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Parental Perceptions: Effects of Home Acoustics on Children with Autism

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Abstract

Background: As more children are being diagnosed with Autism Spectrum Disorder (ASD), there is a greater need for research surrounding how the built environment impacts those children.

Aim: The aim of this study was to analyze how parents of children with ASD perceive the effects of acoustics on their child. Parents of children with ASD completed a survey detailing their perceptions of their child's behaviors to different acoustical aspects of the environment and the effectiveness of the current acoustical design of their home.

Patients and Methods: The survey included Likert-scale questions, and quantitative measures.

Results: Most parents indicated that they strongly agreed that their home is acoustically well-designed (69.5%) followed by agreed (13.4%), neither agreed nor disagreed (11.0%), strongly disagreed (3.7%), and disagreed (2.4%). Parents were also asked what environmental design features are used in the child's home to help reduce noise levels. Parents reported using thick or sound-absorbing carpet (17.9%), thick walls (6.0%), wood chairs/desks (15.5%), and transitional spaces (11.0%). No parents reported using wood panels, sound proof material, or sound proof ceilings in the child's home. Parents rated thick or sound proof walls (Mean = 4.17, Standard Division = 0.92) as being the most important elements of noise control in children's environments. Results indicated a significant relationship between parental rating of noise control being an important issue and observing complaining in response to noise.

Conclusion: The results indicated that there was an association between parents rating noise control as being important for their child and observing behaviors in their children in response to noise. There was no association between observed behaviors and parents rating environmental modifications as being important for noise control.

Recommendations: Future research should seek to combine data from parents, teachers, and children with ASD. Further research could aid in the design and implementation of acoustic settings in the built environment that bring about positive behavior from children with ASDs.

Keywords: Acoustics; Autism Spectrum Disorder; Built Environment; Children; Noise

Introduction

As a neurodevelopmental disorder, Autism Spectrum Disorder (ASD) disrupts social skills, affects receptive and expressive communication, and causes repetitive behaviors [1]. Previous literature has suggested that hyperacusis, or a heightened sensitivity to sound, is often associated with autism [2,3]. As the prevalence and awareness of ASD rises, so does the need for evidence-based research regarding the best environments for children with ASD. In 2014, the prevalence of ASD was estimated to be 1 in 68 children according to the Centers for Disease Control and was reported to be one of the fastest growing developmental disabilities [4]. While typically developing individuals may experience mild reactions to diverse built environments, those with atypical neuro-developmental disorders, such as ASD, may experience more extreme reactions and sensitivities to their environments. In environments that are undesirable in some way, individuals with ASD typically report feeling frustrated, overly sensitive, and physically uncomfortable [5].

The World Health Organization (WHO) has determined that research needs to focus on the effects of noise on vulnerable groups, as noise may have different effects on these groups [6].

Children with ASD often perceive and process their environment differently than those without ASD and exhibit a unique sensory profile in response to different stimuli in their environments [7]. The current study aims to add to existing literature by investigating parents' perceptions of the effects of acoustics on the behavior of their children with ASD. Specifically, the study investigates whether there is a difference in parental reports of repetitive movements, covering of ears, and other behaviors in response to noisy conditions. The study also seeks to determine whether parents perceive their home to be acoustically well-designed.

We hypothesize that parents who observe behaviors in response to noise would also rate noise control as being important to their child. And second: parents who observe behavior changes in their children would be more likely to view use of specific environmental modifications as important for their child.

Materials and Methods

Participants

A total of 84 parents completed the survey. Fifteen of the children were females while 69 were males. Because of the nature of ASD, the complexity of acoustical related questions, and the age of the children, it would not have been a reliable measure to have the children complete the survey. All the children in the study were diagnosed as having high functioning ASD and had an official diagnosis by a medical doctor or psychologist. There was no set age range of those surveyed; participants were 5 to 16 years old (M=9.14 years).

Recruitment

Permission forms were sent to parents through their child's school. Parental approval was given prior to participation in the study. The study was approved by the Institutional Review Board office (IRB) of Ball State University.

Site Selection

The survey was distributed through the mail to the four school administrators that agreed to participate, and school administrators distributed the surveys to parents of children with autism. Parents were given two weeks to complete and return the survey to the school administrator who then mailed the completed surveys to the first author. A total of 84 parents completed the survey, 20 parents replied from school 1, 24 parents replied from school 2, 30 parents replied from school and 10 parents replied from school 4.

Procedure

The present study is one phase of a larger study exploring ASD and the built environment. This survey will be integrated with data currently being collected at the Health Environmental Design Research (HEDR) lab at Ball State University. Parents whose children were current participants in the HEDR lab were also asked to complete the survey used in the present study. Thus, several of the survey responses from the HEDR lab were also used in the present study.

The survey consisted of questions using a 5-point Likert-scale. The Likert-scale questions were formatted as follows: "Please rate your level of agreement with the following statement:" For example: My home is acoustically well designed for children; with the choices being strongly disagree, disagree, neither agree nor disagree, agree, and strongly agree. The complete survey can be found and referenced in Appendix A. Survey questions focused on the parental perceptions of the children's behaviors in response to noise, the importance of noise control, and important environmental modifications for noise control. Depending on the question asked, 3 different Likert- scales were used. The options for each are listed in (Table 1).

5	4	3	2	1
Always	Often	Sometimes	Rarely	Never
Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree
Very important	Somewhat important	Neutral	Somewhat unimportant	Not at all important

Table 1: Likert-scales used in the study's survey.

The statistical work and analyzation of data was conducted on Statistical Program for the Social Sciences (SPSS) Version 24. The mean rating of each quantitative question was recorded as well as the standard deviation. The percentages of scores were also recorded. Chi-square tests of association were run to test the two hypotheses.

Results

Environmental Factors

Parents were asked to rate the importance of various environmental sounds regarding how negatively they impact their child's behavior in their home with 1 = not at all important and 5 =

very important (Table 2). Most parents rated sounds from other rooms (M = 3.99, SD = 1.26) and sounds from children in the same room (M = 4.05, SD = 1.21) as being the most important factors influencing their child's behavior. Air conditioner (M = 1.60, SD = 0.66) and echoes (M = 1.74, SD= 0.92) were ranked as being the least important. Traffic noise (M = 3.93, SD = 0.95) was ranked in the middle. Individual percentages can be viewed in (Table 2).

Noise Source	Very important	Somewhat important	Neutral	Somewhat unimportant	Not at all important	Mean	Standard Deviation
Air conditioner	0	1.2	6	44	48.8	1.60	0.66
Echoes	1.2	7.1	3.6	40.5	47.6	1.74	0.92
Sounds from children in same room	52.4	16.7	20.2	4.8	6	4.05	1.21
Sounds from other rooms	51.2	15.5	21.4	4.8	7.1	3.99	1.26
Traffic noise	25.3	53	15.7	1.2	4.8	3.93	0.95

Table 2: Parents' Ratings Negative Impact of Home Noise.

Noise Management

Parents were asked to rate their level of agreement with the statement that their home is acoustically well-designed for children. Most parents indicated that they strongly agreed that their home is acoustically well-designed (69.5%) followed by agreed (13.4%), neither agreed nor disagreed (11.0%), strongly disagreed (3.7%), and disagreed (2.4%). Parents were also asked what environmental design features are used in the child's home to help reduce noise levels. Parents reported using thick or sound-absorbing carpet (17.9%), thick walls (6.0%), wood chairs/desks (15.5%), and transitional spaces (11.0%). No parents reported using wood panels, sound proof material, or sound proof ceilings in the child's home.

Most parents strongly agreed that noise control is an important issue for children (73.5%), followed by agree (19.3%), strongly disagreed (3.6%), neither agreed nor disagreed (2.4%), and disagreed (1.2%). Parents were then asked to rank the importance of specific aspects of the environment on a child with 1 = strongly disagree and 5 = strongly agree. Parents rated thick or sound proof walls (M = 4.17, SD = 0.92) as being the most important elements of noise control in children's environments. Wood chairs and tables (M = 3.22, SD 0.77), having carpet on the floor (M = 3.85, SD = 1.03), and having wood panels on the walls (M = 3.13, SD = 0.56) were rated as less important ways of modifying the environment. To view individual percentages, see (Table 3).

Noise Source	Strongly Agree	Agree	Neither agree nor disagree	Disagree	Strongly Disagree	Mean	Standard Deviation
Carpet on the floor	31.7	32.9	28	3.7	3.7	3.85	1.03
Wood panels on walls	2.4	14.5	78.3	3.6	1.2	3.13	0.56
Thick or sound-proof walls	41	43.4	9.6	3.6	2.4	4.17	0.92
Wood chairs and tables	2.4	32.5	51.8	10.8	2.4	3.22	0.77

Table 3: Parents' Rating the Importance of Specific Design Modifications.

Behaviors in Response to Noise

Parents were asked to indicate which behaviors they observe in their child in response to noise levels in the environment, with 1 = never and 5 = always. Parents rated covering ears (M = 4.52, SD = 1.23) as the most observed behavior, followed by repetitive motor movement (M = 3.1, SD = 1.12), repetitive speech (M = 2.99, SD = 1.45), complaining (M = 2.88, SD = 1.53), screaming (M = 2.39, SD = 1.4), hitting others (M = 1.48, SD = 0.91), hitting self (M = 1.37, SD = 0.92), and destroying property (M = 1.30, SD = 0.90). To view individual percentages, see (Table 4).

Behaviors	Always	Often	Sometimes	Rarely	Never	Mean	Standard Deviation
Repetitive motor movements	9.5	32.1	25.0	26.2	7.1	3.1	1.12
Repetitive speech	21.4	15.5	27.4	11.9	23.8	2.99	1.45
Covering ears	84.5	3.6	1.2	1.2	9.5	4.52	1.23
Complaining	22.6	15.5	16.7	17.9	27.4	2.88	1.53
Hitting others	3.6	1.2	3.6	22.6	69.0	1.48	0.91
Hitting self	2.4	3.6	4.8	7.1	82.1	1.37	0.92
Destroying property	2.4	4.8	1.2	3.6	88.1	1.30	0.90
Screaming	10.7	14.3	17.9	17.9	39.3	2.39	1.4

Table 4: Parents' Ratings of different Behaviors in Response to Home Noise.

A Chi-square test of association was conducted to test the hypothesis that parents who rate noise control as important will be more likely to observe behavior change in their child. Results indicated a significant relationship between parental rating of noise control being an important issue and observing complaining in response to noise, $X^2=(4,N=81)=11.125$, $p=0.025$. There was also a significant relationship between parental rating of noise control as an important issue and observing destroying property, $X^2=(4,N=81)=19.794$,$p=.001$. No other significant relationships were found.

Discussion

The main purpose of this survey was to receive input from parents of children with autism spectrum disorder regarding their perceptions of their child's home environment and how noise impacts their child's behavior. Overall, parents were aware of and able to identify specific behaviors their child exhibits in response to noise in the built environment.

Noise is often described as an undesirable sound that can be distracting or cause disturbances [8]. According to the National Institute on Deafness and Other Communication Disorders [9], noise at or above 85 decibels (dB) can cause damage to one's hearing. Sounds perceived as being loud can cause a series of physiological responses, such as increased heart rate, eye movement, blood flow changes, and respiration rate changes [10,11]. Apart from physiological changes, unwanted noise may also cause psychological responses. Psychological responses may include stress, the inability to focus, and annoyance [12].

Hatfield, et al. [13] examined the cortisol levels of 35 industrial workers three times daily. The workers were exposed to noise typically above 85 dB, without the use of Hearing Protection Devices (HPD). The cortisol levels of the workers without HPD rose significantly throughout the work day, and those workers reported fatigue and irritability. The same 35 workers were then tested in the same conditions wearing HPD, attenuating around 30 dB of sound, which resulted in lower cortisol levels accompanied by lower levels of reported fatigue and irritability.

Autism and the Environment

Due to this increased prevalence as well as the sensitivity to acoustics that individual's with ASD display, research has been focused on the built environment surrounding those with ASD. Jacques Black, an architect, commented on the lack of research-based evidence used in the process of designing The Center for Autism and the Developing Brain [14]. While Black did take noise control into consideration during the design process, there remains a lack of evidence regarding which acoustical levels are best when designing spaces for individuals with ASD.

Autism: Noise

A 2009 study summarized data from parent surveys in a meta-analysis regarding the behaviors of children diagnosed with ASD [15]. This analysis found that parents reported sensory behaviors, including visual and hearing distortions, between 45%-95% of the time [16-19].

Autism: Sensory Profiles

In a Magnetic Resonance Imaging (MRI) study, participants were presented with mildly unpleasant visual and auditory stimuli. Researchers found that there was greater activation in areas of the brain associated with integrating sensory information as well as greater activation in areas of the brain that regulate emotions, such as the hippocampus and amygdala [20].

According to Van Kamp and Davies [21], as the vulnerability of a group increases, such as those with high functioning ASD, so too does the negative effects associated with noise. Although children with ASD can be considered a vulnerable group, the research surrounding noise levels and their impact on these children is currently lacking.

Autism: Parental Perceptions

When asked to rate how often the parents saw certain behaviors in their child in response to noise, every behavior was seen by numerous parents. Former research has shown that children with ASD engage in behaviors such as repetitive motor movements (spinning, flapping hands), repetitive speech (repeating specific words, phrases, or sounds repeatedly; not screaming), and/or covering ears to cope with aversive noise in their environment [22]. Thus, the present study demonstrates that for children with ASD, noise can be uncomfortable, and lead to uncharacteristic behaviors. This aligns with past studies as it can lead to more comfortable home environments for children with ASD and makes further research in this field important.

Hypotheses

The first hypothesis stated that the parents who rated noise control as being important for their child would also observe behaviors in response to noise levels in the environment. There was an association between the rating of noise levels as being an important factor for children and observing children complaining and children destroying property.

The second hypothesis stated that that parents of children with ASD who observed behavior changes in their children would also be more likely to view use of specific environmental modifications as being important for children. There were no associations found between parents observing behavior changes in response to noise and parents rating environmental modifications as being important for children [23].

As Cheung [12] noted, unwanted noise can lead to stress, inattention, and feelings of annoyance. These psychological effects, as well as the physical effects such as increased heart rate, eye movements, and blood flow changes [10,11], demonstrate the importance of conducting research related to the nature of the present study. Past literature suggesting that noise affects children, whether they are diagnosed with ASD or not, gave rise to the need for more literature documenting the effects of noise.

Limitations

Several limitations may have contributed to the results found in the present study. First, responder bias may have affected the results. Parents may have responded in a way that they felt was most appropriate, depending on whether their child had a diagnosis of ASD. Second, it is possible that the wording of the survey prompted parents to respond in a certain manner. It should also be noted that this measure has not been psychometrically validated.

Third, this research is a reflection of parental perceptions regarding their children and does not take into account the children's own perceptions.

Conclusion and Recommendation

Despite the growing depth of this knowledge, few studies have focused on the ways in which specific acoustic levels in the home may either worsen or pacify the behaviors commonly associated with children with ASD. Future research should lean in the direction of observing children in a more controlled environment to find which noise levels are best for children with ASD, which may differ from child to child. Research must also focus on which types of noises in their homes bring about maladaptive behaviors in children with ASD.

Considerations and modifications must be made to the environments of children with ASD by incorporating scientific research and data to better ensure the comfortability of these individuals. Through future research and a better understanding of different levels of acoustics in the built environment, a better understanding can be made of how to lessen the sensory overload that children with ASD often experience. It is the authors' hope that architects and interior designers will take into consideration the findings from the present study and future findings on the topic to design spaces that free children from unwanted noise exposure.

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Appendix A

❖ Survey Questions

1. Gender of Rater:
2. How old is your child?
3. What kind of education does your child participate in?
4. Please rate the importance of the following regarding how negatively they impact the children's behavior. Fill in the rating on the line provided next to each source of noise. Rating for each: Not important at all, somewhat unimportant, neutral, somewhat important, very important

A. Air conditioner

B. Echoes

C. Sounds from children in the same room

D. Sounds from other rooms

E. Traffic noise

F. Other, please specify

5. Please indicate which, if any, of the following environmental design features are used to help reduce noise levels in your home.

-Thick or sound-absorbing carpet

-Thick walls

-Wood panels

-Wood chairs/ desks

-Sound proof ceilings

-Sound proof material on walls (egg cartons, etc.)

-Other, please specify

6. Please rate your level of agreement with the following statement: My home is acoustically well- designed for children. Rating for each: Strongly disagree, disagree, neither agree nor disagree, agree, strongly agree
7. Please evaluate the importance of the following aspects of the environment on a child. Rating for each: Strongly disagree, disagree, neither agree nor disagree, agree, strongly agree

A. Noise control is an important issue for children.

B. Having a carpet on the floor of the primary work space is an important issue for children.

C. Having wood panels fixed over the wall is an important issue for children.

D. Thick or sound proof walls are an important issue for children.

E. Using wood chairs and tables rather than steel chairs and tables is an important issue for children

8. Please rate the importance of the following regarding how negatively they impact the children's behavior. Fill in the rating on the line provided next to each source of noise. Rating for each: Not important at all, somewhat unimportant, neutral, somewhat important, very important

A. Air conditioner

B. Echoes

C. Sounds from children in the same room

D. Sounds from other rooms

E. Traffic noise

F. Other, please specify

9. Please indicate which behaviors you observe most frequently in your child in response to noise levels in the environment: Rating scale: Never, rarely, sometimes, often, always

A. Repetitive motor movements (spinning, flapping hands)

B. Repetitive speech (repeating specific words, phrases, or sounds repeatedly; not screaming)

C. Covering ears

D. Complaining (verbally notifying an adult of distress)

E. Hitting others

F. Hitting self

G. Destroying property

H. Screaming

End of Survey