

# Male antisocial behaviour in adolescence and beyond

Terrie E. Moffitt <sup>1,2,3,4</sup>

**Male antisocial behaviour is concentrated in the adolescent period of the life course, as documented by the curve of crime over age. This article reviews recent evidence regarding the hypothesis that the age-crime curve conceals two groups with different causes. Life-course-persistent males show extreme, pervasive, persistent antisocial behaviour from early childhood to adulthood. They are hypothesized to be rare, with pathological risk factors and poor life outcomes. In contrast, adolescence-limited males show similar levels of antisocial behaviour but primarily during the adolescent stage of development. They are hypothesized to be common and normative, whereas abstainers from offending are rare. This Review recaps the 25-year history of the developmental taxonomy of antisocial behaviour, concluding that it is standing the test of time in research, and making an impact on policy in early-years prevention and juvenile justice. Research is needed into how the taxonomy relates to neuroscience, health, genetics and changes in modern crime, including digital crime.**

Male antisocial behaviour harms victims, perpetrators and society, and it is heavily concentrated in the adolescent stage of life. This article reviews new research stemming from a developmental taxonomy of antisocial behaviour<sup>1</sup>. Twenty-five years ago, the taxonomy outlined two hypothetical prototypes: life-course persistent versus adolescence limited (hereafter LCP and AL). According to this taxonomy, LCP individuals' antisocial behaviour has its origins in neurodevelopmental processes and family adversity, beginning in childhood, building persistently thereafter and continuing into midlife. In contrast, AL delinquents' antisocial activities have their origins in age-graded social processes that begin with a maturity gap in adolescence and end when social adulthood is attained. According to the taxonomy, LCP antisocial behaviour is rare, persistent, pervasive and pathological, whereas AL antisocial behaviour is common, relatively transient, situational and near normative (Fig. 1). This Review emphasizes research since 2005, when the last comprehensive reviews appeared (for example, refs 2–5). The Review is limited to research on male LCP and AL behaviour; related topics such as girls' delinquency or childhood-limited conduct disorder are omitted because findings have not reached consensus. Coverage is not exhaustive; instead this Review selectively covers empirical research supported by rigorous designs, strong samples and/or new methods. It identifies what is new and flags what still needs to be learned.

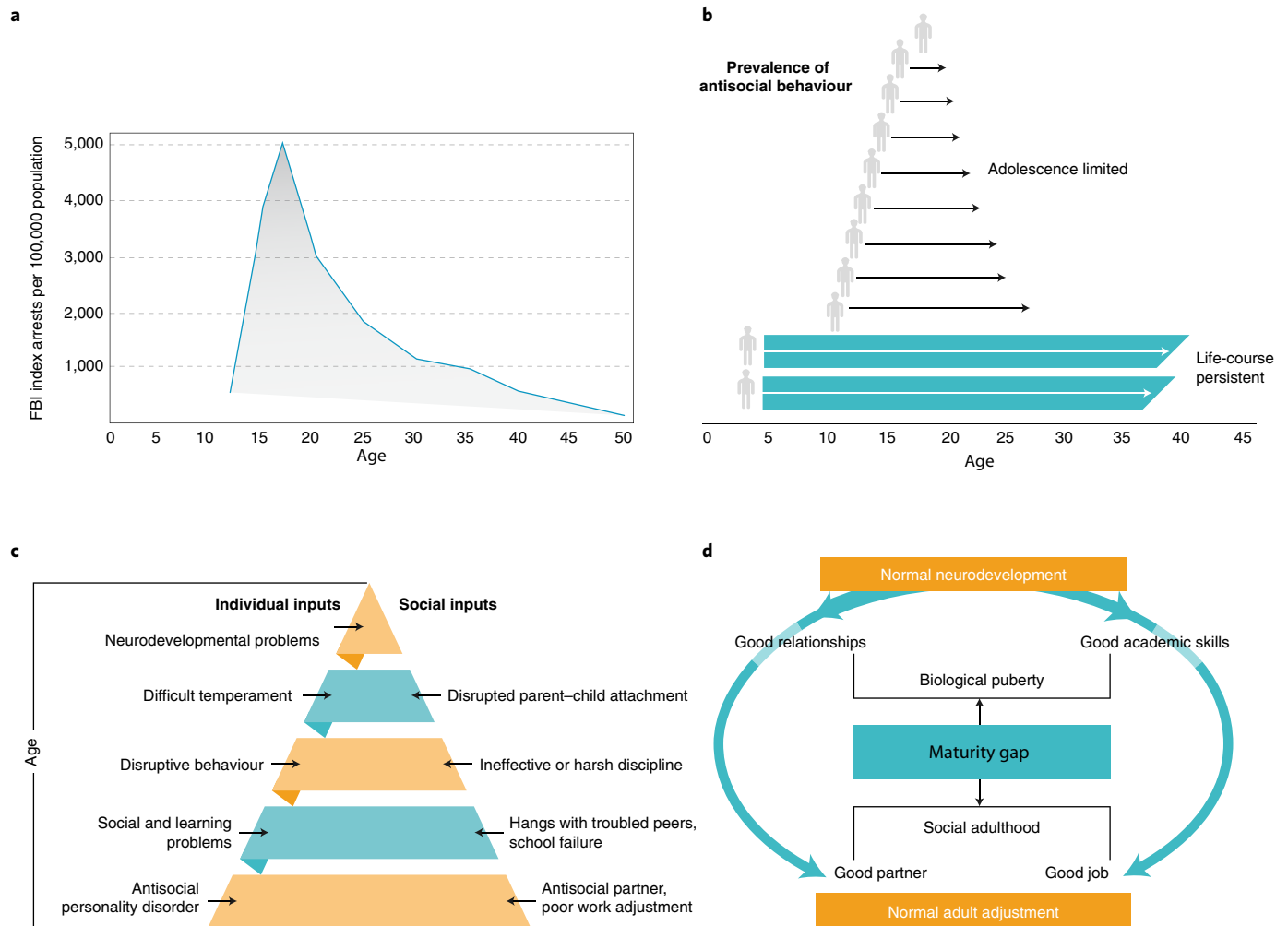
## Historical context of the taxonomy

Before looking into what is new, it is useful to revisit the 1980s, to understand why at that time there was a need for a taxonomy of youth crime that juxtaposed two types of offenders, each framed in its own theory. Two influential reports had drawn scholarly attention to the importance of change in rates of antisocial behaviour across age. Epidemiologist Lee Robins<sup>6</sup> reported an apparent paradox that puzzled psychiatry: antisocial adults virtually always begin as children with antisocial misconduct, but most young people who engage in antisocial misconduct do not grow up to be

antisocial adults. Criminologist Al Blumstein, leading the US National Academy of Sciences panel on crime careers<sup>7</sup>, enumerated the replicated facts about crime at that time. First, a small fraction of the population commits a large fraction of crime, a fact recently reconfirmed by meta-analysis<sup>8</sup>. This fraction was termed 'chronic offenders'. Chronic offenders are a subset of the 30–40% of males convicted of non-traffic crimes in developed nations<sup>9</sup>. Second, chronic offenders tend to have a younger onset age, and younger onset predicts higher offending frequency, longer career duration and thus a large share of offenses. Chronic offenders also commit a broad repertoire of crime types, including violence. Third, Blumstein's panel confirmed that offending followed a curve over age, which became known as 'the age-crime curve' (Fig. 1a). Onset of illegal behaviour was typically between ages 8 and 14 years (later in official data than in self-report data), and desistance from offending was typically between ages 20 and 29 years. The peak age of offending occurred inbetween: among 15–19-year-olds, when upwards of 90% of males break laws, according to self-report cohort studies<sup>1</sup>. These were the known facts at the time the LCP/AL taxonomy was developed. Two possible explanations were advanced to account for this adolescent crime peak: it could result from the few chronic offenders escalating their personal crime rate between ages 15 and 19 years, or it could result if the few chronic offenders were joined by large numbers of young people who offended around 15–19 years old and then desisted within a few years. The developmental taxonomy was developed to explain the age-crime curve (Fig. 1b).

Until the early 1990s, biological and psychological theories did not account for the age-crime curve's adolescent onset and peak, while simultaneously, sociological theories did not account for the age-crime curve's steep post-adolescent drop of crime desistance. Psychobiological researchers typically conducted their studies in child clinics or adult prisons and thus trained their lenses on early childhood or adulthood, neglecting adolescence. They typically focused on the long-term stability of individual differences in traits

<sup>1</sup>Department of Psychology and Neuroscience, Duke University, Durham, NC, USA. <sup>2</sup>Department of Psychiatry and Behavioral Sciences, Duke University School of Medicine, Durham, NC, USA. <sup>3</sup>Center for Genomic and Computational Biology, Duke University, Durham, NC, USA. <sup>4</sup>Social, Genetic, and Developmental Psychiatry Research Centre, Institute of Psychiatry, Psychology, and Neuroscience, King's College London, London, UK. e-mail: [tem11@duke.edu](mailto:tem11@duke.edu)

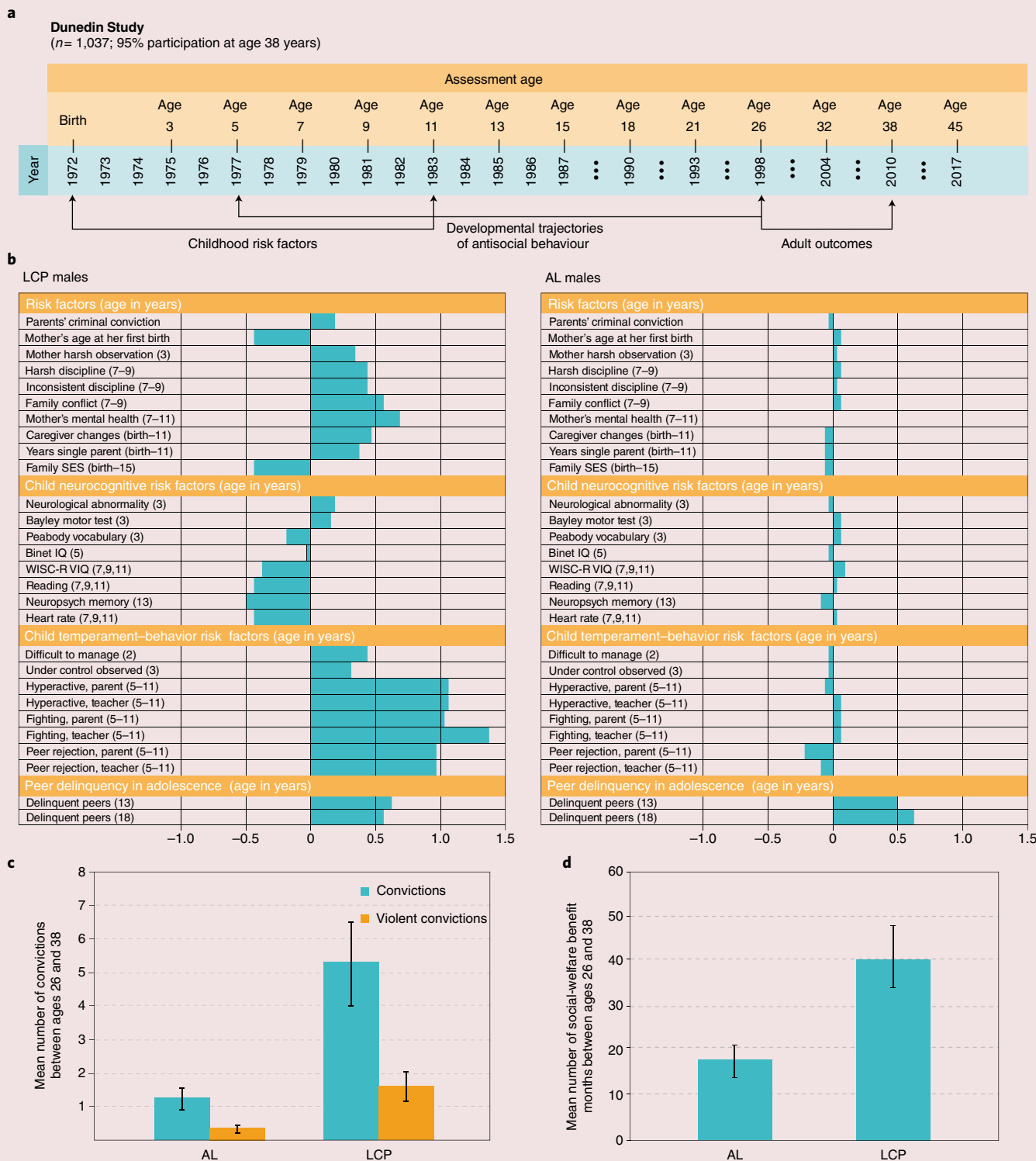


**Fig. 1 | LCP and AL antisocial behaviour.** **a**, The age-crime curve, circa 1980s. The onset of illegal behaviour was typically between ages 8 and 14 years, the peak age of offending was between ages 15 and 19 years and desistance was typically between ages 20 and 29 years. FBI, Federal Bureau of Investigation. **b**, The developmental taxonomy proposed that the age-crime curve conceals two groups, and proffered two distinct theories. **c**, LCP originates early in life, when the difficult behaviour of a high-risk child is exacerbated by a high-risk social environment. According to the theory, the child’s risk emerges from inherited or acquired neuropsychological problems, initially manifested as difficult temperament, cognitive deficits or hyperactivity. The environment’s risk comprises factors such as disrupted family attachment bonds, inadequate parenting, maltreatment and poverty. The environmental risk domain expands beyond the family as the child ages, to include poor relationships with other people, such as peers and teachers. Opportunities to learn prosocial skills are missed. Over the first two decades of development, accumulating transactions between the individual and the environment incrementally construct a disordered personality with hallmark features of violent physical aggression and a broad repertoire of antisocial behaviours persisting to midlife. Antisocial behaviour that is LCP infiltrates multiple adult life domains, including illegal activities, substance misuse, problems with employment, and victimization of intimate partners and children. This cumulative infiltration gradually diminishes the possibility of reform, accounting for the persistence of LCP behaviour. **d**, AL emerges alongside puberty, when otherwise ordinary healthy youngsters experience psychological discomfort during the relatively roleless years between their biological maturation and their access to mature privileges and responsibilities, a period termed the ‘maturity gap’. These young people become dissatisfied with their childlike dependent status, and impatient for what they anticipate are the privileges and rights of adulthood. While young people are in this gap, it is virtually normative for them to find aspects of the delinquent lifestyle appealing and to emulate it as a way to demonstrate autonomy from parents, win affiliation with peers and hasten social maturation. In fact, adolescent abstainers from offending are rare. However, because their pre-delinquent development was healthy in realms such as academic achievement and interpersonal attachments, most adolescence-limited delinquents have the personal characteristics needed to desist from crime when they age into real adult roles. Thus, they are able to return to a more conventional lifestyle as young adults. Panels adapted from: **a**, ref. <sup>108</sup>, American Society of Criminology; **b**, ref. <sup>1</sup>, American Psychological Association.

such as impulsivity, neuroticism, autonomic nervous-system reactivity or low intelligence, but psychobiological trait theories could not explain the adolescent peak of the age-crime curve without positing a sudden and dramatic population upshift in criminogenic traits followed by return to baseline a few years later. In contrast, sociologically oriented criminologists favoured studying the adolescent age period. Historically, reliance on legal definitions of antisocial behaviour had kept these delinquency researchers preoccupied

with the question of why illegal offending onsets in adolescence. Adolescence was when crime peaks, and therefore offending could be most conveniently studied by administering surveys to adolescents in high schools. But the resulting sociological research failed to address the long-term stability of antisocial behaviours that begin years before adolescence, even in the preschool years. In addition, most sociological crime theories at that time invoked causes such as low social class, school drop-out, cultural approval of violence

**Box 1 | Research on the taxonomy from the Dunedin Study**



**Results from the Dunedin Study.** **a**, Design of the longitudinal study. **b**, A comparison of effect sizes for risk factors for LCP (left) and AL (right) groups, as defined in the study. SES, socioeconomic status; WISC-R VIQ, Wechsler intelligence scale for children verbal intelligence quotient. **c**, Prevalence of criminal conviction between ages 26 and 38 years in the LCP and AL groups defined in the study. **d**, Social-welfare payments received by the LCP and AL groups defined in the study. The error bars in **c** and **d** are standard errors.

Several reports about the developmental taxonomy have emerged from the Dunedin Study<sup>17,34,40,45,56,109-113</sup>. Drawing on parent and teacher reports collected at ages 5, 7, 9 and 11 years, my co-authors and I identified children who showed extreme antisocial

behaviour persistently across years, and pervasively at home and in school (panel a). Drawing on self-reports during confidential interviews at ages 15 and 18, we distinguished teenagers who did versus did not participate in many antisocial acts. Combining this

**Box 1 | Research on the taxonomy from the Dunedin Study (continued)**

information from childhood and adolescence revealed that fewer than 10% of male cohort members met our LCP research criteria, while about a quarter met AL criteria<sup>11</sup>. Although some AL boys had temporary or situational problems as children, none manifested a stable, pervasive pattern of high-rate childhood conduct problems. Yet their self-reports, their parents' reports and official police records all confirmed that they reached levels of antisocial behaviour by mid-adolescence that were indistinguishable from their LCP counterparts'. The two groups did not differ on amount of adolescent antisocial behaviour, but LCP teenagers self-reported more violence and were more often convicted for violence.

As children, LCP boys had elevated levels of risk in domains of parenting, neurocognitive development and temperament/behaviour (panel b, left). AL boys scored near the cohort norm on these risk factors, and were elevated only on adolescent peer delinquency (panel b, right). Personality assessments (not shown) revealed that LCP boys were impulsive, hostile, alienated, suspicious, cynical, and callous and cold towards others. This personality profile contrasted with AL boys, who were willing to dominate others if necessary to get ahead, and who held unconventional values (such as approval of drug legalization). Personality testing showed AL boys desired close relationships more than LCP boys. By their late 20s, LCP men were 2.5 times more likely than AL men to have been convicted for adult crime. AL men continued to report property and drug-related offenses while LCP men reported more serious crimes. LCP men were described by informants as having symptoms of antisocial personality

disorder. They self-reported excess violence towards partners and children; although few LCP men reared the children they fathered. They had poor work histories and interpersonal conflicts in low-status, unskilled jobs, lacked high-school qualifications to get better jobs, and made a poor impression in an interview-type assessment. AL men had better outcomes on all of these measures of work and family life. By the cohort's early 30s, we were able to define the groups using trajectory modelling<sup>16</sup>. In their 30s, LCP men had worse mental health, more suicide attempts and worse physical health. AL men also experienced problems in their 30s, prominently alcohol abuse.

Approaching midlife, most LCP men had not desisted from crime; 55% were convicted between ages 26 and 38 years, versus 30% of AL men (panel c). In comparison, the prevalence of conviction among all men in the cohort between ages 26 and 38 was 18%.

Searches of national administrative databases revealed that LCP men had received social-welfare benefits for on average 3.3 years per group member between ages 26 and 38 years, significantly more than AL men, who averaged 18 months of benefits (panel d). In comparison, the entire cohort of men averaged 12 months of benefits. Of note, LCP men had high levels of conviction and benefit receipt despite the fact that many had been in prison, where they were ineligible for further conviction or social-welfare benefits. One in four LCP men had been incarcerated (eighteen months per group member on average), compared with only one in twenty of AL men (two months on average).

and deviant labels. However, such causal factors do not disappear in time to explain the marked downward shift in offending that ends the age-crime curve.

The developmental taxonomy was developed to integrate psychobiological and sociological theories. It proposed that psychological and biological theories applied best to LCP offenders, who behave in antisocial ways during childhood, adolescence and adulthood (Fig. 1c). It proposed that sociological theories applied best to AL offenders, whose antisocial acts elevate the age-crime peak (Fig. 1d). The 1993 article also integrated into one developmental taxonomy the many disparate measures of behaviour that violates the rights and safety of others: sociology's self-reported and officially registered offending, and psychobiology's childhood conduct problems and adult antisocial personality.

**Research designs for testing the taxonomy**

The original 1993 article made testable predictions, and listed research design desiderata to test them. Samples should be population-representative to capture the population range of natural histories. The same individuals should be studied longitudinally to trace trajectories of antisocial behaviour within individual lives, ideally starting in childhood and continuing into adulthood. Measures of antisocial behaviour should allow for the emergence of new forms of antisocial behaviour (for example, automobile theft in adolescence, intimate-partner violence and workplace deviance in adulthood) and the forsaking of old forms (for example, childhood tantrums, truancy). Reports of antisocial behaviour should be gathered from multiple sources and settings to tap pervasiveness. In addition to official measures of offending, research should also analyse self-reports and informant reports to ascertain childhood onset of antisocial conduct and to insure coverage of antisocial behaviours not captured in official crime data. Risk factors should be measured prospectively to avoid confusing consequences of an antisocial lifestyle with its causes. Among studies that met this

challenge is the Dunedin Study<sup>10</sup>, which followed a representative birth cohort of 1,037 children born in 1972–1973 across the age-crime curve (panel a of the figure in Box 1).

**How have the predictions from the 1993 taxonomy fared?**

I now look at the four main predictions from the developmental taxonomy of antisocial behaviour and how they fare in terms of the latest research.

**The age-crime curve conceals two groups.** The 1993 article stated that fewer than 10% of males should show extreme antisocial behaviour that begins during early childhood and is thereafter sustained at a high level across time and circumstances. A much larger percentage of males should show similar levels of antisocial behaviour during the adolescent age period but should lack a childhood history of stable, pervasive problem behaviour.

*What's new? Group-based trajectory methods.* About the time the developmental taxonomy was put forward, methods to test it in repeated-measures datasets were developed<sup>11</sup>. Chief among them were modelling techniques designed to detect hypothesized groups with distinctive developmental trajectories of behaviour within a population<sup>12</sup>. Since the advent of group-based trajectory modelling methods, the existence of trajectory groups fitting the LCP and AL taxonomy has now been confirmed by reviews of more than 100 longitudinal studies<sup>13–16</sup>, including the Dunedin Study<sup>17,18</sup>, plus more recently published studies<sup>19–22</sup>. Studies vary in sampling, geographic area, historical period, phases of the life course observed, length of observation period and data sources analysed, and thus understandably in the number and shape of trajectories reported. However, reviews conclude that results are reasonably consistent with the taxonomy, detecting heterogeneity in the temporal course of offending, and pointing to a minimum of three groups: a low or non-offender group, a group whose offending peaks in adolescence

but drops as adulthood begins, and a chronic/high-rate group that continues offending into adulthood.

*What's new? Digital crime.* The Internet and related communication technologies have altered the behavioural landscape, including the landscape of methods young people use to victimize others<sup>23,24</sup>. The taxonomy was proposed in an era when the adolescent crime peak meant 'street crimes', such as shoplifting, house-breaking and vehicle theft. But virtual Internet-enabled crimes do not require physical strength or proximity; for example, drug trafficking is accomplished via Telegrass (<https://www.haaretz.com/israel-news/.premium-1.813284>). Research is needed on the taxonomy in digital natives.

**In adulthood AL and LCP groups go separate ways.** The 1993 article stated that AL delinquents can profit from opportunities for desistance, because they retain the option of successfully resuming a conventional lifestyle. LCP delinquents may make transitions into marriage or work, but their injurious childhoods make it less likely that they can leave behind their longstanding antisocial style of solving life's problems; they should express antisocial behaviour at home and at work (Fig. 1c,d).

*What's new? Cohorts followed through adulthood.* When the taxonomy was published, few cohort studies of antisocial behaviour had reached adulthood, rendering them unable to test whether LCP and AL groups have different outcomes<sup>25</sup>. What is new is that more cohorts have now collected data on duration of offending careers at least to midlife, when the age-crime curve of officially recorded crime drops to very low. The results of these long-term follow-ups are broadly consistent with the hypothesis that the age-crime curve comprises a small group of chronic offenders whose crime careers extend to at least midlife and a larger group of short-term offenders whose careers end younger. Prospective longitudinal studies from multiple countries that have tested the taxonomy while following cohorts since childhood report that LCP groups show poorer life outcomes into their late 40s<sup>26–29</sup>. Two studies extend the follow-up period into the 50s. The Cambridge Study in Delinquent Development followed 411 London males from ages 8 to 56 using official conviction records and self-report interviews<sup>21</sup>. Trajectory modelling revealed an adolescent high-peak group and a chronic high-rate group. Members of the chronic group had poor midlife outcomes and were still being convicted at age 56. The most recent study that modelled crime trajectories up to age 51 found a small chronic high-rate offender group, men characterized by a childhood history of abuse and neglect<sup>22</sup>. Two remarkable studies tested the taxonomy in offenders followed to age 70. A Netherlands study of over 5,000 offenders detected a small group still being regularly convicted in their 70s<sup>29</sup>. In the Gluecks' cohort of reform-school boys, trajectory models confirmed the existence of chronic offenders and early crime desistors, but the authors emphasized that all men's offending declines precipitously with age; even chronic offenders rarely offend into late life<sup>30</sup>.

*What's new? Many LCP offenders end up with ill-health or incarceration.* Midlife follow-ups revealed an important finding unanticipated by the 1993 taxonomy: the LCP lifestyle often culminates in illness, hospitalization, sickness disability and premature mortality<sup>17,31–33</sup>. Antisocial lifestyles probably damage health, but alternatively, childhood neurodevelopmental risks may signal weak system integrity of the body, which emerges as poor adult health. Furthermore, the LCP antisocial lifestyle tends to land offenders behind bars, as shown in the Dunedin Study (Box 1), and other studies<sup>22,29</sup>. Excess incarceration, sickness disability and premature mortality preclude offending, selectively removing LCP offenders from criminal-record data. Studies testing the hypothesis of life-course persistence should measure illness and incarceration.

*What's new? No adult-onset antisocial behaviour.* Some studies of official crime-record data point to offenders first convicted as adults. The taxonomy asserted that LCP and AL offenders account for the bulk of crime under the age-crime curve; it did not address the possibility of an adult-onset group. However, this possibility has now been tested in several longitudinal studies that analysed official conviction records alongside parent-, teacher- or self-reported offending measures taken before the age when conviction is possible. They report that so-called adult-onset offenders, in fact, had clear histories of childhood conduct problems and juvenile offending, undetected by police<sup>25,34</sup>.

*What's new? Surrogate methods to define LCP and AL.* Research on the taxonomy has revealed an urgent need for a way to discriminate between LCP and AL persons at one time-point. Many researchers lack access to child-to-adult longitudinal data, and practitioners often lack prospective childhood information to decide whether a client is on an AL versus LCP trajectory. Several expedients suggest themselves, including elevated scores on aggression<sup>35</sup>, callous unemotional traits<sup>36</sup>, comorbid conduct disorder and hyperactive impulsivity<sup>37</sup>, consensus across reporters that antisocial behaviour is pervasive across settings<sup>38,39</sup> and family history of substance dependence<sup>40</sup>. All have empirical merit, yet none has sufficient evidence to justify its use alone as a surrogate for child-to-adult data. Research to build a one-time-point assessment tool is needed.

**AL and LCP groups differ on childhood risk factors.** The 1993 article stated that the strongest prospective predictors of persistent antisocial behaviour are individual characteristics (for example, difficult temperament, neuropsychological deficits, hyperactivity) and family characteristics (for example, socioeconomic deprivation, poor parenting), but not age. Individual and family differences should play little or no role in short-term adolescent offending careers.

*What's new? More cohorts support the risk hypothesis.* Accumulated research showing that LCP offenders have differential childhood risk factors has been described in reviews<sup>2,4,5,41,42</sup>. A query has emerged: whether AL offending shares the same risk profile as LCP offending, albeit at a lower level, which could indicate a quantitative rather than qualitative group difference in risk<sup>42–44</sup>. This query provides an opportunity to clarify here that the taxonomy conceptualizes LCP offenders as abnormal on childhood risk factors, but AL offenders as ordinary, average and normative. During adolescence, large numbers of young men who come from all varying backgrounds, from very low levels of risk to risk levels above the mean, engage in offending and join the AL group. The main risk factor for the AL group is the maturity gap itself, which is not a risk factor for LCP offending. LCP offenders should show extreme risk on childhood risk factors, while AL offenders should show population-normative levels (population-normative risk levels alas are not zero). Comparisons show that the LCP group scores significantly above their cohort mean on risk factors while the AL group scores near the mean (panel b of the figure in Box 1). It is the 'low', non-antisocial comparison group who scores significantly below the mean on risk factors<sup>44,45</sup>. Earlier I reported an exception: Dunedin AL offenders had above-normal sensation seeking, a personality risk unanticipated in the 1993 article<sup>4</sup>.

In recent years, some very large nationally representative surveys have weighed in on the taxonomy. The Collaborative Psychiatric Epidemiology Studies (CPES) of over 20,000 US citizens reported that the LCP group had low childhood socioeconomic status, lack of maternal closeness and a history of harsh discipline, relative to the AL group<sup>46</sup>. The National Epidemiologic Survey on Alcohol and Related Conditions (NESARC) of over 43,000 US citizens identified 5% of respondents who had a greater

variety and severity of antisocial behaviours characteristic of LCP offenders, and also had more extreme sociodemographic, psychiatric and behavioural risk correlates, compared with other respondents (although this study did not define an AL group)<sup>47</sup>. CPES and NESARC had the shortcoming that lifetime antisocial behaviours were retrospectively ascertained in a cross-sectional adulthood interview. The 1970 British Cohort Study of over 16,000 respondents measured child, parent and socioeconomic risk factors prospectively up to age 5 years, and found they predicted conviction at age 34 years<sup>48</sup>. This study did not designate LCP or AL groups, but it is valuable for its very young risk measurements in a population-representative sample.

Additional longitudinal studies with sample sizes from 400 to 1,000 that were well-designed to define LCP and AL groups have reported that they differ on child and family risks measured prospectively during childhood<sup>17,21,22,40,44,49</sup>. As one example, the Pittsburgh Youth Study investigated parenting<sup>50</sup>. For teens on an LCP path, parent-child communication was unhealthy from the earliest years. For teens on an AL path, parent-child communication was healthy in childhood, but after the teenager began offending it deteriorated.

*What's new in risk research? Genetics.* The 1993 article noted that LCP children should be distinguished by traits that are heritable, such as low verbal ability and low self-control, but did not explicitly mention genes. Until recently, researchers who tested for genetic influence on behaviour relied on biometric studies of twins or adoptees. A 2005 review of such studies<sup>51</sup>, plus subsequent studies<sup>35,39,52,53</sup>, provide evidence of elevated genetic influence on LCP-type antisocial development, compared with AL.

Today, advances in the genomic sciences make it possible to investigate genetic influences on behaviour at the molecular-genetic level, using genome-wide association studies (GWASs)<sup>54</sup>. The effect size is minuscule for any single GWAS-detected genetic variant, but it is possible to aggregate the effects of millions of variants across the genome, thereby constructing a polygenic score that indexes each person's genetic propensity along a continuum. A very large GWAS recently yielded a polygenic score for highest educational degree<sup>55</sup>. We hypothesized that this educational-attainment polygenic score would be low among LCP individuals because genetically influenced traits that promote LCP development, such as low verbal ability and low self-control, also reduce educational attainment<sup>56</sup>. As hypothesized, the Dunedin Study LCP trajectory group had a significantly lower mean polygenic score than the AL group (whose mean polygenic score was cohort average). The educational-attainment polygenic scores' prediction of offending careers was mediated by primary-school risk factors: lower cognitive abilities, lower self-control, academic difficulties and truancy. Soon polygenic scores for conviction itself will be derived from GWASs<sup>57</sup>, which can be tested for LCP-specific risk.

*What's new in risk research? Neuroimaging.* Many well-designed studies have shown that abnormalities on neuropsychological tests are prospectively associated with LCP but not AL patterns of antisocial behavior<sup>4,58-60</sup>. Thus, there is good evidence that LCP behaviour is characterized by difficulties in the brain's mental functions, particularly its verbal and executive functions. Advances in neuroscience now make it possible also to investigate brain-behaviour associations using magnetic resonance imaging (MRI) techniques. Children can now be scanned, so prospective neuroimaging data could feasibly be compared for LCP versus AL groups. However, at this point, what can be confidently said is only that neuroimaging studies of children whose antisocial behaviour onsets in childhood (variously defined) tend to show abnormal MRI findings of both brain structure and brain function during mental tasks<sup>43,61-63</sup>.

Despite confirming that childhood antisocial behaviour is accompanied by neural abnormalities, decisive tests of the hypothesis that neural abnormality should characterize LCP but not AL individuals are lacking. This lack is because neuroimaging studies are costly, precluding them from employing research designs suitable for risk-factor research<sup>64,65</sup>. Designs in LCP/AL neuroimaging comparisons so far have used small unrepresentative middle-class samples, and been under-powered, cross-sectional and retrospective<sup>66</sup>. Some comparisons between a childhood-onset versus an adolescent-onset conduct disorder group yielded small group differences<sup>67-69</sup>, but other comparisons in the same sample yielded nil group differences<sup>43,67,69,70</sup>. However, it is not possible to evaluate reports of either hypothesis confirmation or disconfirmation on the basis of studies with insufficient designs. Ideally the design requirements of neuroimaging studies must be the same as for studies of any other risk factor: population-representative samples, adequate statistical power, repeated measures of antisocial behaviour beginning in childhood and prospective neuroimaging before adolescence to establish that MRI abnormalities are antecedent, not consequential to offenders' lifestyles. In future, LCP/AL comparisons may be accomplished in large cohorts of young people followed longitudinally with repeated neuroimaging, such as IMAGEN (<https://imagen-europe.com>) or the NIDA-ABCD cohort (National Institute of Drug Abuse-Adolescent Brain and Cognitive Development Longitudinal Study; <https://addictionresearch.nih.gov/abcd-study>). Unfortunately, many such cohorts recruit adolescent participants, omitting childhood MRI scans.

It is useful to mention that the field of developmental neuroscience reports MRI findings that are associated with risk-taking during adolescence<sup>71-74</sup>. In a nutshell, the argument is that a lack of synchrony in brain maturation characterizes adolescence, thereby explaining why adolescence is a life-stage of excessive risk-taking and susceptibility to peer influence, compared with childhood or adulthood. This approach points to a population-wide upshift in neural processes that promote delinquent offending, followed by a downshift a few years later, therefore fulfilling the requirement for a causal factor in AL offending. A normative brain maturity gap should be conceptualized among the causes of AL offending, an addition that could not have been foreseen in 1993. Research is needed to integrate new developmental neuroscience findings into the sociological theory of AL offending. Moreover, developmental neuroscience, which typically compares age groups, has not yet tackled brain-behaviour differences between individuals who are on different trajectories of offending to test the LCP hypothesis.

**AL antisocial behaviour in a maturity gap.** When the existence of AL offenders was proposed to account for the peak in the age-crime curve, an explanation of their origin was required. The 1993 article stated that the strongest prospective predictors of this short-term offending should be attitudes towards adulthood and autonomy, knowledge of peers' delinquency, cultural and historical context, and age. The hypothesized motivation that drives AL offending is a gap between biological and social maturation. Evidence that this maturity gap is associated with adolescent offending has been presented earlier<sup>4,75,76</sup>.

*What's new about the maturity gap?* More studies have added support for the maturity-gap hypothesis. In 6,500 participants of the National Longitudinal Study of Adolescent Health (ADDHEALTH), the maturity gap was measured as the discrepancy between pubertal stage and the amount of autonomy each teen reported<sup>77</sup>. As hypothesized, the width of this measured gap predicted drug use and minor delinquent offenses, but not the violent offenses characteristic of LCP offending. Similarly, in the Social Network Analysis of Risk Behaviour in Early Adolescence Study (SNARES), the width of the gap between pubertal stage and decision-making autonomy

predicted substance use and delinquency<sup>78</sup>. In the Cambridge Study in Delinquent Development, a financial version of the maturity gap predicted offending among non-LCP participants<sup>79</sup>.

One question relevant to the maturity gap hypothesis is whether AL offenders age out of crime and into conventional lifestyles as predicted. Studies following cohorts into young adulthood showed AL offenders had continued difficulties, particularly related to substance abuse. More recent follow-ups into midlife of the Cambridge Study on Delinquent Development<sup>80</sup> and the Dunedin cohort (panels c and d of the figure in Box 1), indicate that more AL offenders have ordinary life outcomes. Nevertheless, this recovery is delayed beyond anticipations, a delay that recommends interventions to help AL offenders recover.

Something else is new that was unanticipated by the taxonomy: adolescence lasts longer. Since the 1980s, the transition from adolescence to adulthood has elongated, and traditional milestones of adulthood, such as completing education, marriage, first child and a steady occupation, along with the psychological maturation they bring, now arrive years later than in previous generations<sup>81,82</sup>. The taxonomy's assumption that AL offenders would exit the maturity gap and desist offending shortly after adolescence, and even the choice of the term 'adolescence limited', was based on published age-crime curves calculated for a generation before adolescence began to elongate<sup>7,83</sup>. It is possible that desistance is now delayed by late social maturation. There is evidence that the crime peak has shifted slightly older, but the reasons for this are under debate<sup>84-88</sup>. Moreover, other historical shifts are relevant: the turn of the millennium saw an international drop in crime rates<sup>89,90</sup>, particularly in teens<sup>84</sup>. The 1993 taxonomy included 'historical context' among the causes of AL offending. Tests of this prediction are lacking and needed.

*What's new about snares?* Not every AL offender desists from offending at the same age, as revealed in the tapering off of the age-crime curve. The AL theory explained this variation by invoking the concept of 'snares', experiences that can retard desistance from crime, such as addiction, a criminal record, imprisonment, victimization or truncated education<sup>91</sup>. The Mater University Study of over 3,000 Australians recently tested this hypothesis and reported that adolescent-onset offenders who continued offending further into adulthood had experienced a larger number of snares, particularly substance dependence, a criminal record, victimization and early school-leaving<sup>92</sup>.

*What's new about abstainers?* The 1993 article argued that AL offending is a group social activity that is so highly prevalent as to be normative, as well as understandable from the perspective of contemporary teens. If this assertion is true, then the existence of abstainers, teens who commit no delinquency at all throughout their adolescent years, requires explanation. The article cited cohort studies showing that teens who self-report no delinquent acts are rare, and speculated that they must have one of three causes: barriers that prevent them from learning about delinquency, no maturity gap because of early access to adult roles or personal characteristics unappealing to other teens that bar abstainers from risk-taking teen groups. The resulting research mainly focused on the hypothesis of unappealing characteristics. It suggests some abstainers do have characteristics that exclude them from delinquent groups, but that these characteristics pay off in life success. In the Dunedin cohort, abstainers described themselves on personality measures as over-controlled and lacking social confidence, and they were latecomers to sex for their cohort. However, their highly conscientious style became successful in adulthood. Since then, other studies have reported that abstainers are less involved with peers<sup>93-96</sup>, and are less accepted in early adolescence but become more accepted later<sup>97</sup>. Abstainers were reported to be latecomers to puberty<sup>93</sup>, withdrawn,

shy, socially anxious<sup>98,99</sup>, methodical and conscientious<sup>96</sup>, rational thinkers, and good at coping<sup>94</sup>. Interestingly, the Cambridge Study in Delinquent Development yielded two abstainer groups: one characterized by low popularity and low school achievement who ended up poorly adjusted as adults, and another characterized by high honesty who ended up well-adjusted<sup>100</sup>.

### Impact of the developmental taxonomy

Impacts on clinical practice and policymaking can be difficult to track. Ideas that make their way from the ivory tower to policy circles often lose their provenance along the way, because policymakers seldom reference academic journals. However, the taxonomy is cited in reports that guide policy in the United Kingdom (for example, Home Office<sup>101</sup> and The Centre for Social Justice<sup>102</sup> reports) and the United States (for example, National Research Council reports<sup>103,104</sup>). Key themes in these reports are the notion that individual development is one driver of serious recidivistic crime, and the need for early-childhood prevention aimed at families and schools. Another key theme picked up in these reports is the need to appreciate heterogeneity within adolescent offenders, to distinguish the few who have adverse backgrounds and a poor prognosis from the many who have ordinary backgrounds and a better prognosis. The reports articulate the need to limit formal justice-system sanctions to fewer juveniles, and the need for non-punitive diversion approaches for more juveniles to avoid a damaging criminal record and give them room to reform. All of these themes chime with the taxonomy.

Policy-relevant research has analysed the economic cost of LCP offending. Lifetime crime-career trajectories derived in a 1958 Philadelphia birth cohort were connected to the monetary cost calculated for each offense recorded for each trajectory member<sup>105</sup>. LCP offenders, who committed crimes at high frequency while young and then turned to more serious crimes as adults, accounted for greater costs than AL offenders, whose offending peaked during adolescence. Use of crime-costing methodology in the Cambridge Study in Delinquent Development similarly concluded that the cost of LCP offending is up to ten times greater than the cost of AL offending<sup>106</sup>. These reports recommend that prevention and intervention resources should be invested in individuals whose offending fits an LCP pattern.

In legal practice, the taxonomy is cited (alongside developmental neuroscience research<sup>107</sup>) in amicus curiae briefs submitted for United States Supreme Court cases in 2009 and again in 2013 (Roper versus Simmons, overturning the death sentence for juveniles; Graham, Sullivan versus Florida, Miller versus Alabama, regarding life sentence without possibility of parole for juveniles). Both sides drew on the taxonomy, a reminder that scientists cannot always anticipate the uses of their work. Briefs arguing for sentences of death or life without parole for juveniles cited the taxonomy as evidence that juvenile offenders on a LCP trajectory have low probability of reform, and therefore should be permanently incapacitated. In contrast, briefs arguing against adult sentences cited the taxonomy as evidence that LCP offenders have cognitive deficits that render them incompetent to be prosecuted as adults. Briefs against adult sentences also cited the taxonomy as evidence that illegal behaviour is normative for adolescents, inferring that adult sentences for juveniles constitute 'cruel and unusual' punishment. The court ruled that a juvenile cannot be sentenced to life without parole if their crime reflects 'transient immaturity'. During sentencing, defence attorneys must show that the offender has transient immaturity, whereas prosecutors must show the same offender lacks transient immaturity.

### Conclusion

Evidence about LCP antisocial behaviour provided impetus for the early-years crime prevention movement. However, less appreciated

is that evidence about AL antisocial behaviour provides impetus for movements to reform juvenile-justice and mental-health services in directions that are more supportive for young people. The taxonomy achieved its original goal, to account for the age-crime curve. Its dual theories of LCP and of AL development met their original goal of drawing from biological, psychological and sociological theories to explain antisocial behaviour. The theory must remain sufficiently flexible to stay as pertinent tomorrow as yesterday, while simultaneously keeping its defining tenets. Empirical research continues to sand and polish.

Received: 5 November 2017; Accepted: 22 January 2018;

Published online: 21 February 2018

## References

- Moffitt, T. E. Adolescence-limited and life-course-persistent antisocial behavior: a developmental taxonomy. *Psychol. Rev.* **100**, 674–701 (1993).
- Moffitt, T. E. in *The Causes of Conduct Disorder and Serious Juvenile Delinquency* (eds Lahey, B., Moffitt, T. & Caspi, A.) Ch. 5 (Guildford Press, New York, NY, 2003).
- Moffitt, T. E. in *Taking Stock: The Status of Criminological Theory* (eds Cullen, F. T., Wright, J. P. & Coleman, M.) 502–521 (Transaction Publishers, New Brunswick, NJ, 2006).
- Moffitt, T. E. in *Developmental Psychopathology* 2nd edn (eds Cicchetti, D. & Cohen, D. J.) 570–598 (Wiley, New York, NY, 2006).
- Moffitt, T. E. in *The Cambridge Handbook of Violent Behavior* (eds Flannery, F., Vanzonsyi, A. & Waldman, I.) Ch. 3 (Cambridge Univ. Press, New York, NY, 2007).
- Robins, L. N. Sturdy childhood predictors of adult antisocial behaviour: replications from longitudinal studies. *Psychol. Med.* **8**, 611–622 (1978).
- Blumstein, A., Cohen, J., Roth, J. A. & Visher, C. A. *Criminal Careers and "Career Criminals"* (National Academy Press, Washington DC, 1986).
- Martinez, N. N., Lee, Y. J., Eck, J. E. & O, S. H. Ravenous wolves revisited: a systematic review of offending concentration. *Crime Sci.* **6**, 10 (2017).
- Skardhamar, T. Lifetime conviction risk. *J. Scand. Stud. Criminol. Crime Prev.* **15**, 96–101 (2014).
- Poulton, R., Moffitt, T. E. & Silva, P. A. The Dunedin Multidisciplinary Health and Development Study: overview of the first 40 years, with an eye to the future. *Soc. Psychiatry Psychiatr. Epidemiol.* **50**, 679–693 (2015).
- Nagin, D. S. & Land, K. C. Age, criminal careers, and population heterogeneity: specification and estimation of a nonparametric, mixed Poisson model. *Criminology* **31**, 327–362 (1993).
- Nagin, D. *Group-Based Modeling of Development* (Harvard Univ. Press, Cambridge, MA, 2005).
- Jennings, W. G. & Reingle, J. On the number and shape of developmental/life-course violence, aggression, and delinquency trajectories: a state-of-the-art review. *J. Crim. Justice* **4**, 472–489 (2012).
- Nagin, D. S. & Odgers, C. L. Group-based trajectory modeling in clinical research. *Annu. Rev. Clin. Psychol.* **6**, 109–138 (2010).
- Piquero, A. R. in *Long View of Crime: A Synthesis of Longitudinal Research* (ed. Liberman, A. M.) 23–78 (Springer, New York, NY, 2008).
- Piquero, A. R. Invited address: James Joyce, Alice in Wonderland, the Rolling Stones, and criminal careers. *J. Youth Adolesc.* **40**, 761–775 (2011).
- Odgers, C. L. et al. Prediction of differential adult health burden by conduct problem subtypes in males. *Arch. Gen. Psychiatry* **64**, 476–484 (2007).
- Odgers, C. L. et al. Female and male antisocial trajectories: from childhood origins to adult outcomes. *Dev. Psychopathol.* **20**, 673–716 (2008).
- Brook, J. S., Lee, J. Y., Finch, S. J., Brown, E. N. & Brook, D. W. Long-term consequences of membership in trajectory groups of delinquent behavior in an urban sample: violence, drug use, interpersonal, and neighborhood attributes. *Aggress. Behav.* **39**, 440–452 (2013).
- Carkin, D. M. & Tracy, P. E. Delinquent and criminal career paths in the 1958 Philadelphia birth cohort. *J. Law Crim. Justice* **3**, 14–39 (2015).
- Farrington, D. P., Piquero, A. R. & Jennings, W. G. *Offending from Childhood to Late Middle Age: Recent Results from the Cambridge Study in Delinquent Development* (Springer, London, 2013).
- Widom, C. S., Fisher, J. H., Nagin, D. S. & Piquero, A. R. A prospective examination of criminal career trajectories in abused and neglected males and females followed up into middle adulthood. *J. Quant. Criminol.* <https://doi.org/10.1007/s10940-017-9356-7> (2017).
- George, M. J. & Odgers, C. L. Seven fears and the science of how mobile technologies may be influencing adolescents in the digital age. *Perspect. Psychol. Sci.* **10**, 832–851 (2015).
- Kowalski, R. M., Giumetti, G. W., Schroeder, A. N. & Lattanner, M. R. Bullying in the digital age: a critical review and meta-analysis of cyberbullying research among youth. *Psychol. Bull.* **140**, 1073–1137 (2014).
- Jolliffe, D., Farrington, D. P., Piquero, A. R., MacLeod, J. F. & van deWeijer, S. Prevalence of life-course-persistent, adolescence-limited, and late-onset offenders: a systematic review of prospective longitudinal studies. *Aggress. Behav.* **33**, 4–14 (2017).
- Bergman, L. R. & Andershed, A. K. Predictors and outcomes of persistent or age-limited registered criminal behavior: a 30-year longitudinal study of a Swedish urban population. *Aggress. Behav.* **35**, 164–178 (2009).
- Huesmann, L. R., Dubow, E. F. & Boxer, P. Continuity of aggression from childhood to early adulthood as a predictor of life outcomes: implications for the adolescent-limited and life-course-persistent models. *Aggress. Behav.* **35**, 136–149 (2009).
- Pulkkinen, L., Lyyra, A. L. & Kokko, K. Life success of males on nonoffender, adolescence-limited, persistent, and adult-onset antisocial pathways: follow-up from age 8 to 42. *Aggress. Behav.* **35**, 117–135 (2009).
- Blokland, A. A. J., Nagin, D. S. & Nieuwebeerta, P. Life span offending trajectories of a Dutch conviction cohort. *Criminology* **43**, 919–954 (2005).
- Sampson, R. J. & Laub, J. H. Life-course desisters? Trajectories of crime among delinquent boys followed to age 70. *Criminology* **41**, 555–592 (2003).
- Piquero, A. R., Daigle, L. E., Gibson, C., Piquero, N. L. & Tibbetts, S. G. Are life-course-persistent offenders at risk for adverse health outcomes? *J. Res. Crime. Delinq.* **44**, 185–207 (2007).
- Reingle, J. M., Jennings, W. G., Piquero, A. R. & Maldonado-Molina, M. M. Is violence bad for your health? An assessment of chronic disease outcomes in a nationally representative sample. *Justice Q.* **31**, 524–538 (2014).
- Piquero, A. R., Shepherd, I., Shepherd, J. P. & Farrington, D. P. Impact of offending trajectories on health: disability, hospitalisation and death in middle-aged men in the Cambridge Study in Delinquent Development. *Crim. Behav. Ment. Health* **21**, 189–201 (2011).
- Beckley, A. L. et al. Adult-onset offenders: Is a tailored theory warranted? *J. Crim. Justice* **46**, 64–81 (2016).
- Burt, S. A. How do we optimally conceptualize the heterogeneity within antisocial behavior? An argument for aggressive versus non-aggressive behavioral dimensions. *Clin. Psychol. Rev.* **32**, 263–279 (2012).
- Frick, P. J. & White, S. F. Research review: the importance of callous-unemotional traits for developmental models of aggressive and antisocial behavior. *J. Child Psychol. Psychiatry* **49**, 359–375 (2008).
- Lynam, D. R. Early identification of chronic offenders: who is the fledgling psychopath? *Psychol. Bull.* **120**, 209–234 (1996).
- Arseneault, L. et al. Strong genetic effects on cross-situational antisocial behaviour among 5-year-old children according to mothers, teachers, examiner-observers, and twins' self-reports. *J. Child Psychol. Psychiatry* **44**, 832–848 (2003).
- Wertz, J. et al. Etiology of pervasive versus situational antisocial behaviors: a multi-informant longitudinal cohort study. *Child Dev.* **87**, 312–325 (2016).
- Odgers, C. L. et al. Predicting prognosis for the conduct-problem boy: can family history help? *J. Am. Acad. Child Adolesc. Psychiatry* **46**, 1240–1249 (2007).
- Assink, M. et al. Risk factors for persistent delinquent behavior among juveniles: a meta-analytic review. *Clin. Psychol. Rev.* **42**, 47–61 (2015).
- Jolliffe, D., Farrington, D. P., Piquero, A. R., Loeber, R. & Hill, K. G. Systematic review of early risk factors for life-course-persistent, adolescence-limited, and late-onset offenders in prospective longitudinal studies. *Aggress. Violent Behav.* **33**, 15–23 (2017).
- Fairchild, G., van Goozen, S. H. M., Calder, A. J. & Goodyer, I. M. Evaluating and reformulating the developmental taxonomic theory of antisocial behaviour. *J. Child Psychol. Psychiatry* **54**, 924–940 (2013).
- Roisman, G. I. et al. Is adolescence-onset antisocial behavior developmentally normative? *Dev. Psychopathol.* **22**, 295–311 (2010).
- Moffitt, T. E. & Caspi, A. Childhood predictors differentiate life-course persistent and adolescence-limited antisocial pathways among males and females. *Dev. Psychopathol.* **13**, 355–375 (2001).
- Moore, A. A., Silberg, J. L., Roberson-Nay, R. & Mezuk, B. Life course persistent and adolescence limited conduct disorder in a nationally representative US sample: prevalence, predictors, and outcomes. *Soc. Psychiatry Psychiatr. Epidemiol.* **52**, 435–443 (2017).
- Vaughn, M. G. et al. The severe 5%: a latent class analysis of the externalizing behavior spectrum in the United States. *J. Crim. Justice* **39**, 75–80 (2011).
- Murray, J., Irving, B., Farrington, D. P., Colman, I. & Bloxson, C. A. J. Very early predictors of conduct problems and crime: results from a national cohort study. *J. Child Psychol. Psychiatry* **51**, 1198–1207 (2010).
- Silberg, J., Moore, A. A. & Rutter, M. Age of onset and the subclassification of conduct/dissocial disorder. *J. Child Psychol. Psychiatry* **56**, 826–833 (2015).
- Keijsers, L., Loeber, R., Branje, S. & Meeus, W. Parent-child relationships of boys in different offending trajectories: a developmental perspective. *J. Child Psychol. Psychiatry* **53**, 1222–1232 (2012).
- Moffitt, T. E. Genetic and environmental influences on antisocial behaviors: evidence from behavioral-genetic research. *Adv. Genet.* **55**, 41–104 (2005).



52. Silberg, J. L., Rutter, M., Tracy, K., Maes, H. H. & Eaves, L. Etiological heterogeneity in the development of antisocial behavior: the Virginia twin study of adolescent behavioral development and the young adult follow-up. *Psychol. Med.* **37**, 1193–1202 (2007).
53. Tackett, J. L., Krueger, R. F., Iacono, W. G. & McGue, M. Symptom-based subfactors of DSM-defined conduct disorder: evidence for etiologic distinctions. *J. Abnorm. Psychol.* **114**, 483–487 (2005).
54. Visscher, P. M. et al. 10 years of GWAS discovery: biology, function, and translation. *Am. J. Hum. Genet.* **101**, 5–22 (2017).
55. Okbay, A. et al. Genome-wide association study identifies 74 loci associated with educational attainment. *Nature* **533**, 539–542 (2016).
56. Wertz, J. et al. A polygenic score for educational attainment also predicts criminal offending: replicated evidence from two birth cohorts. *Psychol. Sci.* (in the press).
57. Tielbeek, J. J. et al. Genome-wide association studies of a broad spectrum of antisocial behavior. *JAMA Psychiatry* **74**, 1242–1250 (2017).
58. Barker, E. D. et al. Developmental trajectories of male physical violence and theft: relations to neurocognitive performance. *Arch. Gen. Psychiatry* **64**, 592–599 (2007).
59. Eme, R. F. Sex differences in child-onset, life-course-persistent conduct disorder. A review of biological influences. *Clin. Psychol. Rev.* **27**, 607–627 (2007).
60. Eme, R. Male life-course persistent antisocial behavior: a review of neurodevelopmental factors. *Aggress. Violent Behav.* **14**, 348–358 (2009).
61. Hyde, L. W., Shaw, D. S. & Hariri, A. R. Understanding youth antisocial behavior using neuroscience through a developmental psychopathology lens: review, integration, and directions for research. *Dev. Rev.* **33**, 168–223 (2013).
62. Rogers, J. C. & De Brito, S. A. Cortical and subcortical gray matter volume in youths with conduct problems: a meta-analysis. *JAMA Psychiatry* **73**, 64–72 (2016).
63. Sterzer, P. & Stadler, C. Neuroimaging of aggressive and violent behaviour in children and adolescents. *Front. Behav. Neurosci.* **3**, 35 (2009).
64. Button, K. S. et al. Power failure: why small sample size undermines the reliability of neuroscience. *Nat. Rev. Neurosci.* **14**, 365–376 (2013).
65. Falk, E. B. et al. What is a representative brain? Neuroscience meets population science. *Proc. Natl Acad. Sci. USA* **110**, 17615–17622 (2013).
66. Raine, A. An amygdala structural abnormality common to two subtypes of conduct disorder: a neurodevelopmental conundrum. *Am. J. Psychiatry* **168**, 569–571 (2011).
67. Fairchild, G. et al. Cortical thickness, surface area, and folding alterations in male youths with conduct disorder and varying levels of callous-unemotional traits. *Neuroimage Clin.* **8**, 253–260 (2015).
68. Fairchild, G. et al. Mapping the structural organization of the brain in conduct disorder: replication of findings in two independent samples. *J. Child Psychol. Psychiatry* **57**, 1018–1026 (2016).
69. Passamonti, L. et al. Neural abnormalities in early-onset and adolescence-onset conduct disorder. *Arch. Gen. Psychiatry* **67**, 729–738 (2010).
70. Fairchild, G. et al. Brain structure abnormalities in early-onset and adolescent-onset conduct disorder. *Am. J. Psychiatry* **168**, 624–633 (2011).
71. Casey, B. & Caudle, K. The teenage brain: self control. *Curr. Dir. Psychol. Sci.* **22**, 82–87 (2013).
72. Crone, E. A., van Duijvenvoorde, A. C. K. & Peper, J. S. Neural contributions to risk-taking in adolescence — developmental changes and individual differences. *J. Child Psychol. Psychiatry* **57**, 353–368 (2016).
73. Spear, L. *The Behavioral Neuroscience of Adolescence* (Norton, New York, NY, 2010).
74. Steinberg, L. *Age of Opportunity: Lessons from the New Science of Adolescence* (Houghton Mifflin Harcourt, Boston, MA, 2014).
75. Galambos, N. L., Barker, E. T. & Tilton-Weaver, L. C. Who gets caught at maturity gap? A study of pseudomature, immature, and mature adolescents. *Int. J. Behav. Dev.* **27**, 253–263 (2003).
76. Piquero, A. R. & Brezina, T. Testing Moffitt's account of adolescence-limited delinquency. *Criminology* **39**, 353–370 (2001).
77. Barnes, J. & Beaver, K. M. An empirical examination of adolescence-limited offending: a direct test of Moffitt's maturity gap thesis. *J. Crim. Justice* **38**, 1176–1185 (2010).
78. Dijkstra, J. K. et al. Explaining adolescents' delinquency and substance use: a test of the maturity gap: the SNARE study. *J. Res. Crime Delinq.* **52**, 747–767 (2015).
79. Craig, J. M., Piquero, A. R. & Farrington, D. P. The economic maturity gap encourages continuity in offending. *J. Dev. Life Course Criminol.* **3**, 380–396 (2017).
80. Piquero, A. R., Farrington, D. P., Nagin, D. S. & Moffitt, T. E. Trajectories of offending and their relation to life failure in late middle age: findings from the Cambridge Study in Delinquent Development. *J. Res. Crime Delinq.* **47**, 151–173 (2010).
81. Arnett, J. J. Emerging adulthood — a theory of development from the late teens through the twenties. *Am. Psychol.* **55**, 469–480 (2000).
82. Cote, J. E. *Arrested Adulthood: The Changing Nature of Maturity and Identity* (University Press, New York, NY, 2000).
83. Farrington, D. P. Age and crime. *Crime Justice* **7**, 189–250 (1986).
84. Farrell, G., Laycock, G. & Tilley, N. Debuts and legacies: the crime drop and the role of adolescence limited and persistent offending. *Crime Science* **4**, 1–10 (2015).
85. Matthews, B. & Minton, J. Rethinking one of criminology's 'brute facts': the age-crime curve and the crime drop in Scotland. *Eur. J. Criminol.* <https://doi.org/10.1177/1477370817731706> (2017).
86. Salvatore, C., Taniguchi, T. & Welsh, W. N. Is emerging adulthood influencing Moffitt's developmental taxonomy? Adding the "prolonged" adolescent offender. *West. Crim. Rev.* **13**, 1–15 (2012).
87. Sweeten, G., Piquero, A. R. & Steinberg, L. Age and the explanation of crime, revisited. *J. Youth Adolesc.* **42**, 921–938 (2013).
88. Wensveen, M., Palmen, H., Blokland, A. & Meeus, W. Examining the work-crime association in emerging adulthood: a longitudinal analysis based on a Dutch population sample. *Eur. J. Criminol.* **14**, 467–484 (2017).
89. Tonry, M. Why crime rates are falling throughout the Western world. **43**, 1–63 (2014).
90. Van Dijk, J. J. M., Tseloni, A. & Farrell, G. *The International Crime Drop: New Directions in Research* (Palgrave Macmillan, Basingstoke, 2012).
91. Hussong, A. M., Curran, P. J., Moffitt, T. E., Caspi, A. & Carrig, M. M. Substance abuse hinders desistance in young adults' antisocial behavior. *Dev. Psychopathol.* **16**, 1029–1046 (2004).
92. McGee, T. R. et al. The impact of snares on the continuity of adolescent-onset antisocial behaviour: a test of Moffitt's developmental taxonomy. *Aust. NZ J. Criminol.* **48**, 345–366 (2015).
93. Barnes, J., Beaver, K. M. & Piquero, A. R. A test of Moffitt's hypotheses of delinquency abstention. *Crim. Justice Behav.* **38**, 690–709 (2011).
94. Chen, X. J. & Adams, M. Are teen delinquency abstainers social introverts? A test of Moffitt's theory. *J. Res. Crime Delinq.* **47**, 439–468 (2010).
95. Johnson, M. C. & Menard, S. A longitudinal study of delinquency abstention: differences between life-course abstainers and offenders from adolescence into adulthood. *Youth Violence Juv. Justice* **10**, 278–291 (2012).
96. Mercer, N. *Why Aren't All Adolescents Delinquent? Examining the Predictors, Pathways, and Processes Leading to Adolescent Delinquency (Abstention)*. PhD dissertation, Univ. Utrecht (2017); <https://dspace.library.uu.nl/bitstream/handle/1874/347589/Mercer.pdf>
97. Rulison, K. L., Kreager, D. A. & Osgood, D. W. Delinquency and peer acceptance in adolescence: a within-person test of Moffitt's hypotheses. *Dev. Psychol.* **50**, 2437–2448 (2014).
98. Mercer, N., Crocetti, E., Meeus, W. & Branje, S. Examining the relation between adolescent social anxiety, adolescent delinquency (abstention), and emerging adulthood relationship quality. *Anxiety Stress Coping* **30**, 428–440 (2017).
99. Owens, J. G. & Slocum, L. A. Abstainers in adolescence and adulthood: exploring the correlates of abstention using Moffitt's development taxonomy. *Crime Delinq.* **61**, 690–718 (2012).
100. Mercer, N. et al. Childhood predictors and adult life success of adolescent delinquency abstainers. *J. Abnorm. Child Psychol.* **44**, 613–624 (2016).
101. May, T. *Modern Crime Prevention Strategy* (Home Office, London, 2016).
102. Allen, G. & Duncan Smith, I. *Early Intervention: Good Parents, Great Kids, Better Citizens* (The Centre for Social Justice, London, 2008).
103. National Research Council *Reforming Juvenile Justice: A Developmental Approach* (National Academies Press, Washington DC, 2013).
104. National Research Council *Implementing Juvenile Justice Reform: The Federal Role* (National Academies Press, Washington DC, 2014).
105. Cohen, M. A., Piquero, A. R. & Jennings, W. G. Studying the costs of crime across offender trajectories. *Criminol. Public Policy* **9**, 279–305 (2010).
106. Piquero, A. R., Jennings, W. G. & Farrington, D. The monetary costs of crime to middle adulthood: findings from the Cambridge Study in Delinquent Development. *J. Res. Crime Delinq.* **50**, 53–74 (2013).
107. Steinberg, L. The influence of neuroscience on US Supreme Court decisions about adolescents' criminal culpability. *Nat. Rev. Neurosci.* **14**, 513–518 (2013).
108. Blumstein, A., Cohen, J. & Farrington, D. P. Criminal career research: its value for criminology. *Criminology* **26**, 1–35 (1988).
109. Jeglum-Bartusch, D. R., Lynam, D. R., Moffitt, T. E. & Silva, P. A. Is age important? Testing general versus developmental theories of antisocial behavior. *Criminology* **35**, 13–48 (1997).
110. Moffitt, T. E., Lynam, D. R. & Silva, P. A. Neuropsychological tests predicting persistent male delinquency. *Criminology* **32**, 277–300 (1994).
111. Moffitt, T. E., Caspi, A., Dickson, N., Silva, P. A. & Stanton, W. Childhood-onset versus adolescent-onset antisocial conduct in males: natural history from age 3 to 18. *Dev. Psychopathol.* **8**, 399–424 (1996).

112. Moffitt, T. E., Caspi, A., Harrington, H. & Milne, B. J. Males on the life-course-persistent and adolescence-limited antisocial pathways: follow-up at age 26 years. *Dev. Psychopathol.* **14**, 179–207 (2002).
113. Rivenbark, J. et al. The high societal costs of childhood conduct problems: evidence from administrative records up to age 38 in a longitudinal birth cohort. *J. Child Psychol. Psychiatry* <https://doi.org/10.1111/jcpp.12850> (2017).

### Acknowledgements

Work on this Review was supported by grants from the UK Medical Research Council (P005918, G1002190), National Institute of Child Health and Development

(HD077482), National Institute on Aging (AG032282, AG049789), Jacobs Foundation and Avielle Foundation.

### Competing interests

The author declares no competing interests.

### Additional information

**Reprints and permissions information** is available at [www.nature.com/reprints](http://www.nature.com/reprints).

**Correspondence and requests for materials** should be addressed to T.E.M.

**Publisher's note:** Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.