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Motivational consequences of environmental stress

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Abstract

Exposure to uncontrollable stimuli produces deficits in task performance linked to learned helplessness. It is not widely appreciated, however, that many of these stimuli are environmental stressors. Both acute and chronic exposure to noise, crowding, traffic congestion, and pollution are capable of causing learned helplessness in adults and children. Pre-exposure to brief, acute environmental stressors that are uncontrollable produces learned helplessness wherein participants manifest difficulties in learning a new task because of their mistaken belief that they are incapable of influencing their environment. Another index of learned helplessness, less persistence in the face of challenge also follows acute exposure to uncontrollable environmental stressors. Finally depressed affect may co-occur with learned helplessness under certain circumstances. Field studies of chronic environmental stressors reveal parallel trends. Chronic environmental stressors also heighten vulnerability to the induction of learned helplessness by acute, uncontrollable stimuli. The potential pathway linking chronic environmental stressor exposure to helplessness and then, in turn, to mental health is an important area for future research. Furthermore, the generalizability of environmental stressor-induced motivational deficits, as well as their longevity, particularly among children, remains to be investigated.

1. Introduction

The purpose of this article is to review evidence for potential motivational consequences of exposure to environmental stressors. Motivation is an underlying psychosocial process that may provide a critical link between environmental conditions and mental health. Although there have been reviews of the mental health correlates of the physical environment, no systematic attention has been given to the physical environment and motivation (Freeman, 1984; Stansfeld, 1993; Halpern, 1995; Evans, 2001, in press). Moreover reviews on motivation in the clinical and developmental psychology literatures, respectively have completely ignored the role of the physical environment, instead focusing on personality, interpersonal relationships and social factors (Seligman, 1975; Miller & Norman, 1979; Garber & Seligman, 1980; Dweck & Elliott, 1983; Bandura, 1997; Eccles, Wigfield, & Schiefele, 1998). Only Peterson, Maier, and Seligman (1993) in their monumental book on learned helplessness make any mention of environmental stressors, and their brief note is limited to two studies. The dearth of attention to this issue is ironic given that the first human study of helplessness employed noise as the induction stimulus (Hiroto, 1974). As we show below, in the past 25 years there has been a plethora of studies linking both acute and chronic exposure to environmental stressors such as noise, crowding, traffic congestion, and pollution, to motivational deficits among human beings.

Learned helplessness provides a cogent theoretical framework for understanding the data on environmental stressors and motivation. Belief that actions on the environment produce outcomes proportionate to those actions is a critical component of human competency (White, 1959). When repeated attempts to cope with aversive, environmental conditions fail, learned helplessness may occur. Among the consequences of learned helplessness are decrements in learning new tasks, diminished feelings of control, and sometimes depressive symptomotology (Seligman, 1975; Peterson et al., 1993; Bandura, 1997).

Three different research paradigms have been used to examine the motivational consequences of environmental stressor exposure. In one paradigm, uncontrollable stressors (e.g. noise) are used to directly induce helplessness during task performance. A second group

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of studies has looked at how stressor exposure can increase vulnerability to the induction of learned helplessness by other uncontrollable stimuli. Finally, the most ubiquitous approach to studying environmental stressors and motivation has been the Glass and Singer (1972) behavioral aftereffects paradigm (Cohen, 1980) Persistence on unsolvable or difficult puzzles is monitored following exposure to environmental stressors.

2. Helplessness induction and environmental stress

2.1. Acute environmental stressors

In the first human, learned helplessness study, Hiroto (1974) examined college students performing a task under escapable or inescapable, loud noise or under quiet conditions without a task. Participants who worked under inescapable noise were less likely to successfully perform a subsequent task to avoid noise than those who had previously worked in escapable noise or were in a control group who had no noise exposure. Krantz, Glass, and Snyder (1974) independently demonstrated the same effects of inescapable noise on subsequent, noise-avoidant learning among college males. Others have replicated these findings (Winefield, Barnett, & Tiggeman, 1985; Barber, 1989). Glass (1977) found a similar pattern of results with 9–11 year old boys. Stressor exposure in most helplessness studies is comparable between the inescapable and escapable stressor conditions. This is accomplished with a yoked procedure wherein each subject in the inescapable stressor conditions is matched on the amount of stressor exposure to a prior subject who had the opportunity to terminate the stressor. This experimental control is useful because it helps demonstrate the adverse effects on motivation are due to uncontrollability rather than stressor intensity. On the other hand exposure duration is important. The negative effects of the pretreatment with inescapable noise increase as a function of exposure duration (Krantz et al., 1974).

Furthermore, the effects of uncontrollable noise on helplessness were stronger for individuals with an external locus of control (Hiroto, 1974) as well as for Type-A individuals (Krantz et al., 1974; Glass, 1977). Type-A individuals are characterized by hostility, competitiveness, time urgency, and high needs for control. Although there are not a lot of data on individual difference variables and learned helplessness in relation to environmental stressors, there are consistent trends in the general learned helplessness literature showing that control beliefs moderate vulnerability to helplessness induction (Peterson et al., 1993). People with high needs for control, external locus of control, Type A personality, and attributional styles that blame negative events on stable, internal characteristics (e.g. ability or skill) tend to elevate susceptibility to helplessness induction from uncontrollable stressors (Peterson et al., 1993).

Learned helplessness theory implies that the belief in noncontingency induced by repeated exposure to an uncontrollable stimulus should generalize (hence, 'learned') beyond the immediate situation. To test this proposition, Hiroto and Seligman (1975) replicated Hiroto (1974), adding two conditions. For some subjects the test phase consisted of word problem performance instead of noise-avoidance learning; whereas for others the induction phase incorporated exposure to unsolvable, concept formation problems. This allowed them to test the degree to which the helplessness produced by exposure to an aversive, uncontrollable situation was learned or was generalized to another, different situation (e.g. phase one inescapable noise to noise-avoidance learning in phase two or phase one inescapable noise to problem solving in phase two). As in the previous study, inescapable noise induced helplessness, whether assessed by subsequent noise avoidance learning or performance on the word problems. Furthermore, the cross modality and within modality effects were equivalent. Numerous investigators have found similar impacts of inescapable noise on subsequent, diminished task motivation utilizing moderately difficult word problems instead of noise-avoidance learning (Gatchel, Paulus, & Maples, 1975; Miller & Seligman, 1975; Gatchel & Proctor, 1976; Gatchel, Mc Kinney, & Koebernick, 1977; Eckelman & Dyck, 1979; Coyne, Metalsky, & Lavelle, 1980; Miller & Tarpy, 1991; Hatfield & Job, 1998). On the other hand, how broadly the effects of short-term exposure to uncontrollable noise generalize to other situations has been questioned (Cole & Coyne, 1977; Tiggeman & Winefield, 1978).

In addition to motivational behaviors, physiological and mood data have also been collected in conjunction with the classic learned helplessness paradigm. Consistent with Seligman's (1975) theory of learned helplessness and depression, persons exposed to inescapable noise versus no noise manifested reduced skin conductance (Gatchel & Proctor, 1976; Gatchel et al. 1977), indicative of lowered autonomic arousal. Subjects in inescapable versus escapable noise also reported feeling more depressed (Gatchel et al., 1975; Miller & Seligman, 1975; Gatchel et al., 1977). Miller and Seligman (1975) also found that the effects of inescapable noise on cognitive performance among a sample of nondepressed individuals closely resembled the performance pattern of depressed individuals when no uncontrollable noise was present. Breier et al. (1987) found a different pattern of results however. Thirty minutes of inescapable compared to escapable noise elevated rather than depressed physiological arousal yet did elevate self-reports of depression and helplessness. With the exception of the Breire et al. data, the physiological and depressive/

nondepressive comparative findings, in addition to providing corroborative evidence for uncontrollable noise exposure and learned helplessness, raise concern about possible linkages between chronic, environmental stressor exposure and depression. This concern has not been systematically investigated.

Table 1 provides a summary of empirical studies examining learned helplessness as indicated by assessments of task learning following experience with an uncontrollable environmental stressor. Table 1 and other summary tables are subdivided by stressor type plus by acute and chronic stressor exposure.

2.2. Chronic environmental stressors

A few investigators have implemented similar learned helplessness paradigms in field studies. Third and fourth grade children attending either airport noise-impacted schools or quiet schools were given moderately difficult jigsaw puzzles under quiet, well controlled conditions (Cohen, Evans, Stokols, & Krantz, 1986). Fifty three percent of children from quiet schools solved the puzzles whereas 36% from noisy schools solved them. Of particular interest to a helplessness interpretation of these findings, Cohen and colleagues found that 31% of children from noisy schools and 7% from quiet schools who failed to solve the puzzles did so because they gave up within the 4 min time allotment. Furthermore, the longer the children were exposed to aircraft noise, the stronger the link to helplessness. All of these results held with statistical controls for socio-economic status. The giving up data suggest the association between chronic noise exposure and children's puzzle performance is not caused by cognitive deficits or learning problems. Giving up seems like an unambiguous index of helplessness.

The most detailed, programmatic look at chronic environmental conditions and learned helplessness has been undertaken by Baum and colleagues in a series of studies of crowding in college dormitories. Students randomly assigned to more crowded dormitories when participating in small group interaction games were more likely to engage in passive, withdrawal strategies; whereas their relatively uncrowded counterparts were more apt to behave either cooperatively or competitively (Baum & Valins, 1977). Subsequent, longitudinal studies over the course of the initial year in the dormitory revealed an interesting temporal course to the development of these more passive, withdrawal strategies among crowded dormitory residents (Baum, Aiello, & Calesnick, 1978; Baum, Gatchel, Aiello, & Thompson, 1981). At the beginning of the semester, crowded dormitory residents interacted in the game in a competitive manner, exhibiting little cooperation or withdrawal. Uncrowded residents were about equally cooperative or competitive in their game playing strategies. However by the end of the first semester, the behaviors of the crowded residents had shifted markedly, matching the high levels of withdrawal and disengagement found in the previous study (Baum & Valins, 1977). Over the same time period, the mixed profile (cooperative or competitive) of the uncrowded residents remained similar. Of further interest to the crowding and helplessness model, the changes in game playing strategies of the crowded dorm residents over the course of the semester closely paralleled shifts over the same time period in residents' perceptions of their abilities to regulate social interactions in the dormitory.

Baum, Calesnick, Davis, and Gatchel (1982) also found individual differences in vulnerability to the induction of helplessness from residential crowding. Persons tolerant of high levels of environmental stimulation were better able to regulate social interaction in the crowded dorms and did not manifest helplessness behaviors in the group interaction games. Crowded students intolerant of high levels of stimulation were more susceptible to helplessness from residential crowding. Interestingly students intolerant of stimulation also perceived the dormitory as more crowded. This interactive pattern of stimulation tolerance and resiliency to crowding fits with research showing that individual differences in tolerance of stimulation interacts with stimulation levels in different settings to predict preference and affective responses. Persons high in stimulation tolerance reacted less negatively to very high information load environments, including crowded settings, in comparison to individuals low in stimulation tolerance (Mehrabian & Russell, 1974).

Baum and colleagues program of crowding research is important because it replicates laboratory findings in the field both with cross-sectional and longitudinal data. Furthermore participants were randomly assigned to varying levels of crowding in these field studies. Moreover, the data demonstrate concordance between behavioral and self-report measures of helplessness. It is also important to note a procedural aspect of the group game procedures. The group prisoner dilemma games were conducted with strangers, outside of the dormitory, and under low-density conditions. Therefore the behaviors and feelings of helplessness developed in reaction to chronic residential crowding had generalized widely both to social interactions with other people and to settings that were not crowded. This speaks to a central tenet of helplessness theory—namely that behaviors generalize from one set of uncontrollable stimuli to other venues. Finally, Baum's program of research demonstrates a theoretically plausible personality characteristic, stimulation tolerance, that accounts for individual differences in reactivity to residential crowding. Table 1 provides a summary of empirical results examining chronic environmental stressor exposure and behavioral outcomes indicative of learned helplessness.

Table 1
Helplessness induction and environmental stress

Author	Sample size	Independent variables	Motivation measure	Results		Comments
Stressor=acute noise						
Hiroto (1974)	96 college students	*E*	Percent not reaching anagram solution criterion	$E = 8$	Percent trials failed to escape	Interaction of locus of control, externals more vulnerable to LH
		I		$I = 34$	$E = 13$	
		Q		$Q = 8$	$I = 50$	
					$Q = 11$	
Krantz et al. (1974)	24 college students	*E*	Response latency in seconds during test trials to avoid noise	$E = 5.85$		Effect stronger over trials. Type A subjects react to stress by trying to escape, Type B subjects react by giving up initially but over time more LH among Type A
		I		$I = 8.45$		
Gatchel et al. (1975)	30 college students	*E*	Mean number of trials to reach criterion for anagram solutions	$E = 10.1$	Mean number of failures	
		I		$I = 16.3$	$E = 5.8$	
					$I = 12$	
Hiroto and Seligman (1975)	96 college students	*E*	Mean number of trials to reach criterion for anagram solutions	$E = 10$		
		I		$I = 14$		
		Q		$Q = 15$		
Miller and Seligman (1975)	57 college students	*E*	Mean number of trials to reach criterion for anagram solutions	$E = 2.92$	Mean number of failures	Depressed subjects needed more trials to reach criterion
		I		$I = 5.58$	$E = 2.04$	
		Q		$Q = 2.61$	$I = 2.75$	
					$Q = 1.86$	
Gatchel and Proctor (1976)	48 college students	*E*	Mean number of trials to reach criterion for anagram solutions	$E = 11.5$	Mean number of failures	
		I		$I = 15.6$	$E = 6.2$	
		Q		$Q = 13.4$	$I = 12.1$	
					$Q = 8.0$	
Cole and Coyne (1977)	80 college students	*E*, *I*	Mean number of trials to reach criterion for anagram solutions	$ES = 12.8$, $IS = 13.2$		
		Similar (*S*) or dissimilar (*D*) condition during induction and testing phase		$ED = 13.3$, $ID = 12.7$		

Gatchel et al. (1977)	18 depressed	E	Mean number of trials to reach criterion for anagram solutions	$E = 9.95$	Mean number of failures	Depressed subjects required more trials to reach criterion
	18 nondepressed students	I		$I = 16.55$	$E = 4.8$	
		Q		$Q = 14.55$	$I = 12$	
					$Q = 8.4$	
Glass (1977)	88 fourth graders	E, I	Response latency in seconds during test trials	$E = 3.0$		Type B subjects more vulnerable to LH
				$I = 5.8$		
Tiggeman and Winefield (1978)	60 college students	E, I, Q	Mean number of trials to reach criterion on dissimilar task	$E = 9.2$	Mean number of trials to reach criterion on similar task	
		Similar or dissimilar condition during induction and testing phase		$I = 8.3$	$E = 4.7$, $I = 12.5$, $Q = 4.6$	
				$Q = 11.6$		
Eckelman and Dyck (1979)	70 college students	E, I, Q	Mean number of trials to reach criterion for anagram solutions	$E = 9.30$, $I = 16.60$, $Q = 13.10$		LH attenuated if subjects given practice trials
Coyne et al. (1980)	108 college students	E, I, Q	Mean response latency on anagram task	$E = 19.25$	Mean failure to solve anagrams	
		followed by attention redeployment (imagination)		$I = 44.64$	$E = 2.15$, $I = 4.76$	
				$Q = 27.20$	$Q = 2.22$	
Winefield et al. (1985)	60 college students	E, I	Mean number of failures on test response measure	$ES = 0$, $IS = 2$	Mean latency on test response measures	
		Success (S), average (A) or failure (F) feedback		$EA = 1$, $IA = 2.4$	$ES = 1.24$, $IS = 1.63$	
				$EF = .10$, $IF = .40$	$EA = 1.62$, $IA = 1.83$	
					$EF = 1.14$, $IF = 1.43$	
Barber (1989)	130 college students	E, I	Trials to escape three successive tones	$I > E$		Ten pre-training trials only significant LH effect
		Length of pre-training (5, 10, 15, 20, 25 or 30 trials)		(Means not provided)		
	100 subjects	E, I	Trials to escape three successive tones	$I > E$		LH effect stronger with high vs. low task motivation
		Length of pre-training (10 or 30)		(Means not provided)		
Miller and Tarpy (1991)	24 college students	E, I	Mean number of trials to reach criterion for anagram solutions	$E = 10.6$	Mean number of trials for noise escape task	Helplessness subjects inescapable noise performed worse on later tasks
		or control group with noise but no task performance		$I = 17.9$	$E = 9.4$, $I = 21.9$	
				Control = 14.4	Control = 13.3	

Table 1 (*continued*)

Author	Sample size	Independent variables	Motivation measure	Results		Comments
Stressor=chronic noise						
Cohen et al., 1986	262 3rd-4th graders	Airport noise (AN) and quiet schools (Q)	Percent giving up on unsolvable puzzle	$AN = 31$	Failure rate (%)	Longer exposure to chronic noise, the greater the LH effect
				$Q = 7$	$AN = 53$, $Q = 36$	
	165 3rd graders	Airport noise (AN) and quiet schools (Q)	Failure rate (%)	$AN = 55$		
				$Q = 40$		
Stressor=chronic crowding						
Baum and Valins (1977)	64 college students	Crowded (C) or uncrowded (UC) college dormitories	Percentage helpless/ withdrawal responses in group social interaction game	$C = 22$, $UC = 11.5$		
Baum et al. (1978)	60 college students	Crowded (C) or uncrowded (UC) college dormitories	Percentage helpless/ withdrawal responses in group social interaction game	$C = 22.33$, $UC = 11.67$		Longer exposure to crowded dormitory, the greater the helpless/ withdrawal behaviors
Baum et al. (1981)	college students	Crowded (C) or uncrowded (UC) college dormitories	Number of helpless/ withdrawal responses in group social interaction game	$C > UC$	Percent of unresolved problems in dormitory attributed to the environment vs. the self	Longer exposure to crowded dormitory, the greater the helpless/ withdrawal behaviors. Corresponding increase in environmental attributions for unresolved problems
				(Means not provided)	$C > UC$ (Means not provided)	
Baum et al. (1982)	214 college students	Crowded (C) or uncrowded (UC) college dormitories	Percentage helpless/ withdrawal responses in group social interaction game	$C = 22$		Crowding impacts stronger for people less adept at screening out low priority information (non-screeners) vs. screeners. Moreover the interaction between crowding and screeners on helpless behaviors grows stronger over the course of the 20 trial game
				$UC = 11$		

E = Escapable noise, I = Inescapable noise, Q = Quiet.

If prolonged exposure to crowding induces helplessness as manifested by decreased persistence on tasks, one would also expect to find self-reports of feelings of helplessness or lack of control over the environment. Baum and colleagues found in their series of dormitory studies that residents of more crowded dormitories felt less control over the dormitory environment, particularly with respect to their ability to regulate social interaction. Several other crowding studies have replicated these perceived control findings (Baron, Mandel, Adams, & Griffen, 1976; Ruback & Carr, 1984; Ruback, Carr, & Hopper, 1986; Lepore, Evans, & Schneider, 1992). Fleming, Baum, and Weiss (1987) also showed that persons living in more crowded neighborhoods, independent of social class, perceived less control over their neighborhood environment and felt helpless more often than their uncrowded counterparts.

2.3. Summary

Acute exposure to inescapable noise induces learned helplessness in human beings. As shown in Table 1, this has been found in 14 studies but not replicated in three. Two chronic noise studies replicate the majority of the acute studies. Four studies suggest chronic exposure to crowded living conditions have similar adverse impacts on helplessness (see Table 1).

3. Environmental stressors and vulnerability to helplessness induction

3.1. Acute environmental stressors

A second research paradigm has been used to examine motivational consequences of environmental stressors. The previous laboratory studies employed inescapable noise to induce helplessness directly. The field studies of noise and crowding discussed above examined the correlations between chronic exposure to an uncontrollable environmental stressor and motivation while performing a task or engaged in a group problem solving game. Rodin (1976) reasoned that chronic exposure to uncontrollable, environmental stressors like crowding could also alter susceptibility to the induction of helplessness. Thus she exposed a group of adolescents to concept formation problems with or without false performance feedback. Following this initial induction phase, all participants were given similar concept formation problems but with accurate performance feedback. Consistent with earlier work by Hiroto and Seligman, random feedback about performance successfully induced helplessness. Of particular interest to research on environmental stressors, these helplessness effects were substantially stronger among adolescents when examined under crowded versus uncrowded, laboratory conditions. Similar results were uncovered among middle class college students (Kuykendall & Keating, 1984) (see Table 2).

3.2. Chronic environmental stressors

Elementary school children residing in identically designed, low income public housing were exposed to an operant conditioning procedure in a quiet, uncrowded setting. Residential crowding (people per room) was negatively related to self-selected rewards and positively related to experimenter-selected rewards (Rodin, 1976). Relinquishment of self-selected rewards is viewed as an indicator of learned helplessness. Evans, Lepore, Sejwal, and Palsane (1998) examined the potential for residential crowding to affect vulnerability to helplessness induction among 10–12 year children living in India. Children tried to solve a difficult geometric puzzle for 5 min and then were given a second, similar but solvable puzzle to work on. Statistically controlling for income, girls but not boys were five times more likely to give up on the second puzzle as a function of high residential density.

Maxwell and Evans (2000) found that male and female, preschool children took longer to solve a solvable puzzle, following exposure to an unsolvable puzzle, as a function of interior, daycare noise levels. A sound attenuation intervention provided the opportunity to compare two, highly similar (age, income, education) cohorts over a 1-year period from the same preschool before and after shifts in ambient noise levels.

Table 2 summarizes the empirical data on *Environmental Stressors and Vulnerability to Helplessness Induction*. Four crowding studies and one noise study reveal environmental stressor exposure can heighten vulnerability to the induction of helplessness.

4. Environmental stressors and task persistence

The most ubiquitous index of motivation in conjunction with environmental stressors is based on the behavioral aftereffects procedure introduced by Glass and Singer (1972). In the experimental version of this procedure, individuals are randomly assigned to exposure to a stressor (e.g. noise) or a nonstress condition (e.g. quiet) for approximately one half-hour. Immediately following exposure, with the stressor no longer present, the participant is given a behavioral aftereffects measure. Various aftereffect indices have been used but of clearest relevance to motivation is a task in which individuals are given a series of puzzles. Unbeknownst to participants, some of the puzzles are unsolvable. Persistence on the unsolvable puzzles is the primary index of motivation. Other aftereffects measures including proofreading, Stroop performance, and anagrams

Table 2
Environmental stressors and vulnerability to helplessness induction

Author	Sample size	Independent variables	Motivation measure	Results	Comments
Stressor=acute crowding					
Rodin (1976)	172 7th and 8th graders	Crowded (*C*), uncrowded (*UC*) laboratory experiment	Number correct on concept formation problem following solvable or unsolvable pretreatment phase	$C > UC$ vulnerability to LH induction (Means not provided)	
Kuykendall and Keating (1984)	108 college students	Crowded (*C*), uncrowded (*UC*) laboratory experiment	Visual search task following solvable or unsolvable concept formation task	$C > UC$ vulnerability to LH induction (Means not provided)	
Stressor=chronic crowding					
Rodin (1976)	32 6–9 year olds	Residential density	Amount of time out of 360 sec child spent on each component of reinforcement schedule Absence of choice yields a 180/180 split between two reinforcement options	Highest household density spent 180/180; lowest density 275/85 seconds	Strong linear gradient from highest density to lowest density
Evans et al. (1998)	281 10–12 year olds	Residential density	Percent giving up on solvable geometric puzzle following exposure to unsolvable geometric puzzle	Girls from high-density homes gave up more often (17.6%) than girls from low-density homes (3.7%). No effects for boys	
Stressor=chronic noise					
Maxwell and Evans (2000)	90 4 and5 year olds	Pre- and post-sound attenuation work in classrooms (Cohort comparison from year 1 to year 2)	Time to solve second geometric puzzle following exposure to initially unsolvable puzzle.	Quiet = 1.84 min Noisy = 2.43 min	

have been employed. How long one persists at a difficult, challenging set of puzzles seems like a more direct index of motivation since performance on the other aftereffect indicators might also reflect skill and experience.

4.1. Acute environmental stressors

Among the many stressors studied with the unsolvable puzzles, aftereffect measure, Glass and Singer frequently used noise. Two of their findings, which have been widely replicated, are of particular interest. First, unpredictable or unsignalled noise causes greater deficits in task persistence than either predictable or signaled noise. Second, the adverse effects of noise on motivation can be significantly curtailed by instilling in participants a sense of perceived control over the noise source. By providing subjects a button they can push to reduce noise exposure, the negative aftereffects of noise are significantly attenuated. As shown in Table 3, the effects of uncontrollability over noise on problem solving persistence have been replicated both by Glass and Singer (1972) plus many others (Wohlwill, Nasar, DeJoy, & Foruzani, 1976; Sherrod, Hage, Halpern, &

Table 3
Environmental stressors and task persistence

Author	Sample size	Independent variables	Motivation measure	Results		Comments
Stressor=acute noise						
Glass and Singer (1972)	48 college students	Loud unpredictable (*LU*)	Number of attempts on unsolvable puzzles	$LU = 5.00$	Percent errors on proofreading task	
		Loud predictable (*LP*)		$SU = 10.80$	$LU = 40.11, SU = 36.70, LP = 31.78, SP = 27.40$	
		Soft unpredictable (*SU*)		$LP = 22.67$	$Q = 26.40$	
		Soft predictable (*SP*)		$SP = 22.85$		
		Quiet (*Q*)		$Q = 20.60$		
	28 college students	Loud unpredictable (*LU*)	Number of attempts on unsolvable puzzles	$LU = 9.95$	$LU = 41.82$	
		Loud predictable (*LP*)		$LP = 24.35$	$LP = 29.24$	
		Quiet (*Q*)		$Q = 19.33$	$Q = 29.66$	
	42 college students	Signaled noise (*SL*)	Number of attempts on unsolvable puzzles	$SL = 11.54$		
		Uncorrelated signaled noise (*UL*)		*UL*-6.00		
		No signal (*NS*)		$NS = 4.77$		
	18 college students	Perceived control (*PC*)	Number of attempts on unsolvable puzzles	$PC = 20.84$		
		No perceived control (*NC*)		$NC = 5.44$		
	28 college students	Perceived control (*PC*)	Number of attempts on unsolvable puzzles	$PC = 18.80$		
		No perceived Control (*NC*)		$NC = 12.34$		
	20 college students	Escapable noise (*EN*)	Percent errors on proofreading task	$EN = 36.5$	Stroop performance (Reading time sec)	Noise exposure prior to motivation measures contingent (escapable) or noncontingent on performance
		Inescapable noise (*IN*)		$IN = 53.1$	$EN = 63.8$ $IN = 90.8$	
	45 college students	Perceived indirect control (*PIC*)	Percent errors on proofreading task	$PIC = 31.00$		Indirect control obtained by another subject who had a button available to terminate noise.
		No perceived indirect control (*NPIC*)		$NPIC = 49.91$		
		Together, no perceived control (*TNPC*)		*TNPC*- $= 41.08$		
		Alone, no perceived control (*ANPC*)		$ANPC = 37.92$		
Blechman and Dannemiller (1976)	40 college students	Perceived control (*PC*)	Percent errors on proofreading task	$NC > PC$		Effects stronger for longer exposure

Table 3 (*continued*)

Author	Sample size	Independent variables	Motivation measure	Results		Comments
		No perceived control (*NC*)		(Means not provided)		
Wohlwill et al. (1976)	80 college students	Uncontrollable noise (*NC*)	Time spent on unsolvable puzzles (s)	$NC = 970$		No interaction between noise and task/no task condition
		Quiet (*Q*) Task vs. no task		$Q = 1200$		
Moran and Loeb (1977)	120 subjects	Continuous, intermittent noise or quiet	Number of attempts on unsolvable puzzles	No noise effects (Means not provided)		Noise in both conditions predictable
			Percent errors on proofreading task	No noise effects (Means not provided)		
	48 subjects	Continuous noise, quiet	Number of attempts on unsolvable puzzles	No noise effects (Means not provided)		Predictable noise
			Percent errors on proofreading task	No noise effects (Means not provided)		
Sherrod et al. (1977)	60 college students	Uncontrollable noise (*NC*)	Percent errors on proofreading task	$NC = 57$	Number of trials on unsolvable puzzles	Perceived control significant overall with strongest effects for combined initiation and offset control
		Perceived noise initiation Control (*PCI*) Perceived noise offset Control (*PCO*) Perceived noise initiation and offset control (*PCIO*) Quiet (*Q*)		$PCI = 50$ $PCO = 45$ $PCIO = 40$ $Q = 31$	$NC = 22.58$ $PCI = 22.83$ $PCO = 31.83$ $PCIO = 39.25$ $Q = 38.75$	
Gardner (1978)	60 college students	Uncontrollable noise (*NC*)	Percent accuracy on proofreading task	Involuntary exposure		Significant interaction of noise condition and human subject instructions
		Quiet (*Q*)		$NC = 41.4$		$Q >$ NC in three other studies conducted prior to stricter human subject standards requiring communication re: voluntariness of exposure
		Experiment conducted with or without explicit human subject instructions re:		$Q = 44.1$		$Q =$ NC in two other studies conducted after new regulations

		voluntariness of exposure (freedom to leave at any time)				
				Voluntary exposure $NC = 44.2$ $Q = 44.8$		
Rotton et al. (1978)	80 college students	Uncontrollable noise (NC)	Number of attempts on unsolvable puzzles	$Q > NC > SC$		Task difficulty exacerbated after effects under quiet but not speech. Floor effect suspected
		Uncontrollable speech (SC)		(Means not provided)		
		Quiet (Q)				
Percival and Loeb (1980)	42 college students	Loud unpredictable (LU)	Number of attempts on unsolvable puzzles	$LU = 9.28$		
		Loud predictable (LP)		$LP = 12.64$		
		Quiet (Q)		$Q = 16.54$		
	60 college students	Loud unpredictable (LU)	Number of attempts on unsolvable puzzles	$LU = 7.93$		Multiple intensity and unpredictable noise produces greatest after effect
		White noise (WN)		$WN = 18.59$		
		Normal aircraft noise (AN)		$AN = 17.25$		
		Aircraft noise peaks only (AP)		$AP = 10.94$		
		Quiet (Q)		$Q = 19.25$		
Klein and Beith (1985)	45 college students	Loud unpredictable (LU)	Number of attempts on unsolvable puzzles	LU (difficult) = 11.5		
		Moderate unpredictable (MU)		MU (difficult) = 3.4		
		Accompanied by easy or difficult task		LU (easy) = 6.9		
				MU (easy) = 10.1		
	30 college students	Loud predictable (LP)	Number of attempts on unsolvable puzzles	LP (difficult) = 11.2, MP (easy = 12		
		Moderate predictable (MP)				
		Accompanied by easy or difficult task		LP (easy) = 6.0		
				MP (difficult) = 5.2		
	23 college students	Loud unpredictable (LU)	Number of attempts on solvable and unsolvable puzzles	$LU = 12.7$	Response time (min) to detect whether solvable or not. Solvable puzzles	
		Moderate unpredictable (MU)		$MU = 17.2$	$LU = .85, MU = .90$	
		Low unpredictable (LWU)		$LWU = 12.7$	$LWU = .85$	

Table 3 (*continued*)

Author	Sample size	Independent variables	Motivation measure	Results		Comments
		Accompanied by easy or difficult task			Unsolvable puzzles $LU = 1.45, MU = .78$ $LWU = 1.76$	
Boman (1994)	64 students	Loud unpredictable (LU)	Visual search (s) for unsolvable embedded figures	$LU = 286$		Effects of unpredictable noise only found for first, not second unsolvable embedded figure. No interaction with task difficulty during noise exposure
		Loud predictable (LP)		$LP = 360$		
Evans et al. (1996)	80 college students	Uncontrollable noise (NC), quiet (Q) Preceded by high (HS) or low stress (LS) (give speech/watch nature video)	Number of attempts on unsolvable puzzles	$NC/HS = 12.40$ $Q/HS = 20.00$ $NC/LS = 20.50$ $Q/LS = 21.20$		
	80 college students	Uncontrollable noise (NC) Quiet (Q) During final exam period (HS) or low workload period (LS) of the semester	Number of attempts on unsolvable puzzles	$NC/HS = 15.44$ $NC/LS = 24.91$ $Q/HS = 22.96$ $Q/LS = 23.16$		
Evans and Johnson (2000)	40 clerical workers	Uncontrollable noise (NC) Quiet (Q)	Number of attempts on unsolvable puzzles	$NC = 11.50$ $Q = 19.10$		Exposure to simulated open office noise for 3 h.
Stressor=chronic noise						
Moch-Sibony (1981)	80 kindergarteners	School in airport noise impact zone	Standardized frustration tolerance test (visual discrimination)	Noisy school = 13.50		
		School in airport noise impact zone with sound attenuation		Attenuated school = 12.62		
Wachs, 1987	88 one year olds	Home noise level ratings	Mastery behavior in toy play with parent	Greater noise levels less mastery (Means not provided)		Effect found for males only
Evans et al. (1995)	135 third and fourth graders	Airport noise (AN) Quiet (Q)	Number of attempts on unsolvable puzzles	$AN = 5.48$ $Q = 6.77$		
Bullinger et al. (1999)	326 3rd–5th graders at onset of study	New airport opened (NN), quiet comparison group for new airport (QN), old airport closed	Number of attempts on unsolvable puzzles	At 18 months		Effects only significant after 18 months for new airport (no differences before opening or 6

		(NO), quiet comparison group (QO)				months afterward)
				$N = 6.3$		Effects significant for old airport before closure and at both post closing measures
				$QN = 7.9$ $NO = 6.8$ $QO = 7.9$		
Haines et al. (2001)	340 4th–5th graders	Airport noise (AN)	Number of attempts on unsolvable puzzle	$AN = 5.86$	Teacher ratings of motivation (lower score means less motivation)	Differences not significant
		Quiet (Q)		$Q = 5.93$	$AN = 15.00$ $Q = 16.89$	
Evans et al. (2001)	115 4th graders	Noisy (N) and quiet (Q) residential neighborhoods	Number of attempts on unsolvable puzzles	Males		Noise only affected girls puzzle persistence
				$N = 5.54$ $Q = 4.91$ Females $N = 4.26$ $Q = 5.50$		
Stressor=acute crowding						
Sherrod (1974)	71 high school students	Crowded (C)	Number of attempts on unsolvable puzzles	$C = 17.34$		
		Crowded with perceived control (CC)		$CC = 23.11$		
		Not crowded (NC)		$NC = 27.32$		
Mackintosh et al. (1975)	20 adult students	Crowded (C)	Stroop color word task (s)	Females		Worse performance in females following exposure to a crowded setting. Opposite pattern for men. Questionnaire data suggest gender differences related to aggressive reactions to being crowded by men
		Not crowded (NC)		$C = 73.56$ $NC = 67.25$ Males $C = 69.88$ $NC = 79.30$		
Dooley (1978)	227 college students	Crowded (C)	Proofreading	Large PS		Negative effects from crowding but only for individuals with large personal space zones
		Not crowded (NC) Large personal space (PS) zone	(% errors missed)	$C = 0.44$ $NC = 0.49$		

Table 3 (*continued*)

Author	Sample size	Independent variables	Motivation measure	Results	Comments
		Small personal space (*PS*) zone		Small *PS*	
				$C = 0.39$	
				$NC = 0.38$	
Evans (1979)	100 college students	Crowded (*C*)	Number of attempts on unsolvable puzzles	$C = 10.92$	
		Not crowded (*NC*)		$NC = 12.21$	
Nicosia et al. (1979)	160 college students	Crowded with physical contact (*CT*)	Number of attempts on unsolvable puzzles	$CT = 12.3$	Means for second unsolvable puzzle
		Crowded without physical contact (*C*)		$C = 16.4$	First puzzle not significantly affected by crowding condition. Means not provided for puzzle one
		Not crowded (*NC*)		$NC = 15.2$	
Stressor=chronic crowding					
Fleming et al. (1987)	54 adults	Crowded (*C*)	Persistence (seconds) on difficult visual search task	$C = 75$	
		Not crowded (*NC*) residential blocks		$NC = 137$	
Evans et al. (2001)	40 3rd–5th graders urban	Residential density (people/room)	Number of attempts on unsolvable puzzles	Dose response function as density increases less persistence on unsolvable puzzles	
	113 3rd–5th graders rural	Residential density (people/room)	Number of attempts on unsolvable puzzles	Dose response function as density increases less persistence on unsolvable puzzles	
Evans et al. (2001)	227 3rd–5th graders	Housing quality	Number of attempts on unsolvable puzzles	Dose response function as housing quality worsens, less persistence on unsolvable puzzles	
Stressor=commuting					
Stokols et al. (1978)	100 adults	High traffic congestion (*HT*)	Number of attempts on unsolvable puzzles	Type A	
				$HT = 18.27$	
		Medium traffic congestion (*MT*)		$MT = 15.33$	
		Low traffic congestion (*LT*)		$LT = 14.45$	
		Type A/Type B		Type B	
				$HT = 10.00$	
				$MT = 16.17$	
				$LT = 11.50$	

Novaco et al. (1979)	100 adults	High traffic congestion (HT)	Number of attempts on unsolvable puzzles	Internal locus of control		
		Medium traffic congestion (MT)		$HT = 15.92$		
		Low traffic congestion (LT)		$MT = 17.92$		
		Locus of control (internal/external)		$LT = 11.92$		
				External locus of control $HT = 15.66$ $MT = 11.25$ $LT = 18.21$		
Schaeffer et al. (1988)	46 adults	High traffic congestion (HT)	Proofreading % correct	$HT = 59.5$	Stroop (number items)	
		Low traffic congestion (LT)		$LT = 72.3$	$HT = 177$	
					$LT = 202.9$	
White and Rotton (1998)	165 college students	High traffic congestion car (HTC)	Number of attempts on unsolvable puzzles	$HTC = 15.32$		
		High traffic congestion bus (HTB)		$HTB = 13.87$		
		No commuting (NC)		$NC = 31.69$		
Wener et al (2003)	29 adults	Train commute intervention to reduce commuter time and number of train changes	Proofreading	Post intervention-		Proofreading performance equivalent prior to intervention
		Experimental group (E)	% correct	$E = 61$		
		Control group (C)		$C = 55$		
	24 college students	Students randomly assigned to experimental (E) and control (C) commuting routes on different days in different orders	Proofreading	$E = 59$		
			% correct	$C = 34$		
Stressor=air pollution						
Rotton (1983)	80 subjects	Air pollution (odor) (AP)	Number of attempts on unsolvable puzzles	$NAP = APC > AP$		
		Air pollution with control (APC)		(Means not provided)		
		No air pollution (NAP)				

Moore, 1977; Gardner, 1978; Rotton, Olszewski, Charleton, & Soler, 1978; Boman, 1994). These perceived control results are important because they indicate that the uncontrollability of noise exposure is a key element in its influence on motivation. It is also important to understand that the beneficial effects of control on motivation following exposure to stressors occur even though subjects do not avail themselves of the avoidance response. The perception of control is sufficient to produce its salugenic effects. Furthermore, since behavioral control is not actually exercised, the amount of objective noise exposure for the different conditions remains constant.

It is also worth noting that Glass and Singer and several other investigators have found that while participants perceive the noise as more or less controllable as expected, they do not perceive differences in aversiveness or annoyance with the noise. This is an important and potentially practical finding. It suggests that controllability, rather than aversiveness, is the key element in linking noise to motivation. Moreover, measures in the community of citizen's annoyance with noise or other environmental problems may not be sensitive indicators of potential adverse, motivational consequences of chronic environmental exposure. Important negative outcomes of prolonged suboptimal environmental exposure may not be manifested in self-report data.

In addition to many replications of the noise by control interaction on task persistence, Sherrod et al. (1977) demonstrated that the more control participants had over noxious noise, the stronger the benefit of control. They manipulated both onset and offset control over noise. Rotton and colleagues (1978) found when a noise stimulus was speech rather than conglomerate noise (matched on sound intensity), the adverse motivational consequences were greater. Interestingly speech, even at typical conversational intensity, relative to quiet conditions, has similar motivational effects in the laboratory (Blechman & Dannemiller, 1976). Recently researchers have investigated the possible motivational consequences of low intensity, open office noise. Female clerical workers were randomly assigned to perform typical secretarial tasks for 3 h under simulated open office noise or quiet, ambient conditions. At the termination of the experimental session, women who had worked in noise attempted significantly fewer, unsolvable puzzles than women who had worked under quiet (Evans & Johnson, 2000).

As in the case of noise, several experimental studies of crowding have applied the Glass and Singer aftereffects procedure to study persistence on difficult or unsolvable puzzles immediately following short-term exposure to high density conditions. Sherrod (1974), Evans (1979), and Nicosia, Hyman, Karlin, Epstein, and Aiello (1979) all found that short-term exposure to crowding in the laboratory reduced post-stressor persistence on the unsolvable puzzles. Dooley (1978) found parallel results for the proofreading aftereffects measure. Mackintosh, West, and Saegert (1975) reported parallel results with the Stroop task (saying the color of ink of words written in contrasting colors) but only for women. Men revealed the opposite pattern of results with additional data indicating that aggressive reactions to crowding may have caused men following crowding to try harder rather than give up.

Similar to the original Glass and Singer (1972) noise study, Sherrod (1974) also demonstrated that perceived control over crowding significantly reduced its negative effects on puzzle persistence. Increasing behavioral options in a crowded field setting also diminished perceived crowding (Rodin, Solomon, & Metcalf, 1978).

Two experimental studies have examined other environmental stressors. Rotton (1983) showed that brief exposure to uncontrollable, noxious odor in the laboratory elicited similar motivational deficits in task persistence. Moreover, perceived control over odor exposure significantly attenuated the motivational deficits. Both a laboratory study and a similar naturalistic investigation revealed that multiple stressors including noise reduced task persistence on the aftereffect puzzles in comparison to persons facing only one stressor or no stressors (Evans, Allen, Tafalla, & O'Meara, 1996).

4.2. Chronic environmental stressors

Chronic environmental stressor exposure is also associated with reduced persistence on tasks. Both Stokols, Novaco, Stokols, and Campbell (1978) and White and Rotton (1998) recorded less persistence on the Glass and Singer aftereffect puzzles as a function of traffic congestion. The latter study simulated a daily commute with random assignment, replicating the data in the former, naturalistic study. Schaeffer, Street, Singer, and Baum (1988) replicated the correlation between naturalistic traffic congestion and motivation employing a different measure, the Stroop color word discrimination test. They, like Glass and Singer's (1972) noise study, found that exposure to an uncontrollable environmental stressor (traffic congestion) led people to persist for a shorter period of time on the Stroop. Wener, Evans, Phillips, and Nadler (2003) reported data from an evaluation of a public transit intervention designed to reduce commuting time for train commuters. Improved commuting efficiency was associated with greater performance on proofreading. In an experimental simulation of the real world field study (students randomly assigned to different train commuting conditions), similar gains in proofreading accuracy were found. Fleming et al. (1987) reported that residents of high-density neighborhoods exhibited less persistence on a visual search task relative to residents from nearby, low-density neighborhoods. These results occurred independently of socio-economic status. They also found that persistence degraded in proportion to length of residence in crowded neighborhoods. Furthermore, residents of more crowded neighborhoods felt they had less control over the neighborhood environment and rated themselves as more helpless relative to their uncrowded counterparts. Long term exposure to residential crowding (Evans, Saegert, & Harris, 2001a) and to inadequate housing quality (Evans, Saltzman, & Cooperman, 2001b) have also been associated with poorer task persistence on the Glass and Singer unsolvable puzzles adapted for young children. Both of these studies controlled for income.

Novaco, Stokols, Campbell, and Stokols (1979) also showed that the correlates of commuting to work on motivation were buffered by individual differences in locus of control. Those commuters with external locus of control beliefs suffered significantly greater motivational deficits on the Glass and Singer unsolvable puzzles as a function of traffic congestion. Note the parallel pattern of data to Hiroto's (1974) experimental noise and helplessness induction study. Control beliefs also moderate perceived crowding and negative affect in response to high density laboratory settings, with externals responding more negatively than internals (Mc Callum, Rusbult, Hong, Walden, & Schopler, 1979). Persons with high needs for control also respond more negatively to crowded laboratory settings (Burger, Oakman, & Bullard, 1983). The reader may recall, as well, that Krantz et al. (1974) found that individuals high in needs for control over the environment (Type A's) were more susceptible to the induction of helplessness by exposure to uncontrollable, acute noise in the laboratory.

Temporal parameters may be important in gaining a fuller understanding of the role of personality in environmental stressor exposure and motivation. Krantz et al. (1974) demonstrated that longer exposure periods within the context of a lab study were necessary to produce greater vulnerability to helplessness among those with high needs for control. Moreover although locus of control appears to moderate reactions to short-term crowding exposure, several field studies of crowding have found little or no moderating effects of locus of control on density and negative reactions (Baron et al., 1976; Wiesenfeld, 1987). Presumably despite the internal's general belief that environmental mastery is possible, given sufficient exposure to a specific uncontrollable stimulus, like residential crowding, one may lose feelings of self-efficacy over the particular stressful situation encountered (Bandura, 1997).

A few investigators have employed the Glass and Singer unsolvable puzzles paradigm in field studies of noise. Fourth and fifth grade children exposed to airport noise attempted fewer of the puzzles than children living in quiet neighborhoods (Evans, Hygge, & Bullinger, 1995). Evans, Lercher, Meis, Ising, and Kofler (2001) replicated these results in a study of 3rd and 4th grade girls but not boys living close to road and railroad traffic. Haines, Stansfeld, Job, Berglund, and Head (2001) were unable to replicate these findings, however, in a study of airport noise.

In addition to attempts on an unsolvable puzzle, Haines and colleagues also assessed teacher ratings of student motivation but again found no noise effect. All of these cross-sectional findings controlled for SES.

The adverse impacts of airport noise exposure on motivation in children have been reported in a prospective, longitudinal study (Bullinger, Hygge, Evans, Meis, & von Mackensen, 1999). Six months prior to the opening of the new Munich International Airport, six months after the new airport opening, and then 18 months later, fourth and fifth grade (at Time 1) children were tested under quiet, well controlled conditions. Eighteen months following the inauguration of the new airport, children residing in the newly noise-impacted communities showed deficits in the task relative to those in quiet areas. Prior to the airport opening, performance was equivalent. Interestingly, this longitudinal study by Bullinger et al. also showed that the effects of airport noise on unsolvable puzzles shown prior to the closure of the Munich airport (Evans et al., 1995) persisted 6 and 18 months following the airport's closure.

In the prospective study, attributional data revealed corresponding, time-related shifts in children's reasons for failure. At Time 3, children from the noisy areas were more apt to blame their failure on ability and less likely to attribute it to task difficulty than their quiet community counterparts. Internal, stable attributions for failure (e.g. blaming failure on ability) increase the likelihood of helplessness induction (Abramson, Garber, & Seligman, 1980; Miller & Norman, 1979). At the old airport where adverse aftereffects persisted following airport closure, these same attributions remained stable.

Moch-Sibony (1981) employed a standardized self-report measure of frustration tolerance in two schools near Orly airport in Paris. Kindergarten children in a school without sound attenuation scored significantly lower in tolerance for frustration than their closely matched (SES) counterparts in an attenuated school. In addition, systematic observations of mastery behaviors using a standard developmental protocol revealed that 1-year old boys who lived in noisier homes manifested more passive, less mastery oriented behaviors in comparison to children living in quieter homes (Wachs, 1987).

4.3. Nonreplications

Two laboratory studies have not replicated the effects of noise with the Glass and Singer task persistence paradigm. Moran and Loeb (1977) were unable to show any motivational effects using tape-recorded aircraft noise played at typical levels. The authors reasoned that perhaps the nonreplication was created by the predictable onset and offset patterns of aircraft noise. Recall that Glass and Singer (1972) had previously found that exposure to unsignalled noise produced motivational deficits, whereas signaled noise produced little or no impact. Thus in a second experiment the authors included both typical aircraft noise and re-engineered aircraft noise with the onset and offset periods removed (Percival & Loeb, 1980). When the noise stimuli were altered, aftereffects closely matched Glass and Singer's earlier work. These two sets of findings obviously raise questions about the potential for ambient aircraft noise to induce motivational deficits. Given the Los Angeles (Cohen et al., 1986), Paris (Moch-Sibony, 1981) and Munich (Evans et al., 1995; Bullinger et al., 1999) airport studies suggesting such impacts from chronic airport noise, one resolution could be related to duration of exposure. Continuous, daily exposure to aircraft noise, even with its predictable signal properties, remains uncontrollable. Such noise may come to represent an inescapable, aversive stimulus that one can do little either behaviorally or cognitively to cope with. Recall that both laboratory (Krantz et al., 1974) and field studies (Cohen et al., 1986; Bullinger et al., 1998) have found that greater duration of exposure to uncontrollable noise, intensifies motivational deficits. Similar duration effects were also noted in Baum's dormitory and neighborhood crowding studies (Baum et al., 1978, 1982; Fleming et al., 1987).

Glass and Singer and others using the task persistence procedure interpret lower persistence on the unsolvable puzzles as an indicator of retarded motivation. However an alternative interpretation is possible. Perhaps people give up on the puzzles because they believe (correctly) that the puzzles are unsolvable. In two laboratory experiments when participants had to perform a demanding, complex task during noise rather than an easy, simple task as employed previously by Glass and Singer, the opposite pattern of results occurred (Klein & Beith, 1985). Persistence on unsolvable puzzles increased following noise exposure relative to quiet conditions. In a third study participants again worked in the induction phase under quiet or moderate or high noise conditions. Following one of these three sound conditions, participants were given sheets depicting different variations of the geometric line drawings used in the Glass and Singer task persistence paradigm. For the quiet and high noise conditions, participants took longer to evaluate which puzzles would be unsolvable than those who had worked previously under the moderate noise condition.

Klein and Beith (1985) suggest that perhaps high noise produces overarousal and thus impairs decision making relative to the optimally aroused, moderate noise group. Unfortunately no indices of arousal were monitored by Klein and Beith. Their interpretation is further clouded by other studies that have varied task load and noise levels during the test phase of the aftereffects paradigm and found different results. Both Wohlwill et al. (1976) and Boman (1994) found no impact of task load during the test phase on number of attempts on the unsolvable puzzles but replicated the main effects of noise. Rotton et al. (1978) uncovered a more complex pattern of results. Speech caused fewer puzzle attempts than conglomerate noise at comparable sound intensities, but when participants were also informed they would be tested on the contents of the speech, even greater deficits occurred. However the addition of noise to the speech plus recall condition did not cause further declines, possibly indicating a floor effect.

It is difficult to know what to make of the Klein and Beith findings. If accurate, they indicate that when task demands are high during acute exposure to noise, deficits in task persistence will not ensue. But as indicated, three studies do not replicate this task load effect. Furthermore, Klein and Beith do not provide a satisfactory explanation for why literally more than a dozen noise studies (see Table 3) find that uncontrollable in comparison to controllable noise produces differences in task persistence. Furthermore, participants in several of these studies when queried report that the puzzles were solvable and, even more damaging to Klein and Beith's hypothesis, report this at equally high levels in relation to varying noise exposure levels. This directly contradicts Klein and Beith's hypothesis of arousal-induced shifts in subject's cognitive processing of the task. On the other hand, it is reasonable to question whether giving up attempts to solve what is in reality an unsolvable puzzles should be construed as an index of helplessness. In part the issue turns on whether participants realize the puzzles are unsolvable. There is disagreement about this.

Table 3 summarizes the data for *Environmental Stressors and Task Persistence*.

A large number of studies of acute noise (19) indicate that noise exposure can interfere with subsequent task performance that relies upon persistence. Five studies of acute noise failed to find this pattern. Five studies of chronic noise exposure show adverse aftereffects and one does not. Five studies of acute crowding and three studies of chronic crowding reveal adverse aftereffects with no contradictory data. Five studies of traffic congestion reveal the same trends with no failures to replicate. One housing quality study and one odorous air pollution study show similar findings.

5. Summary and conclusions

5.1. Summary

Three different paradigms have been employed to examine the motivational consequences of exposure to environmental stressors. The first paradigm has investigated behavioral responses on tasks following exposure to uncontrollable noise, crowding, or pollution. Pre-exposure to a period of short, acute environmental stress (noise, crowding, pollution) under laboratory conditions produces learned helplessness. Chronic, ambient stressor exposure reveals similar trends (see Table 1 for a summary). In addition to the direct effects of exposure to environmental stressors on helplessness, susceptibility to the induction of helplessness caused by exposure to unsolvable puzzles is greater among children chronically exposed to crowding or noise (Table 2). Lastly, a large number of laboratory and community studies reveal that environmental stressor exposure adversely impacts persistence on challenging tasks that demand persistence (Table 3).

In general there is consistency in findings particularly with respect to the first and third paradigm. The magnitude of the effects is also impressive, in many instances revealing three or four times greater deficits in the uncontrollable environmental stressor conditions or naturalistic situations. Several studies also show that the longer the duration of exposure to environmental stressors, the stronger the impacts on motivation. There are also a few demonstrations of theoretically compatible personality by environmental stressors interactions on motivation (e.g. greater vulnerability among externals). At the same time, few dose response functions exist and for the second paradigm, vulnerability to helplessness induction, not a lot of data are available.

The controllability of the environmental stressor is a critical factor in producing motivational deficits. When individuals perceive they can control exposure to an environmental stressor, the negative effects of the environmental stressor on motivation are substantially attenuated. There is also evidence both in the laboratory and in the field that the negative, motivational effects of environmental stressor exposure are stronger among individuals with external locus of control beliefs. Furthermore, the longer the duration of exposure to the uncontrollable, environmental stressor, the more substantial the decrements in motivation.

5.2. Conclusions

Many studies have shown that both acute environmental stressor exposure in the laboratory as well as chronic exposure in the community diminish task motivation and can lead to feelings of helplessness. Unfortunately this body of work has stopped short of testing perhaps the most critical question—are these environmentally induced deficits in motivation viable mediational processes, capable of explaining linkages between chronic environmental stressor exposure and psychological distress? The evidence for greater psychological distress in relation to chronic residential crowding is moderately strong (Gove & Hughes, 1983; Baum & Paulus, 1987; Evans, 2001) whereas for chronic noise exposure the data are equivocal (Stansfeld, 1993; Kryter, 1994; Evans, 2001). There is also evidence, as reviewed above, that both of these environmental stressors are capable of inducing behavioral and affective concomitants of helplessness. What is missing are studies directly testing whether these environmentally related indices of helplessness could, in turn, help explain linkages between chronic environmental stressor exposure and psychological distress. Both Evans and Carrere (1991) and Kluger (1998) have demonstrated that diminished control mediates the link between traffic congestion exposure and stress outcomes. Parallel findings were uncovered by Lepore, Evans, and Schneider (1992) examining residential crowding and mental health outcomes. Unfortunately none of these studies directly examined motivation. Recently, Evans et al. (2001a) attempted to test such a pathway. They found significant associations between residential crowding and indices of both psychological distress and learned helplessness in two different samples of low income, elementary school children. The linkage between crowding and psychological distress was not mediated, however, by helplessness. Clearly more research needs to test the hypothesized mediational pathway between chronic exposure to environmental stressors and adverse mental health outcomes.

Given what appear to be consistent individual differences in susceptibility to adverse motivational consequences of exposure to environmental stressors, more research should incorporate moderator variables, paying particular attention to vulnerable subgroups of the population. Females, those already depressed, individuals who tend to make internal failure attributions, persons with external loci of control, and those with high needs for environmental control (e.g. Type A) are among the groups most likely to be vulnerable to the induction of helplessness from exposure to uncontrollable environmental stressors. The potential role of cultural differences in control beliefs ought to be integrated into research on environmental stressors and motivation. All of the studies reviewed herein were conducted in economically developed, Western societies that emphasize beliefs in individual mastery and instrumental control over the environment (Shapiro & Astin, 1998). Would members of societies who tend to believe more strongly in the need for accommodation and acceptance of external forces respond similarly to repeated experiences of uncontrollable, environmental stimuli (Rothbaum, Weisz, & Snyder, 1982; Evans, Shapiro, & Lewis, 1993)?

Only one study has examined the attributions individuals make about their poor performance in reaction to an uncontrollable stressor (airport noise). More work is warranted on this topic. Given well documented links among chronic stressors, attributional style, and depression (Peterson et al., 1993), research should also examine attributional processes as possible explanatory mechanisms for the development of helplessness and possibly depression in the long term. Some research suggests, for example, that negative mental health sequelae of residential crowding, independent of SES, are caused by diminished feelings of control over the residential setting (Lepore et al., 1992).

More motivation research needs to examine a wider range of stressor intensity since nearly all studies have examined high versus low stressor conditions. Duration of stressor exposure should be examined more thoroughly as well. Several laboratory studies of noise (Krantz et al., 1974), two field studies of noise (Cohen et al., 1986; Bullinger et al., 1998) and field studies of crowding (Baum et al., 1978, 1982; Fleming et al., 1987) reveal the importance of longer exposure duration in elevating negative motivational consequences of environmental stressors. Although it has not been investigated, the generalizability of helplessness effects may be broadened as well by longer exposure duration. Recall that Baum et al. (1978, 1981, 1982) found marked evidence of the generalizability of helplessness caused by crowding in college dormitories. They showed that college students on multiple tasks experienced outside their crowded dormitory setting manifested learned helplessness. Moreover, these behaviors occurred with strangers and under uncrowded conditions.

There are important differences between the classic helplessness procedure and the task persistence, aftereffects paradigm that may have implications for motivation assessment. One, the testing phases differ. In the Seligman learned helplessness procedure, following exposure to a noncontingent or contingent stimulus, participants are confronted by *solvable* tasks; whereas in the Glass and Singer aftereffects procedure, following exposure to an uncontrollable stressor, participants are challenged by *unsolvable* puzzles. Two, the traditional helplessness paradigm explicitly instills in subjects the expectation that termination of the aversive stimulus is possible for all participants; whereas controllability of exposure to the environmental stressor in the Glass and Singer aftereffects experimental paradigm is possible for only half the participants who are provided perceived control over the stressor. The other half of subjects are given no control option. Three, termination of the aversive stimulus in the learned helplessness paradigm is contingent upon performance. In the Glass and Singer paradigm controllability is unrelated to performance. Instead controllability is made available by the presence of a switch to shut off or remove oneself from the negative stimulus.

Although the motivational performance results from the two procedures converge in a multitude of experimental and field studies, indicating that exposure to uncontrollable environmental stressors (noise, crowding, traffic congestion, pollution) is associated with diminished motivation in subsequent task performance, one noticeable difference between the two sets of findings is negative affect (Cohen, 1980). Negative affect is typically found in helplessness studies (Gatchel et al., 1975, 1977; Miller & Seligman, 1975) but rarely uncovered in the Glass and Singer (1972) task persistence, aftereffects procedure. One possible explanation could be expectancies for instrumental control that are established in the classical helplessness procedure but absent in the aftereffects procedure.

Furthermore although some classical helplessness studies have uncovered depressed physiological arousal during the test phase (Gatchel & Proctor, 1976; Gatchel et al., 1977), attempts to link measures of physiological arousal either during the induction or test phase with performance on the Glass and Singer aftereffects puzzles have proven futile (Glass & Singer, 1972; Cohen, 1980). Thus although the two procedures converge in terms of performance indicators of motivation, they clearly do not converge in measures of negative affect or physiological arousal. Self-reports of motivation during the test phase as well as indices of actual and expected control prior to the test phase could prove useful as adjunct measures for both procedures. The absence of negative affect in the Glass and Singer (1972) paradigm is important for another reason. It helps refute the possibility that the environmental stressor effects on task persistence are simply a function of annoyance.

The absence of negative affect accompanying at least some helplessness behavioral data also provokes important questions about the utility of reliance on self-report indices of annoyance or negative affect in response to environmental problems. Several studies herein have documented clear, adverse performance decrements following adverse environmental condition with no concomitant impacts on subjective feelings. Suboptimal environmental conditions may harm individuals without causing negative subjective awareness. This is not a trivial issue when one considers reliance on public opinion for many environmental impact assessments.

The construct validity of the Glass and Singer behavioral aftereffects paradigm has been challenged by Klein and Beith (1985) but as discussed does not provide a satisfactory alternative explanation for the robust stressor aftereffects. None the less this begs the larger question about helplessness and motivation. One can reasonably ask whether motivations for success or interest and ability to plan for the future are related to the inability to learn a new task or lack of persistence on challenging, often unsolvable puzzles.

Experimental work with both procedures indicates the critical role of control in motivation. In the learned helplessness procedure, the principal manipulation has been the subject's ability to escape from the stressor. In the task persistence, aftereffects procedure, experimental studies of noise, crowding, and pollution, all show that when participants believe they can control exposure to the stressor, subsequent deficits in task motivation are substantially reduced. Lab studies also indicate that control-related beliefs (e.g. locus of control) can moderate the induction of motivational deficits from exposure to uncontrollable environmental stressors. It would be valuable to attempt to tease apart the role of chronic environmental stressor exposure per se from its inherent, uncontrollable properties in studies of motivation in the community. Presumably it would be feasible to either find situations or create them where some people had or felt they had more control over a chronic environmental stressor than others. Laboratory research with both the learned helplessness paradigm and with the unsolvable task persistence paradigm would predict a control by stressor interaction on motivation.

More research is called for to assess children's motivation under poor environmental conditions at home and in school. Such work ought to also measure adult caregivers' feelings of fatigue, frustration, plus index adult caregiver's motivation. Some of the potential link between environmental stressor exposure and motivation in children may be mediated by caregivers' own reactions to these stressors. Observations of actual teaching or parenting behaviors in situ might be revealing of both affective and cognitive content. Research on noise for example has documented frequent interruptions of teaching time in noise impacted schools (Bronzaft & Mc Carthy, 1975). Parents in crowded homes, independent of social class, are less responsive to infants and toddlers (Bradley & Caldwell, 1984; Wachs, 1989; Wachs & Camli, 1991; Evans, Maxwell, & Hart, 1999). One could hardly envision a more powerful stimulus to induce helplessness in young children than nonresponsive parenting. Apropos of our earlier discussion regarding the need to examine the potential role of helplessness as a mediator of the linkages between environmental stressors and mental health, it is important to point out that numerous studies have documented negative socioemotional sequelae in young children in relation to unresponsive parenting (Bronfenbrenner & Morris, 1998). The potential role of chaotic home environments (e.g. noisy, crowded, lack of routines and rituals) for healthy motivational and emotional development in children is an important area for future research (Fiese & Kline, 1993; Matheny, Wachs, Ludwig, & Phillips, 1995; Bronfenbrenner & Evans, 2000).

Both acute and chronic exposure to uncontrollable environmental stressors, including noise, crowding, traffic congestion, and air pollution, can produce learned helplessness in adults as well as in children. In general the pattern of findings converge between true experiments in the laboratory with acute stressors and chronic environmental stressor exposure in the field. Certain subgroups of the population, particularly those with lower mastery beliefs, may be especially vulnerable to these adverse outcomes. The potential linkages between such deficits and other behavioral endpoints of concern including cognitive development (e.g. reading acquisition, scholastic achievement) or psychological well being (e.g. depression) warrant further examination. The generalizability of environmental stressor-induced, motivational deficits as well as their longevity, particularly among children, remain to be investigated.

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