

Ever Heard of Noise? - An examination of perspectives on transportation noise and health

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Abstract:

This research does a systematic review of transportation related noise and the disproportionate health outcomes associated with it. The sources of noise explored are road traffic, rail, and aircraft noise. Six interviews were conducted to evaluate people's respective preferences and perspectives on noise. From these interviews, discussions of ecosystems, policy, property, infrastructure, were looked at more in depth within the framework of transportation noise. Nonetheless, looking at these sources of noise, people's personal preferences, and how those personal preferences potentially impact their health is a central component of this research. Because this research is relatively sparse, especially in the field of Sociology, this necessitates an interdisciplinary focus on this subject more substantively. This specific research found that people's personal preferences play just as significant of a role as the physical noise emitted. Considering both of these perspectives will be crucial to moving forward with this research.

Introduction:

Most individuals find transportation-related noise to be undesirable. Through conversations with a diverse group of individuals, all of whom have varying perspectives on noise and its meaning to them personally, interpersonally, and occupationally, a conversation surrounding meanings of noise and the social consequences of it are explored. These are seen through engagement with class, gender, race, health accessibility, education, technology, and development. From this constructed lens, we will try to better understand preferences and variations in how it affects people financially, socially, and personally.

In the first section of this thesis, the health implications and social elements of noise are explored, especially focusing on the existing research that has primarily been conducted in Europe. This starts by looking at an overview of the issue and a theory that underlies health perspectives called the Noise Stress Concept. From there, different sources of noise are explored in order to get a broader understanding of what an individual's day to day exposure is like. After, a look at the total impact of noise on a community level and then on an individual level are examined. Community level risks review social inequalities along lines of class, population density, race, ethnicity, and gender. Individual risks are more health focused, reviewing conditions associated with high levels of noise stress or physical impacts of noise on an individual's hearing. Finally, a policy section is discussed looking at federal, state, county, and municipal noise regulations.

Next there is a review of the methods of the research, which lays out the process behind my sampling, my process during my interviews, the questions I asked and a

general outline of my methodology. After this, the findings from my interviews will be reviewed in a hybrid discussion and results section. This section reviews the six interviews conducted, who they were with, and the content of each and how it relates back to the scholarship reviewed in chapter one. After this, potential road traffic technology will be discussed because in order for noise reduction to happen, private and public development will need to know what technology can be used to mitigate noise. Finally, the conclusion will include an in-depth discussion of how noise policy could be viable in America and how development in the future can be more aware of noise.

Chapter 1, Literature Review:

Introduction to Literature:

Noise is a uniquely complicated issue. Although, it is in many ways a social determinant of health. This issue affects people all around the world in ways entirely unique to where they live. The purpose of this study will be to zoom in on transportation related noise and how that impacts the well being of broader communities and their health. Health means really different things when looking at noise on an individual and community scale. These differences are seen in mental and physical health. In determining how people are affected by noise, the level of noise annoyance will be very indicative of the broader community impact. Finally, assessing the importance of noise exposure and then noise sensitivity will be crucial to understanding how this issue potentially impacts some individuals and communities more than others. So, how does transportation-related noise impact mental and physical health, and how do noise annoyance, sensitivity, and exposure impact individuals and communities?

We now must lay out our general definitions that will be used through the remainder of this project. To understand noise, we need to set some guidelines for what kind of noise we are looking at and what the role of our own perception is in that. As mentioned, noise annoyance for the most part is what we are interested in because we are focusing on the role of perception as a strong variable in health effects caused by noise. "Noise annoyance is a stress reaction to environmental noise, which is thought to be linked to the release of catecholamines from the hypothalamic–pituitary–adrenal axis. Repeated noise annoyance may increase the risk of higher stress-hormone exposures, which could be associated with a variety of mental health disorders." (Gong

et. al. 2022:1) Noise annoyance is exceptionally important when looking at different sources of noise because although some noises might be louder than others, they are not necessarily what people are annoyed by the most.

Noise sensitivity, on the other hand, refers to the physiological and psychological reactions and internal states that increase the degree of reactivity to noise. (Shepherd, et. al. 2015:1) Within these categories, the amount of noise exposure, or the amount of time you are exposed to a noise, determines how much of a physical and mental impact the noise can have on you.

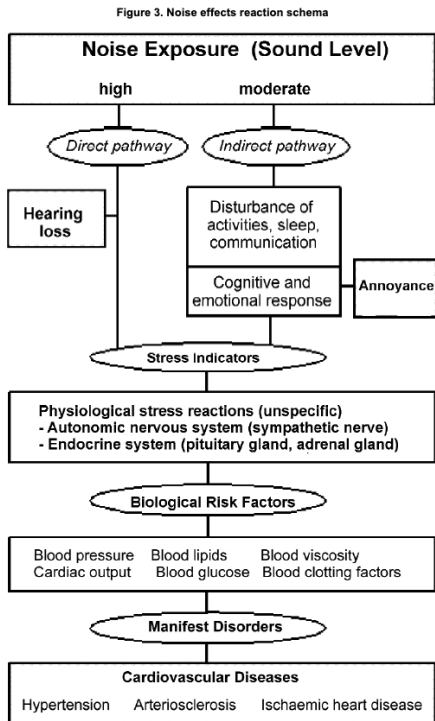
For us to best contextualize these definitions, we need to split up the problem of noise into three categories: Source, Total Impact, and Policy. Currently, two of the strongest documents (which will be continually cited) are the World Health Organizations' Noise Guidelines and also their Environmental Health Inequalities Report, both of which are for the European Region. These documents review all elements of the categories mentioned above, but it is important to note that the locational specificity of these reports is a limitation given that we will be applying this in the United States.

First, when looking at sources of noise, turning to acoustic research is the best way to understand where potentially harmful noise comes from. The primarily cited and researched sources of transportation noise are from traffic, public transportation, airports or planes. These sources when combined together have been shown to cause high levels of annoyance (Marquis-Favre, C., Gille, L., & Breton, L, 2021). This section will expand upon the different quantitative measures used to determine a type or amount of noise exposure an individual experiences over varying periods of time. In

terms of noise exposure, “The World Health Organization (WHO) recommends that noise exposure levels should not exceed 70 dB over a 24-hour period, and 85 dB over a 1-hour period to avoid hearing impairment.” (CDC, 2018).

Second, impact on a community risk level and on an individual risk level become very important factors in evaluating the risk of noise annoyance and exposure and how that correlates with varying levels of noise impact. Also, these measures become increasingly relevant when looking at broader sociodemographic differences in noise exposure, annoyance, and sensitivity.

An important element of assessing risk is a medical theory that examines the role of perception in noise and also the best methods to assess stress, health, and noise. The theory is called, “the Noise-Stress Concept.” This theory outlines the clear connections between noise sensitivity, annoyance, exposure and health effects that are not exclusively auditory. The theory also explores how much of the noise exposure that manifests itself in stress levels is based on perception (Babisch, 2002). In the most specific terms, Babisch states that the importance and significance of health outcomes should be evaluated in a specific order, “changes in physiological stress indicators, increase in biological risk factors, increase of the prevalence or incidence of diseases, and premature death.” Babisch demonstrates the “Noise / Stress Concept” using a particular figure (figure 3 in the article).



Here, Babisch uses three main physiological health outcomes to describe his point. He uses “Stress Indicators,” “Biological Risk Factors”, and “Manifest Disorders.” (Babisch, 2002, figure 3). Understanding the relevance of this diagram is crucial to understanding relationships between noise exposure and varying health outcomes.

Finally, in many instances, noise can seem like a potentially unsolvable issue or one that takes more effort than it is worth. Despite that, I will describe some relevant policies that have been implemented in the United States. For instance, in the early 1970’s when the Environmental Protection Agency was first founded, they had an Office of Noise Abatement. This office conducted research on noise levels throughout the United States. A few years later in the 1980’s the office was left unfunded and noise pollution and exposure problems were left to the states. The department was discontinued because “budgetary support was discontinued.” (Staples, 1997) These regulations and the differences in them will be explored in the policy section.

Sources of Noise:

The varied sources of noise identified above are connected to the different types of noise. I will categorize noise into three categories: Anthropophonic noise, Geophonic noise, and Biophonic noise. These terms are coined by Bernie Krause, a soundscape ecologist (Krause, 2022). First, anthropophonic noise is human made noise. This includes trains, buses, cars, oil rigs, truck horns, airplanes, et cetera. Second, geophonic noise is noise made from naturally occurring but inanimate sources. This can be wind in the trees, thunder, a waterfall, a tree falling, water running in a stream, et cetera. Finally, biophonic noise is noise made by animals (not including humans). This can be the sound of insects at the end of the day or the morning birds chirping. From here, we will focus on the different sources of anthropophonic sounds and also the best methods to measure them. More specifically, we will focus on transportation noise.

To understand the units being used in this, it is important to understand some of the more physical aspects of what sound is. Amplitude is very relevant to this study, as it is the volume of noise. This is measured in decibels (dB). Frequency is a measurement of pitch. This is measured in hertz (Hz). (MNN., 2022) There is also another dimension of noise that is becoming increasingly important when evaluating noise exposure. This is kurtosis. "Kurtosis (β) is a statistical measure of extreme values (or outliers) in data in either tail relative to a Gaussian distribution." (Qiu, W., et. al, 2020: 40) In other words, a Gaussian distribution would be a continuous and steady noise while a noise with high kurtosis would be characterized by many volume spikes over a short period of time. Essentially kurtosis measures the extreme changes in amplitude levels. Also, it is important to understand the differences between continuous noise environments, which are characterized by having low kurtosis, and complex noise environments

characterized by high kurtosis. (Qiu, W., et. al, 2020: 40) These measures become relevant when discussing different types of regulations and also varying exposure thresholds.

Studies report that individuals find traffic noise to be the most likely source of noise annoyance. First, a study conducted by the European Environmental Agency (EEA) looked at reported noise and then estimated amounts of noise and they found that the more noise there is the more likely it is to be reported (Peris, 2021:2). This seems logical but it is important especially when looking at what kind of noise was reported. In the study, they found that traffic noise was the most reported and also it had the highest level of estimated noise as well. Second, third, and fourth were rail lines, airplane and airport noise, and industrial noise, respectively. These sources were looked at both in urban and rural areas. (Peris, 2021:2). Similar to Peris' report, the WHO's 2018 report on environmental noise looked at five main sources of noise, road traffic noise, railway noise, aircraft noise, wind turbine noise, and leisure noise (xvii), and found that according to large scale surveys performed in France, Germany, Slovakia, Netherlands, and the United Kingdom, road traffic noise is the "most important source of noise annoyance."

The WHO report also found that "Railway noise and industrial noise are enumerated less frequently" (WHO, 2018:5). It is important to note, the WHO does not provide any reasons as to why these sources of noise are perceived to be as annoying as they are. This is simply a measurement to see how people feel about these sources of noise, it is most likely that because the sounds are the loudest, people perceive them more (Peris, 2021: 2). They address this question by saying, "While perception surveys

do not provide information on actual quantitative relationships between noise exposure and health outcomes, it is important to note that the results of such surveys represent people's preferences and values regarding environmental noise." (WHO, 2018:5) These noises are all the loudest and most annoying sources of anthropophonic noise.

The WHO's 2018 report examined leisure noise as mentioned. This brings up an important discussion surrounding the impact of personal or leisure noise. A study from Beach et. al. found that when evaluating five leisure activities that "young" people participated in, nightclubs were the highest source of leisure noise and also that when an individual participated in one noise activity they were also more likely to participate in multiple others. The study also states that, "Active young adults who engage in noisy activities are showing early signs of hearing damage. Furthermore, they perceive the risk associated with their activities." (Beach, et al., 2013). This thesis will focus on transportation-related noise, though.

Total Impact (Community Risk and Individual Risk):

This section is crucial to being able to understand the effects of noise on human behavior, health, and many other factors. This will be broken up into two main categories: community risk and individual risk. There is an individual risk to people's personal health, but from a community perspective, the amount of noise people experience varies based on many demographic factors.

Community Risk:

Understanding noise exposure and different thresholds of it is crucial to understanding how at risk an individual or a community may be. Noise exposure is quantified differently depending on the area someone is trying to study. In other words, if you are measuring an area with high noise levels, you will use higher noise exposure ranges, whereas if you are somewhere with low noise levels you will use lower noise ranges.

An example of a noise range could be a study from Zhang et. al. This study used 2,333 workers from varying industries in China to measure the average amplitude and kurtosis of the noise experienced. This measurement was then used to evaluate how effective existing noise measurements are at evaluating noise exposure. They eventually found that the existing model needs to be reexamined on a basis of kurtosis, or the amount of time it takes for the sound to reach maximum amplitude. The method this study employed to study noise is also important to understanding the most up-to-date methods of measuring noise exposure. “The entire cohort was exclusively divided based on four noise exposure levels ($85 \leq LA_{eq.8h} < 88$, $88 \leq LA_{eq.8h} < 91$, $91 \leq LA_{eq.8h} < 94$, and $94 \leq LA_{eq.8h} \leq 100$ dBA), two exposure durations ($D \leq 10$ years, and $D > 10$ years), and four kurtosis categories (Gaussian, Low-, Medium-, and High-kurtosis)”. (Zhang et. al., 2021). This study’s findings were that, with a fixed range of noise exposure and duration, the measured Noise Induced Permanent Threshold Shift (NIPTS) increased as the kurtosis of the noise increased. “The noise with kurtosis greater than 75 was found to be particularly hazardous to hearing.” (Zhang et. al, 2021). Just to clarify some measures used, LA_{eq} represents the “level of a constant sound

over a specific time period that has the same sound energy as the actual (unsteady) sound over the same period.” (Davis L., 2021) This is also referred to as the sound pressure level. These metrics are commonly used to determine individual experiences with exposure. It is also important to note that “The World Health Organization (WHO) recommends that noise exposure levels should not exceed 70 dB over a 24-hour period, and 85 dB over a 1-hour period to avoid hearing impairment” (CDC, 2018).

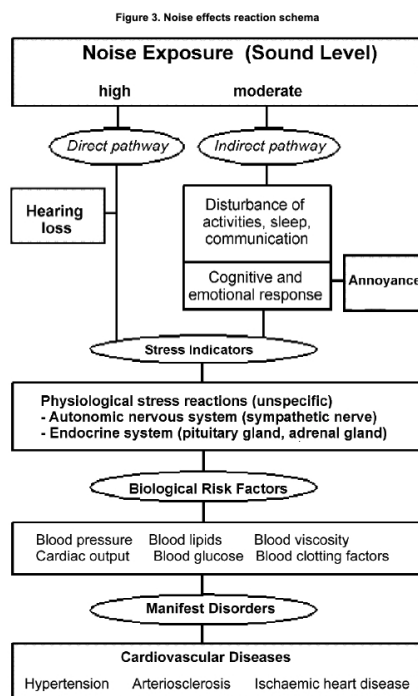
This research is important because type of work is one factor that connects noise levels to income, which is an important demographic characteristic that varies across communities. The World Health Organization looked closely at environmental health inequalities in Europe in 2019. In the report, they look closely at noise annoyance by income status. They found that reports of noise annoyance varied based on income quintiles, poverty status, and urban rural location (WHO, 2019: 9).

A study from Marquis-Favre, Gille, L., and Breton, L. found that income has several direct and indirect effects on noise annoyance and the number of anthropophonic noises you experience. It was also found that better off households were less likely to experience high amounts of aircraft noise (Marquis-Favre, C., Gille, L., & Breton, L., 2021). This is important from an impact perspective because this also has many socio economic implications. If a lower income demographic group is more likely to encounter aircraft noise then more historically marginalized groups are also more likely to encounter more noise. The study also found that, “As expected income is negatively related to road traffic noise annoyance.” (Marquis-Favre, C., Gille, L., & Breton, L., 2021). Meaning, if you have lower income, you are more likely to experience more road traffic annoyance, and the converse being true as well.

In another study from Collins, Nadybal, and Grineski found that there is a clear pattern of higher noise exposures based on race and ethnicity. These specifically included disproportionate road and aviation noise effects in areas with high concentrations of Hispanic, Black, Asian, Pacific Islander, and other racially and ethnically marginalized groups. The study also found that for areas with high concentrations of white people, there were more “protective effects” from traffic and airplane related noise. This study used a sample size of 70,780 by compiling census data. (Collins, T., Nadybal, S., & Grineski, S, 2019). In addition, this study found that when doing noise exposure assessments, socially and economically disadvantaged communities were likely to have an underestimated noise exposure because the quality of structures were not evaluated. (Collins, T., Nadybal, S., & Grineski, S, 2019)

Individual Risk:

When evaluating individual risk, we must look at many different dimensions. First,



there is an individual's physical risk and then there is cognitive risk. This can be viewed from two angles that were shown in the figure from the Noise / Stress concept paper from Babisch. One type of physical risk is health conditions that are exacerbated by stress. The other type is a “direct pathway” risk which could be tinnitus or hearing loss (WHO, 2018: 19) (Babisch, 2002, figure 3).

For physical risk, cardiovascular risks are a well researched medical risk correlated with high levels of noise. A study from Babisch, Beuele, and Schust found that, “chronic exposure to high levels of traffic noise increases the risk for cardiovascular diseases.” (Babisch, Beuele, & Schust, 2005). Another study by Youn-Hee, et. al. found that “a 10 dB increase in long-term exposure to road traffic noise above 56 dB is associated with 30% and 46% increases in overall and nonfatal myocardial infarction incidence.” (Youn-Hee, L., et. al., 2021). In addition, the WHO’s 2018 environmental noise guidelines report that along with adverse birth outcomes, congenital anomalies can be a result of increased noise exposure. (WHO, 2018:19).

An example of a “direct pathway” or critical physical health outcome (as mentioned earlier) is hearing impairment and tinnitus. These can be especially common in kids exposed to high levels of noise at a young age (WHO, 2018:19). In terms of direct pathway hazards, hyperacusis is an important condition to look at. Hyperacusis is a disorder that is characterized by a high sensitivity to noise. A study from UCSF states that, “The most common is related to damage to the cochlea from exposure to loud noises such as those experienced at certain work environments, rock concerts, gunfire, airbag deployment in cars and fireworks.” (UCSF, 2022). In a study from Nelson & Chen, the connections between hyperacusis, tinnitus, and hearing loss were explored. They state that the “literature clearly describes how trauma, Meniere's disease, salicylate intoxication, chemical induction, noise, and other factors are associated with tinnitus, but the exact biochemical source(s) remains to be elucidated.” (Nelson & Chen, 2004). Mental health conditions like depression, anxiety, and post traumatic stress

disorder (PTSD) may be associated with hyperacusis, but the research is still sparse. In other words, these conditions as of right now are still considered to be mostly physical.

Now we turn to mental health and cognitive health. These are crucial to understanding especially the relationship between annoyance, sensitivity, and exposure. In two separate studies from Seidler, et al. and Ising & Ising, it was found that there's an association between children exposed to high levels of traffic noise and hyperactivity deficit. Ising found that children exposed to long term traffic noise during the night experienced chronic stress hormone regulation disturbances, impaired sleep, memory and ability to concentrate (Ising, H., & Ising, M. 2002). The Seidler research also found that an increase in aircraft noise was associated with higher depression risk, the onset of dementia, and general cognitive decline (Seidler, et. al., 2019).

In terms of adult populations, studies from Gong et al. and the WHO found that the high noise annoyance is associated with worse depression, generalized anxiety disorder, mental health, well being, metabolic health, sleep, and cognitive impairment. (Gong, et. al., 2022: Conclusions) (WHO, 2018:11). Cognitive impairment includes a number of conditions as well, including short and long term memory deficit, attention deficit, and executive function deficit (or working memory capacity). (WHO, 2018:19).

Also, phonophobia (the fear of sound), and misophonia (dislike of sound), “carry a suggestion that the intolerance may be specific to certain sounds with emotional associations. In neurology, phonophobia tends to be used specifically for the loudness intolerance reported by some patients with migraine.” (Baguley, 2003). These are important when evaluating the differences between certain types of hearing sensitivity disorders. Also, it is important to note that in the Baguley study, of 10,349 respondents,

(in Poland) 15.2% of respondents reported hyperacusis (12.5% males and 17.6% females) although, the lack of specificity with the description of hyperacusis in this report was described as a weakness. On that, these were self reported, so without any specificity, hyperacusis could be easily misconstrued as phonophobia or just a high noise sensitivity. (Baguley, 2003).

When looking at noise sensitivity there is another side to it as well, these would be auditory processing disorders that aren't necessarily hypersensitivity but the opposite. "Children with APD may have difficulty understanding speech in noisy environments, following directions, and discriminating (or telling the difference between) similar-sounding speech sounds." (Bellis, 2022). It is important to note that higher order mental deficits such as ADHD (Attention Deficit Hyperactivity Disorder) or autism could have hearing deficits being associated with their condition, but APD is different according to Bellis in that it isn't necessarily associated with these conditions (Bellis, 2022).

Policies

It is clear that noise is a hazard, and now an important question arises, what can we do about such a broad issue? In this section that will be explored. The European World Health Organization's 2018 noise guidelines suggest that there are many recommendations that reduce high levels of noise. In the report, they gauge the "strength" of a recommendation based on "the confidence that the desirable effects of adherence to the recommendation outweigh the undesirable consequences" (WHO,

2018: xv) Within this, they organize the type of noise recommendation based on what the source of the noise is (rail, traffic, air, etc).

In terms of traffic noise, they recommend that during the day there is less than 53 dB of sound and during the night less than 45 dB (WHO, 2018: xv). For rail, they recommend 54 dB during the day and 44 dB during the night. For aircraft noise they recommend that there is less than 45 dB during the day and below 40 dB during the night (WHO, 2018: xv). Finally, they suggest choosing more sustainable methods of transportation such as rail that mitigate environmental noise by reducing motorized traffic. (WHO, 2019: 71)

Earlier from the WHO's report on environmental inequalities, the noise exposure study states, "vulnerable groups such as children, chronically ill, and elderly people should always be considered in monitoring social inequalities in noise exposure and in the development of mitigation actions specifically to address those with increased vulnerability and poorer coping capacities due to their socioeconomic position." (WHO, 2019: 70). They also suggest that the EU Environmental Noise Directive takes a closer look at traffic noise and its impact on physical and mental health. To do that, they suggest tackling noise at the regional level in order to take social inequalities into account. They also recommend the implementation policies that can mitigate noise hazards in the future (WHO, 2019: 71). These include a suggestion for better monitoring of the subjective role of noise annoyance and better reporting of gender, race, and socioeconomic inequalities in that.

In the United States, the Environmental Protection Agency (EPA) states, "In the 1970s, EPA coordinated all federal noise control activities through its Office of Noise

Abatement and Control. EPA phased out the office's funding in 1982 as part of a shift in federal noise control policy to transfer the primary responsibility of regulating noise to state and local governments.” (EPA, 2022). Although the Noise Control act of 1972 and Quiet Communities Act of 1978 were never rolled back by Congress, those acts remain without funding. (EPA, 2022). Looking more closely at the Noise Control Act of 1972, the Government Accountability Office wrote in 1977:

The Noise Control Act of 1972 was designed to eliminate excess noise in the design stage of a wide variety of new consumer products. The Environmental Protection Agency (EPA) has accomplished little in carrying out its responsibilities under the act, and where action has been taken, implementation has been very slow” (GAO, 1977).

The Quiet Communities Act of 1978, amended the Noise Control Act of 1972. It requires the EPA to: distribute educational materials on the health impacts of noise, finance research on noise, “administer a nationwide Quieter Communities Program designed to assist local governments in controlling levels”, and “provide technical assistance to State and local governments in implementing noise control programs.” (Gov Track, 2004). Although, since the EPA gets little to no funding for noise abatement, the strength of this act is minimal.

Interestingly enough, the GAO wrote congress another letter in 1989, titled: *Transportation Noise Federal Control and Abatement Responsibilities May Need to Be Revised*. In this letter, they review the goals of the previous acts (Noise Control Act and Quiet Communities), and how they pertain to varying sources of transportation noise. The letter states that because the Noise Control Act, Quiet Communities Act, and EPA’s

noise standards weren't removed (but rather defunded), federal preemption remains which limit the ability of states and localities to regulate. Also because the issue lost priority, local standards enforcement and assistance has decreased as well (GAO, 1989: 71).

Looking at non-transportation related noise policy is another important perspective to take when looking at the politics of noise. For instance, OSHA or the Occupational Safety and Health Administration regulates the amount of occupational noise that can be experienced. The United States Department of Labor states that, "OSHA's permissible exposure limit (PEL) is 90 dBA for all workers for an 8 hour day. The OSHA standard uses a 5 dBA exchange rate." (US Department of Labor, 2022). Also, the National Parks Service currently has a number of noise regulations in order to preserve the natural soundscape within the parks. These regulations range from setting general human made noise baselines and preserving those baselines all the way to minimizing noise from snowmobiles. (National Parks Service, 2018). Nonetheless, the National Parks Service is very focused on maintaining a healthy soundscape of non-anthropophonic noises.

Turning to New York, which will be the focus of this thesis, the New York State Department of Environmental Conservation lays out some of their policies and actions against noise saying, "The Division of Air Resources has regulations in 6 NYCRR Parts 450 through 454 that regulate the allowable sound level limits on certain motor vehicles." (Air and Noise, 2001). In that report, they reference the "New York State Vehicle and Traffic Law, Article 10, Section 386." (Air and Noise, 2001). This regulation looks at traffic from large motor vehicles, motorcycles, and cars and sets regulations on

the amount of noise that is acceptable for them to emit depending on the vehicle's speed. These decibel measurements are measured "from the center of the lane in which the motor vehicle is traveling." (New York State, 2021).

Other New York State regulations are focused mostly on occupational noise and setting rules and suggestions on how noise should be in an occupational environment. Those regulations according to the New York State Department of Labor require that an employer must offer hearing protections at noise levels over 85dB. Then, for levels over 90dB hearing protection is required (NY State Department of Labor, 2016).

Concluding Research:

Clearly, noise has many hazardous elements that can affect large groups of people based on many broad factors. These impacts range from mental health, to physical health, to even socially determined health. We know transportation noise is shown to have varying effects on people's health. It is clear that the United States is lacking centralized citywide research that shows how given areas are affected by transportation noise. That is where my research will fall into place. How does transportation noise affect people in the United States, specifically Schenectady, New York? Then, what do people think about noise and how does that reflect the levels of noise exposure they are experiencing?

Chapter 2. Methods

The purpose of this study will be to zoom in on transportation related noise and how that impacts the well being of broader communities and their health. In my study, the subjects will be a combination of community leaders, and specialized workers within the private sector. Community leaders will be able to give me insights on how the community experiences and reacts to noise. My specialized private industry worker will be an acoustics expert. The environmental experts conducted research for their occupation. These two people will be able to give me insights on how acoustics experts measure and mitigate high noise exposure and the environmental expert will be able to give me perspectives on environmental impacts of noise.

These experts will be from many different parts of the United States. Once I locate these individuals through informal and formal connections, I will conduct interviews with each group (please see Appendix A for the interview guides). First, the community leaders will experience a short interview regarding perspectives on noise in the community and what neighborhoods they think experience it the worst. Third, the acoustics experts will get a series of questions about their personal experiences with measuring noise and what sources tend to be the worst. Then I will ask what policies help them and how their specific organization is working towards minimizing noise levels from transportation. Environmental experts will be asked about sound in nature (natural sounds) and then conversely about human made sound and how those two intersect and impact one another.

All of the subjects will be given an opportunity to agree or decline to participate before the interview, and they will be asked to sign the informed consent form if they

agree. This will be confidential. Before I ask them to read and sign the informed consent form, I will explain that their identity and any identifying characteristics will be kept confidential. I will not use deception of any kind and the information collected is not sensitive. Finally, after approval from the Human Subjects Committee at Union College, I began mobilizing on these plans. It is important to note that a goal of mine going into these interviews was to also interview policy makers and residents but within the timeframe I had it was not viable.

Chapter 3. Results / Discussion:

Six interviews were conducted with individuals with varying backgrounds. Some of whom are employed to work within an occupation related to noise or sound and some of whom are more dedicated towards representing people, nature, or industrial development. A common theme is that these individuals were primarily focused towards environmental issues in their day to day life whether related to noise or not. Professions included three environmental experts, two acoustics experts, and one community organizer. Each interview serves its own unique purpose of describing noise in ways unique to the individual interviewed, thus they are discussed separately.

Environmental Civil Engineer

After looking for people to be included in my research, I found an Environmental Civil Engineer. This interview really opened my eyes to the plurality of personal opinions people have on noise and how much variation there is within that. Although they had no personal work related experience with noise being an issue, they were very adamant about noise as a massive problem within their work-sphere and especially in their personal life, a narrative that came up more than I expected. As we continued, they started talking about the area they live in and how much of the rail is loud enough that if you are a consistent commuter, you can be subjected to seriously harmful amounts of noise. This continued, eventually wrapping to “car culture” and the individualistic approaches to transportation that the US uniquely has. This is a very crucial perspective that I do not think I fully addressed in chapter one. Largely, I was focused on estimations of what it was like to live near a transportation center (rail, airport, traffic) but

the perspective of commuters is very important too and likely is a very different set of data which by itself is an incredibly relevant problem within transportation noise.

“Our most important finding however may be the frequency of which peak noise levels measured in the public transport system exceeded recommended thresholds. Up to 20% of subway measurements had mean peak noises greater than 114 dBA, and up to 85% of bus platform measurements exceeded that threshold, with 54% greater than 120 dBA. Referring back to the EPA noise threshold guidelines, an exposure longer than four seconds for a 114 dBA noise exposure, and one second of 120 dBA may place the individual at greater risk of NIHL (Noise Induced Hearing Loss).” (Yao, et al., 2017: 4).

Since this person was a civil engineer who was environmentally focused, I got a lot of nuanced and interesting stances on policy related to infrastructure on a federal level. They didn't hesitate to start talking about the military as a disrupting force to the acoustics of the United States but also the countries the United States military occupies. They elaborated explaining the harmful effects of delayed maintenance in the United States. From their perspective, this not only made US infrastructure significantly worse, but also made the world's acoustic environment significantly worse. Even saying policy makers “elected against ears with war”, both in the countries occupied and in the US. They referenced specific times when infrastructure money was reallocated, but overall stuck to the narrative that most United States presidents and policy makers made the decision to use much of the funding for the military.

During this interview I ran into a series of policies that I had not reviewed in my literature review. These were delayed maintenance policies. This essentially was when there were relocation efforts in the United States to move funding out of infrastructure and to other places. In terms of transportation, funding in the US was reallocated on numerous occasions and has led to many bridges, trains, and roads being years overdue on their recurring maintenance. They framed this as an issue in many *non-personal* ways and largely this interview had much less to do with their personal experiences with noise, especially compared to interviews after. Because this person was a civil engineer they were concerned with the lower quality of transportation and how it affects people's ability to get to work and function in their day to day life. They criticized car culture and its impacts on public transportation infrastructure, something that we visited in the literature review, this was in terms of noise specifically and how a stronger emphasis on rail transportation can reduce transportation noise (WHO, 2019: 71).

Acoustician

The next person I talked to was an acoustician. Compared to the first person interviewed, this view was much more specialized and informative, being less personal since the person's job was to evaluate noise as a whole. We started by talking about commonly used metrics or benchmark numbers which acousticians typically will measure sound with, saying, "Objective noise limits are presumably based on someone's idea of exposure to noise and human health." In addition, they spoke on how most limits are set by the Department of Transportation, from the Noise Control Act

discussed earlier. As mentioned, “The World Health Organization (WHO) recommends that noise exposure levels should not exceed 70 dB over a 24-hour period, and 85 dB over a 1-hour period to avoid hearing impairment” (CDC, 2018).

As we continued, we talked about which transportation noises were harder or easier to measure. They spoke on this by starting with easier sources, the easiest being rail noise. This is because you can set up a sound level meter next to the rail and get approximations and then generalize them along the track. They also said that aviation noise is also pretty easy because you can refer to the existing databases that airports use to monitor themselves, but there are exceptions to this. These databases commonly do not include private planes and private planes will operate all day and night, so they are not treated the same as typical commercial flights. As this respondent said, “there isn't as much of an analytical or data processing infrastructure.” It is important to note that the Federal Committee on Aircraft Noise (FICAN) is the primary organization responsible for researching aircraft noise. Their primary responsibility is to, “carry out interagency coordination on matters related to aviation noise research in the United States.” (National Academy of Engineering, 2010: 113).

Afterwards, I asked them what some typical qualities of high noise areas are. They said a few things in response to this. They said one, close proximity to transport corridor airports is typically very high noise. Then, they said typically low property value areas are the most affected by noise. They finally said that the cheapest property values usually indicate a house is in a high noise area or they are in a floodplain, contextually I think this was with more urban environments in mind, but I still think this was very important.

The Acoustician also had a lot to say that connected well with the policies reviewed in the literature review. We looked a bit at what policies protect people from transportation related noise the most. They went into more detail talking about certain states and cities which had very strict regulations, in contrast to those which do not. For instance, in Minnesota, the pollution control agency doesn't consider impulsive noise sources a source of noise. An impulsive noise is typically associated with industrial hammering machines that not only let off very loud noises but also a significant vibration to the surrounding area as well. Thus, people end up with a lot of noise from ground vibration in surrounding communities. They also indicated that it is typical (but not guaranteed) that more liberal areas typically have more regulation on noise. In New York City, they said the regulation is based on an allowable increase above existing noise levels. As discussed, the Noise Control Act's responsibilities were to distribute educational materials on the health impacts of noise, finance research on noise, "provide technical assistance to State and local governments in implementing noise control programs." among other responsibilities (Gov Track, 2004).

Despite this, much of the focus in our conversation was focused on what states do to regulate noise. When talking about New York State, I learned a lot about policy, specifically the way it is broken up. As mentioned, New York City regulates noise based on the allowable increase above existing levels. This sort of more municipally focused regulation is something that I largely missed when reviewing the Noise Control Act. This is because this policy was largely left up to the states, thus, policies can vary massively across states, some having no regulations outside of noise ordinances (DEFINE) and some with strict regulations. These policies according to the Acoustician can also vary

massively from a cluster perspective. In other words, noise can be regulated by a town or city, a county, or a state.

In terms of measuring noise, they provided me with some information I missed specifically when speaking on airport and airplane related noise. This was because many of the databases used to track the noise of commercial flights do not include private flights. They said that this in a lot of circumstances can leave some private airports or even just planes left without any understanding of their impact on the environment. It is important to note in this that airplane noise is the third most reported noise by residents on average (Peris, 2021:2).

Another point that was interesting was the property perspective on noise and the political side. They spoke on low property values and that they are a common indicator of high noise areas and that high noise areas also indicate low property values. This theme shows up later and remains relevant throughout the interviews. Finally, they went into occupational noise a little, this ties into the discussion of OSHA (Occupational Safety and Health Administration) policy. Specifically in this interview, we discussed impulsive hammering noise and how in some states this is not considered a source of noise from a policy perspective. This does count as an occupational noise hazard because it is over the limit without ear protection, but for neighboring areas this sort of noise can be very disturbing according to the acoustician.

Technical Music Professional

I interviewed a Technical Music Professional next. This interview was very interesting. They logically had a lot to say when I asked how sound impacts their daily

life. To them, sound is everything, from the basic sensory uses for sound to most of their creative inspiration. They said that sound essentially affects their life in every possible facet. When asking them about what they think the benefits are to hearing noise you like, they viewed it from a mostly musical perspective saying that they think the shared experience of music can be very beneficial. More specifically, they said that communally, being present with other people is very special, especially when you have a shared goal or intention with the people there with you. They called this a “super human thing”, not in the superhero sense, but in a more natural human sense. Afterwards, they said that subjectively, the benefits can be being more curious, learning new things about the world, experimenting and experiencing your environment in different ways, too.

Next I asked what they think a common pattern is with high noise environments. They said that urban environments are most commonly the highest noise areas on a broader scale. They added that they personally could never live in a city for that reason. They said that because it is so loud, focusing on work is very hard for them especially considering they are so accustomed to a low-noise environment. When asking about noise in the town that they live in, they said that their city is noisy in some places and quiet in some places, too. In short, it is a very diverse soundscape with no clear uniformity. They said that they normally hear the most noise when children are around, such as at daycare and sporting events. When asking how often they hear noise, they say all the time but normally it is the worst (in a negative sense) at the beginning and end of days because that is when they are trying to sleep or wake up and they are most sensitive to sound. Afterwards, I asked if they listened to white noise to which they said

yes. They also listen to other kinds of noise to sleep called brown and pink noise, which occupy other frequencies while white noise occupies all frequencies.

I asked when a noise becomes stressful or annoying and they said noise becomes annoying or stressful when it is repeated, constant, or sudden. Really high frequencies can be really annoying but really low frequencies are less so. Outside of low frequencies, though, anything with a long duration or with a lot of repetitions can be really annoying. Volume obviously has a lot to do with it, too.

Contrasting from the more factually focused perspective on the acoustician, the technical music professional seemed to have a more personal relationship with noise. Largely, my literature review was very concerned with bad noise or noise that negatively impacts an individual's health. This interview was very focused on their personal love for music. This is a very important perspective because many people will or will not live somewhere because of the noise that is a part of the soundscape. This individual was not interested in spaces with a lot of noise. In short, the incredibly subjective nature of noise has an effect on the impact the noise exerts on an individual. As mentioned in the literature review, this ties into Babisch's *Noise Stress Concept* and potentially health related outcomes. As mentioned in this theory, since noise annoyance and exposure affect norepinephrine, epinephrine, and cortisol (all of which are stress indicators that affect multiple dimensions of physical health) noise annoyance and exposure can impact your health (Babisch, 2002). This effect can also be seen in a study done by Aletta, et al. where they found that "positively assessed soundscapes (e.g., reduced noise annoyance) are statistically significantly associated with better self-reported health conditions." (Aletta, et al., 2018)

I also think the question related to noise annoyance is very important here. He describes the most annoying sounds as the ones that are mid-high frequency, repeated, or sudden. As referenced in the literature review, a study found that traffic noise is the most reported and also the highest level of estimated noise as well. (Peris, 2021:2). Within this framework, it makes sense that this would be the most reported noise as it is the most repeated noise and it also has a pretty broad range in terms of frequency and volume making it sudden and unpredictable at times as well.

Environmental Geologist

Although the next interview was not directly tied to the individual's profession, I think the precedent it sets is still important. This person (the environmental geologist) did not have any occupational experience with noise. Despite this, they held strong opinions about their own personal preferences about the noise that they experience daily. This notion I think was very central to my literature review and the goals it set out to accomplish. This goes back to noise annoyance, "Noise annoyance is a stress reaction to environmental noise, which is thought to be linked to the release of catecholamines from the hypothalamic–pituitary–adrenal axis. Repeated noise annoyance may increase the risk of higher stress-hormone exposures, which could be associated with a variety of mental health disorders." (Gong et. al. 2022:1) From this though, it is important to understand the notion that noise can be completely neutral to one individual and for another very annoying and stressful. For this individual, they explained to me that they lived far away from where they work because to them it is too noisy. This person even considers having biophonic sounds a crucial part of their mental

health. They are sensitive to the changes in seasonal soundscapes. This is an important piece in understanding the incredibly subjective nature of noise and how some people rely on positive sounds while others grow comfortable with anthropophonic noise like trains, loud music, traffic, et cetera.

In Curating Aural Experience: A Sonic Ethnography of Everyday Media Practices

By Milena Droumeva, This notion of personal preference and hyper-subjectivity within the framework of day to day noise is explored. In this study, a small group of participants were given an ipod touch and told to document their personal experiences with noise using voice memos, videos, notes, and other methods. I think the important takeaway from this study though is something the researchers noted, saying,

“Undoubtedly, the affective dimension of sound – how we feel about it – is a deeply ingrained aspect of listening as a form of sensory encounter. In the initial stages of the study I purposefully avoided framing discussions around ‘pleasant’ versus ‘unpleasant’ sounds, since this has the potential to derail a more comprehensive exploration of listening into the duality of ‘likes’ and ‘dislikes.’ Nevertheless, both the issues of noise and personal preference came up in all participant accounts. Affect and subjectivity were tightly entangled with the idea of ‘attentive’ listening itself, which translated to either being sensitive to unwanted and/or loud sound, or being able to pick out incidental ‘cool and interesting sounds’ from the surrounding environment.” (Droumeva, 2015)

This quotation, although long, and very opinionated, I think is very well worded in the framework of talking about noise, especially when looking at people’s personal

preferences. Something that I almost exclusively got in this interview. Whether these personal preferences are something developed through existing in certain environments or an innate proclivity towards certain soundscapes is something that should be further discussed in more theoretical research in the future. As mentioned, this person didn't seemingly have much experience with noise but because of this, I think their perspective is very important. The initial question I asked was "Do you consider noise in how you analyze an environment or ecosystems health?" and they said, "Not really." Despite this, noise was incredibly important to this person in a *personal* way. They described not only their attentiveness to distinct differences between the seasonal changes and noise associated with each season, but also described their love of birds and their calls.

Environmental Expert

After this interview, I spoke with a more biologically focused environmental expert. This person had a pretty significant amount of experience with environmental noise. When asked how they consider noise within an environmental framework, they spoke on it as a primarily human-made or anthropophonic impact. They were focused on how habitats surrounding industrial areas can be particularly susceptible to high noise levels and in turn, less biodiversity. They also spoke on how aquatic habitats are some of the most affected by noise. This is because many species like dolphins and whales have evolved to rely on noise as a means of communication and because noise carries underwater much better than in air.

Another important aspect of what they talked about was that human noise is not on an evolutionary time scale. Meaning, human impact on the environment does not fall into the “natural” timescale that has historically been the norm for living things. This implies that humans have largely started to shape evolution in a way tailored to them, a narrative they were very focused on. Particularly in terms of noise, they said, “the way we interact with our environment impacts the way that the environment interacts with us and itself.” An example of this trend would be birds living near airports. Birds, like whales and dolphins, use sound to communicate with one another particularly when they are mating. If they are near an airport it makes it harder for them to communicate with one another.

This perspective in particular is crucial to understanding global environmental impacts of noise. This individual (the biology focused environmental expert) was more focused on human made impacts that are not explicitly transportation related. This person was concerned with impacts on animals, something that I did not review. This is a trend that especially soundscape ecologists spend a lot of time talking about. This individual said that many animals have become reliant on somewhat quiet or natural soundscapes and have developed communicative skills based on natural soundscapes, as mentioned. Because of this, when airports, cargo ships, train tracks, et cetera are loud it leads to a lack of communication between the animals, which impacts their ability to reproduce. This point is made clear in a study by Holleman, et al. titled: *Negative Impact of Traffic Noise on Avian Reproductive Success*. Logically, this study found that the clutch size (or number of eggs laid) of Great Tits (a species of bird), has a negative relationship with traffic noise levels in the month of April (Holleman, et al., 2010).

Nonetheless, this perspective adds a lot of complexity to the more physical ecological impacts of anthropophonic noise.

Community Organizer

I met with a community organizer who represents a high noise area in the US. Specifically, their area was characterized by a main rail that runs through the neighborhood they represent and also two main airports that straddle the area as well, in addition to traffic throughout the day and evening. We began the discussion by explaining their role as a community organizer and what their role entails. They not only explained how their own personal view on sound impacts them but also how it impacts people personally close to them and especially the community at large. Noise has a very significant impact on the community this person represents. They described a few main impacts of the impact of noise on their community. As mentioned, this community is in a relatively high noise area by WHO standards and this community organizer described that many residents who were trying to sell their homes would struggle because of the high noise levels from trains and the nearby airports. They mentioned that when the residents tried to sell their house, they didn't even realize the noise was considered a negative sound to buyers. This area is also characterized by older road design, so when discussing traffic noise, the organizer mentioned road traffic noise was a big problem for homes close to the road, especially on higher traffic roads. We then went into the most affected parts of the community. This specifically included areas under the airport's flight path, areas next to the train tracks, and areas that have homes close to the road or close to other homes. In other words, areas close to transportation

are likely to experience more noise and areas in higher density areas are also more likely. As mentioned, areas closer to these sources of noise were more likely to be lower income areas also with lower property values.

When looking at if residents had brought up the issue of noise, they said residents bring up the issue all the time. The source is typically loud music from modified car speakers, parties, or transportation related noise, including modified cars on the street. In addition, they mentioned that because certain parts of the neighborhood are relatively high density homes, the noise from other homes is consistently an issue for residents and the issue is reported to them regularly. The other issue they mentioned was also very significant. In their neighborhood, there is a section of their neighborhood that is louder than others. They said residents in the area have associated this area with loud music and the organizer also said they receive several noise complaints from neighbors. They went into more detail explaining that the city government wanted to shut down a bar in the downtown area where a lot of the people in the area go. They described that the initial issue would likely only be worse if they did shut it down. In short, they said that if the town did shut the bar down, this would only make a residential issue worse. In other words, this issue would likely atomize the group and spread the loud music out to several other locations, primarily residential areas.

Finally, one of the most important aspects of this interview was the final conversation we had. This was surrounding healthcare accessibility in the community they represent and more broadly the town. They went into detail with healthcare, discussing that the local hospital had rolled back many of the existing health services before and during the pandemic. This included adolescent mental health departments,

dental health, women's health, and reproductive health services. From their perspective, the issue was only getting worse in the area and the community is suffering because of it. This is obviously an important aspect of the topic of noise because as discussed in the literature review, it was found that an increase in aircraft noise was associated with higher depression risk, the onset of dementia, and general cognitive decline for adults (Seidler, et. al., 2019). In addition, for children, it was found that there's an association between children exposed to high levels of traffic noise and hyperactivity deficit and that children exposed to long term traffic noise during the night experienced chronic stress hormone regulation disturbances, impaired sleep, memory and ability to concentrate (Ising, H., & Ising, M. 2002) (Seidler, et. al., 2019). This is also just in terms of mental health. When speaking on reproductive health, a study from Ristovska, et al. it was found that:

“The biological evidence points to the contribution of noise exposure to reproductive failure in critical windows of gestational time via implantation failure, dysregulation of placentation, decrease of uterine blood flow.

Recent evidence describes a hierarchy of biological mediators involved in a stress trigger to reproductive failure and a relatively new conceptual approach describes the stress susceptibility in mother and fetus via a pregnancy stress syndrome.” (Ristovska, et al., 2014).

So clearly, in this town, in terms of noise and health accessibility, the issues overlap very consistently and this is very relevant to understanding the impacts of noise on this individual's community.

This interview is easily the most important given that it is the community organizer. This is one of the most important perspectives in this thesis because it is an individual who informs me on how people are affected by noise, this being just people's perspectives. As mentioned, the source of noise in the area they represent is normally loud modified cars on the street, loud music from modified car speakers, parties, or transportation related noise. As repeatedly cited in the literature review, traffic noise is commonly the most reported noise from a transportation perspective. Something this interview did though was look further at leisure noise within a person's house and also at a larger scale with bars and nightclubs. As mentioned, a study from Beach et. al. found that when evaluating activities that younger people participated in, nightclubs were the most significant source of leisure noise and also that when an individual participated in one noisy activity they were also more likely to participate in multiple others (Beach, et al., 2013).

The property perspective is very important too, as mentioned, "As expected income is negatively related to road traffic noise annoyance." (Marquis-Favre, C., Gille, L., & Breton, L., 2021). In a study by Blanco and Flindell, it was found that, "In more geographically constrained areas with much smaller property markets, prospective purchasers may have far fewer options for choosing property with lower outdoor sound levels." (Blanco & Flindell, 2010). In other words, this study found that if you are buying lower property values, you are much less likely to choose a property with lower noise levels. An important thing to note is that this takes place in the United Kingdom so applying this to the United States does have constraints.

Chapter 4, Technological Development:

Road traffic noise remains one of the most central components of noise, especially when discussing harmful impacts on people. In this section, we will briefly look at future innovations or technologies that can mitigate road traffic noise specifically.

First, noise barriers have proven effective. Continuing to construct noise barriers can be a very effective way of mitigating noise along freeways, in particular.

“Because there are no pertinent source emission regulations, road traffic noise is abated in the United States almost exclusively by making noise barriers or sound barriers along freeways.” (National Academy of Engineering, 2010: 68).

Also, “income is negatively related to road traffic noise annoyance.” (Marquis-Favre, C., Gille, L., & Breton, L., 2021). So potentially focusing more on constructing noise barriers in lower income neighborhoods can be a very effective way of combating inequality in noise annoyance. It is also important to note that every state except six states have instituted noise barriers along freeways so potentially extending this policy to the remaining states could be a very effective way of mitigating noise (National Academy of Engineering, 2010: 68).

Second, specific types of rubberized pavement can reduce noise effectively, particularly where noise barriers are not viable to decrease traffic noise.

“By using a rubberized asphalt pavement, noise can be reduced by 3-6.5 dB. The largest application of quieter pavement in the United States was in the greater Phoenix area.” (National Academy of Engineering, 2010: 70)

Continuing these sorts of developments will contribute to the overall reduction of noise in the United States. Also, studies on the durability of pavement show that the age of pavement plays into both the ability to rubberize the pavement and also the noise the pavement emits (National Academy of Engineering, 2010: 71). This goes back to the focus from the Environmental Civil Engineer who brought up the importance of staying up to date on infrastructural maintenance. Overall, private and public development in the United States should make an effort to innovate with a more long term intention. Through these two methods, road traffic noise could be mitigated significantly especially in disadvantaged communities that are disproportionately affected by noise.

Chapter 5, Conclusion:

This research pulled together many diverse perspectives on the issue of noise occupationally, personally, and interpersonally while also reviewing socioeconomically influenced adverse health effects and how certain groups are disproportionately impacted by noise exposure. While this research covered many bases that were assessed in the literature review, many subjects discussed in the interviews were left unanswered, unaddressed, or simply under researched.

Much of the infrastructural policy-end subject matters were covered in both the literature review and the interviews as seen in the discussion with the acoustician for instance. Issues of personal preference and health outcomes related to them were also reviewed and discussed.

In terms of issues left undiscussed, there are quite a few, especially given I turned to many environmental experts to help talk about this issue as opposed to emphasizing more community organizers, policy makers, or residents. It is important to note, when initially starting this thesis, the goal was to eventually interview residents and get more personal accounts of noise but unfortunately, the methods of sampling did not pan out given the time period the research was on. Furthermore, future research *must* review residents' perspectives on noise. Every individual has a unique perspective and reviewing these perspectives is especially important to being able to understand noise on both a structural and individual level. In terms of a more environmental focus, including the impacts of anthropophonic noise on animals and ecosystems should be something future research does not hesitate to cover especially in sociology, as human impacts on ecological systems *will* inevitably have impacts on human society. Also,

within the scope of anthropophonic noise, when speaking on noise, especially non-transportation related noise, positive sound and its impacts on people should be included as there are tangible benefits to it. This especially includes music therapy and how it is used in a more clinical setting.

Moving forward, a really strong way to emphasize more attention towards the potentially harmful effects of noise exposure and annoyance is to call for stronger policies which research and protect people from noise and its impacts. In addition, upholding existing noise policy must be a priority in continuing to mitigate the existing noise in America from becoming worse. I will be referring to some of the findings and recommendations from the National Academy of Engineering's book on *Technology for a Quieter America*. As mentioned, upholding noise policy in varying clusters of government organization is very important, including municipal, county, state, and federal regulation. This includes regulation from the Department of Transportation (DOT), the Occupational Safety and Health Administration (OSHA), and the Environmental Protection Agency (EPA) and then also continuing to fund research for organizations like the Federal Interagency Committee on Aircraft Noise (FICAN) and Partnership for Air Transportation and Emissions Reduction (PARTNER). An interesting potential existing organizational structure is the Joint Planning and Development Office (JPDO). The JPDO is an organization chaired by private sector representatives and members of the DOT. In a quotation from *Technology for a Quieter America*, they talk about their potential role, "Although JPDO is not focused on noise-related activities, its organizational structure provides a potential model for a multiagency cooperative effort to establish policy." (National Academy of Engineering, 2010: 115). Through the

necessary funding from Congress, this organizational architecture could be utilized to take advantage of existing United States code, that allows the noise department of the EPA to have a more significant role in noise reduction and policy (National Academy of Engineering, 2010: 119). In terms of a call to congress,

“The Congressional Research Service (CRS) provides regular reports to Congress in a series titled *Noise Abatement and Control: An Overview of Federal Standards and Regulations*; In addition, three annual reports are available (CRS, 2000, 2003, 2006). CRS should be asked to prepare a new report to Congress outlining policy options and encouraging action to develop a new noise policy.”

(National Academy of Engineering, 2010: 119).

So overall, there are two main recommendations this chapter highlights for recommendations within the “Role of Government.” One being that the EPA should coordinate a functional role in the Department of Defense, the Department of Transportation, the Department of Labor, the Department of Commerce, the Department of Health and Human Services, the Department of Housing and Urban Development, and the National Science Foundation. Second, Congress should pass legislation to provide funds to reestablish the EPA as the lead agency in “noise measurement, abatement, and control involving federal agencies, state governments, industry, consulting firms, and academia.” (National Academy of Engineering, 2010: 119).

In addition to policy, calling on academia to emphasize more acoustics classes and programs in undergraduate programs is very important to covering workforce development side issues if policies are passed. This is because if the policies are

passed there will be a call to more acoustics engineers and noise control specialists and if the supply of jobs is not there then many issues may remain unaddressed or under researched. The National Academy of Engineering calls three main recommendations for how to address this. First, undergraduate programs should focus on offering more courses in noise control engineering and policy. In other words, broadening the scope of the broader engineering curriculum is very important, especially in undergraduate programs. Second, graduate level noise control courses need to “balance: between theory and engineering practice” (National Academy of Engineering, 2010 129). Finally, they call for federal agencies, private companies, and foundations “with a stake in noise” to finance graduate level research more seriously. Saying that, “This support is crucial for the development of noise control professionals and noise control educators.” (National Academy of Engineering, 2010: 119).

Finally, an emphasis on public information and noise awareness is the last point that this book focuses on which is also crucial. This includes looking at past efforts for noise reduction and current ones. Also, using the internet and online availability of resources is a big focus of how to disseminate information properly. Generally, they call the American Society of Mechanical Engineering, American Institute Aeronautics and Astronautics, American Society of Heating, Refrigerating, and Air Conditioning Engineers, Society of Automotive Engineers, and the Institute of Noise Control Engineering of the USA to develop resources and information on noise control and different methods for reducing noise. (National Academy of Engineering, 2010: 134). Through the obvious issues with noise to the more subtle ones, it is clear that this problem is all encompassing in every individual's personal life, health, and experience in

ways we do not consider nearly enough. From this thesis I hope people look more closely not only at their own personal experiences and how they vary from their family and friends, but I hope people look at the distinctions between structurally significant impacts and how tolerance and sensitivity to these things is something everyone should be cognizant of.

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Appendix A: Consent Form:

My name is Cole Maher, and I am a student at Union College. I am inviting you to participate in a research study, which is part of my senior thesis in Sociology under the direction of Professor Melinda Goldner. Involvement in the study is voluntary, so you may choose to participate or not. A description of the study is written below.

I am interested in learning more about transportation-related noise and its impact on health. You will be asked to answer a series of questions about noise within the community or area you represent. This will take approximately 15-20 minutes. The risks to you of participating in this study are minimal. If you no longer wish to continue, you have the right to withdraw from the study, without penalty, at any time. All information will be kept confidential.

If you have any questions about the research please contact Cole Maher at maherc@union.edu, and/or Melinda Goldner at goldnerm@union.edu. If you have any questions concerning your rights as a research participant that have not been answered by the investigator or if you wish to report any concerns about the study, you may contact the Union College Human Subjects Review Committee Chair Joshua Hart (hartj@union.edu) or the Office for Human Research Protections (<https://www.hhs.gov/ohrp/>).

By signing below, you indicate that you understand the information printed above, and that you wish to participate in this research study.

Signature of participant

Date

Printed name of participant

Date

Name of investigator

Appendix B: Interview Guides

Interview Guide for Community Leaders

How does noise impact the community you represent, if at all? Please explain.

What part of the community seems the most affected by noise? Please explain.

Have any residents ever brought up the issue of noise levels to you? Please explain.

Follow up:

How many, if so?

Are they from similar areas (if more than one)?

What is the source?

How do they describe the impact?

Is consistent access to healthcare a problem in this area? Please explain.

Interview Guide for Policy Makers

How does noise impact the town you represent, if at all?

What part of the town seems the most affected by noise, if any?

Have any residents or community groups ever brought up the issue of noise levels to you? Please explain.

Follow up:

How many, if so?

Are they from similar areas (if more than one)?

What is the source?

How do they describe the impact?

How do you think we should address noise in the area you represent?

Is consistent access to healthcare a problem in this area? Please explain.

If so, how do you think you can help residents of the town have more consistent access to healthcare?

Interview Guide for Acoustics Expert

What metrics do you use to evaluate noise from a health perspective?

What transportation noises are the easiest / hardest to measure?

Which policies protect people from transportation-related noise the most?

Have you or your coworkers found recurring qualities of high noise areas?
Please explain.

Interview Guide for Environmental Expert

Do you consider noise in how you analyze an environment or ecosystem's health?

If so, what is an example of noise being important in your experience?

If so, when is noise a problem?

Technical Music Professional

How does sound affect your daily life?

What do you think are the benefits of hearing noises or music that you like?

What do you think are qualities of a high noise environment?

How would you classify Schenectady in terms of noise? Please explain.

Is there a specific place where you hear a lot of noise during the day?

How often do you hear noise?

How loud is it? Does it vary through the day on volume?

What part of the day do you notice noise the most?

When do you think a type of noise becomes annoying or stressful? Please explain.

Is this related to frequency? Noise level? Type of noise?

How do you deal with this type of noise?

Do you listen to white noise?