

# Noise Sensitivity Rating of Individuals

George A. Luz, Luz Social and Environmental Associates, Baltimore, Maryland

**People respond differently to different noise levels. Approximately 1 in 5 people are acutely sensitive to moderately loud noise disturbances. This article presents the Weinstein Noise Sensitivity Index as a method for determining noise sensitivity. People who are more sensitive to noise may want to research the noise levels of new neighborhoods before moving into them and seek out quiet dwelling places.**

In an effort to protect the citizenry from unhealthy community noise exposures, governments publish noise contour maps. In areas where land is undeveloped, these maps can serve as a basis for restrictive zoning. In areas where houses already exist, the maps can serve as a *caveat emptor*. Given that only 20% of subjectively-reported noise annoyance is explained by the measurable sound,<sup>1</sup> how is that *emptor* to decide? Which personal and situational variables are relevant to the decision? Fields,<sup>2</sup> working with social surveys, determined six such variables to be statistically robust. Four are pure attitudes (fear of danger from the noise source, noise prevention beliefs, beliefs about the importance of the noise source, and annoyance with non-noise impacts of the noise source). Another, isolation from sound in the home, belongs to the acoustical engineer. The sixth, general noise sensitivity, belongs to the psychologist.

## Approach

During a noise management workshop at the 2003 USEPA Region III Environmental Colloquium, a participant suggested that noise sensitive (NS) people be advised not to move into noisy neighborhoods. This suggestion led to a review of the literature to determine the best way to alert people to their noise sensitivity. Two problems surfaced as a result of this review –

1. The failure of any physiological measure to identify the NS person.
2. A statistical association between being NS and neurotic.

After discussing these problems, suggestions are provided on how to alert NS individuals without offending them.

## Physiological Indicators of Noise Sensitivity

If noise-sensitivity were as easy to measure as blood pressure, the task of informing the NS person might be simple. Several physiologists and psychologists have studied the NS and found few differences between groups. At traffic noise levels higher than would be found in a normal neighborhood (85 dB, A-weighted), NS men showed significantly larger increases in heart rate, systolic and diastolic blood pressure than NNS (Non-Noise Sensitive) men.<sup>3</sup> At noise levels more typical of real neighborhoods, however, the cardiovascular differences between NS and NNS subjects were negligible.<sup>4</sup> NS individuals do not hear any better than the NNS.<sup>5</sup> Their reaction time to loud sounds is no different than the reaction time of the NNS. The NS does not perceive a loud sound as any louder than a NNS. When listening to helicopter noise at loud levels (80 dB maximum), the blood pressure of NS subjects is no higher than the BP of NNS.<sup>6</sup> In short, common physiological measures cannot be used to identify the NS person.

## Noise Sensitive People and Neuroticism

The most controversial research concerning the NS population is about psychiatric symptoms. A Norwegian study found NS to be predictive of depression among men.<sup>7</sup> An English study found NS women exposed to aircraft noise to have a greater incidence of phobic disorders and depression.<sup>8</sup> A Japa-

nese study reported similar findings.<sup>9</sup> An association between NS and 'neuroticism' has been reported from England,<sup>10</sup> Sweden,<sup>11</sup> and Serbia.<sup>12</sup> If translated into a typical 21<sup>st</sup> Century "sound byte," the statistical connection between NS and neuroticism could be used to isolate and ignore the NS population. To call someone 'neurotic' is pejorative in American society. Managers of noisy facilities, such as airports, industrial operations and military installations, receive most of their noise complaints from a few people. Labeling those few people 'neurotic' could trivialize legitimate public concerns. If one looks at the actual details of these studies, this statistical association is seen as quite complex.

First, neurotic and neuroticism are not the same words. Neurotic is a vague term used widely in every day conversation to suggest that someone is too nervous or unstable. Neuroticism is a construct derived from a statistical procedure known as factor analysis. This statistical procedure allows psychologists to look at the interconnections between answers to a set of questions and find 'clumps' of answers that are statistically interrelated. The neuroticism scale is one of five important dimensions describing the ways in which personalities differ. The other four scales are openness, conscientiousness, extraversion and agreeableness. When people answer questions about their personality, the answers tend to segregate along these five dimensions.

Second, questions designed to measure neuroticism and noise sensitivity are both measuring negative affectivity. People who are more bothered by noise in their neighborhood than their neighbors can be expected to experience negative affectivity. If these NS individuals were transported to a completely quiet environment, the negative affectivity might disappear, but they would still remain NS.

In 1992, Dr. Stephen Stansfeld, an English psychiatrist who has written more about this subject than anyone else, provided the following summary.

*In summary, noise sensitivity may be comprised of two elements. Noise is important to noise-sensitive people who attend to noises more, discriminate between noises more, and tend to find noises more threatening and out of their control than people who are not sensitive to noise. Secondly, because of negative affectivity, they react to noises more than less sensitive people, and may adapt to noises more slowly. This may result in a greater expression of annoyance to noises than in less sensitive people, both because this is a response to greater threat and also because they may have a general tendency to be annoyed, irrespective of noise. Both these latter factors may be active in explaining the association between noise-sensitivity and current psychiatric disorder, and explaining why noise sensitivity is a vulnerability factor for psychiatric disorder.*<sup>13</sup>

## Emphasizing the Positive

Being high on the neuroticism scale can be a burden to individuals and the people close to them. At the same time, neuroticism comes with some benefits, and a more effective way to reach the NS individual would be to emphasize the positive.

The English authors of one of the earliest of these studies<sup>14</sup> wrote in 1972 –

*The most outstanding impression of those people who were noise sensitive was that they were typically friendly, generous and sociable and very much aware of their environment. As is well known about those who complain of noise they were equally liable to complain about other defects in their neighborhood, e.g. the drains, etc. On the positive side they were frequently active in the community, e.g. in voluntary social work and very much aware of the needs of others. Very often they were 'creative,' having some hobby such as painting or*

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writing. Usually they seemed to be of above-average intelligence compared with their neighbors.

The authors of a study of 3445 persons exposed to noise in Amsterdam reported that noise sensitivity appears to be more strongly represented among persons with a higher socio-economic status.<sup>15</sup>

Another way of looking at the NS is that they have a very active "orienting response" (OR). The OR is sometimes called the orienting reflex. It was first recognized and reported by the famous Russian physiologist Sechenov in the 1850s in his book *Reflexes of the Brain*. Pavlov (of salivating dogs fame) referred to the OR as the "What is it?" reflex. In the 1950s, a third Russian physiologist, Sokolov, documented how this distinctive pattern of changes in respiration, heart, skin conductance, eyes and ears gradually decreases when a novel sight or sound is repeated. For our ancestral hunter-gatherers living in natural quiet, an active OR was essential for survival. It helped the hunter keep food on the table and the gatherer to avoid predators. However, in a world filled with roars, buzzes and bangs, an active OR can be a disadvantage, especially for people whose nervous systems have difficulty "turning off" the OR.

The process of "turning off" the OR is called 'habituation,' and NS subjects have a harder time habituating to a repeated sound than NNS subjects. For example, an English study compared changes in skin conductance when NS and NNS women listened to sounds at 50, 75 and 100 dB, A-weighted. The NS women were more reactive to the first presentation of the sound and they were slower to habituate when the sounds were repeated.<sup>16</sup>

The OR prepares our sensory system to take in new information, but if the OR is over active, the NS individual can be distracted from focusing on other important information. So, the NS person may complain, "I can't concentrate with all this noise," whereas that person's NNS spouse may be completely unperturbed. Such distractibility is documented in another study of English women. Two groups of women, one experiencing a relatively high and the other a relatively low exposure to aircraft noise, completed a twenty-question "Everyday Errors Questionnaire."<sup>17</sup> An example of one of these "everyday error questions" was "Do you start doing one thing at home and get distracted into doing something else (unintentionally)?" The NS women reported more everyday errors in both the low and high aircraft noise exposure neighborhoods.

The NS individual does not stop being vigilant when he or she sleeps. The difference in sleep quality between the NS and NNS is not as large at relatively high noise exposures as at relatively low exposures. This tendency was documented in a Swedish study of sleep disturbance from traffic noise. When NS and NNS subjects slept in a 60 dBA environment, the differences in sleep quality between the two groups were not as pronounced as when both groups slept in a 50 dBA environment.<sup>18</sup>

The tendency for the NS to be more disturbed by moderately loud sounds than the NNS is also reflected in judgments of subjective annoyance or unpleasantness. When listening to a clearly aversive sound (jackhammer), the NS rates the unpleasantness of the sound in the same way as the NNS. However, for somewhat less aversive sounds (vent, mower, brake, truck, crash, train), the NS gives a higher unpleasantness rating than does the NNS.<sup>19</sup> In a study of 2933 residents of Greater London exposed to traffic noise, the NS reported being more annoyed than the NNS at relatively low exposures, but converged with the NNS as the intensity of exposure increased.<sup>20</sup> A similar phenomenon has been observed in the laboratory.<sup>21</sup>

### Becoming Aware of One's Noise Sensitivity

In a 1999 review of different field surveys of response to transportation noise, the incidence of noise sensitivity among a sample of 15,171 people was 22%.<sup>22</sup> Therefore, it seems safe to guess that at least one out of five people are NS. In that review, 46% had "low sensitivity" and 32% had "medium sensitivity." An English study in which the incidence of NS was

somewhat higher showed that the incidence of NS is stable across age groups.<sup>23</sup> About 30% of young people (16-24 years) said they were NS, 35% said they were NNS, and about 34% were neutral. For people ages 65 and older, only 17% were neutral and about 30% were NS. It should be noted that the people who said they were NS were living with a noise exposure. The objective should be to educate the NS population before they move into a noisy area.

The simplest way to alert the NS public is to provide them with copies of the Weinstein's Noise Sensitivity Scale. This self-report test has been in use since 1978,<sup>24</sup> and other researchers have found the scale to be satisfactory with regards to reliability, internal consistency, factor structure and construct validity.<sup>25</sup> In Weinstein's original work, the average score for the NS was 67.9 and the average score for the NNS was 39.8. The highest possible NS score is 126. Weinstein's scale is designed to capture sensitivity to different noise sources. This design is consistent with research showing that people who are more annoyed than the general population by one source of noise will also be more annoyed by another source of noise.<sup>26</sup>

### Conclusion

A holistic approach to environmental noise management should include an effort to inform the NS population before they move into a noisy neighborhood. By using the Weinstein Noise Sensitivity Scale, emphasizing the positive side of being a NS person and avoiding mention of the statistical association with neuroticism, it should be possible to educate without offending. As an example of how to educate this sensitive one-fifth of the citizenry, a sample brochure, including a modified version of the Weinstein scale, is provided in the Appendix.

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The author can be contacted at [Luz\\_Associates@msn.com](mailto:Luz_Associates@msn.com).

Table 1. Items on the original Weinstein Noise Sensitivity Scale

1. I wouldn't mind living on a noisy street if my apartment was nice.
2. I am more aware of noise than I used to be.<sup>a</sup>
3. No one should mind much if someone turns up his stereo full blast once in a while.
4. At movies, whispering and crinkling candy wrappers disturb me.<sup>a</sup>
5. I am easily awakened by noise.<sup>a</sup>
6. If it's noisy where I'm studying, I try to close the door or window or move someplace else.<sup>a</sup>
7. I get annoyed when my neighbors are noisy.<sup>a</sup>
8. I get used to most noises without much difficulty.
9. How much would it matter to you if an apartment you were interested in renting was located across from a fire station?<sup>a</sup>
10. Sometimes noises get on my nerves and get me irritated.<sup>a</sup>
11. Even music I normally like will bother me if I'm trying to concentrate.<sup>a</sup>
12. It wouldn't bother me to hear the sounds of everyday living from my neighbors (footsteps, running water, etc).
13. When I want to be alone, it disturbs me to hear outside noises.<sup>a</sup>
14. I'm good at concentrating no matter what is going on around me.
15. In a library, I don't mind if people carry on a conversation if they do it quietly.
16. There are often times when I want complete silence.<sup>a</sup>
17. Motorcycles ought to be required to have bigger mufflers.<sup>a</sup>
18. I find it hard to relax in a place that's noisy.<sup>a</sup>
19. I get mad at people who make noise that keeps me from falling asleep or getting work done.<sup>a</sup>
20. I wouldn't mind living in an apartment with thin walls.
21. I am sensitive to noise.

Note – Most items are presented on a 6-point scale ranging from agree strongly (1) to disagree strongly (6).

<sup>a</sup> Items scored in opposite direction before responses are summed.

## Appendix

**Is a noisy neighborhood a good choice for you?** Acoustical engineers and scientists have been working for decades to develop complex computer programs for making noise contour maps around noisy facilities, such as highways, airports, power plants, railroads and military bases. These maps are intended to guide prospective residents in deciding whether to rent or buy a dwelling unit in a particular area. Even in neighborhoods not covered by noise contour maps, around-the-clock sound exposures can be measured with instruments costing as little as \$1000. In short, prospective residents have the opportunity to know a lot about neighborhood noise before they decide to move into a neighborhood.

Following the recommendation of the U.S. Environmental Protection Agency, the noise contour maps show decibels (dB) of day-night average sound level (DNL). In 1974, the USEPA identified a DNL of 55 dB as the long-term goal for dwellings, and the Federal Aviation Administration authorizes sound insulation when the outdoor DNL from airports exceeds 65 dB. In setting these limits, the Federal agencies used data on average response to community noise, but there is considerable variability around that average. According to an Australian noise expert, R.F.S. Job, only 20% of the variability in individual noise annoyance is explained by the measurable noise. Among the several reasons for this variability is what the experts call "Noise Sensitivity." The purpose of this brochure is to help you find out if you are noise sensitive (NS).

There are no physiological indicators for the NS. NS individuals do not hear any better than the non-NS, and they don't experience a sound as any louder than the non-NS. When lis-

Table 2. Weinstein Noise Sensitivity Scale.

Instructions – Circle the number corresponding to how well you agree or disagree. Don't be disturbed by the reversals of order from one line to another. At the end, add up the numbers for your score.

1. I wouldn't mind living on a noisy street if the apartment I had was nice.	AGREE	1	2	3	4	5	6	DISAGREE
2. I am more aware of noise than I used to be.	AGREE	6	5	4	3	2	1	DISAGREE
3. No one should mind much if someone turns up his stereo full blast once in a while.	AGREE	1	2	3	4	5	6	DISAGREE.
4. At movies, whispering and crinkling candy wrappers disturb me.	AGREE	6	5	4	3	2	1	DISAGREE
5. I am easily awakened by noise.	AGREE	6	5	4	3	2	1	DISAGREE
6. If it's noisy where I'm studying, I try to close the door or window or move someplace else.	AGREE	6	5	4	3	2	1	DISAGREE
7. I get annoyed when my neighbors are noisy.	AGREE	6	5	4	3	2	1	DISAGREE
8. I get used to most noises without much difficulty.	AGREE	1	2	3	4	5	6	DISAGREE
9. How much would it matter to you if an apartment you were interested in renting was located across from a fire station.	A LOT	6	5	4	3	2	1	NOT MUCH
10. Sometimes noises get on my nerves and get me irritated.	AGREE	6	5	4	3	2	1	DISAGREE
11. Even music I normally like will bother me if I'm trying to concentrate.	AGREE	6	5	4	3	2	1	DISAGREE
12. It wouldn't bother me to hear the sounds of everyday living from my neighbors (footsteps, running water, etc).	AGREE	1	2	3	4	5	6	DISAGREE
13. When I want to be alone, it disturbs me to hear outside noises.	AGREE	6	5	4	3	2	1	DISAGREE
14. I'm good at concentrating no matter what is going on around me.	AGREE	1	2	3	4	5	6	DISAGREE
15. In a library, I don't mind if people carry on a conversation if they do it quietly.	AGREE	1	2	3	4	5	6	DISAGREE
16. There are often times when I want complete silence.	AGREE	6	5	4	3	2	1	DISAGREE
17. Motorcycles ought to be required to have bigger mufflers.	AGREE	6	5	4	3	2	1	DISAGREE
18. I find it hard to relax in a place that's noisy.	AGREE	6	5	4	3	2	1	DISAGREE
19. I get mad at people who make noise that keeps me from falling asleep or getting work done.	AGREE	6	5	4	3	2	1	DISAGREE
20. I wouldn't mind living in an apartment with thin walls.	AGREE	1	2	3	4	5	6	DISAGREE
21. I am sensitive to noise.	AGREE	6	5	4	3	2	1	DISAGREE

TOTAL SCORE \_\_\_\_\_

Turn to the last page to see how your score compares with Professor Weinstein's noise-sensitive and non-noise sensitive students.\*\*

tening to loud sounds, the blood pressure of the NS is no higher than that of the non-NS.

The NS are nice people. British researchers who studied NS people in 1972 wrote, "The most outstanding impression of those people who were noise sensitive was that they were typically friendly, generous and sociable, and very much aware of their environment. As is well known about those who complain of noise, they were equally liable to complain about other defects in their neighborhood, e.g. the drains, etc. On the positive side they were frequently active in the community, e.g., in voluntary social work, and very much aware of the needs of others. Very often they were 'creative,' having some hobby such as painting or writing. Usually they seemed to be of above-average intelligence compared with their neighbors." A study from Amsterdam showed that the NS tend to be persons with a higher socio-economic status.

What does distinguish the NS from their NNS neighbors is an inability to "turn off" their response to low intensity sounds.

When the NS and NNS are sleeping in very noisy bedrooms, they are equally disturbed, but when they sleep in moderately noisy bedrooms, the NS will be more disturbed than the NNS. Similarly, the NS and NNS are equally annoyed by intense noises, but the NS are more annoyed than the NNS by moderate noise.

Surveys have found the incidence of noise sensitivity to vary between 22% and 30%, so it is safe to say that you have a 1 out of 5 chance of being noise sensitive. One way to find out if you are in that group is to score yourself on the Weinstein Noise Sensitivity Index\* in Table 2. If you score high, you may want to reconsider moving into a noisy neighborhood.

#### References

\* Weinstein, N. D., *Journal of Applied Psychology*. Vol. 63, 1978, pp. 458-466.

\*\*Noise Sensitive (NS) – 67.9, Non-noise Sensitive (NNS) – 39.8.