Too noisy to think: Infant learning lags

Several recent studies have indicated that school-age children suffer academically when their classrooms are exposed to excessive noise. But it has been unclear whether noise interferes with hearing in the classroom or whether it actually interferes with the fundamental cognitive and intellectual processes involved in learning. According to a new study by a Purdue University psychologist, noise can take its toll at a very basic level, inhibiting the development of mental skills at a very early age: Even excessive household noise may delay cognitive growth in infants as young as 7 months and lead later on to significant behavioral and language deficits.

Theodore D. Wachs, speaking at the meeting of the American Psychological Association in Washington, D.C., this week, reported evidence of a strong connection between a high level of ambient household noise and intellectual deficits at several stages of infant development. Wachs used home observers to rate the level of noisiness from all sources (appliances, televisions and stereos, etc.) in the homes of infants from 7 to 22 months old. He then tested the infants' cognitive development and found that in cases where the noise level at home was high, infants showed various delays in sensorimotor development (or primitive cognitive development) throughout the first two years of life.

Specifically, 7-month-old infants exposed to excessive noise were below normal in gestural imitation of adults — an early indicator of intellectual progress — and in their manipulation of physical objects. These delays persisted at 15 months (especially in homes where the television was often left on), and at 18 months infants in noisy homes showed deficits in foresight and in their comprehension of size, distance and space. At 22 months, infants began to show deficits in imitative verbal behavior that precedes language development.

To further explore the link between environmental noise and early cognition, Wachs did additional studies to investigate the connection between noise and language development. He found that infants exposed to excessive noise at 6 months showed significant verbal delays at 24 months, suggesting that early habituation to noise may deprive the infant of valuable stimulation for linguistic development. He also found that early exposure to noisy environs led to delays in exploratory behavior. This finding, Wachs says, points to an alternate explanation of the cognitive deficits — that high levels of noise interfere with attention and thus disrupt the normal development of curiosity.

Interestingly, when Wachs expanded his study, he found that noise-related intellectual delays persisted at 24 months and 31 months — but only in males. Males apparently have a lower threshold for auditory confusion, Wachs says — a finding that is in accord with the established view that males are biologically more vulnerable to stress.

Wachs discovered, finally, that infants differ in their sensitivity to noise and that this difference is closely related to temperament. He found that infants who are temperamentally "difficult" show significant cognitive delays at 6 months when exposed to noisy surroundings, while "easy" infants show no such delays. Difficult infants, Wachs says, seem to be more sensitive to negative aspects of their environment, while easy infants are more responsive to social interactions. Wachs concludes that it is time to reject the popular notion that the more stimulation an infant receives, the better he will progress intellectually; too much stimulation can be as damaging as too little, he says, especially for males and for more temperamental babies.

Whether or not these findings can be generalized to later childhood is unclear; at least one study suggests that noise may affect school-age children somewhat differently. New York University psychologist Priscilla Hambrick-Dixon studied 5- and 6-year-olds in five Bronx daycare centers, three of which were exposed to a high level of noise from nearby train traffic. Testing the children for "visual vigilance" — a measure of attention — she found that while children in the noisy centers did more poorly after two years in daycare, they actually performed better than children in the quiet centers for the first two years. According to Hambrick-Dixon, it is possible that the demands of adapting to a noisy environment may cause children to develop certain cognitive strategies (selective attention and persistence) more quickly. Prolonged exposure to excessive noise, however, may lead to a sense of helplessness and lack of control, which impairs attention and higher intellectual functioning, she says. Normally, children develop attentional skills steadily over time, so precocious development in a noisy classroom might be viewed as an aberration of normal intellectual growth rather than a true benefit, she concludes.

Hambrick-Dixon also reported, contrary to the findings of Wachs, that the differences in noise-related cognitive development held only for girls. And the girls' performance was most significantly affected by noise when they were performing verbal tasks — a finding that, Hambrick-Dixon suggests, may be related to sex differences in the brain's processing of verbal and non-verbal information.

—W. Herbert

The bubble that could make us vanish

The vacuum may get us if we don't watch out. And we really can't watch out. Such is the message of a short paper in the Aug. 12 NATURE by two very theoretical physicists, Michael S. Turner of the University of Chicago and Frank Wilczek of the University of California at Santa Barbara. We may, suddenly, find ourselves and our kind of physics wiped out, they suggest, because evolution of the universe has already gone into a lethal, blind alley.

"Vacuum" in the language of physical field theory does not mean an absence of matter so much as an absence of energy. The vacuum is the lowest energy state in physics. Anything that exists as a particle represents as long as it exists a fluctuation of energy above that minimum level. Physics is played out above the vacuum level by various kinds of fluctuations interacting with one another.

One of the things learned early in the study of physics is that energy scales are relative: What is zero on one scale may not be zero on another. In fact Turner and Wilczek find that the equation for the potential energy of the universe (which is what determines the value of the vacuum) may have not one well-defined minimum (which would be *the* vacuum) but several local minima separated by rises like a rollercoaster with several dips. Only the lowest of these dips would be the true vacuum, the base level on which to erect a stable physics. The others would be metastable, subject to decay or disruption, a catastrophic dropping out of the bottom, so to speak.

In physics things always tend to the lowest energy level, and one might suppose that the actual universe would be based on the true vacuum no matter what mathematical possibilities there might be. But considerations of cosmological evolution lead Turner and Wilczek to suggest that the universe as it evolved might not have gone straight for the true vacuum but might now be hung up in one of the false ones waiting for the bottom to drop out. This means that our physics would be subject to sudden catastrophe. As they put it: "...without warning a bubble of true vacuum could nucleate somewhere in the universe and move outwards at the speed of light, and before we realized what swept by us our protons would decay away." Not to worry, however, or not to worry too much. They calculate the lifetime of our putative metastable vacuum against such a decay at 10^{30} years. This is about the cube of the estimated lifetime of the universe up to now (one or two times 10^{10} years), and so the probability of the bottom falling out at any given instant is extremely slight. To see it we may have to wait till the universe ages well beyond any tenure we might expect to enjoy.

—D. E. Thomsen