Developmental Trajectories of Male Physical Violence and Theft

Relations to Neurocognitive Performance

Edward D. Barker, PhD; Jean R. Séguin, PhD; Helene Raskin White, PhD; Marsha E. Bates, PhD; Éric Lacourse, PhD; René Carbonneau, PhD; Richard E. Tremblay, PhD

Context: Neurocognitive mechanisms have long been hypothesized to influence developmental trajectories of antisocial behavior. However, studies examining this association tend to aggregate a variety of problem behaviors that may be differently affected by neurocognitive deficits.

Objective: To describe the developmental trajectories of physical violence and theft from adolescence to adulthood, their associations, and the neurocognitive characteristics of individuals following different patterns of trajectory association.

Design: Accelerated cohort-sequential, longitudinal design.

Setting: Rutgers Health and Human Development Project.

Participants: Six hundred ninety-eight men.

Main Outcome Measures: Self-reports of physical violence (ages 12-24 years) and theft (ages 12-31 years) were collected across 5 waves. Neurocognitive performance was assessed with executive function and verbal IQ tests between late adolescence and early adulthood.

Results: The majority (55%) of subjects showed an increased frequency of theft during the study period, while only a minority (13%) evinced an increasing frequency of physical violence. Executive function and verbal IQ performance were negatively related to high frequency of physical violence but positively related to high frequency of theft.

Conclusions: Developmental trajectories of physical violence and theft during adolescence and early adulthood are different and differently related to neurocognitive functioning. Global indexes of antisocial behavior mask the development of antisocial behavior subtypes and putative causal mechanisms.

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YOUTH WHO REPETITIVELY AND persistently violate the rights of others, and breach age-appropriate norms of society, are classified by the DSM-IV as having conduct disorder (CD). The DSM-IV categorizes CD behaviors into 4 main groupings: (1) aggression to people and animals; (2) destruction of property; (3) deceitfulness or theft; and (4) serious violations of rules. Neurocognitive impairments have traditionally been hypothesized to be a cause of chronic antisocial behavior. However, it remains unclear if neurocognitive deficits are related to all forms of antisocial behavior, because most studies aggregate different types of problems into a single outcome.

Aggregating the 2 most feared antisocial behaviors, aggression to people and theft, may be unwarranted for at least 2 reasons. First, it may mask important developmental differences. There is indeed good evidence that the frequency of physical aggression decreases with age, while theft appears to be increasing, at least from preadolescence to adulthood. The second reason to disaggregate physical aggression and theft is that they may be differentially related to neurocognitive functioning. Although surprisingly few studies have examined neurocognitive relationships to specific types of conduct problems, poor neurocognitive functioning has been found in incarcerated males who have perpetrated violent acts and is associated with a history of chronic physical aggression. Theft, on the other hand, has rarely been examined by itself. However, there has been much speculation over close to 2 centuries about how cognitive abilities associate with different forms of crime, and a 20-year-old cross-sectional study of incarcerated male ado-
The present study extends previous research by disaggregating trajectories of physical violence and theft from adolescence into young adulthood and attempting to differentiate the joint development of these 2 types of behaviors through neurocognitive functioning. We used data from male participants in the Rutgers Health and Human Development Project (HHDP), a metropolitan working- and middle-class sample followed up between the ages of 12 and 31 years. This sample was of particular interest for 2 reasons. First, White and colleagues identified developmental trajectories of aggregated antisocial behaviors, including physical violence and theft. Second, the developmental trajectory groups identified by these researchers were not reliably differentiated by neurocognitive assessments.

The 2 most well-established neurocognitive impairments associated with conduct behavior problems are executive function (EF) and verbal IQ. Executive function underlies the self-regulation of thought, action, and emotion, processes that depend largely on the integrity of the prefrontal cortex and associated neural systems. Likewise, normal development in verbal ability is believed to promote verbal mediation for self-control, a prosocial cognitive orientation that supports delay of gratification and communication skills, both of which may circumvent negative interactions that lead to violence.

We analyzed the HHDP data to (1) identify separate aggression and theft developmental trajectories; (2) identify their association; and (3) determine if we could discriminate subgroups of joint developmental trajectories by using indicators of EF and verbal IQ. We thus examined neurocognitive function in relation to subgroup differences in the development of physical violence and theft. More specifically, we expected that individuals on a trajectory of frequent violence would have reduced neurocognitive performance, while individuals on a trajectory of frequent theft would show greater neurocognitive performance.

METHOD

PARTICIPANTS AND PROCEDURE

Data were collected as part of the HHDP, a prospective cohort-sequential, longitudinal study. Adolescents were originally identified by a random telephone survey in New Jersey. Following the telephone survey, field staff interviewed interested participants and their parents at their homes. Subsequently, the participants came to the test site for a full day of testing. Families and middle-class sample followed up between the ages of 12 and 31 years. This sample was of particular interest for 2 reasons. First, White and colleagues identified developmental trajectories of aggregated antisocial behaviors, including physical violence and theft. Second, the developmental trajectory groups identified by these researchers were not reliably differentiated by neurocognitive assessments.

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The physical violence items measured how often (5-point scale, from 0 = never to 4 = 10 times) the participants engaged in the following behaviors during the past 3 years (ever at time 1): used a weapon in a fight, committed armed robbery, and hurt someone badly. To avoid the use of a theft-related behavior (ie, armed robbery) in the physical violence measurements, we excluded this item. The frequencies of these 2 items (ie, used a weapon in a fight and hurt someone badly) were summed within each assessment (range, 0-8) between 12 to 24 years of age. The theft items measured how often (5-point scale, from 0 = never to 4 = 10 times) the participants engaged in the following behaviors during the past 3 years (ever at time 1): breaking and entering, auto theft, petty theft (theft of things worth < $50), and grand theft (theft of things worth > $50). The frequencies of these 4 items were summed within each assessment (range, 0-16) between 12 to 31 years of age.

NEUROCOGNITIVE TESTS

Executive function and verbal ability were assessed with tests administered at time 3 (ages 18-24 years). The neurocognitive measures were originally chosen for their demonstrated sensitivity to cognitive impairment in multiple populations, their ability to discriminate persons with and without brain damage, time efficiency, age appropriateness, standardized administration procedures, and the availability of normative data. Verbal ability was measured by the Shipley Institute of Living Scale Vocabulary Test.
The VT also exhibits good internal consistency, test-retest validity, and criterion-related validity.32-34

Executive function was assessed by 2 tests: the Trail-Making Test Part B (TMT-B)35 and the Booklet Category Test (BCT).36 The TMT-B (mean [SD] score, 55.26 [23.60]) involves drawing a continuous line to circled numbers and letters in an alternating but ordered sequence (ie, 1-A-2-B-3-C, and so on). Response time is the dependent variable, with longer responses indicating a reduced ability to follow more than 1 mental sequence at a time and inflexibility in shifting cognitive-behavioral activities.27,28 The BCT36 (mean [SD] score, 20.21 [17.68]) requires developing and elaborating abstract concepts that relate subsets of multidimensional visual stimuli. Increasing errors are indicative of a deficit in the ability to develop (with feedback) conceptual rules to use in solving novel, unfamiliar problems. A shortened version39 was used, which correlates highly with the full BCT and has been found to be as accurate as full scores in discriminating participants with and without brain damage.40

Mean scores on these 3 tests are indicative of average performance levels based on normative data from similarly aged and educated samples.41,42 A recent confirmatory factor analysis in a different sample that included multiple indicators of verbal and executive functions found that the VT loaded highest on a latent verbal factor, while the TMT-B and BCT loaded highest on a latent executive factor.34

The analysis proceeded in 3 steps. First, individual trajectory models were empirically identified for theft and physical violence. A finite mixture of Poisson distributions was used to identify distinctive clusters of individual trajectories in an SAS-based procedure, TRAJ.33 For each distinctive trajectory group, the model defined the shape of the trajectory (ie, linear, quadratic, cubic) and the proportion of youth belonging to each group. Model selection was based on the Bayesian Information Criteria, calculated as $-2\log(L) + \log(n)k$, where $L$ is the model’s maximized likelihood, $n$ is the sample size, and $k$ is the number of parameters in the model.44 The Bayesian Information Criteria rewards parsimony for the number of groups included in a trajectory model.45

In the second step, joint trajectories of violence and theft were estimated. The individual models identified in the first step guided this analysis. Key outputs of the joint model were the conditional probabilities and the joint probabilities. Conditional probabilities (eg, the probability of chronic physical violence given chronic theft and the converse conditional probability) and the joint probabilities of belonging to both trajectories (eg, the probability of following chronic violence and chronic theft) are useful in concretely describing the developmental overlap between 2 types of distinct but related behavioral phenomena.46

In the second step, we also examined potential cohort effects. No cohort effects were identified in the joint trajectories of violence and theft. Variance attributable to the cohorts in the neurocognitive tests was also examined. In the results presented in the next section, the cohort effects are nonsignificant in both the trajectories and the neuropsychological tests.

In the third step, we examined differences in neurocognitive ability levels associated with the theft and physical violence trajectories. The distributional properties of the 2 test scores were examined prior to analysis. To correct for skew, the TMT-B time score required a log transformation. The TMT-B, BCT, and VT were then standardized to a mean of 0 and standard deviation of 1 to facilitate comparison across tests. Because of unequal $n$s in trajectory groups, mean differences were tested with a general linear model multivariate analysis of variance in SAS47 with weighted data. When data are weighted, each participant is represented in each cell as a function of his probability of being assigned to that cell. This preserved the continuous nature of the classification variable and corrected for potential uncertainty in trajectory assignment.

The trajectories for violence and theft, and the corresponding 95% confidence intervals for each year, are shown in Figure 1 and Figure 2, respectively. Two developmental trajectories were observed for physical violence. More than 1 in 10 (13.1%) were on a high trajectory, confirming that the chronically violent adolescents were already using physical violence frequently at 12 years of age. Frequency of physical violence increased to a peak at 18 years of age and then decreased until age 24 years. Males on the second trajectory (86.9%) very rarely engaged in physical aggression from 12 to 24 years of age.

Four developmental trajectories were observed for frequency of theft between 12 and 31 years of age. The modal theft trajectory represented mainly those who rarely (low) self-reported this behavior (44.7%). The second most prevalent trajectory for theft identified 36.5% of the male sample. These individuals increased from near-zero levels of theft at 12 years of age, peaked to relatively higher but overall low levels at 18 years of age, and thereafter desisted (medium). The third most common trajectory consisted of those (12%) who increased their frequency

![Figure 1. Trajectories for physical violence (12 to 24 years of age). Error bars represent 95% confidence intervals.](image-url)
of theft from 12 to 31 years of age (increasing). The fourth theft trajectory (high) included 6.8% of the individuals who rapidly increased their frequency of theft from 12 to 21 years of age and thereafter steadily desisted to low levels at 31 years of age.

**STEP 2: THE JOINT TRAJECTORIES**

Joint Probabilities of Theft and Violence

The upper portion of the Table shows the joint probabilities of trajectory membership. In the Table, probabilities across all cells sum to 1. The modal trajectory identified those who were low in violence and low in theft (42.8% of the sample). The second most prevalent trajectory comprised those who were low in violence but followed the medium-theft trajectory (30.3%), followed by the low-violence/increasing-theft trajectory (10.6%) and the low-violence/high-theft trajectory (3.2%). The high-violence group was subdivided into 3.6% on the high-theft trajectory, 6.2% on the medium-theft trajectory, and 1.8% on the low-theft trajectory.

Conditional Probabilities of Theft Given Violence

In the third part of the Table, the probabilities within rows also sum to 1. Here, a different picture emerged. Given membership in the high-violence trajectory, the likelihood to follow the high-theft trajectory was much lower (0.28) than the probability of following the medium-theft trajectory (0.47), while the probability of following the increasing-theft trajectory was as low (0.11) as following the low-theft trajectory (0.14).

**STEP 3: VIOLENCE, THEFT, AND NEUROCOGNITIVE PERFORMANCE**

A multivariate analysis of variance using the general linear model was conducted using the trajectory groups as independent variables and the neurocognitive assessments (TMT-B, BCT, and VT) as dependent variables.
Mean differences in neurocognitive performance were evaluated in a 4 (theft) × 2 (physical violence) factorial design. As expected, the TMT-B, BCT, and VT were moderately correlated (mean r = 0.30 [range, 0.29-0.30]; n = 617; P < 0.001). No curvilinear relationships were identified between violence and theft and the TMT-B, BCT, and VT. The overall general linear model multivariate analysis of variance F test was significant for the interaction between theft and physical violence (F3,616 = 1.92; P = 0.045). A significant interaction for violence and theft (F3,616 = 4.01; P < 0.008) was identified for the TMT-B. For the BCT and VT, significant main effects were identified for physical violence (BCT, F1,616 = 52.34; P < 0.001; VT, F1,616 = 156.67; P < 0.001) and theft (BCT, F1,616 = 7.86; P < 0.001; VT, F1,616 = 2.75; P < 0.04). The interaction for violence and theft on the BCT was significant at a trend level (F1,616 = 2.40; P < 0.07).48 For the follow-up contrasts, Bonferroni corrections were set at 0.013 for the 3 dependent variables.49

Means with the corresponding standard errors for the TMT-B interaction are presented in Figure 3. Contrasts for this interaction indicated significant differences for theft trajectory groups within the high-physical violence group (F3,75 = 24.87; P < 0.001) but not the low-physical violence group (F3,536 = 1.28; P = 0.28). Follow-up Bonferroni-corrected contrasts indicated that, within the high-violence group, the low-theft individuals scored more poorly on the TMT-B compared with the 3 other groups: (1) medium theft, t350 = 2.93; P = 0.005; d = 0.82. There were no significant differences between the individuals following the increasing- and high-theft trajectories. The differences between trajectory groups in TMT-B scores (ie, d) all represent large effect sizes.50 The medium and increasing trajectory contrast missed the Bonferroni-corrected P value (t44 = 2.57; P < 0.01; d = 0.99) but is nevertheless a large effect size difference; the medium-theft trajectory performed worse than those in the increasing trajectory.

The adjusted means for the BCT main effects are presented in Figure 4 and Figure 5. A contrast indicated, as expected, that those in the low-violence trajectory performed better than those in the high-violence trajectory (t44 = −7.23; P < 0.001; d = 0.88). For theft, however, the low-theft trajectory performed worse than the high-theft (t114 = 3.91; P < 0.001; d = 0.66), the increasing-theft (t150 = 4.00; P < 0.001; d = 0.52), and the medium-theft trajectories (t56 = 2.93; P < 0.001; d = 0.82). All other theft contrasts failed to reach the Bonferroni significance level. The difference between the high- and low-violence trajectory groups was a large effect; the differences between the low-theft and the high, increasing, and medium groups were moderate.

The adjusted means for the VT main effects are presented in Figure 6 and Figure 7. As expected, contrasts for the VT indicated that those in the low-violence trajectory performed better than those in the high-violence trajectory (t44 = −12.52; P < 0.001; d = 1.52). Similar to the BCT, for theft, the group of individuals in the low-theft trajectory performed worse than the high-theft trajectory (t30 = 7.86; P < 0.005; d = 3.11). When comparing the 3 latter groups, results indicated that the medium-theft individuals also performed more poorly than the high-theft trajectory (t36 = 1.00; P < 0.001; d = 0.82).

The main goal of the present study was to test to what extent the negative association between neurocognitive performance and antisocial behavior held for 2 major types

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of antisocial behavior: physical violence and theft. Longitudinal data on frequency of physical violence and theft from a large population sample of males were used, first, to verify to what extent physical violence and theft developed differently from adolescence to adulthood; second, to identify the different patterns of developmental trajectories when both types of behavior are jointly analyzed; and finally, to describe the neurocognitive characteristics of individuals following different patterns of trajectory association. Results revealed that the development of physical violence and theft was asymmetrical and tended to be associated with neurocognitive performance in opposite directions. These results are important because they clearly show that the aggregation of different subtypes of antisocial behaviors can impede the identification of specific neurocognitive mechanisms associated with chronic antisocial behavior. This tendency to aggregate different forms of antisocial behavior is most clearly illustrated by the DSM-IV diagnostic rules for CD.1

With the developmental trajectory analyses, we first confirmed that the development of physical violence and theft between the start of adolescence and early adulthood was strikingly different.10,12 Indeed, few males (13%) increased the frequency of physical aggressions, while a majority (55%) increased their frequency of theft. Hence, while the frequency of thefts substantially increased from early to late adolescence, the same was not the case for physical violence. Developmental differences were also reflected in the asymmetry of the conditional probabilities of following a theft trajectory, given membership in a violent trajectory, and the converse set of probabilities, violence given theft. Herein we showed, for the first time, to our knowledge, that young men who followed the high–physical violence trajectory were most likely (47% probability) to follow the medium-theft trajectory rather than the high-theft trajectory (28% probability), while young men who followed the high-theft trajectory were most likely (54% probability) to follow the high–physical violence trajectory. The joint analysis of the 2 sets of developmental trajectories, thus, showed very clearly that, within the group of males who frequently use physical violence during adolescence, there are large differences in frequency of theft. From a developmental phenotype perspective, this is an important observation. Not all frequently violent adolescents frequently steal, and the frequent stealers are not all frequent aggressors.

It is obvious that the aggregation of these 2 types of behavior in a total antisocial score confounds different developmental trajectories that should be taken into account for preventive and treatment purposes. But, more importantly, the aggregation of different types of antisocial behavior may seriously impede understanding the etiology of the disorders.

The results from our analyses provide a good example of why aggregation of antisocial behaviors can prevent the identification of underlying mechanisms. The neurocognitive mechanisms that are postulated to correlate with antisocial behavior may be different for different forms of antisocial behaviors. As expected, frequent physical violence was found to be associated with lower cognitive performance,15,16 both for verbal performance and EF. However, frequent theft was associated with better cognitive performance, both for the verbal and EF tests. The statistical interaction between theft and violence for the TMT-B was especially striking. This test measures working memory, mental flexibility, capacity to plan action, and control of interference. Within the group of violent males, TMT-B scores were lower for those with the least frequent thefts and higher for those with the most frequent thefts. Hence, within the current sample of young men, chronically violent individuals had lower neurocognitive abilities, but chronic thieves had better neurocognitive abilities even if they used physical violence.

These results suggest that the 4 categories of CD defined by DSM-IV1 (physical aggressions, theft, vandalism, rule breaking) need to be studied separately, as well as from a comorbid perspective. Such analyses are necessary for understanding onset, development, and underlying mechanisms. From this perspective, the CD diagnosis should be reconsidered to take into account the development of each of the subcategories, the underlying developmental mechanisms, and the important sex differences.51 DSM-IV apparently replaced the earlier DSM symptom-based subtypes (aggressive and nonaggressive) with age-based subtypes (early and late) because of lack of evidence for the former subtypes.52 The results presented in this article support other recent developmental trajectory analyses indicating that there are symptom-based subtypes, especially the physical aggression variety, which has an earlier onset than the present “age 10 years” criterion.31,12,51 Taking into account these subtypes may lead to more effective preventive and treatment interventions.
This study has limitations that should be taken into account. First, the neuropsychological tests were first administered when the participants were 18 to 24 years of age (time 3). To understand to what extent the neurocognitive abilities are antecedents or consequences of the developmental trajectories, future research should include assessments of cognitive performance at the beginning of adolescence and in early adulthood. These measures should also be broader in scope and include more refined aspects of EF as well as EF tests that have been functionally validated.18 More comprehensive assessments of verbal functioning and IQ are also needed to provide a more differentiated neurocognitive characterization of developmental trajectories. Second, the present results add to the literature on criminal versatility/specialization.54-56 Some individuals appear to specialize in theft and others in violence, while a third group appears to be “versatile.” This issue relates to the CD symptom-based subtype discussed earlier, but from a criminological perspective. Future research on this topic could clearly benefit from the use of the dual trajectories. Third, both violence and theft can be the result of instrumental (planned) or impulsive (emotive) processes. Future studies should examine the relation of neurocognitive function to instrumental and impulsive acts of violence and theft. Fourth, the number of individuals in the high–physical violence/low-theft trajectory, the group responsible for the largest effect size difference, is quite small. Low sample sizes in elevated trajectories could be a source of bias when compared with the other high-violent young men, was small. Small sample sizes in elevated trajectories of antisocial behaviors, however, are the norm and not the exception.37-39 Fifth, the sample comprised white males from working- to middle-class backgrounds. Replications are needed with diverse ethnic groups in rural and urban settings to verify the generalizability of the results. In addition, although violence in females was too infrequent to model in the present sample (and other samples60), group-based trajectories have been modeled for physical aggression in females from early childhood to puberty.59,61,62 Additional longitudinal studies of the conjoint development of both physical violence and theft in females from early childhood to adulthood are needed to better understand underlying relations to neurocognitive performance. Additional research is needed to replicate our findings with young women. Sixth, the measurements of violence and theft relied on self-reports. Future studies should also collect collateral reports and/or official reports to avoid limitations associated with a single reporter and data collection method. Seventh, the study used data on physical violence and theft from early adolescence to early adulthood. It is clear that physical aggression9 and object-related aggression46 begin very early in the life span. Future research should focus on the development of the various conduct problems during early childhood and their association with cognitive abilities at that point. Longitudinal studies of these associations from early childhood to adulthood will give a better understanding of the extent to which the developmental trajectories of antisocial behavior are influenced by early cognitive abilities and also influence cognitive development.4

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Correspondence: Richard E. Tremblay, PhD, GRIP, University of Montreal, 3050 Edouard-Montpetit, Montreal, Quebec H3T 1J7, Canada (tremblar@umontreal.ca)

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REFERENCES


Correction

Error in Results. In the Original Article by Barker et al titled “Developmental Trajectories of Male Physical Violence and Theft: Relations to Neurocognitive Performance,” published in the May 2007 issue of the Archives (2007;6[3]:392-399), a computation error affected the conclusions drawn about the relationship between neurocognition and theft. The original conclusion stated in the “Results” section of the Abstract was that “Executive function and verbal IQ performance were negatively related to high frequency of physical violence but positively related to high frequency of theft.” The sentence should have read “Executive function and verbal IQ performance were negatively related to high frequency of physical violence but were unrelated to theft.”

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