

# Developmental Trajectories of Male Physical Violence and Theft

## Relations to Neurocognitive Performance

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**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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**Y**OUTH 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*<sup>1</sup> 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.<sup>2-4</sup> 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.<sup>5-8</sup>

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 devel-

opmental differences. There is indeed good evidence that the frequency of physical aggression decreases with age, while theft appears to be increasing, at least from pre-adolescence to adulthood.<sup>9-13</sup> 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,<sup>14,15</sup> poor neurocognitive functioning has been found in incarcerated males who have perpetrated violent acts<sup>16,17</sup> and is associated with a history of chronic physical aggression.<sup>18</sup> Theft, on the other hand, has rarely been examined by itself. However, there has been much speculation over close to 2 centuries<sup>19-21</sup> about how cognitive abilities associate with different forms of crime, and a 20-year-old cross-sectional study of incarcerated male ado-

lescents reported a positive relationship between property crime and verbal IQ.<sup>22</sup>

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<sup>8</sup> identified developmental trajectories of aggregated antisocial behaviors, including physical violence and theft. Second, the developmental trajectory groups identified by these researchers<sup>8</sup> 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.<sup>4</sup> 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.<sup>14</sup> 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.<sup>2</sup>

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.<sup>22</sup>

## 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 were paid for their participation, and informed consent was obtained from both the participants and their legal guardians.

The HHDP sample includes 698 males and 682 females who were tested initially between 1979 and 1981 (time 1). Three cohorts were tested. The youngest cohort was aged 12 years at time 1, the middle cohort was aged 15 years at time 1, and the oldest cohort was aged 18 years at time 1. These participants returned for retest 3 years later between 1982 and 1984 (time 2), again between 1985 and 1987 (time 3), and finally between 1992 and 1994 (time 4). Ninety-one percent (n=1257) of the original sample returned at time 4. The youngest cohort returned between 1999 and 2000 (time 5) at ages 30 or 31 years. Most participants were from a metropolitan area consisting of working-

and middle-class families. Parents' median family income was between \$20 000 and \$29 000 at time 1. Half of the participants were Catholic; 30% were Protestant; 9% were Jewish; and 11%, other. With regard to racial background, 90% were white, 8% were black, and the remaining 2% were other or mixed.

We limited the present study to males (n=698). Physical violence could not be modeled in the females because its occurrence was too rare. To take advantage of the cohort-sequential design, age scores for violence and theft were created. There were 5 ages at which physical violence was measured (ages 12, 15, 18, 21, and 24.5 years) and 7 ages at which theft was measured (ages 12, 15, 18, 21, 24.5, 28, and 31 years). Physical violence had fewer data points than theft because of a change in the violent self-report items at 28 and 31 years of age. The cohort-sequential design of the HHDP sample is described in detail elsewhere.<sup>8,23</sup>

Delinquent behavior ratings were obtained through self-reports. Self-reports have been described as valid indicators of delinquent behavior and are commonly used in the antisocial behavior literature.<sup>24,25</sup> To maximize reliability and validity of the self-report data, participants were instructed not to put their names on any questionnaire and were repeatedly assured of the complete confidentiality of all data, especially with regard to parents, teachers, and public authorities. Participants were treated according to the ethical guidelines of the American Psychological Association<sup>26</sup> and protected by a Certificate of Confidentiality obtained from the National Institutes of Health.

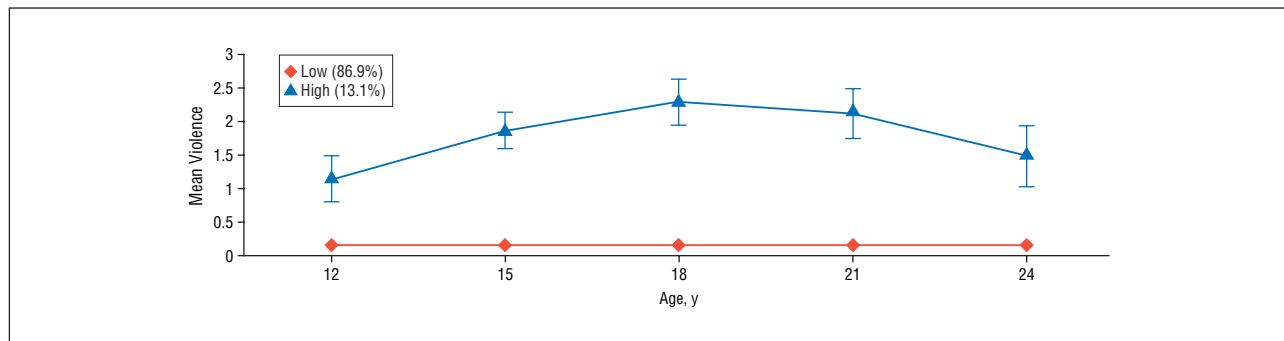
Eighty-eight percent (n=617) of the male participants yielded complete neurocognitive information. To examine whether incomplete responses on the neurocognitive tests were associated with the variables in the present study, we compared those young men with complete neurocognitive information (617) with those with incomplete neurocognitive information (n=82). Individuals with complete information did not differ from individuals with incomplete neurocognitive information on any of the variables used in the study. The trajectories were estimated with the full sample (n=698) and trajectory relations to the neurocognitive tests were examined with the 617 men.

### PHYSICAL VIOLENCE AND THEFT

The physical violence items measured how often (5-point scale, from 0=never to 4=>10 times) the participants had 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 had 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.<sup>27,28</sup> Verbal ability was measured by the Shipley Institute of Living Scale Vocabulary Test



**Figure 1.** Trajectories for physical violence (12 to 24 years of age). Error bars represent 95% confidence intervals.

(VT) (mean [SD] score, 29.65 [5.06]).<sup>29,30</sup> This test comprises 40 multiple-choice-based items and provides a time-saving (10-minute) yet valid alternative to more intensive verbal IQ measurements; studies have shown that the VT is highly ( $r > 0.72$ ) correlated with the Wechsler Adult Intelligence Scale-Revised, Wechsler Adult Intelligence Scale III, and Kaufman Brief Intelligence Test.<sup>31</sup> The VT also exhibits good internal consistency, test-retest validity, and criterion-related validity.<sup>32-34</sup>

Executive function was assessed by 2 tests: the Trail-Making Test Part B (TMT-B)<sup>35</sup> and the Booklet Category Test (BCT).<sup>36</sup> 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.<sup>37,38</sup> The BCT<sup>36</sup> (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 version<sup>39</sup> 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.<sup>40</sup>

Mean scores on these 3 tests are indicative of average performance levels based on normative data from similarly aged and educated samples.<sup>41,42</sup> 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.<sup>34</sup>

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.<sup>43</sup> 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.<sup>44</sup> The Bayesian Information Criteria rewards parsimony for the number of groups included in a trajectory model.<sup>45</sup>

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.<sup>45,46</sup>

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.

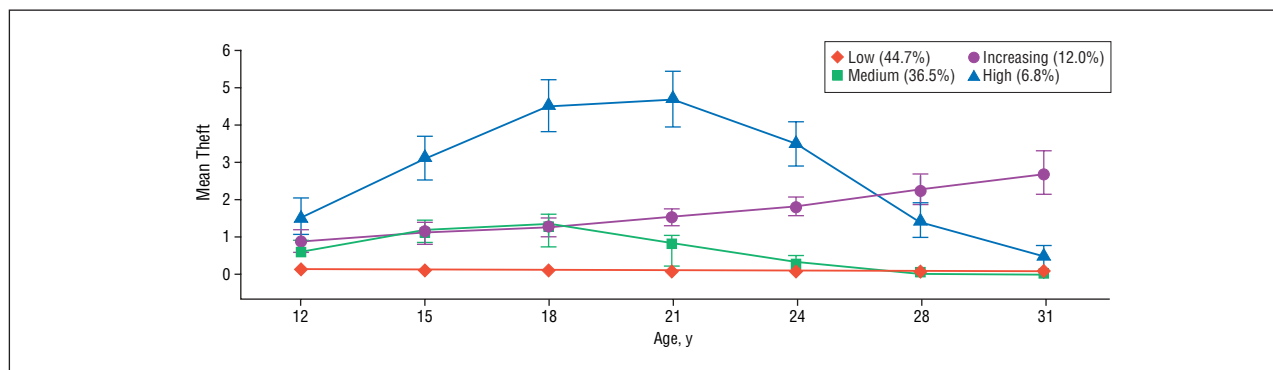
In the third step, we examined differences in neurocognitive ability levels associated with the theft and physical violence trajectories. The distributional properties of the 2 test scores were examined prior to analysis. To correct for skew, the TMT-B time score required a log transformation. The TMT-B, 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 SAS<sup>47</sup> 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.

## RESULTS

### STEP 1: TRAJECTORY MODELS

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 2.** Trajectories for theft (12 to 31 years of age). Error bars represent 95% confidence intervals.

<b>Table. Joint and Conditional Probabilities of Physical Violence and Theft Trajectories</b>				
<b>Variable</b>	<b>Low</b>	<b>Medium</b>	<b>Increasing</b>	<b>High</b>
<b>Joint Probabilities of Violence and Theft</b>				
Low violence	0.428	0.303	0.106	0.032
High violence	0.018	0.062	0.015	0.036
<b>Probabilities of Violence Trajectory Membership Conditional on Theft Trajectory</b>				
Low theft	0.959	NA	NA	0.041
Medium theft	0.831	NA	NA	0.169
Increasing theft	0.879	NA	NA	0.121
High theft	0.465	NA	NA	0.535
<b>Probabilities of Theft Trajectory Membership Conditional on Violence Trajectory</b>				
Low violence	0.493	0.349	0.122	0.037
High violence	0.141	0.471	0.111	0.278

Abbreviation: NA, not applicable.

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, 1.5% on the increasing-theft trajectory, 6.2% on the medium-theft trajectory, and 1.8% on the low-theft trajectory.

### Conditional Probabilities of Violence Given Theft

The second part of the Table contains the likelihood of belonging to a violence trajectory conditional on mem-

bership in a theft trajectory. In this section of the Table, probabilities within rows sum to 1. Those in the low-theft trajectory had a 0.96 probability to follow the low-violence trajectory and a corresponding 0.04 probability to follow the high-violence trajectory. The probability of following the high-violence trajectory was highest (0.54) for those on the high-theft trajectory and much lower (0.12 and 0.17, respectively) for those on the increasing and medium trajectories.

### 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.



**Figure 3.** Means and standard errors for the Trail-Making Test Part B<sup>35</sup> (TMT-B) physical violence  $\times$  theft interaction.



**Figure 4.** Adjusted means and standard errors for the Booklet Category Test<sup>36</sup> (BCT) physical violence main effect.

Mean differences in neurocognitive performance were evaluated in a 4 (theft)  $\times$  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];  $n=617$ ;  $P<.001$ ). 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 ( $F_{9,1848}=1.92$ ;  $P=.045$ ). A significant interaction for violence and theft ( $F_{3,616}=4.01$ ;  $P<.008$ ) was identified for the TMT-B. For the BCT and VT, significant main effects were identified for physical violence (BCT,  $F_{1,616}=52.34$ ;  $P<.001$ ; VT,  $F_{1,616}=156.67$ ;  $P<.001$ ) and theft (BCT,  $F_{3,616}=7.86$ ;  $P<.001$ ; VT,  $F_{3,616}=2.75$ ;  $P<.04$ ). The interaction for violence and theft on the BCT was significant at a trend level ( $F_{3,616}=2.40$ ;  $P<.07$ ).<sup>48</sup> For the follow-up contrasts, Bonferroni corrections were set at 0.013 for the 3 dependent variables.<sup>49</sup>

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 ( $F_{3,75}=24.87$ ;  $P<.001$ ) but not the low-physical violence group ( $F_{3,536}=1.28$ ;  $P=.28$ ). 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,  $t_{36}=6.42$ ;  $P<.001$ ;  $d=2.26$ ; (2) increasing theft,  $t_{18}=6.98$ ;  $P<.001$ ;  $d=3.36$ ; and (3) high theft,  $t_{30}=8.05$ ;  $P<.001$ ;  $d=3.11$ . When comparing the 3 latter groups, results indicated that the me-



**Figure 5.** Adjusted means and standard errors for the Booklet Category Test<sup>36</sup> (BCT) theft main effect.

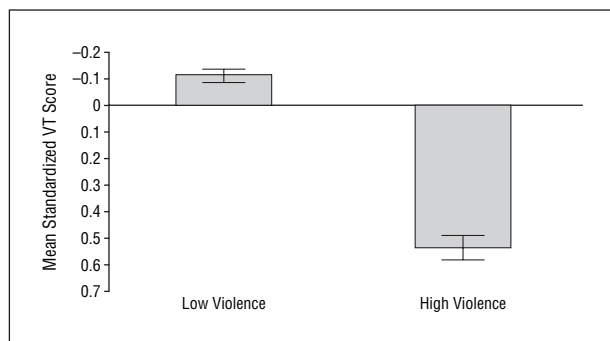
diu-theft individuals also performed more poorly than the high-theft trajectory ( $t_{56}=2.93$ ;  $P<.005$ ;  $d=0.82$ ). There were no significant differences between the individuals following the increasing- and high-theft trajectories. The differences between trajectory groups in TMT-B scores (ie,  $d$ ) all represent large effect sizes.<sup>50</sup> The medium and increasing trajectory contrast missed the Bonferroni-corrected  $P$  value ( $t_{44}=2.57$ ;  $P<.01$ ;  $d=0.99$ ) but is nevertheless a large effect size difference; the medium-theft trajectory performed worse than those in the increasing trajectory.

The adjusted means (violence controlling for theft; theft controlling for violence) 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 ( $t_{615}=-7.23$ ;  $P<.001$ ;  $d=-0.88$ ). For theft, however, the low-theft trajectory performed worse than the high-theft ( $t_{314}=3.91$ ;  $P<.001$ ;  $d=0.66$ ), the increasing-theft ( $t_{350}=4.00$ ;  $P<.001$ ;  $d=0.52$ ), and the medium-theft trajectories ( $t_{499}=4.14$ ;  $P<.001$ ;  $d=0.37$ ). All other theft contrasts failed to reach the Bonferroni significance level. The difference between the high- and low-physical violence trajectory groups was a large effect; the differences between the low-theft and the high, increasing, and medium groups were moderate.<sup>50</sup>

The adjusted means (violence controlling for theft; theft controlling for violence) with the corresponding standard errors for the VT main effects are presented in **Figure 6** and **Figure 7**. As expected, contrasts for the VT indicated those in the low-violence trajectory performed better than those in the high-violence trajectory ( $t_{615}=-12.52$ ;  $P<.001$ ;  $d=-1.52$ ). Similar to the BCT, for theft, the group of individuals in the low-theft trajectory performed worse than the high-theft trajectory ( $t_{314}=2.80$ ;  $P<.005$ ;  $d=0.48$ ). All other theft contrasts failed to reach the Bonferroni significance level. The difference between the high- and low-physical violence trajectory groups was a large effect, whereas the difference between the high- and low-theft groups was a moderate effect size.<sup>50</sup>

#### COMMENT

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



**Figure 6.** Adjusted means and standard errors for the Shipley Institute of Living Scale Vocabulary Test<sup>29,30</sup> (VT) physical violence main effect.



**Figure 7.** Adjusted means and standard errors for the Shipley Institute of Living Scale Vocabulary Test<sup>29,30</sup> (VT) theft main effect.

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.<sup>1</sup>

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.<sup>10,12</sup> 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 be correlates of 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,<sup>15,16</sup> 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-IV*<sup>1</sup> (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.<sup>51</sup> *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.<sup>52</sup> 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.<sup>9,11,12,53</sup> 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.<sup>18</sup> 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.<sup>54-56</sup> 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 differences when compared with the other high-violent young men, was small. Low sample sizes in elevated trajectories of antisocial behaviors, however, are the norm and not the exception.<sup>57-59</sup> 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 samples<sup>60</sup>), group-based trajectories have been modeled for physical aggression in females from early childhood to puberty.<sup>9,53,61,62</sup> 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 aggression<sup>9</sup> and object-related aggression<sup>63</sup> 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.<sup>4</sup>

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### 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;64[5]:592-599), 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."