SUPPLEMENT 1

Normalized Difference Vegetation Index (NDVI)

Using geographic information systems (GIS; ArcMap 10.2), we plotted x-y coordinates for each latitude (y) and longitude (x) pair, and the exported shapefiles were projected onto the same coordinate system as the NDVI GeoTiff files. An R algorithm was created to reclassify and normalize NDVI codes according to the usage information provided by the Global Agriculture Monitoring (GLAM) website. All NDVI codes ≤ 50 and > 250 were reclassified to NoData, as these were indications of either no data or bad data. Values were then normalized between 0 and 1 using the following formula:

$$\text{'Ndvi\_raw'} = (\text{'ndvi\_byte'} - 50.0) / 200.0$$

where 'ndvi_byte' was the assigned NDVI code in the GeoTIFF files.

SUPPLEMENT 2

Ambient Temperature and Relative Humidity

Meteorological data was obtained from the California Air Resources Board (CARB) Air Quality and Meteorological Information System (http://www.arb.ca.gov/aqmis2/aqmis2.php) and was preprocessed following standard practice provided by CARB by removing abnormal and extreme values. In total, data were drawn from 67 meteorological sites for ambient temperature and 73 meteorological sites for relatively humidity. Based on the historical extreme values reported in the US, values beyond the normal intervals ([-45^{o}C, 60^{o}C] for temperature; [3%, 100%] for relative humidity) were removed as abnormal values. Further, based on the data distribution, we defined the fences ([-15^{o}C, 45^{o}C] for hourly ambient temperature; [18%, 95%] for monthly relative humidity) to remove the values beyond the fences as the outlier.

SUPPLEMENT 3

Three-Level Mixed Effects Modeling

Let Y_{ijk} represent the outcome for time "k", subject "i", and twin 'j'

t_{ijk} represent age for subject i, twin j, and time k

x_{ijk}, x_{ij}, x_j represent covariates at various levels

(Assuming a linear slope; $\tilde{t} = \frac{t-c}{\Delta}$ → to focus intercept effect on a given age for a change over a Δ in age)

Level 1: $Y_{ijk} = a_{ij} + b_{ij}\tilde{t}_{ijk} + \delta_1 x_{ijk} + e_{ijk}$

Level 2: a) $a_{ij} = a_j + \delta_2 x_{ij} + e_{ij}$

b) $b_{ij} = b_j + \gamma_2 x_{ij} + f_{ij}$

Level 3: a) $a_j = \alpha + \delta_3 x_j + e_j$

b) $b_j = \beta + \gamma_3 x_j + f_j$

Combined mixed effects model:

$$Y_{ijk} = \alpha + \beta\tilde{t}_{ijk} + \delta_1 x_{ijk} + \delta_2 x_{ij} + \delta_3 x_j + \gamma_2 \tilde{t}_{ijk} x_{ij} + \gamma_3 \tilde{t}_{ijk} x_j + e_j + e_{ij} + e_{ijk} + f_j \tilde{t}_{ijk} + f_{ij} \tilde{t}_{ijk}$$

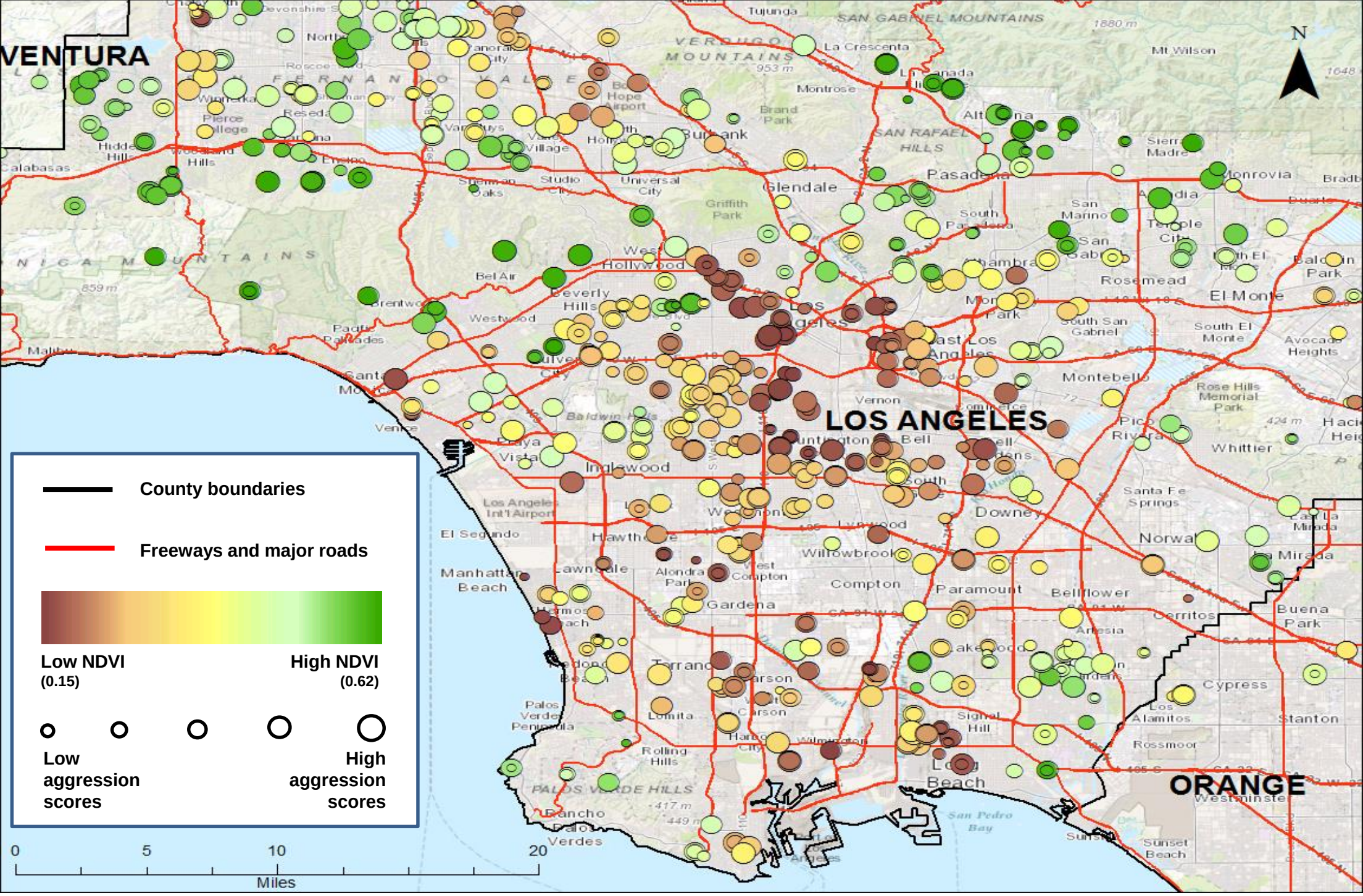

Figure S1. Geographic distribution of risk factors for antisocial behavior study residential locations at baseline in relation to neighborhood greenspace and aggressive behavior scores. Note: NDVI = Normalized Difference Vegetation Index.

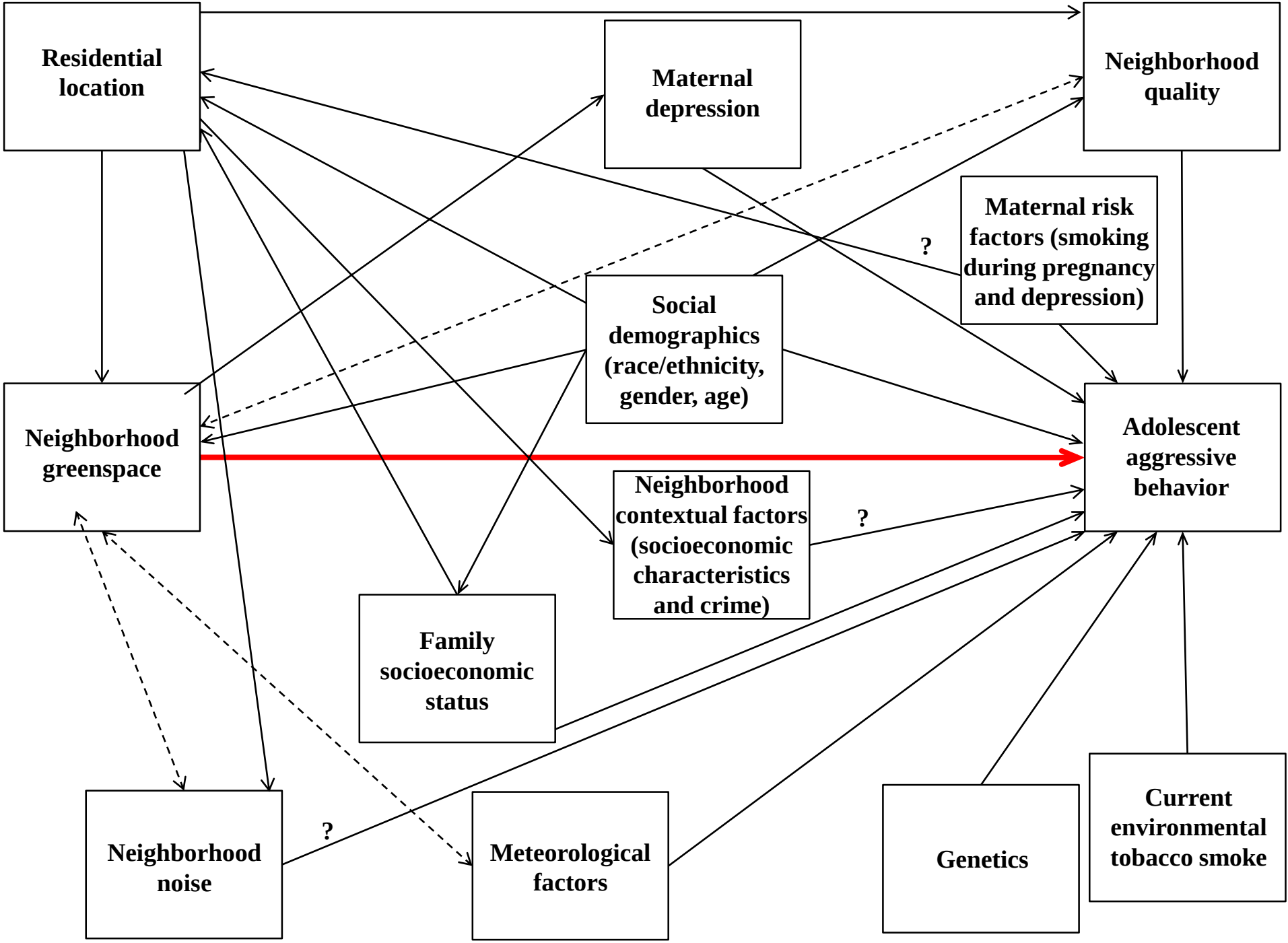

Figure S2. Directed acyclic graph of the relationship between neighborhood greenspace and aggressive behavior

Table S1. Summaries of Studies on Aggressive Behavior and Physical Environmental Factors

References/ Study Design	Population	Exposure	Outcome	Main Findings (95% CI)	Potential Confounders Adjusted/ Controlled	Conclusions
Meteorological Factors						
Baron (1972)[1] Experimental	40 male undergraduates enrolled in summer season classes at the University of South Carolina who participated in the study to attain extra points toward their course grades were randomly assigned to two levels of temperature (cool, hot) and two levels of prior anger arousal (nonangry, angry)	Subjects were asked to write a solution to a complex social problem that were then evaluated by the confederate. In the non-angry condition, the confederate gave a positive evaluation and only delivered 1 shock to the subject. In the angry condition, the confederate gave a negative evaluation and delivered 9 shocks. Variations in ambient temperature were obtained by means of air conditioners and electric heaters. In the cool condition, the average temp was 74° and in the hot condition the average temp was 93°F during all phases of the experiment	After receiving evaluations, subjects played the role of teacher and were instructed to punish the confederate by delivering an electric shock of any intensity whenever he made an error in the learning task (confederate got 20 errors).	<u>Shock Duration*</u> Effect of anger arousal: F = 4.74; p < .05 Effect of temperature: F = 4.54; p < .05 <u>Shock Intensity*</u> Effect of anger arousal: F = 7.31; p < .025 Effect of temperature: F = 3.00; p < .10 Effect of trials: F = 15.90; p < .001 *ANOVA in which temp and anger arousal were the between-subject factors and trials the within-subject factors	NA	Results indicated that uncomfortably high temperatures inhibited aggressive behavior, regardless of the level of anger arousal
Baron and Lawton (1972)[2] Experimental	40 male undergraduates enrolled in sections of elementary psychology at the University of South Carolina who participated in the study in order to fulfill a course requirement were randomly assigned	Subjects were asked to write a short essay on a solution to a problem posed by the experimenter and were then given a bad evaluation by the other subject (a confederate).	After receiving evaluations, subjects played the role of teacher and were instructed to punish the learner by delivering an electric shock of any intensity	<u>Median intensity of shocks delivered to the learner by the subject in four groups</u> Cool: No model 4.28 (2.55-8.05); Model 5.50 (1.00-8.15) Hot: No model 3.78 (1.60-6.25); Model 6.93 (2.70-8.50)	NA	The groups differed significantly in level of aggression. Exposure to the model produced significant increments in the intensity of subjects' attacks against the victim in

	to two levels of temperature (cool, hot) and two levels of exposure to an aggressive model (no model, aggressive model)	Variations in ambient temperature were obtained by means of air conditioners and electric heaters. In the cool condition, the average temp was 74° and in the hot condition the average temp was 97°F during all phases of the experiment	whenever he made an error in the learning task (confederate got 20 errors). In the no-model condition, the subject delivered the electric shocks first, and in the model condition, the confederate went first and delivered high-intensity shocks			the hot condition, but not in the cool condition. Additionally, high ambient temperatures neither facilitated aggression in the model condition nor inhibited such behavior in the no-model condition
Baron and Bell (1975)[3] Experimental	64 male undergraduates enrolled in Elementary Psychology at Purdue University who participated in the experiment in order to satisfy part of a course requirement were randomly assigned to two levels of ambient temperature (cool, hot), of prior anger arousal (non-angry, angry), and two levels of exposure to the behavior of an aggressive model (no model, model)	The subject and confederate wrote personality sketches about their own personalities that were then exchanged. Based on these sketches, both individuals were asked to rate the other on a series of traits. In the non-angry condition, the personality sketch supposedly written by the confederate suggested that he was a pleasant, modest, and friendly individual. Moreover, the ratings he assigned to the subject were quite favorable and flattering. In the angry condition, the self-description prepared by the confederate indicated that he was a nasty, conceited, and hostile	After personality sketch ratings, subjects were told to deliver an electric shock to the confederate of any intensity each time a red signal light illuminated. In the no-model condition, the subject delivered the electric shocks first, and in the model condition, the confederate went first and delivered high-intensity shocks on all occasions when the red light illuminated	<u>ANOVA examining the effects of anger, temperature, and exposure to the model</u> Anger: $F(1,56) = 45.48$; $p<.001$ Model: $F(1,56) = 7.45$; $p<.01$ Temp x Anger Interaction: $F(1,56) = 9.94$; $p<0.005$ Temp x Anger x Model Interaction: $F(1,56) = 2.93$; $p = .09$	NA	Subjects in the angry condition directed higher levels of aggression against the confederate than those in the non-angry group, and those in the model condition directed stronger attacks against this person than those in the no-model group. High ambient temperature served to facilitate later aggression by individuals in the non-angry condition but actually appeared to inhibit such behavior by subjects in the angry group. Therefore, it appears that the influence of unpleasant environmental conditions upon subsequent aggression was

		person. Further, his ratings of the subject were highly unfavorable and quite derogatory. Variations in ambient temperature were obtained by means of air conditioners and electric heaters. In the cool condition the average temp was 73° and in the hot condition the average temp was 95°F during all phases of the experiment				strongly affected by the degree of provocation previously experienced by the subjects
Baron and Bell (1976)[4] Experiment 1	35 undergraduate students (18 males, 17 females) enrolled in sections of Elementary Psychology at Purdue University who participated in the experiment in order to satisfy part of a course requirement were randomly assigned to levels of ambient temperature (cool, warm, hot) or two types of personal evaluation (negative, positive)	The subject and confederate wrote personality sketches about their own personalities that were then exchanged. Based on these sketches, both individuals were asked to rate the other on a series of traits. In the positive evaluation condition, the personality sketch supposedly written by the confederate suggested that he was a pleasant, modest, and friendly individual. Moreover, the ratings he assigned to the subject were quite favorable and flattering. In the negative evaluation condition, the self-description prepared	After personality sketch ratings, subjects were told to deliver an electric shock to the confederate of any intensity each time a red signal light illuminated. In the no-model condition, the subject delivered the electric shocks first, and in the model condition, the confederate went first and delivered high-intensity shocks on all occasions when the red light illuminated (n = 20 times). At the end of the experiment, subjects were asked to fill out a	<u>ANOVA examining the effects of personal evaluations and temperature</u> Personal Evaluations: $F(1,29) = 4.74$; $p < .05$ Temp x Personal Evaluations: $F(2,29) = 4.33$; $p < .025$	NA	High ambient temperature facilitated aggression when other sources of negative affect were absent but inhibited such behavior when another source of these feelings was present

		by the confederate indicated that he was a nasty, conceited, and hostile person. Further, his ratings of the subject were highly unfavorable and quite derogatory. Variations in ambient temperature were obtained by means of air conditioners and electric heaters. In the cool condition the average temp was 73°, in the warm condition the average temp was 85°F, and in the hot condition the average temp was 95°F	questionnaire assessing subjects' affective reactions during the study (e.g., uncomfortable-comfortable, bored-enthusiastic, and irritated-related).			
Baron and Bell (1976)[4] Experiment 2	64 male undergraduate students enrolled in sections of Elementary Psychology at Purdue University who participated in the experiment in order to satisfy part of a course requirement were randomly assigned to levels of ambient temperature (cool, hot) or two types of personal evaluation (negative, positive), and the presence or absence of a drink	The subject and confederate wrote personality sketches about their own personalities that were then exchanged. Based on these sketches, both individuals were asked to rate the other on a series of traits. In the positive evaluation condition, the personality sketch supposedly written by the confederate suggested that he was a pleasant, modest, and friendly individual. Moreover, the ratings he assigned to the subject were quite favorable and	Immediately prior to opportunity to aggress against the victim, subjects were either provided or not provided with a cooling drink. Subjects were then given the opportunity to deliver a series of electric shocks to other participants. After this participants filled out questionnaires describing their feelings while participating in the study, their anger toward the victim, and the extent to which they were	<u>Mean Level of Aggression (Transformed Shock Intensity x Duration) Delivered to the Victim by Subjects in Each of Eight Experimental groups</u> No Drink / Drink Cool / Hot / Cool / Hot Positive: 2.43_a / 3.00_b / 2.34_a / 2.48_a Negative: 3.17_{bd} / 2.60_a / 3.46_{cd} / 3.09_{bd} Means that do not share a common subscript differ significantly at the 0.01 level by Duncan's multiple-range test <u>ANOVA examining the effects of personal evaluations, temperature, and presence of a drink</u> Personal Evaluations: $F(1,56) = 8.21$; $p < .01$ Temp x Personal Evaluations: $F(1,56) = 5.23$; $p <$ x.025 Presence of a Drink x Personal Evaluations: $F(1,56) = 3.76$; $p = .054$	NA	Administration of a cooling drink decreased the influence of high ambient temperatures upon subsequent aggression

		flattering. In the negative evaluation condition, the self-description prepared by the confederate indicated that he was a nasty, conceited, and hostile person. Further, his ratings of the subject were highly unfavorable and quite derogatory. Variations in ambient temperature were obtained by means of air conditioners and electric heaters. In the cool condition the average temp was 72° and in the hot condition the average temp was 93°F	anxious for the study to end.			
Bell (1980)[5] Experimental	80 male American undergraduate students enrolled in General Psychology served as subjects as part of a course requirement	Subjects participated in pairs in a room exposed to either 70-74°F or 92-96°F temperatures (35-45% relative humidity) and to either 55 dB(A) constant background noise or to 95 dB(A) of randomly intermittent white noise bursts delivered over wall speakers	Half the subjects were not provoked and the other half were by a male experimenter who accused them of intentionally moving around to distort physiography recordings of their heart rates, then 7 min later subjects had an opportunity to retaliate against the experimenter when anonymously completing an evaluation form about the experimenter to assess hostile/ retaliatory behavior	<u>Mean Level of Pleasant and Courteous Behavior Reported by Subject</u> Anger condition: $\bar{X}$ = 50.23 No-anger condition: $\bar{X}$ = 65.48 <u>Analysis of item asking if experimenter should be reappointed as research assistant</u> Temp and Anger: $F(1,32) = 5.41$; $p < .05$ <u>A Newman-Keuls analysis ($p<.05$) on the means</u> Hot-angry condition: $\bar{X}$ = 41.50 Cool-nonangry condition: $\bar{X}$ = 61.55 Cool-angry: $\bar{X}$ = 66.75 Hot-nonangry: $\bar{X}$ = 69.15 (last 3 conditions did not differ from each other)	NA	Although heat and anger in combination produced the greatest expression of retaliatory behavior, neither heat nor noise influenced hostile behavior in the expected manner.

Kenrick and MacFarlane (1986)[6] Experimental Field Study	75 drivers (39 male, 36 female) 16-65 years old who were engaged for study participation on a Saturdays while exiting at a specific intersection from a residential area in Phoenix, Arizona during a 4-month period (spring and summer)	Continuous 24-hr graphic readings of temperature and humidity obtained from the Department of Geography to determine weather conditions at the time of each trial	For 15 consecutive Saturdays (11am-3pm) during the months of April-August a woman positioned her vehicle in the target intersection, waited for the light to turn green (set for 12-sec), and remain stationary the whole duration of the light to count the number of horn honks delivered by each subject during the 12-sec and measure the latency until first honk. Composite variable of number of honks and latency to honk was created	<u>Results of Regression Analysis Using Composite Horn Honking Criterion (All Subjects)</u> Temperature R = 0.343* Temperature-Humidity Index R = 0.35* Humidity Multiple R = 0.522 Simple R = -0.004 <u>Results of Regression Analysis Including Only Subjects With Windows Rolled Down (Composite Criterion)</u> Temperature R = 0.757 Temperature-Humidity Index R = 0.74* Humidity Multiple R = 0.846 Simple R = -0.146 (p<.05)	Humidity 'multiple R' models adjusted for window (open vs. closed), age, sex, number of cars behind subject, and passenger composition (family vs. peer)	Temperature and the termperature-humidity discomfort index were directly related to horn honking, and these relationships were even stronger for subjects who had their windows rolled down. Tests for linearity vs curvilinearity strongly suggest the temperature-aggression relationship in this study to be linear
Rule et al. (1987) [7] Experimental	32 subjects (16 men, 16 women) who believed the purpose of the study was to investigate how environmental factors such as noise, heat, and lighting might affect performance on office-like tasks	Subjects were assigned to either a normal temperature condition (21°C) or a hot condition (33°C) with relative humidity at approximately 15% in both conditions	Subjects were told that there were several different types of tasks. The first was a story stem task. Participants were given five story stems to complete. The first and last story stems were neutral and unlikely to encourage aggressive story completions. The other three items presented a context in which either an aggressive or a nonaggressive	<u>Proportion of Responses in Aggression Categories (Verbal and Physical)</u> Neural Stem Hot = 0.04 Normal = 0.04 Ambiguous Stem Hot = 0.17 Normal = 0.09 <u>ANOVA examining the effects of story and temperature on aggression scores</u> Temperature: $F(1,28) = 4.53$, $p < .05$ Story: $F(1,28) = 5.02$, $p < .05$ Story x Temp Interaction: $F(l,28) = 4.25$, $p < .05$	NA	More aggression was mentioned under the hot temperature condition with the ambiguous story stems than was obtained with neutral story stems, but this increase in aggressive content did not occur under the normal temperature condition.

			series of events was plausible. Participants were asked to complete each of the five stories by listing up to a total of 20 actions, emotions, and verbalizations that would typically occur in the incident.			
Essa et al. (1990)[8] Prospective	67 preschoolers (38 boys, 29 girls) aged 2-6 years old in a university laboratory observed for 30 min a day Mondays-Fridays during March and April, over a 5-wk period from two separate classes (2-3 yr olds and 4-6 year olds) in Reno, Nevada	24 hourly sets of data on precipitation, % of sunshine, humidity, barometric pressure, temper, wind velocity and direction, % cloud cover, and visibility from the National Weather Bureau for the days during which observations took place. Weather for each day was classified as stable (characterized by sunshine, little or no cloud cover, no precipitation, little or no wind, and stable barometric pressure), Transitional I (moving from stable to unstable), Transitional II (moving from unstable to stable), and unstable (characterized by combos of rain or snow, cloudiness, poor visibility, high wind, unstable barometric pressure,	Trained observers rated each child in 2-min rotation schedule during a 30min observation period (15 observations recorded for each child) to assess physically aggressive behavior and verbally aggressive behavior	NA	NA	No significant associations between weather type and either physical or verbal aggressive behavior

		and low temp)				
Anderson et al. (1995)[9] Experimental	107 students (males = 48, females = 59) from a large Midwestern university were randomly assigned in a 2 (low, moderate frustration) x 3 (T (comfortable, warm, and hot temperature) factorial experiment.	Participants were told to play a video game and then randomly assigned to one of the six conditions. The game room was set to one of the three temperatures: 1) Comfortable: 72-78ºF; 2) Warm: 79-86ºF; or 3) Hot: 87-94ºF. Room temp was controlled by AC and heating equipment and humidity controlled by a portable humidifier Additionally, those in the low-frustration condition were given a joystick to use to play the video game that was placed in a normal position, while those in the moderate-frustration condition were given a joystick in an inverted position.	The Perceived Arousal Scale to measure perceived arousal Multiple Affect Adjective Check List and the State Anger Scale were administered to subjects to measure state hostility 33 items from the Assault, Irritability, and Verbal subscales from the Hostility Inventory used to assess one's own hostility; 26 items from the Extreme Interpersonal Violence, Corporal Punishment of Children, and Penal Code Violence subscales of the Attitudes Toward Violence Scale and 11 Items from the Rape Myth Scale used to measure violence or aggression-related attitudes or beliefs. These were all used to calculate hostile cognition	<u>Effects on Perceived Arousal</u> Frustration: $F(1,100) = 7.56$; $p < .008$ Temperature: $F(1,100) = 3.65$; $p < .06$ Temperature x Frustration: $F(1,100) = 7.25$; $p < .01$ <u>Effects on Physiological Arousal</u> Temperature: $F(1,99) = 4.25$; $p < .05$ Frustration: $F(1,99) = 3.99$; $p < .05$ <u>Temperature's Effect on State Hostility</u> $F(1,104) = 10.15$; $p < .002$ Slope (b) = 0.80 <u>Temperature's Effect on Hostile Cognition</u> Hostile Cognition: $F(1,102) = 6.07$; $p < .02$ Slope (b) = 0.91	NA	Significant association between temperature and state hostility and hostile cognitions.
Ciucci et al. (2011)[10] Prospective	61 children (33 males and 28 females; mean age 24.1 ± 3.6 mos) attending four day-care centers in Florence	Meteorological data were collected during a 3-week period in the cold season from Jan 28 to Feb 20	Teachers observed children's behavior and filled out the DBEQ (created specifically for	<u>Multilevel Analysis of Child Aggression (SE)</u> Indoor temp (C): $\beta = 0.008$ (0.056) Indoor humidity (%): $\beta = -0.006$ (0.013) Outdoor temp (C): $\beta = -0.026$ (0.042)	NA	Significant association between outdoor humidity and aggression.

	(center of Italy) and their 11 childcare teachers (all females). Excluded residents dwelling in the neighborhood for less than 3 months	2008. Air temperature (°C), relative humidity (%), air pressure (hPa) and solar radiation (J m^{-2}) data were collected every 15 min from a weather station located in Florence city center. At the same time, air temperature and relative humidity data were collected in the classroom and in the garden of each day-care center using two weather sensors	project from the Early Childhood Behavior Questionnaire and Child Behavior Checklist) during the morning until their sleeping time five times over a period of 3 weeks in winter (teachers knew the purpose of the research but not the hypotheses)	Outdoor humidity (%): β = 0.013** (0.005) Atmospheric pressure (hPa): β = 0.015 (0.012) Solar radiation (J m^{-2}): β = -0.291 (0.176) *p<.05; **p<.01		
Ciucci et al. (2013)[11] Prospective	61 children (33 males and 28 females; mean age 24.1 ± 3.6 mos) attending four day-care centers in Florence (center of Italy) and their 11 childcare teachers (all females). Excluded residents dwelling in the neighborhood for less than 3 months	Meteorological data were collected during a 3-week period for each season in 2008 (winter: 1/28 – 2/20; spring: 3/31 – 4/18; summer: 6/9 – 6/27; no data collected for fall because there was no outcome data). Air temperature (°C), relative humidity (%), solar radiation (J m^{-2}), and rain (mm) data were collected every 15 min from a weather station located in Florence city center. At the same time, air temperature and relative humidity data were collected in the classroom and in the garden of each day-care center using two	Teachers observed children's behavior and filled out the DBEQ (created specifically for project from the Early Childhood Behavior Questionnaire and Child Behavior Checklist) during the morning activities until their sleeping time (7:30am – 1:00pm) during a 3-wk period for each season in 2008 (same times as meteorological data; no data available for fall because new children entered during this time and teachers	<u>Multilevel Analysis of Child Aggression (SE)</u> Winter Outdoor temp (C): β = 0.031 (0.044) Outdoor humidity (%): β = 0.015** (0.005) Solar radiation (J m^{-2}): β = 0.013 (0.188) Indoor temp (C): β = -0.083 (0.048) Indoor humidity (%): β = -0.017 (0.012) Spring Outdoor temp (C): β = 0.03 (0.045) Outdoor humidity (%): β = 0.005 (0.012) Solar radiation (J m^{-2}): β = 0.008 (0.088) Indoor temp (C): β = -0.04 (0.073) Indoor humidity (%): β = -0.015 (0.017) Summer Outdoor temp (C): β = 0.061 (0.113) Outdoor humidity (%): β = 0.004 (0.019) Solar radiation (J m^{-2}): β = 0.038 (0.393) Indoor temp (C): β = -0.067 (0.107) Indoor humidity (%): β = -0.003 (0.029) *p<.05; **p<.01	Age at the beginning of the observation period, gender, time spent outdoors (yes or no), other meteorological variables	Significant association between outdoor humidity and aggression during the winter, but not in the spring or summer

		weather sensors	weren't able to fill in questionnaire) (teachers knew the purpose of the research but not the hypotheses)			
Ambient Air Pollution						
Newman et al. (2013)[12] Prospective	576 children from CCAAPS identified from the Cincinnati metropolitan area from 2001 to 2003 using birth records and selected based on if their residence at birth was near (<400 m) or far (>1500m) from a major highway or bus route	Ambient air samples obtained from 27 sampling sites in greater Cincinnati area from 2001-2006 and a time-weighted average daily concentration of ECAT during 1st year of life based on parental report of locations where the child spent ≥8 hrs/wk on average was determined using a newly developed LUR model Source of pollutants: traffic emissions	BASC-2 administered to parents when children were 7 years old	<u>Effect of ECAT (μg/m3) on Continuous BASC-2 T Scores, Unadjusted:</u> Aggression: β = 0.0 (-5.7, 5.7) <u>Effect of ECAT (highest tertile vs. lower two tertiles) on "at risk" BASC-2 T scores (cut-off of 59), unadjusted vs. adjusted:</u> Aggression: OR = 1.5 (0.9, 2.4) vs. OR = 1.2 (0.7, 2.0) *p<.05 **p<.01	Gender, ETS exposure in 1st year of life, maternal education	No association between continuous ECAT and aggression. An association between dichotomized ECAT (≥0.40 vs. < 0.40 $\mu g/m^3$) and aggression was found for both unadjusted and adjusted logistic regressions, but it was not significant
Perera et al. (2013)[13] Prospective	248 children of white, healthy, nonsmoking pregnant women > 18 years old recruited between November 2000 and March 2003 in Krakow, Poland were followed from in utero until age 9	Personal air monitors to measure 8 airborne PAHs and determine maternal exposures over 48-hr period during 2nd or 3rd trimester Source of pollutants: traffic and industrial/residential coal burning emissions	CBCL administered to mothers when children were 6-9 years old to measure aggressive behavior	<u>Interaction Between PAH (High vs. Low) and Maternal Psychological Distress</u> Aggressive behavior: β_{int} = 0.50; p=.0004* <u>Interaction Between PAH (High vs. Low) and Maternal Psychological Distress After Further Adjustment for:</u> Change of residence after delivery: β_{int} = 0.48; p = .0007* Postnatal ETS and PAH urinary metabolites: β_{int} = 0.50; p = .010* Maternal intelligence: β_{int} = 0.64; p < .0001* <u>Effect of Maternal Psychological Distress Within High vs. Low PAH Exposure Groups:</u>	Child's age at assessment, gender, prenatal ETS exposure; Maternal education, gestational age, psychological distress during pregnancy; Season at time of monitoring	Significant effects of maternal demoralization for aggressive behavior within the high-PAH-exposure subgroup. In the Poisson regression model, a significant interaction was observed between prenatal PAH exposure (high/low dichotomized at the median) and maternal demoralization (continuous measure) on the symptoms of

				Aggressive behavior: $\beta = 0.56$; $p<.0001$* vs. $\beta = 0.01$; $p=.92$ *$p<.05$ (95% CI not provided)		aggressive behavior
Genkinger et al. (2015)[14] Prospective	151 children of white, healthy, nonsmoking pregnant women > 18 years old recruited between November 2000 and March 2003 in Krakow, Poland were followed from in utero until age 9	Personal air monitors to measure 8 airborne PAHs and determine maternal exposures over 48-hr period during 2nd trimester Source of pollutants: traffic and industrial/residential coal burning emissions	CBCL administered to mothers when children were 6-9 years old to measure aggressive behavior	<u>Effect of Continuous PAH (Natural Log) on CBCL Scores</u> Aggression: $\beta = 0.17$; $p = .0002$* <u>Interaction Between Continuous PAH (Log) and Micronutrients (High vs. Low) on Aggressive Behavior</u> α-tocopherol: $\beta_{int} = 0.15$; $p = .02$* γ-tocopherol: $\beta_{int} = -0.03$; $p = .62$ Carotenoids: $\beta_{int} = 0.14$; $p = .02$* Retinol: $\beta_{int} = 0.02$; $p = .69$ *$p<.05$ (95% CI not provided)	Child's age at assessment, gender, lead exposure, prenatal and postnatal ETS exposure, dietary PAH; Maternal education, gestational age, psychological distress; Season at time of monitoring	Significant positive associations between each unit increase in continuous natural log PAH exposure and more adverse scores on CBCL for aggressive behavior. Low cord concentrations of α-tocopherol and carotenoid levels significantly modified the association between log airborne PAH exposure and aggressive behavior
Ambient Noise						
Geen and Powers (1971)[15] Experimental	30 male undergraduates who volunteered for extra course credit in introductory psychology	Subjects were asked to perform a problem-solving task that would be judged for adequacy by the confederate to induce stress. Half were told the confederate would punish them for doing poorly by administering a shock and the other half were told a loud noise (both delivered for 0.5 sec). Subjects were either given no stimuli, 2 stimuli, or 8 stimuli	After receiving feedback, subjects were told the confederate would complete a similar problem-solving task and that they were then going to punish confederates for poor performance. Subjects were allowed to give the confederate 1 to 10 stimuli of varying intensities	<u>Number of Stimuli</u> Number of shocks received: $F(2,12) = 22.23$; $p < .001$ Number of noise bursts received: $F(2,12) = 6.93$; $p < .01$ <u>Intensity of Stimuli</u> Number of shocks received: $F(2,12) = 62.44$; $p < .001$ Number of noise bursts received: $F(2,12) = 3.29$; $p < .10$	NA	Subjects who received shocks retaliated with both a greater number and intensity of shock than subjects who did not receive shocks. Subjects who received loud noises retaliated with a greater number of noise bursts than subjects who did not receive noise bursts, but not with a greater intensity
Donnerstein and Wilson (1976)[16]	40 male undergraduates who volunteered for extra course credit in introductory	Subjects were asked to write a short essay on a recent social issue under the stress	After receiving evaluations, subjects were told that the confederate	<u>ANOVA Examining the Effects of Anger, Noise, and Trials on Aggressive Behavior</u> Anger: $F(1,36) = 132.63$; $p<.001$	NA	Non-angered subjects were not affected by differential noise. Angered subjects

Experiment 1	psychology were randomly assigned to two levels of anger (angered, non-angered) two levels of noise intensity (high, low), and five types of trials	that the essay would be evaluated by the other subject (a confederate) through the use of electric shock with higher shocks indicating a poorer rating (ranging from 0 to 10 shocks). Subjects in the anger condition were given nine shocks of .5-second duration. Non-angered subjects received only one shock. While administering a learning task to the confederate, the subject wore a set of headphones over which unpredictable aperiodic 1-second noise bursts of white noise of either low-intensity (55 dB) or high intensity (95 dB) were delivered (half exposed to low-intensity, half received high)	would be taking a 30-item paired-associate learning task and were told to deliver an electric shock of any intensity whenever the confederate had an incorrect response (confederate got 20 incorrect and 10 correct)	Noise intensity: $F(1,36) = 12.59$; $p<.01$ Anger x noise interaction: $F(1,36) = 14.01$; $p<.01$ Trials: $F(4,144) = 2.64$; $p<.05$		exposed to high-intensity noise displayed more aggression than their counterparts exposed to low-intensity noise
Donnerstein and Wilson (1976)[16] Experiment 2	60 male undergraduates who volunteered for extra course credit in introductory psychology (different subjects than experiment 1) were randomly assigned to two levels of anger (angered, non-angered) and three levels of noise intensity (high w/control, high w/o	Subjects were asked to write a short essay on a recent social issue that would be evaluated by the other subject (a confederate) while the subject completed a second task (math test). One third of subjects were exposed to unpredictable,	After receiving evaluations, subjects were told that the confederate would be taking a 24-item paired-associate learning task and were told to deliver an electric shock of any intensity whenever the confederate had an	<u>ANOVA Examining the Effects of Anger and Noise on Aggressive Behavior</u> Anger: $F(1,54) = 260.10$; $p<.001$ Noise: $F(2,54) = 12.47$; $p<.01$ Anger x noise interaction: $F(2,54) = 3.96$; $p<.025$	NA	Although noise did not affect non-angered subjects, it did produce differential responding for angered individuals. Specifically, subjects under noise/no-control were more aggressive than no-noise and noise/with-control

	control, none)	aperiodic, uncontrollable 1-second bursts of white noise of high-intensity (95 dB), another third were exposed to the same noise but perceived that they had control over terminating the noise at any point (none elected to terminate the noise), the final group served as a no-noise control. Essays were then evaluated through electric shock whereby subjects in the anger condition were given nine shocks and non-angered subjects received only one	incorrect response (confederate got 18 incorrect and 8 correct)			subjects, with the latter two groups not significantly different from each other. Perceived control over the noise eliminated any negative consequences due to noise exposure.
Geen (1978)[17] Experiment 1	100 male undergraduates who volunteered for extra course credit in introductory psychology	Subjects were asked to express feelings of agreement or disagreement with 12 attitude statements, then the confederate administered or withheld shocks depending on whether he approved or disapproved with the subject. Half of the subjects received 10 shocks (Attack) and the other half received 2 shocks (No Attack) Subjects were instructed to wear earphones that delivered bursts of	After receiving shocks, subjects were told the confederate would complete a difficult conceptual problem and that he would need to administer shocks to the confederate each time a light went off (total = 12 shocks), but was allowed to select the intensity level from 1 to 10 (1 = lowest).	<u>Mean Duration of Shocks (in seconds) Per Trial Prior to Offset of Noise</u> Treatment Attack / No Attack No Noise: 2.33_b / 2.10_c Control: 2.41_b / 2.07_c Predict: 2.74_a / 2.11_c No Control: 2.83_a / 2.15_c No Control-Total: 2.85_a / 2.12_c *Cells with the same subscripts are not significantly different ($p > 0.05$) <u>ANOVA examining the effects of attack and noise on aggressive behavior</u> Attack: $F(1,90) = 33.81$; $p < 0.001$ Noise: $F(4,90) = 3.52$; $p < 0.05$ Attack X Noise Interaction: $F(4,90) = 4.42$; $p < 0.01$	NA	Shock intensity did not vary significantly across conditions. Significant effects for attack, noise, and the attack by noise interaction were found. Noise had no significant effect on shock duration for those in the no attack treatment. Among those attacked, duration of shocks given did not differ between those who could control the noise and those who heard no noise. It also did not differ between those in the predictability, no

		noise at random intervals while administering shocks to the confederate. Subjects separated into one of five noise conditions: 1) Control: Subject was told they could turn off the noise at anytime; 2) Predictability: Subject was allowed to select the number of seconds of noise exposure for another; 3) No control: Subject was not told they could turn off the noise; 4) No Control-Total: Subject was not told they could turn off the noise and the noise remained until all 12 shocks were delivered; 5) No noise: Subject was not told anything about noise and did not receive any bursts				control, and no control-total conditions.
Geen (1978)[17] Experiment 2	50 male undergraduates who volunteered for extra course credit in introductory psychology	Subjects were asked to express feelings of agreement or disagreement with 12 attitude statements, then the confederate administered or withheld shocks depending on whether he approved or disapproved with the subject. Subjects were either given 10 shocks	After receiving shocks, subjects were told the confederate would complete a difficult conceptual problem and that he would need to administer shocks to the confederate each time a light went off (total = 12 shocks), but was allowed to select the intensity level	<u>Mean Duration of 12 Shocks (in seconds)</u> Condition — Mean Duration Attack – Distraction — 17.97_a Attack – No Reminder — 18.41_a Attack – Noise Reminder — 12.40_b Attack – No Noise — 7.00_c No Attack — 6.03_c *Cells with the same subscripts are not significantly different ($p > 0.05$)	NA	Shock intensity did not vary significantly across conditions. Subjects in the No Attack group were less aggressive than those in the Attack group. Among those in the Attack group, subjects who believed they were aroused by the noise were less aggressive than subjects who were not given such

		(Attack) or 2 shocks (No Attack). Four conditions were used for the subjects who received 10 shocks: 1) Noise reminder: "arousal dial" was introduced whereby the subject was told the needle fluctuated as a response to the subject's arousal to the noise; 2) Distraction: "arousal dial" was introduced whereby the subject was told the needle fluctuated randomly; 3) No reminder: arousal dial was not used; 4) No noise: no noise was used. The total amount of fluctuations in the Noise Reminder and Distraction txs were equal	from 1 to 10 (1 = lowest).	<u>ANOVA examining the effects of attack and noise on aggressive behavior</u> Between-Conditions: $F(4,45) = 9.37$; $p < 0.001$		feedback.
Sherrod et al. (1979)[18] Experimental	48 undergraduate males enrolled in a small liberal arts college, who were recruited and paid $1.50 for their participation were randomly assigned and individually tested in a 2 (loud noise/soft noise) x 2 (perceived control/no control) factorial experiment	Loud-noise subjects heard an 18-min tape of continuous 94 dB noise consisting of 4 superimposed sound tracks, while soft-noise subjects heard 18-min of continuous 60 dB noise consisting of a soothing seashore	Subjects were asked to produce any combination of the unpleasant buzz, the soft hum, or no sound at all for other subjects to listen to. The two dependent measures were total amount of sound recorded and the proportion of the total sound which was aversive	<u>Mean Scores on Independent Variable Measures in Each Condition</u> Loud Noise: No Control / Control; Soft Noise: No Control / Control Total amount of sound (sec): 216.84 / 197.50 / 205.02 / 206.98 Ratio of unpleasant sound to total: 0.54 / 0.50 / 0.35 / 0.48	NA	Subjects in the high noise condition recorded a higher proportion of aversive sound than did those in the low noise condition. For subjects w/o perceived control, the effect of noise was exactly as described for the stress main effect ($F = 11.67$, $p<0.005$). For subjects w/perceived control, there was no significant difference b/w high noise and low noise conditions

						(F<1). Perceived control made those who had been exposed to soft noise as aggressive as those who had listened to loud noise.
Bell (1980)[5] Experimental	80 male American undergraduate students enrolled in General Psychology served as subjects as part of a course requirement	Subjects participated in pairs in a room exposed to either 70-74°F or 92-96°F temperatures (35-45% relative humidity) and to either 55 dB(A) constant background noise or to 95 dB(A) of randomly intermittent white noise bursts delivered over wall speakers	Half the Ss were not provoked and the other half were by a male experimenter who accused them of intentionally moving around to distort physiography recordings of their heart rates, then 7 min later subjects had an opportunity to retaliate against the experimenter when anonymously completing an evaluation form about the experimenter to assess hostile/ retaliatory behavior	<u>Mean Level of Pleasant and Courteous Behavior Reported by Subject</u> Anger condition: $\bar{X}$ = 50.23 No-anger condition: $\bar{X}$ = 65.48 <u>Analysis of item asking if experimenter should be reappointed as research assistant</u> Temp and Anger: F(1,32) = 5.41; p < 0.05 <u>A Newman-Keuls analysis (p<0.05) on the means</u> Hot-angry condition: $\bar{X}$ = 41.50 Cool-nonangry condition: $\bar{X}$ = 61.55 Cool-angry: $\bar{X}$ = 66.75 Hot-nonangry: $\bar{X}$ = 69.15 (last 3 conditions did not differ from each other)	NA	Although heat and anger in combination produced the greatest expression of retaliatory behavior, neither heat nor noise influenced hostile behavior in the expected manner.
Dzhambov and Dimitrova (2014)[19] Cross-sectional	182 residents 18-92 years old (mean age 36.93±18.13 years) in one neighborhood of Plovdiv city, the second-largest city in Bulgaria	Trained interviewers went door to door 5:00-8:00 pm during the period of June 1-July 1, 2013 conducting a semi-structured interview survey. They selected one individual >18 years old in every third household to answer questions on noise frequency, perceived noise sensitivity, and type of noise exposure	The 20-item DAQ comprised of 33 close-ended and open-ended questions was used to assess aggression	<u>Coefficients for multiple regression model predicting the 20-item DAQ score from noise variables</u> Perceived noise sensitivity: β = 0.53; p<.000 Type of noise exposure: β = -0.40; p<.000 Frequency of hearing noises above normal threshold: β = 0.16; p = .001 Noise frequency: β = -0.09; p = .066	All noise variables, age, and years of residency	Significant associations between displaced aggression and low frequency, high intensity and continuous noises were found

		over the last 3 months. Range: 60-80 dB				

Note: ANOVA = analysis of variance; BASC-2 = Behavioral Assessment System for Children, Parent-Rating Scale 2nd Edition; CBCL = Child Behavior Checklist; CCAAPS = Cincinnati Childhood Allergy and Air Pollution Study; DAQ = Displaced Aggression Questionnaire; DBEQ = Daily Behavioral and Emotional Questionnaire; ECAT = elemental carbon attributed to traffic; ETS = environmental tobacco smoke; NA = not applicable; PAH = polycyclic aromatic hydrocarbons; SE = standard error.