

Research Article

Stochastic Resonance and Library Space Design: Rethinking Silent Policy Through Cognitive Psychology

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Abstract

This study explored the integration of cognitive psychology into library space design, specifically examining how stochastic resonance where background noise enhances cognitive performance can inform acoustic zoning policies in academic libraries. Anchored in Ranganathan's principles and the shifting demands of emotionally responsive users, the research critiqued the traditional silent library model. The population included 5,201 users in Donald E. U. Ekong Library, University of Port Harcourt. The sample size was determined using Kpolovie minimum sample size formula, and 400 respondents were determined and sampled using simple random sampling technique. Using a mixed-method approach involving surveys and interviews at the Donald E. U. Ekong Library, the study applied the Swedish Soundscape-Quality Protocol to analyze user perceptions. Findings revealed that structured background sounds, such as music and human activity, moderately increased cognitive focus, emotional engagement, and memory recall while reducing annoyance. Thematic analysis underscored user diversity in sound preferences, challenging the uniform application of silence in libraries. The study advocated multi-zoned library spaces that accommodate both silence-preferring users and stochastic resonants, thereby fostering inclusive learning environments. Recommendations include the adoption of sound-aware policies and architectural zoning to support cognitive diversity and enhance user experience in academic libraries.

Keywords

Stochastic Resonance, Library Spaces, Silent Policy, Cognitive Psychology, Soundscape, Music, Acoustic Zoning

1. Introduction

A library is widely recognized as a professionally organized institution established to collect and preserve information resources, provide access to these materials, and promote the advancement of human knowledge and cultural heritage. It is in this context that one of the foundational laws of librarianship (Ranganathan's 5th law) emphasized that the library is a growing organism. This law posits that a library is not a static

entity but a dynamic institution, constantly evolving to meet the changing needs of its users and society. Therefore, the library must continue to grow and adapt over time in response to changes in the volume and nature/format of information resources, the needs and expectations of its users, technological advancements, and societal and cultural developments.

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Professional librarians are mandated by profession to continuously evolve to incorporate new formats of information and adapt to emerging technologies, remain responsive to the changing needs of their users, and offer tailored services and resources to meet diverse demands. They are to expand their collections to include new and relevant materials while preserving older, valuable resources. They are also mandated to upgrade their physical and digital infrastructure to accommodate growth and ensure accessibility and engage in continuous learning to stay updated with trends and innovations in the field. Accordingly, Ranganathan's Laws portray libraries as dynamic institutions capable of continuous growth and adaptation in response to the evolving needs of their communities.

The information milieu is characterized by a radical change occasioned by technological advancement. This has placed high premium on information resources and lately to user behaviour. However, while extensive research has explored cognitive processing in learning environments, little emphasis has been placed on the design of space in the library in accommodating diverse cognitive needs of users. Umeozor and Emasealu [25] underscored the increasing influence of psychological factors on user behaviour in contemporary information environments, where emotional dispositions play a critical role in shaping decisions and actions. Unlike previous generations that were adapted to rigid educational structures, the emotional orientation of this generation has become even more pronounced such that their engagement with situations increasingly depends on their perceptions. This situation abruptly ended the traditional stereotype of the librarian as a bespectacled, cardigan-clad, hush! hush!! person who dusts, arranges and takes care of books on the shelves [7].

Consequently, libraries must consider psychological factors in designing their spaces, ensuring that users' mental processes and cognitive diversity are acknowledged. Traditional library policies have overlooked the role of spatial and acoustic design in cognitive performance, reinforcing silent reading rooms as a default standard. Conceivably, silent environments may not optimally support users sensitive to stochastic resonance, who benefit from a controlled level of background sound to enhance concentration and cognitive processing. Stochastic resonance is a phenomenon whereby the presence of moderate, structured noise can amplify weak neural signals, improving attention, sensory processing, and cognitive performance [17]. In the context of libraries, this suggests that carefully managed auditory stimuli, such as music or low-level human activity, may facilitate reading and learning by supporting neural signal processing and reducing cognitive load [18]. The American Library Association [3] notes that "good acoustics promote focus, calm, and peace of mind," suggesting that acoustic design is crucial in modern library environments. However, there remains a gap in empirical studies examining the interplay between specific sound sources and user cognition in African academic libraries, where environmental conditions, cultural practices, and technological infrastructure may differ from Western contexts. Most research to date has

focused on experimental or Western library settings, leaving questions about the generalizability of findings regarding stochastic resonance and soundscape preferences. This study investigated how various sound sources such as traffic, industrial activity, human presence, natural sounds, and music affect library users' perceived pleasantness, annoyance, and loudness and interaction with cognitive processes and learning behavior in the Nigerian academic library.

This study is grounded in stochastic resonance theory, which posits that a controlled level of background noise can enhance neural signal detection and cognitive processing [17]. In the context of library use, stochastic resonance provides a lens to examine how auditory stimuli, such as music or ambient human activity, influence attention, concentration, and subjective experience. The Mozart effect further supports this framework, suggesting that structured auditory patterns, including instrumental or non-semantic music, can improve intrinsic motivation and cognitive performance during learning activities [19]. These theories collectively form the assumptions of the study: that library users differ in their cognitive response to sound, that certain types of sound may enhance focus or reduce annoyance, and that soundscape management must consider these differences. Maslow's [16] hierarchy of needs offers a complementary psychological perspective, highlighting that optimal arousal levels are necessary for peak performance and intrinsic engagement.

2. Research Questions

- 1) What role does acoustic zoning play in balancing traditional silent library policies with the cognitive diversity of modern library users?
- 2) How do different stochastic resonance influence user preferences for silence or background noise in libraries?
- 3) How can library space design integrate sound management strategies without disrupting the core functions of academic libraries?

3. Literature Review

The library, as a societal institution, is responsible for the curation, preservation, and provision of information resources and services. However, Emasealu [6] averred that rapid transformations in society have led to evolving and diverse information needs among users, which directly affect the library's functions. This shift has expanded the library's role from merely providing resources to supporting information counseling, mediation, and skill acquisition. The American Library Association [4] similarly documents the evolution of libraries from traditional repositories into dynamic centers for learning and personal development. Contemporary library design increasingly recognizes the impact of acoustic environments on cognitive performance [11]. While traditional silent-library

policies may support some users, others particularly those sensitive to stochastic resonance benefit from a controlled level of background sound.

Libraries have traditionally been perceived as spaces dedicated to the curation, preservation, and provision of information resources, with silence considered a central component of their operational philosophy [4, 7]. However, the rapid transformation of societal information needs and the emergence of technology have shifted the role of libraries toward spaces for active learning, skill acquisition, and knowledge mediation. Modern libraries are no longer mere repositories of books but dynamic environments that support cognitive engagement, social interaction, and user-centered learning. This evolution underscores the importance of considering environmental factors, particularly sound, in supporting effective information use and cognitive performance.

Soundscapes within libraries are critical elements of library environments, influencing user perception, concentration, and overall experience. Studies have emphasized silence as essential for concentration [11], assuming that any background noise constitutes a cognitive disruption. Yet, emerging evidence challenges this assumption, suggesting that moderate, structured sounds can support attentional focus and enhance cognitive processing [18, 26]. Therefore, human-generated ambient sounds, such as low-level chatter or footsteps, can create a socially normative acoustic environment, potentially reduce perceived isolation and support mental engagement. Consequently, music, whether instrumental or vocal, has been shown to facilitate cognitive performance by providing rhythmic and structured auditory stimuli that align with neural processing mechanisms.

The concept of stochastic resonance, originating from neuroscience, provides a framework for understanding this phenomenon. Stochastic resonance refers to the process by which a weak signal is amplified in the presence of moderate noise, thereby improving the detection and processing of information [10, 17]. In the context of library soundscapes, stochastic resonance suggests that users' cognitive performance may be enhanced when exposed to controlled levels of background sound, including music or predictable ambient noise, rather than complete silence. This theory challenges traditional library policies and supports the notion that optimal acoustic conditions vary depending on individual cognitive preferences. Complementing stochastic resonance is the Mozart effect, which posits that exposure to certain structured musical patterns can improve spatial reasoning, attention, and intrinsic motivation during cognitive tasks [19]. Research indicates that music, even when devoid of semantic content, can evoke emotional responses that modulate arousal, enhance focus, and reduce the perception of environmental stressors [8]. Applied to the library context, the Mozart effect provides an explanation for why some users report higher concentration and satisfaction when reading with background music, while others prefer silence.

Studies highlight the diversity of user perceptions and needs.

Orakwe [18] found that sound sources such as natural sounds, music, and human activity can either enhance or diminish perceived pleasantness and attention depending on individual expectations, familiarity, and social conditioning. Woo and Rajagopalan [26] emphasize that acoustic environments influence both the cognitive and affective dimensions of learning, affecting motivation, comprehension, and overall engagement with reading tasks. These studies collectively point to the necessity of moving beyond uniform silence policies and adopting flexible, user-centered soundscape management strategies that accommodate different cognitive profiles and preferences. The studies above demonstrate that sound is not inherently disruptive; rather, its effects on cognitive performance and user satisfaction depend on its structure, predictability, and alignment with individual preferences. These insights justify the focus of the study on stochastic resonance and provide a foundation for analyzing the relationships between sound sources, affective perception, and library user engagement.

There has been a tremendous transformation of contemporary libraries accommodating societal changes. However, as a growing organism, the library must be particular about the behavioural preferences of millennial users in planning library resources and services. Although, there is a tendency to argue that makerspaces in libraries afford stochastic resonant the needed reading preference. The Ranganathan's fourth law mandated libraries to save the time of the user. The user, in this sense is assumed to be a busy person and deliberate effort should be made to save the time the user spends in retrieval and use of information resources. The implication of this law extends to the physical spaces in libraries as part of library services. The physical space should accommodate all that the user requires to get comfortable in retrieval, use of information and reading. Highlighting the need for conformity of reading spaces to the specificity of users, Adetayo *et al.*, [1] emphasized the importance of creating adaptable and welcoming spaces to accommodate personal preferences, environmental influences, and social dynamics that shape reading behaviours. Also, American Library Association [2] advises against restricting access based on age or grade level, emphasizing respect for individual needs, interests, and abilities.

Stochastic resonance is a cognitive process that allows readers benefit from controlled acoustic background stimuli, such as mild noise, (rhythmic patterns) that enhance focus and comprehension. The variety of stimuli in a makerspace is often random and overwhelming rather than controlled, making it difficult for stochastic resonant readers to engage effectively. These readers may find slight, structured distractions helpful but struggle in highly chaotic or unpredictable settings. Therefore, makerspaces are typically loud and dynamic, with 3D printers, power tools, and collaborative discussions creating an environment that is not conducive to deep reading or contemplation. Makerspaces are also structured for hands-on, interactive work, often lacking comfortable, quiet, or structured reading areas that stochastic resonant readers need.

Naturally, the human environment is inherently sound-accompanying, as absolute silence is rare. Some level of noise is inherent in the human environment, coming from natural elements, machines, and human activity. With the sound in human environment, the brain adapts to constant low-level noise, often filtering it out, indicating that absolute silence can feel unnatural or even unsettling. So, for many learners, absolute silence might actually be counterproductive. Instead, structured background sound (such as soft instrumental music or white noise) may mask distracting stimuli reduce cognitive overload, and create a more consistent sensory environment. This stability helps learners maintain focus, particularly during tasks that require sustained attention and the transfer of information into long-term memory.

4. Methodology

This study adopted a mixed-method approach, combining qualitative interviews with quantitative surveys. The population included users of the Donald E. U. Ekong Library, University of Port Harcourt, with an estimated average of 5,201 library visits per week based on weekly access records. Using Kpolovie's [14] minimum suitable size formula, a sample size of 400 was selected through simple random sampling. The primary instrument for data collection was the Soundscape Quality Assessment Scale (SQAS), adapted from the Swedish Soundscape-Quality Protocol (SSQP). The Swedish Soundscape-Quality Protocol (SSQP), was developed by Axelsson, Nilsson, and Berglund [5]. This was selected to examine the acoustic perception of users of Donald E. U. Ekong Library, University of Port Harcourt because it demonstrated effectiveness in quantifying responses to sound situations in experimental and applied settings. The SQAS is a structured, self-administered questionnaire designed to capture both objective and subjective dimensions of the soundscape, including the prominence of specific sound sources, affective evaluation, and overall environmental assessment. It comprises three sections. The first section collects participant demographic and contextual information, such as age, gender, location of assessment within the library, date and time of observation, and frequency of visits. The second section, Sound Source Identification, requires participants to rate the prominence of traffic noise, industrial or construction noise, human activity (talking, laughter, footsteps), natural sounds (birds, wind, water), and music or entertainment sounds using a five-point Likert-type scale ranging from 1 ("Not noticeable") to 5 ("Very dominant"). This section provides quantitative measures of the relative salience of sound sources in the library environment. The third section, Perceived Affective Quality (PAQ), captures participants' subjective evaluation of the soundscape using eight attributes: pleasantness, chaos, vibrancy, calmness, uneventfulness, annoyance, eventfulness, and overall satisfaction. Ratings on a five-point scale from 1 ("Strongly Disagree") to 5 ("Strongly Agree") indicate the degree to which participants perceive the soundscape as positive or negative.

The SQAS was adapted to the local library context to ensure clarity, cultural relevance, and applicability. Modifications included adding music or entertainment sounds as a separate category, reflecting their potential influence on reading experiences, and adjusting wording to align with the auditory characteristics of the library environment. Instructions and response formats were refined based on preliminary consultations with subject-matter experts. To ensure reliability and validity, the adapted SQAS was pilot-tested with 15 participants, yielding a Cronbach's alpha of 0.82, indicating good internal consistency. Complementing the quantitative data, structured interviews were employed to capture participants' subjective experiences and contextual insights. These interviews were pre-tested with a small group of 10 respondents to refine the phrasing of questions, improve clarity, and standardize response interpretation. The combined use of the adapted SQAS and structured interviews allowed for a comprehensive assessment of stochastic resonance effects while ensuring that the instruments were both reliable and contextually appropriate.

Quantitative data obtained from the adapted SQAS were analyzed using a correlation matrix to examine patterns of stochastic resonance and relationships between sound source prominence and perceived affective quality. Qualitative data from structured interviews were transcribed verbatim and analyzed thematically, manually applying an NVivo-inspired style. Coding focused on identifying recurrent patterns, explanations, and contextual factors that could illuminate the quantitative findings. Triangulation between SQAS results and interview insights enhanced the validity of interpretations and provided a comprehensive understanding of participants' stochastic resonance experiences. The study adhered to established ethical standards for research involving human participants. Informed consent was obtained from all respondents through a consent statement written on the front page of the instrument, which participants were required to read and acknowledge before completing the SQAS or participating in interviews. Confidentiality of all data was strictly maintained, and information provided by participants was used solely for the purposes of this research. Participants were also informed of their right to withdraw at any stage without any negative consequences.

5. Result and Discussion

5.1. The Role of Acoustic Zoning in Balancing Traditional Silent Library Policies with the Cognitive Diversity of Modern Library Users

In this study, quantitative results indicate a weak positive correlation between music and perceived pleasantness ($r = 0.28$) and a weak negative correlation with annoyance ($r = -0.18$). Qualitative responses show that 43.6% of respondents

enjoyed reading with music, citing enhanced focus, mood regulation, and intrinsic motivation, whereas 56.4% preferred silence to minimize distraction. These results demonstrate the cognitive diversity of users and the need to accommodate varying preferences in library design.

Stochastic resonance in neuroscience refers to the phenomenon where moderate levels of noise enhance the detection of weak neural signals, improving cognitive processing [17]. Structured auditory stimuli, such as music or predictable human activity, may facilitate this effect, supporting attention, memory, and sensory integration during reading. For participants who perceive music positively, these stimuli likely provide optimal sensory input that aligns with their cognitive processing needs, enabling neural modulation that enhances comprehension and intrinsic motivation [18].

The Mozart effect further explains why music can support cognitive performance. Structured music, even without semantic content, can induce relaxation and enhance focus. Musical compositions like Enya's *Adiemus*, which use vocal sounds without meaning, may produce a symphonic effect that fosters concentration and intrinsic motivation. Neural modulation occurs as multiple neural pathways interact, improving encoding and decoding of information, allowing stochastic-resonant users to process reading material more efficiently. However, the negative perceptions reported by 56.4% of respondents highlight that not all users benefit from music. For these individuals, additional auditory input may increase cognitive load or serve as a distraction, interfering with concentration and comprehension. This variability underscores that stochastic resonance effects are user-dependent. While structured sound can enhance cognitive performance for some, it

may be disruptive for others [18, 17].

From a psychological perspective, these findings align with Maslow's [16] hierarchy of needs and principles of intrinsic motivation [21]. Users who benefit from structured sound achieve optimal arousal and heightened cognitive engagement, making reading activities more meaningful. Conversely, users who prefer silence may reach peak performance in environments with minimal sensory stimulation. This duality emphasizes the importance of acoustic zoning in libraries, providing areas for both strictly silent study and controlled ambient sound. Acoustic zoning, therefore, represents a practical strategy to balance traditional silence policies with cognitive diversity. Libraries can create spaces that promote focus, creativity, and learning while accommodating users with varying preferences through the integration of cognitive psychology, environmental design, and soundscape management. Intentional design of auditory environments allows libraries to support stochastic-resonant users without compromising the needs of those who require silence, fulfilling the institution's evolving role as a dynamic center for intellectual engagement.

5.2. Influence of Different Stochastic Resonance on User Preferences for Silence or Background Noise in Libraries

The correlation matrix in Table 1, showed the trends in relationship with the acoustic characteristics as perceived by the library users.

Table 1. Correlation (Heatmap) Matrix of Soundscape variables in Donald E. U. Ekong Library.

Variables	Traffic_Noise	Industrial_Noise	Human_Activity	Natural_Sounds	Music_Sounds	Pleasantness	Annoyance	Loudness
Traffic_Noise	1.00	0.20	0.49	0.28	0.41	0.19	-0.14	-0.03
Industrial_Noise	0.20	1.00	-0.01	-0.03	0.41	0.17	0.02	0.07
Human_Activity	0.49	-0.01	1.00	0.42	0.32	0.11	-0.39	0.07
Natural_Sounds	0.28	-0.03	0.42	1.00	0.22	0.16	-0.03	0.06
Music_Sounds	0.41	0.41	0.32	0.22	1.00	0.28	-0.18	0.16
Pleasantness	0.19	0.17	0.11	0.16	0.28	1.00	0.07	-0.08
Annoyance	-0.14	0.02	-0.39	-0.03	-0.18	0.07	1.00	-0.29
Loudness	-0.03	0.07	0.07	0.06	0.16	-0.08	-0.29	1.00

The correlation matrix of soundscape variables in this study revealed mostly weak associations between auditory stimuli and perceived pleasantness, annoyance, and loudness. Traffic

noise showed a very weak positive correlation with pleasantness ($r = 0.19$) and a weak negative correlation with annoyance ($r = -0.14$), while its relationship with perceived loudness was negligible ($r = -0.03$). These low associations indicate that

traffic noise has minimal influence on participants' perception of the library soundscape, and any observed trends may reflect tolerance or adaptation rather than meaningful effects [18].

Industrial noise similarly exhibited very weak correlations with pleasantness ($r = 0.17$), annoyance ($r = 0.02$), and loudness ($r = 0.07$), suggesting little impact on the acoustic experience. Human activity had a very weak positive correlation with pleasantness ($r = 0.11$) but a moderate negative correlation with annoyance ($r = -0.39$), indicating that socially structured sounds may help reduce irritation in shared spaces. Natural sounds, such as birds or water, were weakly associated with pleasantness ($r = 0.16$), annoyance ($r = -0.03$), and loudness ($r = 0.06$), reflecting their generally soothing but subtle contribution to the environment.

Music showed the strongest influence, with a weak positive correlation with pleasantness ($r = 0.28$), a weak negative correlation with annoyance ($r = -0.18$), and a very weak positive correlation with loudness ($r = 0.16$). This suggests that structured auditory stimuli like music can enhance perceived pleasantness and slightly reduce irritation. These results are consistent with [18], who reported that predictable or patterned sounds facilitate cognitive processing and positively influence subjective soundscape evaluation.

The qualitative data support these findings. Respondents were asked whether they enjoy reading with music; 43.6% responded affirmatively, citing improved focus, mood regulation, and motivation. The remaining 56.4% preferred silence, emphasizing concentration and minimal distraction. Thematic analysis of participant responses (Table 2) highlighted that while music and human activity can enrich the experience for some users, acoustic management should accommodate diverse preferences.

The finding demonstrates that not all sounds are disruptive. Familiar, patterned, or socially accepted sounds, such as music and human activity, may improve the library soundscape experience. These findings align with the concept of stochastic resonance, which posits that structured background noise can enhance neural processing, focus, and cognitive comfort [18]. This suggests that acoustic zoning and intentional sound design may support cognitive engagement, promoting a productive and pleasant environment without insisting on absolute silence in Donald Ekong Library. This pattern aligns strongly with the concept of stochastic resonance, which frames the presence of structured or predictable background noise as a facilitator of cognitive processing. As earlier argued, stochastic resonance enables the brain to modulate neural activity, filtering out distractions and heightening focus through controlled acoustic stimuli and creating a sonically structured environment that promotes cognitive relaxation and sustained attention [18]. The moderate positive relationship between music and pleasantness in this study reflects that very phenomenon which is often referred to as the Mozart effect where structured sound bolsters mental clarity and intrinsic motivation.

To support the quantitative findings above, a thematic analysis was conducted on qualitative responses gathered from participants regarding their perceptions of reading with music and why. The interview question simply asked the respondents whether they enjoy reading with music, in which 56.4% responded 'No', while the remaining 43.6% responded 'Yes'. Those who said yes were further asked 'why' the preference to read with music. Their responses were recorded and analyzed via thematic analysis in themes (Table 2).

Table 2. Thematic Analysis of Interview Responses.

SN	Theme	Description	Supporting Response	Theoretical Connection
1	Music enhances focus and concentration.	Participants reported that music helps them to concentrate and avoid distractions while reading.	<i>"It makes me concentrate and understand better."</i>	Stochastic resonance; music–pleasantness correlation.
2	Sound as cognitive Buffer (Auditory masking).	Participants described how structured background noise, such as white noise, masks distracting sounds and supports cognitive stability.	<i>"White noise creates a steady sound that prevents distractions, allowing the brain to concentrate better."</i>	Auditory masking; cognitive load theory; structured soundscapes.
3	Music as emotional and motivational reinforcement.	Respondents noted that music brings comfort, relaxation, and motivation while reading, enhancing their emotional engagement.	<i>"It gives comfortability and inspiration."</i>	Maslow's arousal theory; intrinsic motivation (Ryan & Deci, 2000a); stochastic resonance.
4	Music as a memory aid.	Music was perceived to improve memory recall, understanding, and long-term retention of read content.	<i>"It helps me in remembering."/ "Helps me recall better."</i>	Neural modulation; dopaminergic stimulation; Orakwe (2018).
5	Individualized	Participants expressed varying pref-	<i>"That is my personal way of reading."/ "I really don't care</i>	User-centered soundscape design; acoustic zoning; cognitive

SN	Theme	Description	Supporting Response	Theoretical Connection
	soundscape preferences.	ferences in sound environments, indicating the importance of adaptive and personalized acoustic settings.	<i>about the sound as long as I'm focused."</i>	diversity.

Following the principles of thematic analysis emulated through NVivo-style coding, responses were coded and grouped into dominant themes. The analysis revealed five major themes: music as a tool for focus and concentration, sound as a cognitive buffer, music as emotional and motivational reinforcement, music as a memory aid, and individualized soundscape preferences (Table 2).

The first and most frequently occurring theme was the use of music to enhance focus and concentration. Many respondents described how listening to music, particularly through earphones, helped them to concentrate better during reading sessions. Words such as *"focus," "concentrate," "attention,"* and *"interest"* recurred across several responses. This theme directly aligns with the quantitative result that showed a positive relationship between music and pleasantness, and a negative correlation between music and annoyance. It also supports the theoretical foundation of stochastic resonance, where a certain level of background noise optimizes cognitive function by modulating neural activity and enhancing weak information signals.

A second theme emerged around sound as a cognitive buffer, particularly in the context of *auditory masking*. Respondents reported that structured background noise, such as white noise or natural sounds (e. g., waterfalls or rain), helped to mask distracting ambient noise and maintain cognitive stability. One respondent explicitly referenced cognitive load theory [23] and auditory masking [12] to explain how consistent background sound facilitated deeper concentration and minimized interference from environmental distractions. This aligns with research on the functionality of white noise in learning environments [13], suggesting that a controlled auditory backdrop reduces cognitive overload.

The third theme identified was music as emotional and motivational reinforcement. Respondents expressed that music created a sense of comfort, relaxation, or inspiration that positively influenced their reading experience. For example, one participant described music as *"comforting and inspiring,"* while another compared the experience to *"elevator music"—relaxing and non-intrusive*. This supports the psychological framework underpinning stochastic resonance and Maslow's arousal theory, where emotional stability through structured sound encourages intrinsic motivation for reading [16, 20]. The personal resonance of music, as highlighted by respondents who identified as dancers or creatives, reinforces the subjective nature of soundscape perception and its motivational implications.

Music as a memory aid emerged as a recurring theme. Several respondents reported that listening to music while reading improved their recall, understanding, and retention. This perception is well-documented in studies suggesting that music can enhance cognitive processing and working memory, particularly through dopaminergic stimulation and neural modulation [9, 22]. This theme echoes the observations of Orakwe [18], who highlighted the cognitive and spiritual resonance of music, particularly its role in anchoring memory and improving comprehension.

Lastly, the theme of individualized soundscape preferences reflected the diversity of personal experiences and adaptive strategies among respondents. While most respondents affirmed a preference for reading with music, some noted that their tolerance for background noise varied by task, personality, or environment. This highlights the need for acoustic zoning within library environmental spaces that accommodate both stochastic resonant readers who benefit from structured sound, and those who require quieter settings.

The thematic findings reinforce the earlier statistical correlations and the theoretical framework of the study. They reveal that the presence of organized sound particularly music and structured noise not only enhances the subjective pleasantness of the environment but also plays a functional role in cognitive regulation, emotional balance, and memory formation. These insights substantiate the call for sound-aware design in academic libraries, such as the Donald E. U. Ekong Library, where soundscapes can be intentionally structured to support diverse cognitive needs.

5.3. Integrating Sound Management Strategies in Library Space Design Without Disrupting the Core Functions of Academic Libraries

The result from Table 2 proved that auditory simulation through organized environmental acoustic can have a significant impact on cognitive performance. Conversely, excessive noise can be distracting and detrimental to concentration. The optimal acoustic environment is one that provides a balance, offering enough ambient sound to promote focus without overwhelming the senses. Integrating sound management in libraries would require philosophy and policy redirection. The library, as a growing organism, must constantly refer to environmental and behavioural changes in planning the policy and philosophy. The history of the library has witnessed signifi-

cant transformation over time. In the 21st century, the traditional role of librarians as sole custodians of verified information has evolved, repositioning them as information mediators, a situation Kwanya *et al.*, [15] termed apo-mediation. The authors further explained that this has become necessary due to the emergence of numerous information sources, creating the illusion of self-sufficiency in information retrieval and use among users. In response, librarians have stepped up as intermediaries, bridging the gap between users and the overwhelming sea of information. Thus, they assist in identifying, verifying, validating, and sourcing reliable information from the vast and often chaotic pool of available resources [24].

This shift from mediation to apo-mediation requires the librarian to be proactive in facilitating user autonomy while ensuring that the environment supports diverse cognitive and sensory needs. In this light, sound management is not merely a technical adjustment, but a strategic rethinking of spatial design in ways that honour both individual learning styles and communal academic functions. Integrating sound into library space design without disrupting its core functions demands a multi-zoned architectural approach. This involves creating acoustic zones within the library that cater for varied user preferences. Quiet zones can still be maintained for readers and researchers who prefer silent environment, while stochastic-friendly zones can accommodate mild ambient sounds, structured music, or nature-inspired audio designed to stimulate cognitive flow. This zoning ensures that libraries no longer enforce a monolithic culture of silence but evolve into pluralistic cognitive ecosystems where silence and sound coexist with intentionality.

Technological interventions can aid sound management. Directional sound systems, noise-canceling technologies, and adaptive acoustic panels allow libraries to modulate sound levels dynamically, responding to usage patterns throughout the day. Such approaches are already visible in modern learning commons and blended study spaces, where students engage in group discussions, multimedia work, and quiet reading all within the same facility but acoustically distinguished by design.

There is a need to rewrite policy frameworks that traditionally enforce absolute silence without consideration for cognitive diversity. Rather than enforcing silence as a blanket policy, libraries should develop sound-use guidelines informed by empirical findings from acoustic studies and cognitive psychology. These policies should emphasize respect for diverse learning needs, guided by a philosophy that acknowledges sound not as interference, but as a potential enhancer of cognitive engagement, especially for stochastic resonant users. The role of the librarian in this transition becomes even more pronounced. Librarians must not only act as facilitators of access to information but also as curators of the sensory experience within the library space. This includes engaging users in co-creating soundscape preferences, surveying acoustic satisfaction levels, and adjusting sound policies based on ongoing feedback and use-pattern analytics. It also means developing

training modules for library staff to understand how acoustic design and sensory stimuli interact with learning processes, ensuring a shared institutional understanding of sound as a cognitive tool. In integrating sound management into library space design, care must be taken to preserve the scholarly integrity of the academic library. The ultimate goal is not to replace silence, but to redefine quietude as a dynamic state that may be achieved not only in absence of sound but through intelligently curated acoustic environments. In this framework, sound becomes an instrument of scholarly enhancement and not disruption, thereby reinforcing the library's enduring mandate to support deep thought, creativity, and lifelong learning.

6. Conclusion

This study reaffirmed that academic libraries must evolve beyond rigid silent policies to accommodate cognitive diversity. Evidence from the Donald E. U. Ekong Library confirmed that structured background sounds can significantly enhance user concentration, memory retention, and intrinsic motivation. While not all users prefer noise, the findings emphasized the need for intentional sound zoning that acknowledges different learning preferences. The concept of stochastic resonance provides a psychological and neurological framework for rethinking library acoustics. Importantly, the consistent efforts of librarians in promoting reading culture a dedication often disregarded by users highlight the relevance of this type of study. Libraries can serve modern users without compromising academic integrity by integrating sound management into library philosophy and design. Future policies must recognize sound as a cognitive tool rather than a disturbance, ensuring that libraries remain inclusive, user-centered environments for lifelong learning.

Abbreviations

SSQP	The Swedish Soundscape Quality Protocol
SQAS	Soundscape Quality Assessment Scale
PAQ	Perceived Affective Quality

Author Contributions

Stanislaus Nnaemeka Ezeonye: Conceptualization, Data curation, Formal Analysis, Methodology, Resources, Validation, Writing – original draft

Susan Nnadozie Umeozor: Project administration, Resources, Supervision, Visualization, Writing – review & editing

Conflicts of Interest

The authors declare no conflicts of interest.

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