ORIGINAL ARTICLE

Fearlessness, Stimulation-Seeking, and Large Body Size at Age 3 Years as Early Predispositions to Childhood Aggression at Age 11 Years

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Background: Previous cross-sectional research in Western societies has linked adolescent stimulation-seeking, fearlessness, and body size to antisocial behavior. However, it is unclear how early in life these factors exert their influence, and nothing is known about their specificity to aggressive behavior per se. This study tests the hypotheses that stimulation-seeking, fearlessness, and increased body size at age 3 years predict aggression at age 11 years.

Methods: Behavioral measures of stimulation-seeking and fearlessness, together with height and weight, were measured at age 3 years and related to ratings of aggression at age 11 years in 1130 male and female Indian and Creole children from the island of Mauritius.

Results: Aggressive children at age 11 years were characterized by increased measures of stimulation-seeking, fearlessness, height, and weight at age 3 years. Stimulation-seeking and height were independently related to aggression, whereas the fearlessness-aggression relationship was mediated by height. Large body size at age 3 years but not 11 years was related to increased aggression at age 11 years, indicating a critical period in development for the influence of body size on aggression.

Conclusions: Results (1) implicate large body size, stimulation-seeking, and fearlessness in the development of childhood aggression; (2) suggest that there may be a critical period in development in which biological processes influence later aggression; and (3) highlight the importance of early processes in the etiology of aggression.

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BECAUSE AGGRESSION in early childhood is capable of predicting aggression in adulthood, some of the foundations for later aggressive and violent behavior are probably set in the first few years of life.[1-5] Prospective longitudinal research beginning in the preschool years is especially important for identifying the early causal mechanisms but currently remains the exception rather than the rule. This longitudinal study reports on 3 early mechanisms for childhood aggression; body size, stimulation-seeking, and fearlessness.

Early work on body build indicate that criminals and juvenile delinquents tend to be more mesomorphic-endomorphic (muscular and fat), and less ectomorphic (slight and thin) relative to controls.[6-8] Conversely, some studies fail to replicate, control groups have not always been rigorous, experimental groups are largely institutionalized, there are few data on females, only one study was longitudinal, measures were not taken early in life, and group differences in social background were not always controlled for. In the context of the latter, a recent reanalysis of older data confirmed that juvenile delinquents have a mesomorphic body build, but this relationship was not independent of social factors.[9] In contrast to body type, simpler measures like height and weight have rarely been used. One study found developmental effects such that height at age 8 to 10 years, but not at 12 to 14 years, predicted teenage violence at age 16 to 18 years.[4] The current study attempts to address all the above-mentioned issues by relating height, weight, and body bulk measured at ages 3 and 11 years to aggression at age 11 years in a large community sample of ethnically diverse boys and girls in a developing country.

Several studies have demonstrated links between a difficult temperament and later antisocial/aggressive behavior.[10,11] In particular, kindergarten children characterized by novelty-seeking/impulsivity and a lack of anxiety were more likely to be antisocial at age 11 to 13 years.[12] Similarly, children who lack behavioral con-

SUBJECTS AND METHODS

SUBJECTS

Participants consisted of 1795 male (51.4%) and female (48.6%) children from the tropical island of Mauritius (a country lying in the Indian Ocean between Africa and India). All children born in 1969 in 2 towns were recruited into the study when aged 3 years between September 1972 and August 1973. The 2 towns (Vacoas and Quatre Bornes) were chosen to be representative of the ethnic distribution of the island. Informed consent was obtained from the mothers. Ethnic distribution was as follows: Indian 68.7%, Creole (African origin) 25.7%, and others (Chinese, English, and French) 5.6%. Census data for the island as a whole indicated 66% Indian, 29% Creole, and 5% other, indicating that the study achieved its goal of sampling a representative population.

AGGRESSION AND ANTISOCIAL BEHAVIOR

Two scales, Aggression and Nonaggressive Antisociality, were developed from the Child Behavior Checklist.[24] The instrument was completed by the parents when the children were aged 11 years. Data were available on 1130 of the original sample of 1795 children. Not all children were assessed because a major cyclone hit the island in 1980 and destroyed the homes of many children, disrupted the laboratory, and brought the data collection to an end. There were no differences between tested and untested children for sex ($P>.56$), ethnicity ($P>.20$), early personality variables ($P>.20$), or body size variables ($P>.12$), indicating that the children tested at age 11 years were not a biased sample.

Although Achenbach derived subscales from the Child Behavior Checklist to measure both Aggression and Delinquency,[24] there are 2 limitations to these scales. First, different scales were developed for boys and girls with different item contents. As indicated by Achenbach et al,[25] it is desirable to have common-item scales for both boys and girls. Consequently, we recently developed revised scales for the Mauritian population from the Child Behavior Checklist that (1) have items common to boys and girls and (2) are purer measures of aggression and nonaggressive antisocial behavior.[26]

The Aggression scale (10 items) consisted of items measuring both physical and verbal aggression (fights, attacks, shows cruelty, threatens, destroys others' property, destroys own property, argues, swears, screams, is bad-tempered) that were common to both boys and girls. Coefficient α was .72 for boys and .72 for girls. The high-aggression group (see "Establishment of Aggression Group" section) compared with the low-aggression group had higher scores on teacher ratings of Aggression-Hyperactivity[27] at age 8 years ($F_{1,264}=10.6$, $P<.001$), indicating convergent validity. The high-aggression group at age 11 years had lower resting heart rates at age 3 years,[26] a well-replicated biological correlate of antisocial and aggressive behavior in children,[8] thus indicating construct validity. The Nonaggressive Antisociality scale (10 items) consisted of items related to antisocial, delinquent behavior that was not aggressive in nature (disobedient at school, disobedient at home, keeps bad friends, lies, talks excessively, cheats, is moody, sulks, runs away from home, teases), and that was common to both boys and girls. Coefficient α was .64 for boys and .68 for girls.

ESTABLISHMENT OF AGGRESSION GROUPS

Following exactly the same procedures employed in our previous work on aggression at age 11 years in this sample,[26] high- (n = 175) and low-scoring (n = 226) aggression groups were created using a cutoff of as close as possible to 1 SD above and below the mean on the Aggression scale. Similarly, high- (n = 170) and low-scoring (n = 208) Nonaggressive Antisociality groups were formed using the same criterion. As indicated by 3 items that unequivocally measure physical aggression (fights, attacks, and destroys others' property), 80.6% of the aggression group would be characterized as physically aggressive.

HEIGHT, WEIGHT, AND BULK

Height and weight were measured at age 3 and 11 years by a research assistant. Bulk was a measure of body size calculated as the *z* transformation of the product of height (in centimeters) and weight (in kilograms), with a constant of 1 added to scores. This measures the extent to which subjects had an overall large body, with higher scores indicating relatively larger bulk.[26] A bulk index was used in preference to the body mass index (calculated as weight in kilograms divided by the square of the height in meters) because the latter is an index of obesity as opposed to overall bulk.

trol at age 3 years are more likely to have externalizing behavior problems at age 15 years[13]; higher scores on aggression, danger-seeking, impulsivity, and interpersonal alienation measures at age 18 years[14]; more convictions for violent offenses at age 18 years[15]; and antisocial personality at age 21 years.[16] There is increasing evidence, therefore, that early personality characteristics may predispose to later aggressive behavior, although some theories argue that aggressive behavior may require a specific temperamental profile superimposed on a characterological immaturity.[17]

Two specific components of temperament that relate to adult antisocial and violent behavior but that have received relatively little attention in the child literature are stimulation/novelty-seeking and fearlessness. Some children may behave aggressively to seek attention from parents and peers.[8] This self-stimulation is hypothesized to compensate for chronically low physiological levels of arousal.[18-20] Similarly, fearless children are more likely to engage in physical fights to obtain rewards and social status because they do not fear the negative consequences of their aggressive actions due to a lack of fear conditioning.[8] These 2 adult concepts of fearlessness and stimulation-seeking have their analogs in the concept of inhibited-uninhibited temperament as defined by Kagan.[21,22] Regarding fearlessness, uninhibited children are characterized by a lack of fear to novel objects and a lack of crying in novel test situations.[22] With respect to stimulation-seeking, uninhibited children explore the

STIMULATION-SEEKING AND SOCIABILITY

Four putative indices of stimulation-seeking and sociability were taken at age 3 years as follows. (1) The child's exploration away from the mother toward new toys was assessed in a laboratory room by a research assistant. Exploratory behavior was rated on a 4-point scale as follows: 1 = passive, clings to mother, withdrawn; 2 = shows interest, examines toys but stays close to mother; 3 = leaves mother, mild independent exploration, comes and goes to mother; 4 = active independent exploration. This behavior was rated on 4 occasions during the entire testing session (soon after arrival, before psychophysiological testing, between tests, after completion of tests). Scores for the 4 ratings were summed to obtain an overall index of exploration. (2) Extent of verbalizations to the research assistant during cognitive testing was rated on a 4-point scale (1 = very reluctant to speak; 4 = many spontaneous comments). (3) Friendliness with the research assistant during cognitive testing was rated on a 4-point scale (1 = fearful; 4 = immediately friendly). (4) Active social play with other children during free play in a sandbox was rated by a research assistant on a 5-point scale (1 = solitary; 3 = associates with others; 5 = cooperative relationship with role reciprocity).

FEARFULNESS/REACTIVITY

Four putative indicators of fearful/fearlessness and reactivity were assessed by a research assistant during psychophysiological testing at age 3 years as follows. (1) Crying behavior was assessed on a 5-point scale (1 = no crying; 5 = uncontrollable crying). (2) The child's fearful reaction was rated on a 4-point scale (1 = interested; 4 = very frightened). (3) Unresponsiveness to the experimenter was rated on a 2-point scale (unresponsive vs friendly). (4) Tremor (shaking with fear) was rated on a 4-point scale (1 = little activity; 4 = tremor).

STATISTICAL ANALYSES

We hypothesized that 2 relatively independent factors would underlie the 8 measures taken from the 3-year-old assessment battery, ie, stimulation-seeking and fearlessness. Confirmatory factor analysis was conducted using LISREL 8[28] to evaluate 1- and 2-factor models. To provide a baseline comparison the null model was also fitted, in which each of the 8 items was assumed to represent independent and uncorrelated dimensions. All models tested were in hierarchical relationship (ie, nested) and compared using the difference χ^2 test.

Results of these analyses for the total sample are given in **Table 1** and **Table 2**. The 2-factor model provided the best fit to the data and was chosen as a final model because it produced the lowest Akaike Information Criterion[29] and highest Tucker-Lewis Index.[30] χ^2 Tests revealed that the 1-factor model, while fitting significantly better than the null model, fit significantly worse when compared with the 2-factor model. Estimates from the 2-factor model indicate that the fearlessness factor (factor 1) was defined by high loadings from crying, fearfulness, unresponsiveness, and tremor, and thus includes negative reactivity in addition to fear. The stimulation-seeking factor (factor 2) was defined by high loadings from exploration, verbalizations, friendliness, and social play, and thus contains both exploration and extraversion components of stimulation-seeking. The 2 factors had an intercorrelation of 0.04 and thus were largely orthogonal. Virtually identical findings were obtained for boys and girls and for Indians and Creoles.

The 4 items from factor 2 all intercorrelated from 0.25 to 0.68 (mean = 0.43). Item-total correlations for this scale ranged from 0.48 to 0.59 (mean = 0.53). Coefficient α for the scale was .75. These items were z-transformed and summed into a scale of stimulation-seeking, with a constant of 1 added and with high scores indicating high stimulation-seeking. The 4 items from factor 1 intercorrelated from 0.48 to 0.72 (mean = 0.56). Item-total correlations ranged from 0.57 to 0.76 (mean = 0.68). Coefficient α for the scale was .84. Items were z-transformed and summed into a scale of fearlessness. Scale scores were reversed so that high scores indicated relatively greater fearlessness, with low scores indicating relatively greater fearfulness, with a constant of 1 added.

Analysis of variance (ANOVA) was used to test for group differences in stimulation-seeking, personality, and body size, using an α of $P<.05$, while analysis of covariance (ANCOVA) was used to control for the effects of social class and the effects of each age 3 years variable on aggression independent of other predictors. Effect sizes were calculated as the Cohen d.[31]

environment independently of their mothers, seek stimulation through verbalizations and friendly behavior to others, engage in social play, and will approach new stimuli.[22,23] To our knowledge there have been no studies that have related early analogs of fearlessness and stimulation-seeking to later aggression.

Given these background issues, one aim of the current study was to develop indices of fearlessness and stimulation-seeking at age 3 years and assess their links with aggression measured at age 11 years. A second aim was to assess relationships between body size and aggression. A third aim was to test whether stimulation-seeking, fearlessness, and body size factors relate to aggressive forms of antisocial behavior, and also to nonaggressive forms of antisocial behavior.

RESULTS

PERSONALITY AND BODY SIZE CORRELATES OF AGGRESSION

Stimulation-Seeking

Analysis of variance indicated that aggressive relative to nonaggressive children scored higher on stimulation-seeking ($F_{1,394} = 6.1$, $P<.02$, $d = 0.25$) (**Figure 1**). There were no interactions with either sex ($P<.59$) or ethnicity ($P<.11$). There was no main effect for Nonaggressive Antisociality ($P>.11$). There were no interactions with either sex ($P>.26$) or ethnicity ($P>.10$).

Table 1. LISREL 8 Model-Fitting Results of Fearlessness and Stimulation-Seeking Variables*

Model	Description	χ^2	*df*	*P*	AIC	TLI	$\Delta\chi^2$	Δdf
1	2 Factors	371.75	19	.00	333.75	0.90	2760.15	1
2	1 Factor	3131.90	20	.00	3091.90	0.18	2197.19	8
3	Null model	5329.09	28	.00	5273.09	. . .	. . .	. . .

**AIC indicates Akaike Information Criterion; TLI, Tucker-Lewis Index; and ellipses, not applicable.*

Table 2. Standardized Factor Loadings From the 2-Factor Model*

Item	Factor 1 (Fearfulness)	Factor 2 (Stimulation-Seeking)
Cries	.88	. . .
Unresponsive	.81	. . .
Fear	.61	. . .
Tremor	.69	. . .
Verbalization	. . .	.79
Friendly	. . .	.86
Social play	. . .	.53
Exploration	. . .	.63

**Ellipses indicate not applicable.*

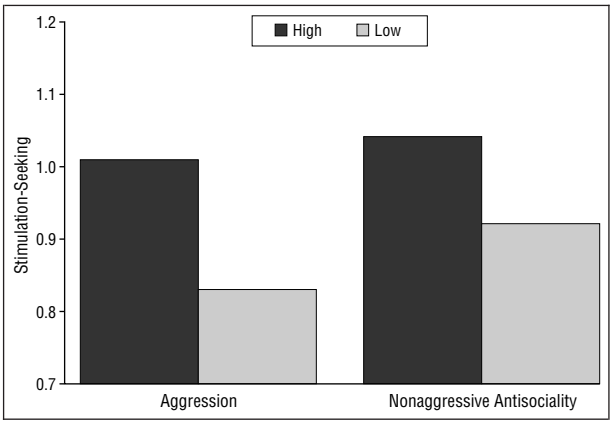

Figure 1. *Increased stimulation-seeking at age 3 years in those scoring high on the Aggression scale at age 11 years.*

Fearlessness

Aggressive relative to nonaggressive children were more fearless ($F_{1,394} = 3.9$, $P<.05$, $d = 0.20$) (**Figure 2**). There were no interactions with either sex ($P>.37$) or ethnicity ($P>.98$). Furthermore, there were no main effects for Nonaggressive Antisociality ($P>.57$). There were no interactions with either sex ($P>.37$) or ethnicity ($P>.78$).

Body Size

Aggressive children at age 3 years were taller (88.9 cm vs 87.6 cm, $F_{1,385} = 8.8$, $P<.002$, $d = 0.30$), weighed more (13.12 kg vs 12.78 kg, $F_{1,394} = 6.0$, $P<.02$, $d = 0.25$), and were bulkier (0.1 vs – 0.2, $F_{1,385} = 8.4$, $P<.004$, $d = 0.25$) relative to nonaggressive children (**Figure 3**). There were no main effects for Nonaggressive Antisociality ($P>.13$) and no interactions with either sex ($P>.33$) or ethnicity ($P>.43$). Aggression groups did not differ on height ($P>.66$), weight ($P>.13$), or bulk ($P>.11$) at age 11 years. Similarly, nonaggressive antisociality groups did not differ on height ($P>.84$), weight ($P>.18$), or bulk ($P>.34$) at age 11 years.

The high-aggression group was divided up into "big aggressives" and "small aggressives," using a median split on body bulk at age 3 years, and groups were compared on each of the 10 items making up the Aggression scale. Big aggressives were significantly more likely to engage in fights than small aggressives ($t = 2.4$, $P<.02$, 2 tailed, $d = 0.25$), while small aggressives were more likely to engage in swearing than big aggressives ($t = 2.0$, $P<.05$, 2 tailed, $d = 0.20$).

COVARIANCE ANALYSES

Control for Socioeconomic Status

Socioeconomic status was significantly related to all variables except fearlessness ($P>.51$). Analysis of covariance using socioeconomic status as a covariate failed to abolish group differences between aggressive and nonaggressive children on stimulation-seeking ($F_{1,384} = 3.0$, $P<.05$), height at age 3 years ($F_{1,376} = 4.4$, $P<.04$), and bulk at age 3 years ($F_{1,378} = 3.8$, $P<.05$), although the effect for weight at age 3 years was only marginally significant ($F_{1,385} = 3.4$, $P<.07$).

Body Size

Body size (height and bulk) at age 3 years was related to aggression independent of fearlessness and stimulation-seeking. After entering fearlessness and stimulation-seeking as covariates, the main effects for height ($F_{1,383} = 7.3$, $P<.007$) and bulk ($F_{1,383} = 4.2$, $P<.04$) remained significant, with the main effect for weight marginally significant ($F_{1,392} = 2.9$, $P<.09$).

Stimulation-Seeking

Stimulation-seeking related to aggression independent of all age 3 years body parameters and fearlessness. After entering height, weight, bulk, and fearlessness as covariates, the main effect for stimulation-seeking on aggression remained significant ($F_{1,380} = 4.4$, $P<.04$).

Fearlessness

The relationship between fearlessness and aggression was not independent of the effects of body size and stimulation-seeking at age 3 years on aggression. After entering stimulation-seeking, height, weight, and bulk as covariates, the effect of fearlessness on aggression was abolished ($F_{1,380} = 1.0$, $P>.31$). Entry of the body size vari-

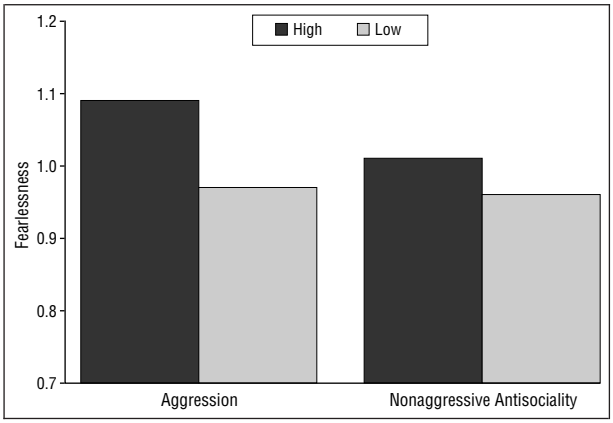

Figure 2. *Increased fearlessness at age 3 years in those scoring higher on the Aggression scale at age 11 years.*

ables alone was sufficient to abolish the fearlessness-aggression relationship ($F_{1,386} = 1.8$, $P > .18$).

COMMENT

The key findings from this study are (1) childhood analogs of stimulation-seeking and fearlessness at age 3 years characterize children who become aggressive by age 11 years; (2) larger body size (taller, heavier, bulkier) at age 3 years, but not age 11 years, characterizes aggressive children; and (3) body size and stimulation-seeking are independent early correlates of later childhood aggression. Effect sizes ranged from 0.20 to 0.30, or between small to medium in size.[31] These prospective longitudinal findings have implications for theories of childhood aggression and the identification of early risk factors for aggressive behavior.

The fact that the findings derive from a prospective longitudinal study set in a developing tropical country and a large sample of ethnically diverse and sex-balanced children is thought to be a strength of the study. The longitudinal nature of the study helps to further establish the causal relationship between these early factors and later aggression. The fact that findings emerge from a developing tropical country with a very different culture supports similar findings from Western studies.[12,13] The fact that there were no interactions with ethnicity and sex shows the generalizability of findings to girls and nonwhite ethnic groups, groups that have received very little attention in previous studies of aggression. On the other hand, study limitations include the inability to assess the differential correlates of physical vs verbal aggression and proactive vs reactive subtypes of aggression, and whether risk factors result in maintained aggression over time.

Previous findings of somatic differences in delinquents and criminals are open to the criticism that police are biased toward arresting more distinctive-looking persons. The fact that a larger body size at age 3 years is characteristic of parent-rated aggression at age 11 years dictates against such bias. Similarly, cross-sectional findings on stimulation-seeking and antisocial behavior could be circular in that adult measures of stimulation-seeking contain items directly or indirectly related to antisocial behavior.[32,33] In contrast, the measure of stimulation-seeking at age 3 years did not contain elements of aggressive or antisocial behavior and yet still was related to aggression at age 11 years. The differential nature of its measurement, in combination with the 8-year age gap between data collection phases, instead suggests that the predilection to seek out experiences is a genuine predisposition to later aggressive behavior.

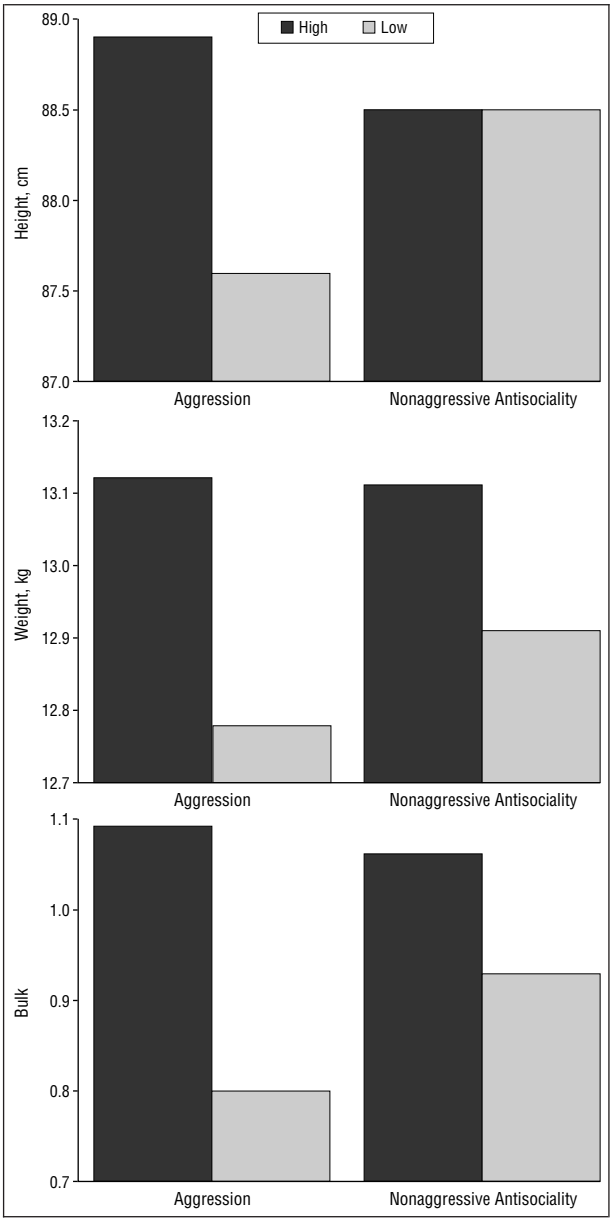

Figure 3. *Increased height, weight, and bulk at age 3 years in those scoring high on the Aggression scale at age 11 years.*

Findings show some theoretical and conceptual consistency with other biological studies of antisocial and aggressive behavior. Increased height, stimulation-seeking, and lack of fear have all been associated with increased testosterone and reduced serotonin levels,[34-39] factors in turn associated with increased aggression. Poor fear conditioning is a well-replicated psychophysiological correlate of antisocial, psychopathic behavior,[8] and subcortical structures that mediate the conditioned

fear response (amygdala, hippocampus, and thalamus) show abnormal functioning in violent offenders.[40] Furthermore, the prefrontal cortex plays a critical role in the assessment of danger and distinguishing among threatening cues[41] and encoding novelty,[42] while novelty-seeking rats (those responding to a novel environment with high locomotor activity) have a lower 3,4-dihydroxyphenylacetic acid–dopamine ratio in the prefrontal cortex.[43] Additionally, increased right frontal electroencephalographic activity is associated with inhibited, fearful, and withdrawn behavior in infants and children.[44-46] The fact that violent offenders have reduced glucose metabolism in the prefrontal cortex[40,47] suggests that lack of fear and increased stimulation-seeking in aggressive persons may in part be due to prefrontal dysfunction, which contributes to the failure to assess danger and respond to threatening cues. Nevertheless, measures of all these constructs need to be obtained in the same subject sample before unequivocal interpretation of the findings can be made.

Behavioral genetic studies have suggested that childhood aggression is in part heritable,[48,49] but it is unclear how this genetic predisposition manifests itself. Fearlessness and stimulation- and novelty-seeking in adults have also been found to have significant heritability.[17,38] Although it is not known if the personality measures used in the current study are heritable, infant temperamental traits have shown heritability in other studies.[22] Furthermore, increased height and body size is strongly influenced by genetics.[50] Consequently, increased height, fearlessness, and stimulation-seeking may represent some of the physical and psychological routes by which the genetic predisposition to aggression becomes manifest.

Alternatively, environmental and psychosocial processes should not be ruled out. For example, children with increased height and body size early in life may, through instrumental learning processes, learn that use of aggression can be an effective strategy in winning social conflicts. Such children would be more likely to have aggression reinforced, in contrast to smaller children who do not have the physical capacity to successfully execute physical coercion. Importantly, our findings suggest that this social learning takes place at a critical period early in development because body size at age 3 years, but not age 11 years, predicts aggression at age 11 years. The potentially important implication for most studies that measure the biological correlates of antisocial and violent behavior in adolescence or adulthood is that these studies may be missing a much earlier critical period in development when the influence of biological functioning is maximal.

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