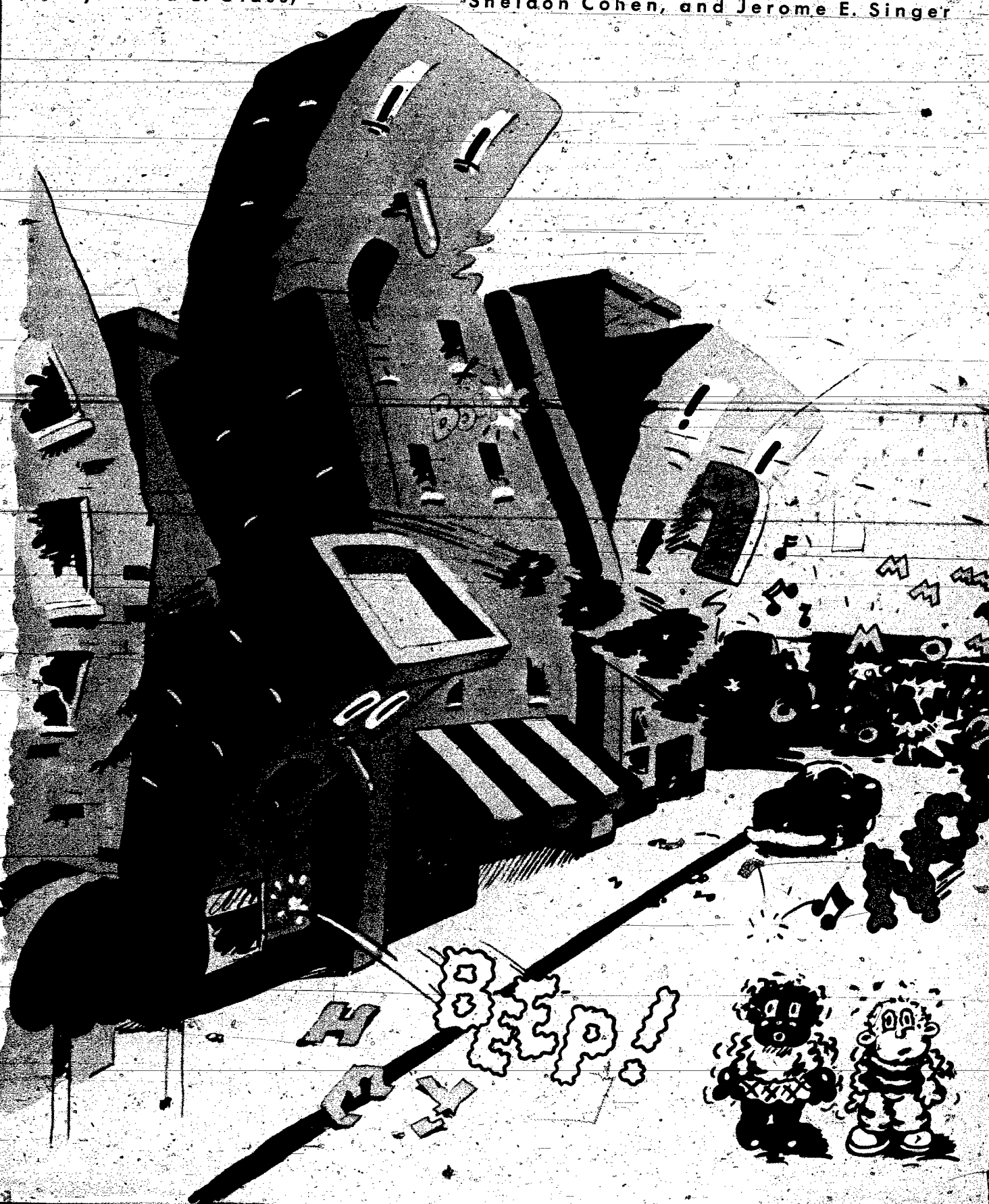


URBAN DIN FOGS THE BRAIN

by David C. Glass,

Sheldon Cohen, and Jerome E. Singer

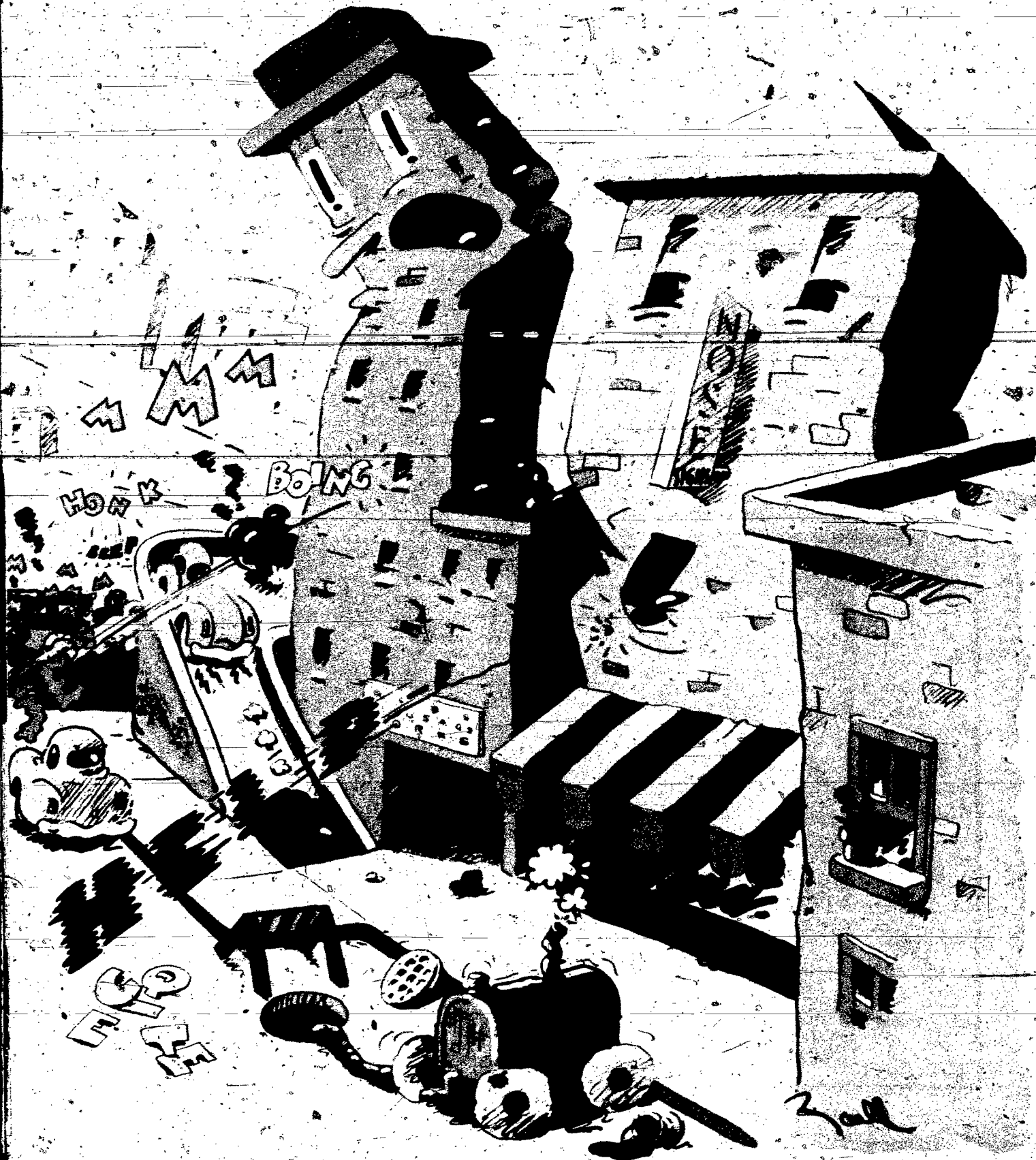


Forget about the lullaby of Broadway. The city's noise does not soothe. Children who live in it develop trouble in discriminating between similar words. How do you suppose that affects their ability to read? Right.

AN APARTMENT BUILDING sits astride a traffic-choked city street. The people who live there are daily exposed to the din of diesel trucks, sirens, the screech of cars coming to a halt, the roar of motorcycles.

The noise-drenched environment is home to thousands of

people in hundreds of cities. The noise is irritating and esthetically displeasing, but the residents adapt. Most of them learn to tolerate the noise and some may even become insensitive to it. But people pay for their tolerance. Recently completed research suggests that the cost may be high, at least



for children who are exposed to this kind of noise for prolonged periods.

In a typical noise experiment, researchers study the effects of noise on behavior by asking students to perform a task while being exposed intermittently to an unpleasant sound. Ordinarily, persons exposed to noise perform about as well as those in a control group, who perform the same task in silence. Even very loud noise has little effect, at least for short periods of time. We adapt. We learn to concentrate on the task in spite of the noise.

We conducted a series of studies which suggest that noise may produce serious effects in humans—after the noise stops. In one study, we examined the effect of predictable and unpredictable noise. We varied the noise intensity between loud (110 decibels) and soft (56 decibels). Forty-eight undergraduate women took part in the experiment. Some students heard noise at the end of every minute for about nine seconds; half heard loud noise and half heard soft. Others heard the noise for varying lengths of time and at random intervals; again, half heard soft noise and half heard loud. A control group heard no noise at all.

The Unattractive Blend. We established first that the noise we used indeed produced stress. Imagine this: a tape recording on which are superimposed the voices of two people speaking Spanish, one

We established first that the noise we used indeed produced stress.

speaking Armenian, the clatter of a typewriter, the staccato of a desk calculator, and the methodical beat of a mimeograph machine. The blend is indescribable and unattractive. A physiological measure of stress, the Galvanic Skin Response, showed us that our subjects felt substantial stress when the tape was played. The stress occurred whether the noise was predictable or unpredictable, loud or soft. Previous research had suggested that our subjects would adapt quickly to the noise, and they did. However, we were interested in whether there would be ill effects after the tape ended.

Diluted Persistence. With silence restored, we asked our subjects to trace over the lines of a diagram without tracing any line twice, and without lifting the pencil from the paper. Each individual received four diagrams. The subject had a limited amount of time for any one trial, but she could make as many attempts on each diagram as she wished. However, once she decided to go on to another diagram, she could not go back to work on an earlier problem.

Two of the problems were insoluble, but this was not apparent to the person. Thus we took a person's persistence at

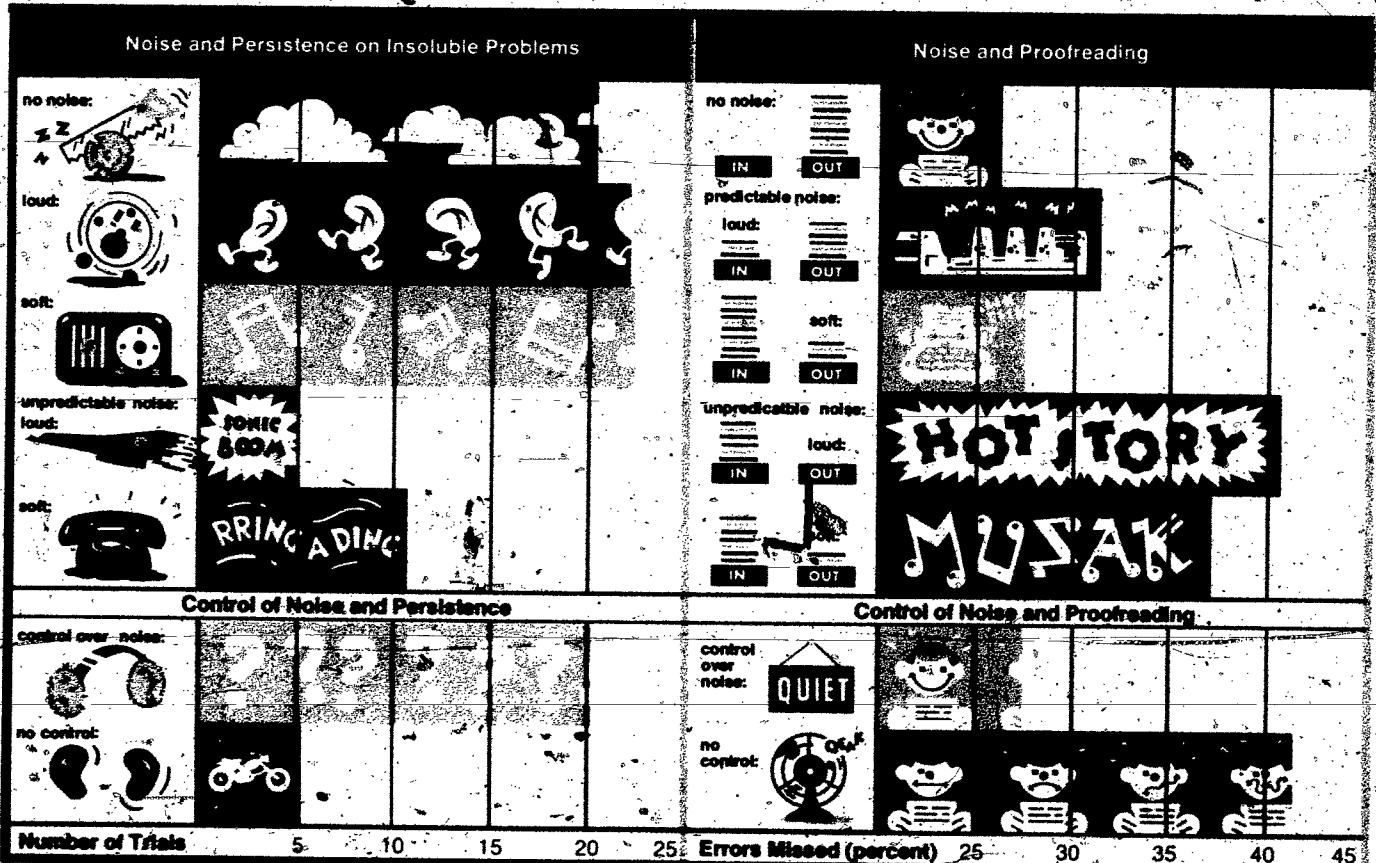
trying to solve the insoluble puzzles as a measure of her tolerance for frustration. We gave a control group the tracing problems without previous exposure to noise.

The subjects exposed to noise were markedly less persistent in working on the two insoluble problems. In addition, unpredictable noise was more detrimental than was predictable noise. The fact that soft *unpredictable* noise produced lower tolerance for frustration than loud *predictable* noise suggests that predictability may be even more important than the intensity of the noise.

Spelling Test. With the figure-tracing task completed, we asked the subjects to proofread a seven-page passage. We had deliberately included a number of errors, such as misspellings; we asked our subjects to correct as many of them as possible in 15 minutes. We then used the number of errors not corrected as a measure of working efficiency. Again, exposure to noise meant significantly poorer performance.

Unpredictable noise caused a greater inefficiency than predictable noise. Soft, unpredictable noise produced poorer results than loud predictable noise, but the difference was not statistically significant.

A later study showed that a subject's ability to control noise is also important in determining its effect. Two groups of students were exposed to unpredictable,



loud noise. One group had control over it; while the other did not. We told the first group that they could terminate the noise by throwing a switch. We explained that we would prefer that they not use the switch, but that they could if they wished. None of the subjects threw the switch.

After exposing our subjects to noise, we gave them the same figure-tracing and proofreading tasks. The results suggest that the ability to control noise limits its subsequent adverse effects. This was true for both tolerance of frustration and for efficiency in proofreading.

In other studies, we have tested different ways of manipulating both the unpredictability of the noise and its level. We have also tested males and nonstudents. These studies confirm our results with female college students.

Thus far, we have demonstrated that noise can have undesirable aftereffects when it is unpredictable and uncontrollable. It is tempting to note that the noises of everyday city life are, for most people, unpredictable and uncontrollable. We might then speculate that "real life" noise reduces our frustration tolerance and interferes with our ability to work efficiently. However, the studies we have described were conducted in the laboratory, and the testing took place immediately after the noise ended. We felt it was entirely possible that the "natural" noises of a city did not have compara-

The results suggest that the ability to control noise limits its adverse effects.

ble effects. So we left the comfort of our laboratory to examine the real world. **Bridge Over Noisy Waters.** Our subjects were elementary school children who lived in one of four Manhattan apartment buildings. The buildings span a heavily traveled expressway. The noise level in the buildings was moderately loud at ground level, but dissipated as one went from the first to the 32nd floor. We found that the volume decreased a reliable amount as we moved higher in the building, so we used floor level as our measure of apartment noise. We could then test the relationship between floor level (noise level) and a child's performance on auditory discrimination and reading achievement tests.

Our previous research in the laboratory led us to expect that exposure to this kind of noise would have adverse effects. If so, we reasoned, the effects should be greater on residents who lived in apartments on lower floors, where the traffic noise was greatest.

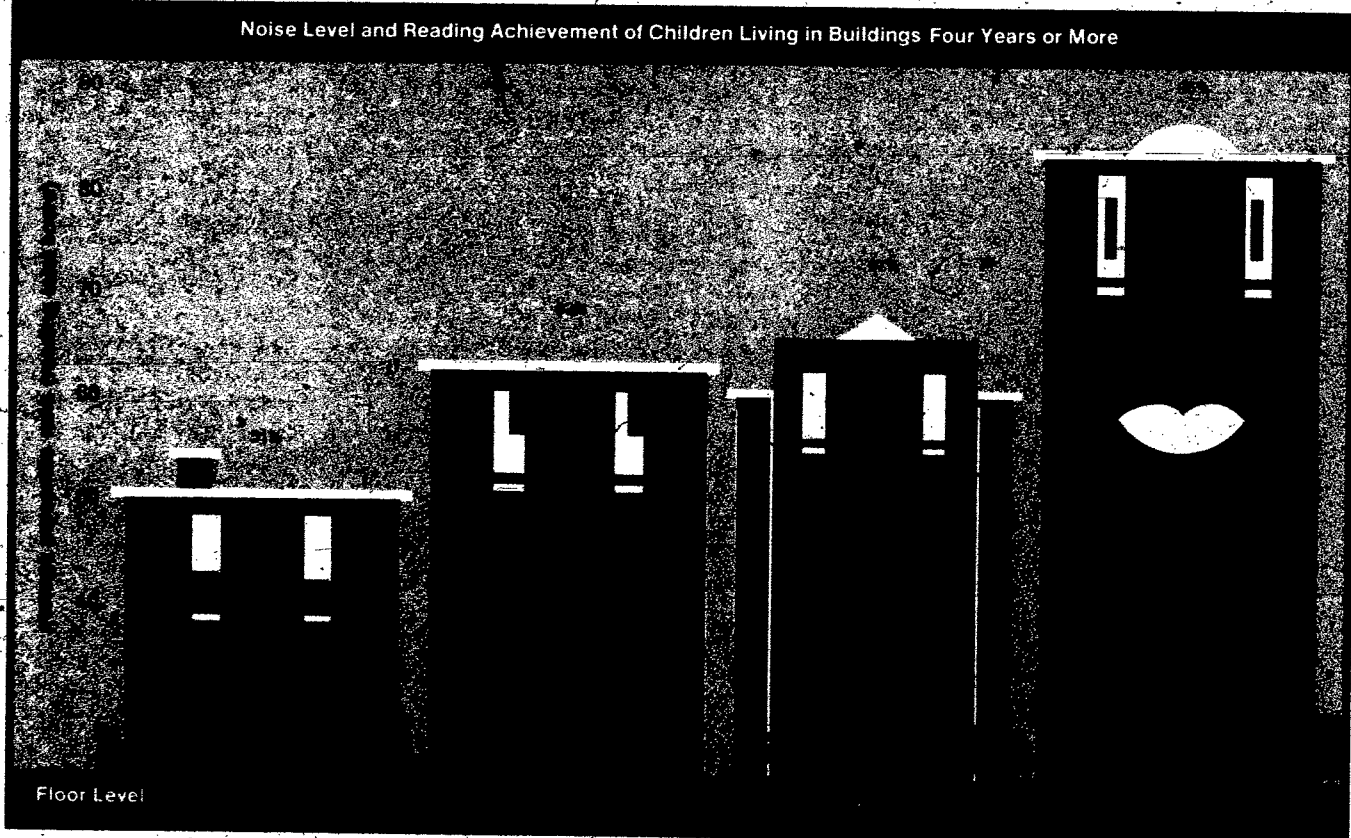
We suspected that one adverse effect of the highway noise might be an inability to discriminate linguistic sounds. To test this hypothesis, we gave Joseph Wepman's Auditory Discrimination Test. This consists of 40 pairs of words such as "gear-

beg" or "cope-coke." We recorded the word pairs on tape and played them to each child through earphones. We asked the child to tell us whether the two words in each pair were the same or different. If auditory discrimination was impaired by prolonged exposure to noise, this, in turn, might result in impaired reading ability. Therefore, we also studied reading achievement. As part of a routine testing program in the New York elementary schools, our subjects took the Metropolitan Achievement Tests soon after the beginning of our study. These tests provide three reading scores: word knowledge, reading comprehension, and reading total (a weighted average of the other two scores).

The Higher the Better. We found a significant relationship between floor level and auditory discrimination in children who had lived in the apartment for four years or more. This relationship did not hold for children who had lived in the apartment for less than four years. Thus, children who had been exposed to high levels of noise (those on the lower floors) for four years or more experienced a loss in auditory discrimination.

The Cost of Time. We found a similar association between floor level and scores in word knowledge, reading comprehension and reading total. With auditory discrimination, the relationship held for children who had resided in the apartment

Noise Level and Reading Achievement of Children Living in Buildings Four Years or More



for four years or more, but not for those who had been there less than four years.

These findings suggest that length of exposure and intensity of noise were important in determining the ability to discriminate between sounds and reading achievement. We suspect that the reading deficit is largely a function of poor auditory discrimination. The two factors were, in fact, significantly correlated. In any case, we can say that both auditory discrimination and reading achievement were related to the intensity of the noise and the length of exposure to it.

We realized that in field studies of this sort, much of the rigorous control of the laboratory setting is lost. We could not, for example, randomly assign residents to floor levels, and we know that a resident's selection of one floor level over another might reflect some difference in the subjects themselves. Apartments on the upper levels were more expensive than those at lower levels. Thus, our results might have been due to socioeconomic factors rather than to noise. In fact, we found that floor level was related to the mother's and father's level of education. The higher the floor level on which a child lived, the higher his parents' education was likely to be, which meant that the differences in auditory discrimination and reading achievement could be due to the home environment the parents created. To rule out this possibility we examined the relationship between auditory discrimination and floor level, using a statistical technique that allowed us to eliminate the effects of the mother's education. Next, we controlled for the father's education. In each case, the relationship between floor level and auditory discrimination was essentially unchanged.

We examined reading achievement and floor level, again taking into account the father's and mother's education. Though somewhat weaker, that relationship also tended to remain the same: the higher the floor on which the child resided, the higher his reading achievement was likely to be.

The research reported here suggests there are four factors of importance in determining the effects of noise on behavior: intensity, duration, predictability and controllability. The clangor found in modern cities is frequently intense, unpredictable, and largely uncontrollable. Our evidence warns that decreased tolerance for frustration, loss of efficiency, deficits in auditory discrimination, and lowered reading achievement may be the price for living in modern cities.

To obtain reprints of this article, see page 119.

Conversation (Continued from page 72.)

ship captains. They formed cargo cults, religious societies that tried to produce "cargo" by magical means. [See "The Noise," by Theodore Schwartz, PT, March 1971.] They mimicked the gestures of the whites, they erected bamboo antennas, sat at makeshift desks and moved scraps of paper around all day. Now there are whites who drop out to seek the spiritual values of the Indians, and they rely on the same tactics. The counterculture, for example, dressed itself as native Americans.

Waters: A few years ago Taos was a mecca for hippies. I was out in the yard building a fence with two Indians from Taos pueblo. A group of hippies came walking up the road, and turned in at the gate. They were bare to the waist, with huge sheath knives hung on their belts, red bandanas around their hair and wearing Indian moccasins. One of my Indian friends nudged me and said, "Jiggers, here come the Apaches." I asked a Pueblo woman what she thought of the kids wearing cradle boards on their backs with babies in them, looking like Indians. She answered, "These hippie Indians are dirty. They never wash. We wash, we are clean. And another thing, why do they all look mad at the world? We are happy."

Wearing a feather won't make you an Indian, and neither will initiating the rituals described in *The Book of the Hopi*. I fear that the Indians will eventually give up the ceremonies and rituals. They take years to learn, and most of the young men on the reservation don't have the time. They go away to school or join the service and when they come back they just aren't interested. I can only hope that the religious meaning embodied in the ceremonies will still be carried on and translated into new, living forms.

Petersen: Are there any models for what you have in mind?

Waters: I recently spent six months in Mexico studying the pre-Columbian culture and religion of the Toltecs and Aztecs. They conceived the same four-world structure as our Pueblos and Navajos, with one difference. They believed that we have emerged into the fifth world which lies at the dead center of the successive four worlds pictured as occupying the quadrants of universal space, like a mandala. The meaning is clear. Further evolution rests in the soul of man. We must, by our own volition and will, obtain the unconscious and the conscious, the timeless and the evanescent. We must each journey to our own centers, and wake old gods, or perhaps create new ones.

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