaningfully improve children's retention of primary learning material

Final Word Count (including headings and data table): 3094

[29] Klatte, M., Bergström, K., & Lachmann, T. *Does noise af ect learning? A short review of noise effects on cognitive performance in children.* (2013).
[30] Treisman, A. M. *Selective attention in man*. (1960).

[31] Shield, B., & Dockrell, J. E. *The effects of noise on children at school: A review.* (2003).

Appendix

A. Raw Data

Group	Scores
Control	2 / 8
	3 / 8
	3 / 8
	3 / 8
	3 / 8
	4 / 8
	4 / 8
	4 / 8
	4 / 8
	4 / 8
	4 / 8
	5 / 8
	5 / 8
	5 / 8
	6 / 8
Experimental	0 / 8
	0 / 8
	0 / 8
	1 / 8
	1 / 8
	2 / 8

	2 / 8
	2 / 8
	2 / 8
	2 / 8
	3 / 8
	3 / 8
	3 / 8
	3 / 8
	4 / 8

B. Informed Consent Form

Tentative Title of Study: Selective Attention in Dichotic Listening: Attenuation Theory vs. Filter Theory

Researchers: Ananya Goel and Rianna Tejada, Menlo School
Contact Info: ananya.goel@menloschool.org, rianna.tejada@menloschool.org

Purpose of Study: This study examines how people process and recall auditory information, particularly when multiple sounds are presented at the same time. Our goal is to explore whether people fully ignore secondary auditory information or whether it is partially processed without conscious awareness.

Procedures: You will be asked to listen to one or more audio recordings through headphones in a quiet environment. Depending on your group assignment, you may hear either one track or two separate audio streams (one in each ear). After listening, you will answer brief questions to test your recall and comprehension. The entire session will last approximately 10-15 minutes.

Voluntary Participation: Your participation is entirely voluntary. You may choose not to participate without any penalty or negative consequences. You may also choose to withdraw your data at any point.

Risks & Benefits: If you are part of the group that will be listening to two audio tracks, you might feel overwhelmed or overstimulated. However, that risk was deemed to be low-risk, and this listening test was deemed safe for participation. While there is no direct personal benefit, your participation contributes to our understanding of how attention and memory work in everyday environments.

Confidentiality: All responses will remain anonymous. No identifying information will be connected to your results.

Post-Task Interview (Optional): Following the experiment, you may be invited to participate in a brief discussion about your experience. This will help us gather more detailed insight into how participants perceived the task. Your conversation will be recorded, but the recording will be deleted permanently after the study is over. Not everyone will be selected to be interviewed, and if you are selected, you can choose not to participate in the interview. Your name would not be tied to any of your quotes.

Consent Statement: By signing below, you acknowledge that:

- You have read and understood the purpose and procedures of this study.
- You understand your participation is voluntary.
- You understand that you can withdraw your data at any time.
- You understand that you may stop participating at any time.
- You agree to participate in this research study.

Participant Name (Print):

_____ Signature:

_____ Date: _____

C. Control Email

Subject: You're invited to be part of a selective attention study!

Hi [Name],

My name is Ananya, and I'm a junior here at Menlo. Rianna is a senior here, and we've been working on a project together for our psychology class and need your help.

Have you ever thought about how your brain decides what to pay attention to—and what it filters out? We're running a short psychology experiment studying this topic at Menlo, and we'd love to have you be part of it.

You've been randomly selected for our study, which will take part in a short and simple audio listening task. It's quick, it's fun, and your responses will help us better understand how students process information.

We'd love to talk with you more about it and hope you'll consider participating. Let us know if you're interested—we'll send over the details and a quick consent form.

Best,
Ananya Goel and Rianna Tejada

D. Experimental Email

Subject: You're invited to be part of a selective attention study!

Hi [Name],

My name is Ananya, and I'm a junior here at Menlo. Rianna is a senior here, and we've been working on a project together for our psychology class and need your help.

Have you ever thought about how your brain decides what to pay attention to—and what it filters out? We're running a short psychology experiment studying this topic at Menlo, and we'd love to have you be part of it.

You've been randomly selected for our study, where you'll participate in a short task involving two simultaneous audio streams—one in each ear. Your responses will help us understand how people focus and whether background info gets through without us realizing it.

We'd love to talk with you more about it and hope you'll consider participating. Let us know if you're interested—we'll send over the details and a quick consent form.

Best,
Ananya Goel and Rianna Tejada

E. Follow-Up Email

Hi [Name],

I just wanted to bump this to the top of your email, in case it got lost in your inbox. Please let me know by tomorrow if you are interested in participating in this study. We would really appreciate your insight!

Thanks!
Ananya and Rianna

F. Confirmation Email

Hi [Name],

Thank you so much for your interest in participating in our study. Here are a couple of things to do before you can participate:

1. Please sign up for a time here.
2. Please fill out this consent form and bring it with you to your participation time. If you forget the form, we will have extras with us.

Thank you again!
Ananya and Rianna

G. Control Interview Questions

1. Did you notice any sounds or voices other than the passage you were instructed to focus on? a. Follow-up: Can you describe what you heard?
2. Were there any words or phrases that stood out to you from the audio?
3. Was it hard to stay focused on the audio?
4. How confident did you feel in your answers to the comprehension questions?

H. Experimental Interview Questions

1. Did you notice any sounds or voices other than the passage you were instructed to focus on? a. Follow-up: Can you describe what you heard?
2. Was it hard to stay focused on the audio?
3. At any point, did the secondary audio distract you or make it harder to concentrate on the main passage?
   a. Follow-up: How did it affect your understanding of the main content?
4. Were there any words or phrases from the secondary audio that stood out or seemed familiar? 5. How confident did you feel in your answers to the comprehension questions? a. Follow-up: Did you feel less confident because of the audio setup?
6. Do you think you processed anything from the second track, even if you weren't consciously paying attention to it? Why?

I. Control Interview Transcripts (Responses to the Questions in Appendix G)

Person 1:

1. There were some little conversations going on in the library, but other than that, not really. I

was mainly focused on the recording itself.
2. I noticed when it rhymed or when there were patterns - I was able to keep track of it better.
3. Yeah, definitely. It definitely sidetracked my mind a little.
4. Not that much. I think that if there weren't as many distractions, I would have been able to catch the little details that I wasn't able to catch.

Person 2:

1. Yeah, for sure. I think that there's definitely voices and like slight background noise in the surroundings.
2. I remembered the names. Those I was good at remembering. I memorized the general plot, but I didn't memorize specific instances, so I kind of summarized the entire thing in my head. 3. To an extent, yes. Because I was also hearing other stimuli while listening to the passage itself. 4. Not at all. I think that, especially at the speed that it was moving and the length of the listening period, I lost a lot of the information I heard at the beginning and was unable to fully concentrate and focus on the audio at hand.

Person 3:

1. There was music. And also just sound effects that enhanced the story. I didn't notice when the other two people came or anything in the background.
2. I remembered the way they said it. I remembered "oddly" and " on a cat." And also "Clifford turned green." And "checkerboard." I don't know, just small parts stood out.
3. It was hard to keep track of things and like remember. Like I wasn't distracted by things going on around me, but I definitely couldn't like completely follow the whole thing.
4. The first one, I was like 50% confident, and the second was like 85% confident.

Person 4:

1. There was like music playing in the background. And there were also like sound effects. They say like an exclamation, and then the sounds go like wooooo. Yeah.
2. Pink polka dots.
3. Yes. Immensely. I don't think I usually listen to children's stories, so it wasn't very brain-stimulating. I was like, okay, I'll listen to this.
4. Oh, like 20%.

Person 5:

1. Um, no.
2. Um, well, for the first one, I noticed a lot about Easter and how like Clifford was turning different colors and how she dyed the eggs. And for the second one, I just remember the dinosaur not bringing anything home from the zoo.
3. Sometimes it was. The music in the background of the audiobook was sometimes distracting.

4. I was pretty confident in the Clifford one, but I struggled a bit with the dinosaur one.

J. Experimental Interview Transcripts (Responses to the Questions in Appendix H)

Person 1:

1. Um, only when one of the passages wasn't talking.
2. Not really.
3. Like sometimes I would listen to it, but I remembered that I needed to listen to this one, so I just ignored it.
4. Green. I remember that word.
5. I didn't remember the exact wording, but I remembered like the general things about what happened.
6. No. Except for the word "green." "Clifford turned green" or something, that's all I heard.

Person 2:

1. Yes. Like sometimes, because I'm not an audio person, like I would drift onto the Clifford one, but it was a lot easier than I expected to focus on the left ear, so there was some drifting, but yeah.
2. Not really. I'm just bad at focusing. I could focus on it if I concentrated super hard, but my mind just like subconsciously moved.
3. Yeah. I can't really remember stuff from the passage you told me to focus on, so I'm sure that affected that.
4. Frantic.
5. Not at all. I definitely like. I was trying to focus on specific details. Like I remember an elephant in a wagon. But like, the questions that you asked me about, I was like, I remember there was a boa constrictor, but I don't remember what it did.
6. Oh yeah, for sure. I was like, oh yeah, Clifford is dyed green for some reason. What's going on there? Yeah, I felt less confident because I was listening to both at the same time.

Person 3:

1. Yeah. I heard [name redacted]. Not really anything else.
2. Yeah, I was kind of listening to both at the same time.
3. Yes. Yes.
4. Clifford turned green.
5. Not at all. Yeah, I think that's because I was listening to both.
6. Yeah, I think I processed the Clifford one more because the first one didn't make any sense.

Person 4:

1. Yeah, you guys talking.
2. Because of you guys talking? Um, a little bit. The audios were kind of boring so… 3. Yes. When the primary one wasn't talking, the secondary one was like, yeah. 4. It rhymed. Oh, the Clifford one? Red, white, and blue. Because it reminds me of America. 5. Negatives. Bad. All I knew was that it was in a cap. That's it.
6. Yeah, I knew Clifford was jumping around in some water with colors.

Person 5:

1. Yeah. Because I was listening to different audio at once, and also it was really loud where we were doing the experiment.
2. Well, it depends. If nobody was talking on the other one, then no. But if both people were talking, then yeah.
3. I feel like the second audio was louder than the main passage. Was that intended? Well, I feel like it was louder.
4. Clifford turned bright green. [laughs]
5. Not.
6. Clifford turned bright green! And it was about Easter.

K. Quiz Questions + Correct Answers

Primary Audiobook:

1. What does the dinosaur bring back from the zoo?
    a. A big cat
2. How does the boa constrictor look at the dinosaur's dog?
    a. In an "odd" way
3. How does the dinosaur sneak home an iguana?
    a. In a cap
4. Where does the dinosaur keep his shark?
    a. In a pail

Secondary Audiobook:

1. What is the name of the narrator?
    a. Emily Elizabeth
2. What is the narrator's favorite season?
    a. Spring
3. Why does the narrator love that season?
    a. Easter happens in Spring

4. What did the narrator's parents bring her and Clifford last Easter?
    a. A lot of eggs

L. Experiment Script

Thank you for agreeing to participate in our study, and thank you for signing the consent form.

Before we begin, I just wanted to reiterate some important information. Your name won't be shared anywhere, and your data will be completely anonymous. If you want to stop or withdraw your data at any point, you can do so without any consequence.

[Audio check - make sure they can hear out of the AirPods]

[Play the primary audio track] This is the track I'd like you to focus on. After you finish listening to the tracks, you'll answer a few comprehension questions.

Are you ready to begin?

IF INTERVIEWED:

Is it okay if I record this conversation? Again, your name won't be shared anywhere, and your quotes will be completely anonymous. I will delete the recording of this interview after I get all the quotes I need.

M. Transcript of Primary Audiobook

How do dinosaurs choose their pets? By Jane Yolen

Scholastic Audio presents How do dinosaurs choose their pets? Written and read for you by Jane Yolen.

How does a dinosaur pick out his pet? Does he go on the prowl with a stick and a net? Does he head to the zoo and take home a big cat? And what does his mom have to say about that?

Does she drag a huge elephant back in a wagon with both its long trunk and its wee tail, a dragon? Or speaking of dragons, does she go acquire a high-flying beastie who loves to breathe fire?

Does he pick out a boa constrictor for play? Does it look at his dog in a very odd

way? Does he sneak an iguana inside of a cap? Or lead home a kangaroo by a long

strap? Does he ask for a manatee, maybe a whale? Or wish for a shark he can keep

in a pail?

Goel, 22

Does she carry off tortoises, zebras, a mink? Giving them hay and a cola to drink? Is that what you think?

No. A dinosaur doesn't. She knows what to do. And she never brings anything home from the zoo. He goes to a shelter or pet store or farm. To find a small creature who will do no harm.

He brings home a kitten or hamster or pup. That he can teach manners as they both grow

up. She cares for her pet, and gives love even more. Big hugs to your friend, little

dinosaur.

N. Transcript of Secondary Audiobook

Clifford's Happy Easter. Written and read by Norman Bridewell.

Hi, I'm Emily Elizabeth, and I love spring. So does my dog Clifford! The best part of springtime is Easter. Last spring, Mom and Dad brought us a lot of eggs to color for a big Easter hunt.

On the day before Easter, I dye the eggs. Clifford wanted to help. Poor Clifford. He wasn't very good at painting eggs. So Clifford helped by watching me decorate the eggs! He's a good watcher.

When I went to bed that night, I fell asleep dreaming about Easter eggs. It was a beautiful dream. Clifford was stirring a giant tub of dye while I tossed in the eggs. But then Clifford lost his balance! He tumbled into the tub of dye. Something surprising began to happen! Suddenly, Clifford was bright green! It was just like Saint Patrick's Day.

Then, he turned sunshine yellow. This was becoming a very strange dream. I grabbed a brush and began to dab on purple polka dots. Clifford looked good in polka dots, but…they didn't last long. The purple dots turned into squares, and Clifford looked like a giant checkerboard. I didn't like that. I threw on some more dye.

Clifford started to change colors again! Now, he was red, white, and blue! I always used to wonder if I dreamed in color. Now I know! This was too much.

I tried to scrub the dye off Clifford. I was getting frantic. Then I woke up. It was Easter morning, and the sun was shining. I ran out to see Clifford. Thank goodness, he looked just like the same as always. Good old Clifford. We joined my friends and set off on the Easter egg hunt.

We looked high. We looked low. Clifford looked in places I would not have thought. No hiding place was missed. Sometimes Clifford went a little too far. His hard work helped. We ended up with heaps of eggs. Which we shared with our friends. After all, friends are what make Easter a happy day.

Bibliography

Baddeley, Alan. "Working Memory." *Science* 255, no. 5044 (1992): 556–559.

Broadbent, Donald. "Perception and Communication." London: Pergamon Press, 1958.

Brockhoff, Laura, Laura Vetter, Maximilian Bruchmann, Sebastian Schindler, Robert Moeck, and Thomas Straube. "The effects of visual working memory load on detection and neural processing of task-unrelated auditory stimuli." *National Library of Medicine*. https://doi.org/10.1038/s41598-023-31132-7.

Cain, K. (2006). "Children's reading comprehension: The role of working memory and language skills."

British Journal of Psychology, 97(3), 365–380.

Cherry, E. Colin. “Some experiments on the recognition of speech, with one and with two ears.” *APA PsycNet*. https://doi.org/10.1121/1.1907229.

Craik, Fergus I. M., and Robert S. Lockhart. “Levels of Processing: A Framework for Memory Research.” *Journal of Verbal Learning and Verbal Behavior* 11, no. 6 (1972): 671–684.

de la Chapelle, Aurélien, Salomé Serres-Blain, Alma El Shafei, Denis Schwartz, Sébastien Daligault, Julien Jung, Perrine Ruby, Anne Caclin, and Aurélie Bidet-Caulet. “Auditory selective attention during a working memory task with melodies: a MEG study.” *Cold Spring Harbor Laboratory*. https://doi.org/10.1101/2023.09.19.558422.

Dixon, Travis. “Memory Effects & The Working Memory Model.” IB Psychology. Last modified October 8, 2021. https://www.themantic-education.com/ibpsych/2021/10/08/memory-effects-the-working-memory-model/.

Klatte, M., Bergström, K., & Lachmann, T. (2013). “Does noise affect learning? A short review on noise effects on cognitive performance in children.” *Frontiers in Psychology*, 4, 578.

Landry, Phillip, and Carl Bartling. “The Phonological Loop and Articulatory Suppression.” *American Journal of Psychological Research*. PDF.

McLeod, Dr. Saul. “Theories of Selective Attention in Psychology.” SimplyPsychology. Last modified June 11, 2023. https://www.simplypsychology.org/attention-models.html.

Moray, Neville. “Attention in Dichotic Listening: Affective Cues and the Influence of Instructions.” *Quarterly Journal of Experimental Psychology*, (1959). Accessed March 24, 2025. https://doi.org/10.1080/17470215908416289.

Prabhu, Sujatha, Reshmi Nair, Luh Yee Lau, Ju Yang Chong, Zhi Fung Sia, and Ashwini Aithal. “An Experimental Study on the Effect of Background Music on Memory Recall among Medical Students.” *Journal of Datta Meghe Institute of Medical Sciences University*. https://doi.org/10.4103/jdmimsu.jdmimsu_26_21.

Shield, B., & Dockrell, J. E. (2003). “The effects of noise on children at school: A review.” *Building Acoustics*, 10(2), 97–116.

Spurgeon, Jessica, Geoff Ward, and William J. Matthews. “Examining the relationship between immediate serial recall and immediate free recall: common effects of phonological loop variables but only limited evidence for the phonological loop.” *National Library of Medicine*. https://doi.org/10.1037/a0035784.

Sweller, J. (1988). “Cognitive load during problem solving: Effects on learning.” *Cognitive*

Science, 12(2), 257–285.

Treisman, Anne. “Strategies and Models of Selective Attention.” *Psychological Review* 76, no. 3 (1969): 282–299.

Treisman, Anne M. “SELECTIVE ATTENTION IN MAN.” *Oxford Academic*. https://doi.org/10.1093/oxfordjournals.bmb.a070274.