Appendix B: Articles on Non-auditory Effects of Noise on Children. Evans and Lepore 1993

Table 1. Effects of noise on cardiovascular outcomes

Author(s)	Outcome	Noise Source/Level	Sample Population (*n*)	Basic Result
		Chronic noise		
Brackbill et al. (1982)	HR	1 h white noise for 4 consecutive days. 50 and 75 dBA.	(78 males) ages 1 mon. to 80 yrs.	In infants and 8-year olds, HR decreased as sound levels increased. No other main or interactive effects of noise.
Cohen et al. (1980)	BP	Aircraft. 95 dBA peak.	(262) grades 3 – 4.	Noisy-school children had higher SBP and DBP than quiet-school children.
Cohen et al. (1981)	BP	Aircraft. 95 dBA peak.	(163) grades 3 – 4, longitudinal sample.	In the longitudinal attrition sample, there were no effects of noise on BP.
Cohen et al. (1986)	BP	Aircraft. 16 dBA sound reduction in noise-abated classrooms.	(163) grades 3 – 4, longitudinal sample.	SBP marginally lower and DBP significantly lower in quiet- than noisy-school children. SBP and DBP marginally lower in quiet- than noise-abated school children. No BP differences in children in noisy *vs.* noise-abated school.
Cohen et al. (1986)	BP	Aircraft. 95 dBA peak.	(165) grade 3, new sample.	Noisy-school children had higher BP than quiet-school children if were enrolled for 2 yrs or less. No noise effects on children enrolled more than 2 yrs.
Karsdorf & Klappach (1968)	BP	Traffic and street. 63 – 84 phon.	(262) grades 7 – 10.	Children in quiet schools had normal BP; whereas those in moderately- to very-noisy schools had elevated BP, especially among older boys.
Ising et al. (1990)	BP	Low altitude military flights. 125 dBA peak/Leq 68 dBA.	(433) ages 10 – 13 yrs.	Noise-related increases in SBP and DBP for girls, but not boys. Noise-related HR deceleration in boys and girls, but deceleration only significant in boys.
Karagodina (1969)	BP	Aircraft. 112 dBA peak/Leq 58 dBA.	(unavailable) ages 9 – 13 yrs.	Noisy-school children had higher BP than quiet-school children.
Roche et al. (1982)	BP	Self-report of exposure to loud noise sources. 80 – Leq.	(233) ages 12 – 14 yrs.	Self-reported noise exposure levels not associated with BP.

Note: HR = heart rate, BP = blood pressure, S = systolic, D = diastolic.

Table 2. Effects of noise on motivation (learned helplessness)

Author(s)	Outcome	Noise Source/Level	Sample Population (*n*)	Basic Result
		Chronic noise		
Cohen et al. (1980)	Performance on moderately difficult puzzle after pretreatment with insoluble or soluble puzzle.	Aircraft. 95 dBA peak.	(262) grades 3–4.	Noisy-school children failed more on pretreatment soluble puzzle and difficult test puzzle, and were more likely to give up on difficult puzzle, than quiet-school children. There was a nonsignificant trend suggesting that longer exposure to a noisy school was associated with greater time to complete difficult puzzle.
Cohen et al. (1981)	Performance on moderately difficult puzzle.	Aircraft. 95 dBA peak.	(163) grades 3–4, longitudinal sample.	Noisy-school children were more likely to fail at the test puzzle and to take longer to solve the puzzle than quiet-school children. No noise effect on rate of giving up.
Cohen et al. (1981)	Performance on moderately difficult puzzle.	Aircraft. 16 dBA sound reduction in noise-abated classrooms.	(163) grades 3–4, longitudinal sample.	Sound attenuation improved children's performance on the original test puzzle.
Cohen et al. (1986)	Performance on moderately difficult puzzle.	Aircraft. 95 dBA peak.	(165) grade 3, new sample.	Noisy-school children failed difficult puzzle more frequently than did quiet-school children.
Cohen et al. (1986)	Choice task.	Aircraft. 95 dBA peak.	(165) grade 3, new sample.	Noisy-school children more likely than quiet-school children to give choice of reward to experimenter.
Moch-Sibony (1984)	Rosenzweig frustration tolerance test.	Aircraft. 29 *vs* 54 SIL.	(80) kindergarten.	Noise-related decreases in frustration tolerance.
Wachs (1987)	Observer ratings of mastery-oriented play behavior.	Ratings of noise: 1 = normal level voices in home for 15 min. period to 4 = noisy level voices in home for more than half 15 min. period.	(88) 12 mon.	Less mastery-oriented play behavior in noisier homes.

Note: SIL = speech interference level.

Table 4. Effects of noise on auditory discrimination/speech perception

Author(s)	Outcome	Noise Source/Level	Sample Population (*n*)	Basic Result
		Chronic noise		
Cohen et al. (1973)	WAD	Traffic and street. 55–66 dBA.	(54) grades 2–5.	Noise associated with poorer auditory discrimination.
Cohen et al. (1980)	WAD	Aircraft. 95 dBA peak.	(262) grades 3–4.	No effects of noise on auditory discrimination.
Cohen et al. (1986)	WAD	Aircraft. 95 dBA peak.	(165) grade 3, new sample.	No effects of noise on auditory discrimination.
Moch-Sibony (1984)	MP	Aircraft. 29 *vs* 54 SIL.	(80) kindergarten.	Noise associated with poorer auditory discrimination.
		Acute noise		
Blue & Vergason (1975)	GFW	Recorded sounds (unspecified). 55 dBA.	(34) grades 1,3.	Race × Noise interaction: Black children's performance affected more negatively by noise than was white children's performance.
Nober & Nober (1975)	WAD	Recording of classroom noise *vs* ambient noise. 39.5–64.7 dBA.	(39) ages 5–7 yrs (healthy control, retarded, and speech-deficit).	Fewer errors when tested in quiet *vs*. normal classroom noise levels. Control and retarded children performed worse in noise than in quiet; speech-deficit group performed worse in noise than in quiet, but the effect was not significant.
McCroskey & Devens (1977)	WAD	Classroom noise recording. 4 dBA above ambient classroom noise	Unavailable.	Noise associated with decrements in auditory discrimination.
Glenn et al. (1978)	Speech discrimination	Recorded hospital sounds. 75 dB SPC (typical for hospitals).	(21) ages 9–14 yrs (institutionalized MR).	Noise mask significantly degraded speech discrimination.
Laraway (1985)	Digit discrimination	Intermittent white noise. 80 dB SPC.	(46) ages 5–21 yrs (CP, healthy controls).	Noise mask degraded performance of CP children but not controls. Noise effects greatest in younger (< 7 yrs) children.
Laskey & Tobin (1973)	Message comprehension	Speech and white noise. 74 dB SPC.	(22) ages 6–8 yrs (possible LD, non-LD controls).	Speech, but not white noise, interfered with auditory message comprehension in LD children. Control children unaffected by noise.

Note: WAD = Wepman auditory discrimination test, GFW = Goldman-Fristoe-Woodcock auditory discrimination task, MP = Massiot Phillips auditory discrimination test, SIL = speech interference level, LD = learning disabled, CP = cerebral-palsied, MR = mentally retarded.

Table 5. Effects of noise on resistance to auditory distractors

Author(s)	Outcome	Noise Source/Level	Sample Population (*n*)	Basic Result
		Chronic noise		
Cohen et al. (1980)	Cross-out letters in ambient or distracting (story recording) condition.	Aircraft. 95 dBA peak.	(262) grades 3–4.	Noise × Month enrolled interaction: with less than 2 yrs enrollment, noisy-school children performed better than quiet-school children under distraction. Between 2–4 yrs enrollment, no noise effects. With more than 4 yrs enrollment, noisy-school children performed worse than quiet-school children.
Cohen et al. (1981)	Cross-out letters in ambient or distracting condition.	Aircraft. 95 dBA peak.	(163) grades 3–4, longitudinal sample.	With 2–4 years enrollment, noisy-school children were less distracted than quiet-school children. With more than 4 yrs enrollment, performance was nearly the same across conditions.
Cohen et al. (1986)	Cross-out letters in ambient or distracting condition.	Aircraft. 95 dBA peak.	(165) grade 3, new sample.	Children attending noisy schools for 2–4 yrs were less distracted than their quiet-school counterparts. However, after 4 yrs enrollment, performance was nearly the same across conditions.
Cohen et al. (1981)	Cross-out letters in ambient or distracting condition.	Aircraft. 16 dBA reduction in noice-abated classrooms.	(163) grades 3–4, longitudinal sample.	No effects of noise abatement on distractibility.
Hambrick-Dixon (1986)	Weschler IQ task and match animals with color disks in quiet or noise conditions.	Train. 108 dBA peak.	(109 black) ages 4–6 yrs.	Children from noisy daycare performed better in noisy than in quiet conditions. The opposite was found for children from quiet daycare centers.
Heft (1979)	Figure discrimination in matching task in quiet or noise.	Story reading. Noise ratings: 1 = low to 7 = high.	(94) ages 4–7 yrs.	Auditory distraction had less of a negative effect on children from noisy homes than on children from quiet homes.
		Acute noise		
Turnure (1970)	Performance and glances away from a visual discrimination task.	Recording of child songs/stories. 60 dBA.	(30) ages 5.5, 6.5, 7.5 yrs.	No noise effects on glances, but performance worse in noisy than in quiet conditions.
Steinkamp (1980)	Multiple perceptual and cognitive tasks.	Classroom sounds and gadgets. Ambient noise.	(24) ages 6–8 yrs (hyperactive, non-hyperactive controls).	Classroom noise and distracting visual materials caused deficits on most tasks. No interaction with hyperactivity.

Table 6. Effects of noise on memory

Author(s)	Outcome	Noise Source/Level	Sample Population (*n*)	Basic Result
		Chronic noise		
Hambrick-Dixon (1986)	Serial, incidental, visual, paired-associates learning.	Train. 108 dBA peak.	(109 black) ages 4 – 6 yrs.	No noise effects.
Heft (1979)	Incidental memory of visual stimuli.	Noise ratings: 1 = low to 7 = high.	(94) ages 4 – 7 yrs.	Higher household noise level associated with poorer incidental memory.
		Acute noise		
Fenton et al. (1974)	4 number digit-span.	White noise. 22 – 72 dBA.	(10 male) ages 9 – 11 yrs (LD and non-LD).	More errors made in the high noise than in the low noise conditions.
Hygge (1993)	Recall and recognition of reading passage.	Recorded simulations of aircraft, train, traffic, and verbal noise. 66 – 76 dBA.	(417) ages 12 – 14 yrs.	Within-subjects analyses revealed a marginal Noise × Source interaction: recall on difficult questions was lower among children in aircraft and traffic noise conditions than in control conditions; no differences in recall in train and verbal noise conditions relative to control condition. Between-subjects analyses also revealed a Noise × Source interaction: recall on difficult questions was lower among children in aircraft noise conditions than in controls; other noise sources did not affect recall. No noise effects on recognition task. Individual differences in learning ability did not moderate noise effects.
Johansson (1983)	Paired-associates learning and letter memory.	White noise. 51 dBA continuous; 55 – 78 dBA intermittent.	(66) age 10 yrs.	No noise effects.

Note: LD = learning disabled.

Table 7. Effects of noise on intellectual achievement

Author(s)	Outcome	Noise Source/Level	Sample Population (*n*)	Basic Result
		Chronic noise		
Bronzaft (1981)	Reading.	Train. 6–8 dBA sound reduction in noisy classrooms.	(955) grades 2–6.	After sound reduction with insulation on noisy side of school, students' reading scores on noisy side of school were equivalent to those of students on quiet side of school. In the year before insulation, students on noisy side of school had worse reading scores than students on quiet side of school.
Bronzaft & McCarthy (1975)	Reading.	Train. 59–89 dBA.	(161) grades 2, 4, 6.	Students' reading scores lower on noisy side of school than on quiet side, especially in higher grades.
Cohen et al. (1973)	Reading.	Traffic and street. 55–66 dBA.	(54) grades 2–5.	Noise associated with greater reading deficits in children living in apartments for 4 or more years.
Cohen et al. (1980)	Reading and math.	Aircraft. 95 dBA peak.	(262) grades 3–4.	No noise effects.
Cohen et al. (1981)	Reading and math.	Aircraft. 95 dBA peak.	(163) grade 3–4, longitudinal.	No noise effects.
Cohen et al. (1981)	Reading and math.	Aircraft. 16 dBA sound reduction in noise-abated classrooms.	(163) grade 3–4, cross-sectional.	Noise abatement results in 3rd grade only. Third graders in noise-abated classrooms performed better in math than 3rd graders in non-abated classrooms; 3rd graders in noise-abated classrooms also performed better in reading, but not significantly so.
Cohen et al. (1986)	Reading and math.	Aircraft. 95 dBA peak.	(165) grade 3, new sample.	No noise effects.
Gottfried & Gottfried (1984)	BSID, OP, MS, TELD	Noise ratings: 1 = normal level voices in home for 15 min. period to 4 = noise level voices in home for more than half 15 min. period.	(130) 12 mon. infants tested every 6 mon. up to 42 mon.	Higher household noise associated with lower scores on OP at 12–18 mon., on TELD at 39 mon., on BSID at 18 mon., and on MS scores at 42 mon.
Green et al. (1982)	Percent reading below grade level.	Aircraft. 96.2 dBA peak.	(8,240) grades 2–6.	Greater percentage of noisy-school children read below grade level. Effects strongest in higher grades.
Lukas et al. (1981)	Reading and math.	Traffic and street. 70 dBA peak.	(2500) grades 3,6 (100 classes sampled).	Reading scores lower for 3rd and 6th graders in noisier classes. Math scores lower in students in noisier 3rd grade classes, but higher in 6th grade students in noisier classes.
		Ambient classroom and community. 45–75 dBA.		Inverse correlations between community noise and math and reading scores were similar to but less consistent than those between classroom noise and math and reading scores. There also was a synergistic effect of home and school noise on reading.

Author(s)	Outcome	Noise Source/Level	Sample Population (*n*)	Basic Result
Wachs et al. (1971)	IPDS	Noise ratings: 1 = normal level voices in home for 15 min. period to 4 = noise level voices in home for more than half 15 min. period.	(102) ages 7, 11, 15, 18, 22 mon.	Higher household noise associated with lower IPDS scores.
Wachs (1978)	SB	Ratings of noise: same as Wachs et al. (1971).	(23) ages 2–3 yrs, longitudinal.	Higher household noise associated with poorer SB performance in boys, no significant effect in girls.
Wachs (1979)	IPDS	Ratings of noise: same as Wachs et al. (1971).	(31) ages 2–3 yrs, longitudinal.	Higher household noise associated with lower IPDS scores in boys and higher IPDS scores in girls.
Wachs & Gandour (1983)	IPDS	Ratings of noise: same as Wachs et al. (1971).	(100) ages 7, 11, 15, 18, 22 mon.	Higher levels of household noise associated with lower IPDS scores, particularly in fussy and irritable infants.
Michelson (1968)	Language, spelling, and math.	Home environment ratings. Scale unavailable.	(710) grades 1–5.	Noise associated with language and spelling difficulties. Noise not associated with math achievement.
Maser et al. (1978)	Reading and math.	Aircraft. 90 dBA peak.	(1917) grades 3, 5, 7, 10.	Noise associated with reading and math deficits in 7th and 10th graders, but only marginal effects on 5th graders. Children with lower aptitudes were most adversely affected by noise.
		Acute noise		
Christie & Glickman (1980)	SPM	Recorded classroom noise. 40 and 70 dBA.	(156) grades 1, 3, 5.	Noise × Sex interaction: Boys performed better in noisy than in quiet conditions; girls performed better in quiet than in noisy conditions.
Johansson (1983)	Reading and math.	White noise. 51 dBA continuous, and 55–78 dBA intermittent.	(66) age 10 yrs.	Noise × Intelligence interaction on multiplication and reading performance. Above-average intelligence children solved more multiplication problems in noise than in quiet; below-average intelligence children showed the opposite trend, but noise effects were not significant. Below-average intelligence children tended to have poorer reading speed under noise; there was little difference in reading performance between noise groups with above-average intelligence.
Kassinove (1972)	Math.	Recorded child stories and music. 70–80 dBA.	(80) grades 3,6.	No noise effects on response latency, accuracy, or time-out from task.
Slater (1968)	Reading and math.	Ambient classroom noise, music, stomping and banging, tractor-mower, or quiet crossed with taped white noise. 45–90 dBA and 50–80 dBA white noise.	(263) grade 7.	No noise effects on speed or accuracy.