



Public Safety
Canada

Sécurité publique
Canada

www.publicsafety.gc.ca/ncpc

www.securitepublique.gc.ca/cnpc

**THE OFFENDING TRAJECTORIES OF
YOUTH PROBATIONERS FROM EARLY
ADOLESCENCE TO MIDDLE ADULTHOOD:
RELATION TO DUAL TAXONOMIES**

Research Report: 2012-4

NATIONAL CRIME PREVENTION CENTRE / CENTRE NATIONAL DE PRÉVENTION DU CRIME

ACTING TO PREVENT
CRIME
AGIR POUR PRÉVENIR

Canada 

**THE OFFENDING TRAJECTORIES OF
YOUTH PROBATIONERS FROM EARLY
ADOLESCENCE TO MIDDLE ADULTHOOD:
RELATION TO DUAL TAXONOMIES**

Research Report: 2012-4

Annie K. Yessine
National Crime Prevention Centre
Public Safety Canada
269 Laurier Ave. West
Ottawa, ON K1A 0P8
Office: (613) 957-6356
FAX: (613) 991-9013
Email: Annie.Yessine@ps-sp.gc.ca

James Bonta
Corrections Research
Public Safety Canada
340 Laurier Ave. West
Ottawa, ON K1A 0P8
Office: (613) 991-2831
FAX: (613) 990-8295
Email: Jim.Bonta@ps-sp.gc.ca

Published by:

National Crime Prevention Centre (NCPC)
Public Safety Canada
Ottawa, Ontario Canada
K1A 0P8

**Visit the Public Safety website and add your name to the NCPC Mailing List:
www.PublicSafety.gc.ca/NCPC**

Catalogue number: PS4-162/2012E-PDF
ISBN: 978-1-100-20346-1

© Her Majesty the Queen in Right of Canada, 2012

This material may be freely reproduced for non-commercial purposes provided that the source is acknowledged.

The views expressed in this report are those of the author and do not necessarily represent the views of Public Safety Canada. Correspondence concerning this report should be addressed to: Annie K. Yessine, National Crime Prevention Centre, Public Safety Canada, 269 Laurier Avenue West, Ottawa, Ontario, K1A 0P8; email: Annie.Yessine@ps-sp.gc.ca

La présente publication est aussi disponible en français. Elle s'intitule : Détermination et définition des principaux facteurs de risque du comportement antisocial et délinquant chez les enfants et les jeunes.



Table of Contents

- Acknowledgments 1**
- Executive Summary 1**
- Introduction 3**
- Method 6**
 - Participants 6
 - Procedures..... 6
 - Measures 7
 - Data Analysis 8
 - Missing Data 8
- Results 9**
 - The Overall Criminal Pathway 9
 - Identifying the Number and Types of Offending Trajectories..... 9
 - Risk Factors Associated with Trajectory Membership..... 12
- Discussion 12**
 - Risk Factors Associated with Offending Trajectories 13
 - Implications, Limitations and Directions for Future Research..... 14
- References 17**
- End Notes..... 23**



Acknowledgments

The authors would like to extend their appreciation to Dr. Kenneth A. Bollen and Dr. Linda K. Muthén who provided analytical recommendations and statistical advice throughout the completion of this research. We are also grateful to Jennifer Cooney, Louise Grace, Terri-Lynne Scott, and Simon Young for their assistance with the coding of the recidivism data.

Executive Summary

This study sought to identify the distinctive criminal pathways, and specify the early characteristics that predict offending trajectories for a Canadian sample comprised of 514 male and female juvenile probationers followed into middle adulthood. Using latent growth curve mixture modeling, the results revealed the existence of two main types of offenders who differed in composition, offending activity, and desistance throughout the life-course. One group represented approximately 13% of the offenders, and showed a chronic high level of offending behaviour throughout the life-course. The offending frequency/severity of this group increased steadily from adolescence onwards. The remainder of the sample (87%) was characterized by sporadic and/or less serious involvement in criminal behaviour over the years. The offending pattern of this latter group remained stable although it tended to show a slight decline in frequency/severity from age 26 onwards. The offenders classified in the chronic high trajectory group disproportionately engaged in a wider variety of offences as well as more of the violent crimes. Of the criminogenic risk/needs domains studied, the youths' patterns of associations were the most robust and reliable predictor of group membership. Not surprisingly, the chronic high trajectory group comprised more offenders who had negative and unconstructive ties with their peers than the stable low group. Overall, the findings are consistent with the original dual taxonomies proposed by Loeber and Stouthamer-Loeber (1996), Moffitt (1993) and Patterson, Reid and Dishion (1992). The paper concludes with a discussion of policy and practical implications and directions for future research.



Introduction

The identification and characterization of subgroups of youths who engage in various levels of delinquent and criminal activity has been central on the research agenda of developmental criminologists. This research interest stemmed from the undisputed finding that in early adolescence offending escalates to a peak in late adolescence and then declines in young adulthood (e.g., Blockland, Nagin and Nieuwbeerta 2005; Blumstein and Cohen 1987; Elliott 1994; Farrington, Lambert and West 1998; Loeber, Farrington, Stouthamer-Loeber, Moffitt and Caspi 1999). In an attempt to explain this age-crime curve, one question has attracted a great deal of attention and this relates to the question of whether there exists distinct groups within the offender population that share distinctive etiologies that follow different trajectories of offending.

Within this context, the need to address heterogeneity in the incidence and maintenance of criminal behaviour across development has become widely accepted within the field of criminology and psychology (Loeber and Stouthamer-Loeber 1998). While some scholars (e.g., Gottfredson and Hirschi 1990) argue that the observed rise in offending during adolescence mirrors a transitory increment in the actual number of criminal acts committed by a small and constant subgroup of individuals, a growing number of developmental and life course theorists (e.g., Loeber and Stouthamer-Loeber 1996; Moffitt 1993; Patterson, Capaldi and Bank 1992) posit that the number of individuals willing to offend during adolescence is greater, which suggests that the age-crime curve hides distinctive developmental pathways within the offending population.

During the past decade, a number of developmental taxonomic systems have been advanced to account for within-individual continuity and change in criminal behaviour over time. Among the most influential are those proposed by Loeber and Stouthamer-Loeber (1996), Moffitt (1993) and Patterson et al. (1992). According to their theories, the offender population is comprised of two primary hypothetical categories of offenders who follow a distinctive prototypical course of offending related to different risk factors. The antisocial behavioural pattern of one group (referred to as “early onset persisters”) is said to start with less serious forms of offending and/or deviant activity in childhood as a result of abnormal neurodevelopment, and gradually worsen during the life-course as the individuals are in constant interactions with various high-risk environmental factors (e.g., inadequate parenting). The second, much larger group (“late onset desisters”), is posited to begin offending later in life (during adolescence), and to desist on entering the adult years. The antisocial behaviour of this latter group is not believed to originate from neuropsychological impairments, but rather from the influence of various social processes such as a gap in maturity, social modeling, and reinforcement for rule-breaking behaviour.

Findings from this line of research have provided evidence for the existence of these two distinctive subgroups of offenders, and have generated important theoretical considerations regarding the development of offending behaviour over the life span. Perhaps most notable is the suggestion that a number of offenders do not fit into either an early onset persister or late onset desister group, which implies that the offender population is potentially comprised of more than two subgroups. Several studies have now found a number of distinct trajectory groups typically ranging from three to six (see Piquero 2008 for a review). Most notably, Moffitt (2006, 2007; Moffitt, Caspi, Dickson, Silva and Stanton 1996) has modified her dual taxonomic theory to include a third trajectory consisting of a small group of offenders characterized by a pattern of recurrent, but low level offending throughout a certain period of their life-course (e.g., childhood to adolescence). This third trajectory type appears to replicate across longitudinal studies (e.g., Fergusson, Horwood and Nagin 2000; Laub, Nagin and Sampson 1998; Moffitt, Caspi, Harrington and Milne 2002; Sampson and Laub 2003). So, the question as to whether the dual taxonomic system overlooks the presence of other, logically possible, offending trajectory types remains relevant.

Are Trajectories Types an Analytical Artefact?

The debate about the actual number and types of distinct offending trajectories can be partly traced to methodological and analytical differences, with the kind of statistical analyses used to examine the data as a prime contributor (Kreuter and Muthén 2008; Piquero 2008). A historical sketch of studies aimed at classifying individuals into groups based on their offending pattern reveals the popularity of several diverse approaches. Some researchers have employed cluster analysis (e.g., Aalsma and Lapsley 2001; Eklund and af Klinteberg 2006; Raine, Moffitt, Caspi, Loeber, Stouthamer-Loeber and Lynam 2005; Stattin and Magnusson 1991; Vincent, Vitacco, Grisso and Corrado 2003), others have used factor analysis (e.g., LeBlanc 1996), and still others have applied taxometric methods (e.g., Skilling, Quinsey and Craig 2001). While these traditions appear well suited to analyze data measured at one point in time, their application to the analysis of repeated measures data over time is limited as observations are not independent within units.

For the analysis of longitudinal data, individual growth modeling offers many opportunities, and has demonstrated its superiority to alternative methods for various reasons, among which is that the analytical and statistical framework uses latent variables which reduces measurement error. The latent classes are further identified using dynamic (i.e., longitudinal) data rather than point estimates. This allows researchers to identify temporal patterns in the data and distinguish between groups that differ in offending patterns over time (e.g., start at a similar level of offending but diverge in offending later on). Individual growth modeling is also flexible concerning the research design (e.g., different data collection schedule and/or number of waves across individuals), and the statistical techniques allow inclusion of contextual variables, and use all participants' data, even if incomplete.

Briefly, latent trajectory models allow separate trajectories over time for repeated measures. Each case in the sample can have a distinct time trend as marked by a different intercept and/or slope when followed over time as well as being a structural equation modeling (SEM) approach that has deep roots in social science methodology. It has been used in such diverse areas of research as substance use (e.g., Chassin, Flora and King 2004; Greenbaum, Del Boca, Darkes, Wang and Goldman 2005; Simons-Morton and Chen 2006), intelligence testing (e.g., Raykov 1997), and offending behaviour (e.g., Blockland et al. 2005; Chung, Hill, Hawkins, Gilchrist and Nagin 2002; Laub and Sampson 2003; Wiesner and Windle 2004).

Latent trajectory models are referred to as semi-parametric group-based trajectory models or latent growth (finite) mixture models when group membership is unknown (Li, Duncan and Duncan 2001; Muthén and Shedden 1999; Nagin 1999; Nagin and Tremblay 2001)¹. These models are an elaboration of the conventional maximum likelihood models that form the basis for many commonly used statistical methods (e.g., Poisson, logit regression). In fact, the mixture modeling approach utilizes maximum likelihood estimation to obtain the estimated probabilities of group membership in accounting for the probabilistic nature of group assignment. Two central missions of latent growth mixture modeling are the identification of clusters of individuals with similar trajectories of development, and the testing for the presence of distinctive predictors of the groups. As such, the approach assumes that the population is composed of a mixture of distinct subgroups, each defined by a prototypical growth curve. Group membership is not known, but is inferred from the data. Unobserved heterogeneity in the development of an outcome over time is captured by latent variables.

The Identification and Assessment of Risk

Regardless of theoretical orientation, most scholars agree on the importance of identifying juvenile delinquents most at risk of continued offending, understanding the factors contributing to persistent offending, and concentrating intervention resources on the chronic and serious offenders. The identification of high-risk, chronic offenders (and the characteristics that differentiate them from lower risk, relatively transient offenders) is important for focusing resources on the former given the fact that intervening with all offenders is neither feasible nor desirable. As noted by Anderson (2010), "the new research points to policies

that affect high-rate chronic offenders as the key to lowering crime costs” (p. 276). The efficiency of a criminal justice system in reducing rates of criminality, and the ensuing social and human costs typically associated with crime and other antisocial acts, can thus be gauged by its ability to successfully identify the small number of offenders who commit a high proportion of serious offences. Only then, can intervention efforts and other resources be invested wisely and distributed profitably.

In this regard, there are two principal hazards that criminal justice systems face. First, there is the possibility of selectively focusing on offenders who may not be demonstrably more dangerous or at risk to reoffend than other offenders from the larger pool from which they are drawn. Second, there are the human costs associated with incorrectly classifying serious, chronic offenders as low risk for reoffending. The appropriate disposition of cases by criminal justice officials is therefore a crucial element to the proper functioning of any correctional or criminal justice system, especially when dealing with a relatively small group of high-risk offenders who commit a disproportionate share of crime.

Underlying this responsibility is the assessment of risk, which raises one fundamental question: Can we predict and treat well enough to make a difference on recidivism? By most accounts, the answer is yes. There is now a consensus that both general and violent reoffending can be predicted among typical criminal populations, as well as groups of violent and sexual offenders (e.g., Andrews and Bonta 2006; Campbell, French and Gendreau, in press; Gendreau, Little and Goggin 1996; Rice and Harris 1997). The degree of success in prediction, however, remains contingent upon the methods used by criminal justice professionals to assess offender risk level (i.e., clinical vs. actuarial). Most would argue that actuarial assessments of offender risk are superior to clinical, unstructured prediction procedures (e.g., Ægisdóttir, White, Spengler, Maugherman, Anderson and Cook 2006; Bonta 2002; Grove, Zald, Lebow, Snitz and Nelson 2000).

Fortunately, the past several years have witnessed an increasing reliance on “actuarialism” by criminal justice systems in their preferred approach to risk assessment (Andrews, Bonta and Wormith 2006; Bonta and Wormith 2006; Kemshall and MacGuire 2001). Acknowledging the current state of affairs, the adoption of a theoretical perspective and empirical methods that seek to understand and predict individual variation in criminal conduct in terms of offending pathways or criminal careers appears promising in assisting researchers to develop improved, and refine existing, actuarial instruments.

The Present Study

Two main statistical modeling techniques have assumed prominence in the developmental criminological literature. Some experts have recommended the use of latent class growth analysis (LCGA; Nagin 1999; Roeder, Lynch and Nagin 1999), while others have advocated growth mixture modeling (GMM; Muthén and Shedden 1999; Muthén, Brown, Masyn, Jo, Khoo, Yang, Wang, Kellam, Carlin and Liao 2002). In LCGA, the mixture corresponds to different latent trajectory groups and no variation across individuals is allowed within groups. An advantageous feature of GMM is that both cross- and within-group variation is allowed for the latent trajectory groups. In a recent paper, Kreuter and Muthén (2008) demonstrated the benefits of GMM over alternative modeling techniques (including LCGA) to capture heterogeneity in trajectories.

Given the growing body of evidence supporting the notion that criminal behaviour does not vary regularly throughout the population, but instead tends to reveal itself in markedly different intensities in specific groups of individuals, this analytical strategy appeared especially suited to the specific content domain of criminology and criminal justice research in terms of identifying heterogeneity in the number and types of offending trajectories. In addition, the present study also explored possible risk factors that predict membership in these trajectories. At the same time, statistical modeling techniques address the constraints and limitations of alternative strategies to analyze change over time. In an attempt to provide additional insight into the debate around the number and types of distinct offending trajectories, we therefore chose to investigate heterogeneity in the developmental course of offending in the present study using Muthén and Shedden’s latent growth curve mixture modeling approach (GMM; 1999).

Method

Participants

The sample consisted of 514 juveniles from Manitoba, Canada who were sentenced to probation during the years 1986 to 1991. At the time of the index offence, the participants ranged in age from 12 to 19 years, with a mean age of 16 years ($SD = 1.6$)². Roughly, 44% of the youths lived with both of their parents. The remainder lived with one parent (10%), one third with an adult who was not a parent, and 14% were in a foster or group home. As expected, the sample was not gender-balanced such that 85% of the juvenile probationers were male and 15% were female. Based on a modified Wisconsin risk assessment instrument, the Primary Risk Assessment – Version 1 (PRA – V1; Bonta, Parkinson, Pang, Barkwell and Wallace-Capretta 1994)³, their scores upon admission to supervision classified 19.8% of the juvenile offenders as low risk, 54.3% as medium risk, and 25.9% as high risk.

The majority of the juvenile probationers were first-time, non-violent offenders. Only about 14% had one or more prior convictions (84.3% of those were for non-violent offences). Furthermore, less than 5% had previously served time in an institutional setting (i.e., open or closed custody) prior to the index offence conviction. While 76.5% of the juvenile probationers were convicted of a non-violent index offence, 21.3% were found guilty of a violent person offence and only 2.2% of a violent sexual offence. For the index offence convictions, 11.3% received some form of custodial sentence along with their term of probation (five additional offenders were sentenced to time served). Sentence lengths for those offenders ranged from 2 to 729 days, with a mean time of 181 days ($SD = 148.5$).

Procedures

One hundred youth probation offenders were originally randomly drawn from each year of all cases closed between 1986 and 1991⁴. Upon admission to supervision, probation officers interviewed the offenders to garner details on personal-social demographic characteristics as well as various indicators of criminal history, emotional functioning and personal circumstances. Many of these factors were regarded as relevant to involvement in criminal activity. This information was used to create a database encompassing a number of background variables that a review of the literature identified as relevant to the prediction of the criminal careers of juvenile offenders. A search on the Offender Management System of Correctional Service of Canada complemented missing information from the original database (e.g., date of birth). Criminal history records from the RCMP's Criminal Records Branch (Canadian Police Identification Centre [CPIC] records) also supplemented and corroborated information that was not readily available from the probation officers. CPIC provides a national database of criminal history records.

The follow-up period ended in 2005. For approximately one-quarter of the sample (25.2%), the RCMP had no record of criminal activity in its system. The failure on the part of the RCMP to locate information on some of the offenders' past criminal activities was expected, given standard practices that authorize the purging of criminal history records. Accordingly, a request was made to the province of Manitoba to provide criminal history records from its own provincial system. By doing so, criminal history information was recorded for an additional 38 offenders⁵. Offenders were excluded from the study for whom criminal activity information was unobtainable (i.e., no CPIC record and no provincial record). An earlier study of this sample on a different topic had CPIC records from 1993. Thus, if the 2005 CPIC records had missing information for some offenders because of purging policies for youths, the 1993 records were used. We assumed that those cases remained alive and in the country until the end of the follow-up period, and so treated these offenders as non-recidivists, beyond any convictions revealed by their 1993 CPIC record. Using these exclusion criteria, 73 of the 149 juvenile offenders for whom the RCMP could not retrieve criminal history information were dropped from the study, producing a final sample totalling 514 offenders⁶.

Measures

Risk Factors

The predictors of offence trajectory were measured by the probation officers when the juvenile probationers were admitted to supervision during the years 1986 and 1991. However, we had to make an exception related to the criminal history variables for which follow-up criminal history records were used as a source of information. The predictors sought to operationalize constructs that were theoretically and empirically relevant to understanding developmental trajectories of offending. Those constructs reflected the peer, familial, education, accommodation, attitudinal, substance use, financial, and criminal history of the offenders' lives. All eight criminogenic risk/needs domains were coded on a three-point scale, with total scores ranging from 0 to 2 and higher scores indicating a higher risk for criminality.

Outcome Criterion

A retrospective examination of the offenders' criminal history records identified developmental trajectories of offending. An outcome measure that assessed a combination of offending frequency and severity was developed specifically for the purpose of the present study. The measure was named the Criminal Seriousness Index (CSI; see Table 1) and had seven levels, ranging from 1 (no offending) to 7 (at least two violent incidents and two non-violent incidents). Combining offending frequency and severity was important as both dimensions of criminal behaviour have the capacity to differentiate non-offenders from chronic offenders (Tolan and Gorman-Smith 1998). While frequent offenders are often serious offenders (and vice versa), the two dimensions are not perfectly correlated. For instance, an offender scoring 3 may commit many offences but not have committed a serious, violent offence. This distinction is important to recognize as Moffitt (1993) postulates that adolescent-limited (late onset desisters) and life-course-persistent (early onset persisters) offenders do not differ with respect to the frequency of antisocial acts during adolescence. What differentiates the two groups during that period is a combination of the variety and seriousness of offending behaviours. By combining the two methods of assessment, we were thus able to address an important theoretical consideration.

TABLE 1. CRIMINAL SERIOUSNESS INDEX

SCORE	OPERATIONAL DEFINITION
1	No offence
2	1 Non-violent incident
3	> 1 Non-violent incidents
4	1 Violent incident
5	1 Violent incident + \geq 1 non-violent incident(s)
6	> 1 Violent incidents
7	> 1 Violent incidents + \geq 1 non-violent incident(s)

Offenders were given a score on the CSI at each of five time periods starting with the age at which they were convicted for their index offence. Offending trajectories were modeled as a function of chronological age rather than year as it was a less bias measure of time given the considerable amount of age heterogeneity at each year cohort. The age periods were defined as follows: (1) Early Adolescence (12-15); (2) Late Adolescence (16-20); (3) Early Adulthood (21-25); (4) Adulthood (26-30); and (5) Middle Adulthood (31 onwards). Because some offenders spent time in confinement during the course of the study, we adjusted scores on the CSI for "time-at-risk" in the community. Specifically, we divided the scores by the natural log of the number of months the offender was "street free" to commit an offence (i.e., not incarcerated) during the particular period of assessment (the resulting scores were further

multiplied by 10 to facilitate interpretation)⁷. Values on the CSI for offenders who did not reoffend during a certain age period due to having spent the entire period incarcerated and thus having had no opportunity to reoffend were treated as missing values. Missing values were also assigned to age categories that did not have a criminality score to avoid making assumptions about the frequency/severity of offending in the absence of information.

Data Analysis

Analyses were conducted with the software package Mplus 4.2 (Muthén and Muthén 1998, 2006). Mplus facilitates the analysis of structural equation modeling relations by building causal models that more realistically reflect complex relationships and estimate the strength of variable relationships. In addition, Mplus has the beneficial capability of identifying clusters or groups of individuals with similar trajectories. The software program was designed to simultaneously use both continuous (e.g., random effects corresponding to individual differences in development) and categorical (e.g., latent trajectory groups corresponding to types of development) latent variables. That is, the modeling framework allows estimation of trajectory shapes as random rather than fixed effects, thus modeling individual variation in trajectory shape within each latent group.

There were three steps in the data analysis. First, the functional form of the overall criminal pathway for the young offenders was explored using latent trajectory modeling to identify the optimal structural equation model to fit the data and determine whether there were significant individual differences in criminal behaviour at baseline and in rates of progression over time. Second, growth mixture modeling was then used to identify subgroups of offenders with distinct offending trajectories from early adolescence to middle adulthood. Finally, logistic regression was used to predict group membership from the criminogenic risk/needs factors assessed when the juvenile probationers were admitted to supervision. Given that the study sample consisted of adjudicated youths, all offenders, including the non-recidivists who had no criminal conviction following the index offence ($n = 48$ or 9.3% of the sample) were included in the analyses. These individuals engaged in criminal activity at some point during the period under investigation and therefore, contributed to an analysis of change.

Missing Data

Mplus allows missing data in all parts of the model, except observed background variables (i.e., predictors/covariates). When the program reads the data file and encounters missing values, it automatically computes maximum likelihood estimates (Anderson 1957). Missing data in the present study was imputed using a regression method assuming ignorable missingness at random (MAR). More specifically, after the model parameters were set equal to their maximum likelihood estimates, linear regression was used to predict the unobserved values for each case as a linear combination of the observed values for that same case. Data on the majority of the individual predictors were available for all participants. Two variables (Education and Accommodation) had missing values, but given that it was for less than 10% of the sample, those missing values were imputed using the sample median for the rest of the dataset.

Results

The Overall Criminal Pathway

In the first series of analyses, the shape of the criminal pathway was explored for the entire sample over the age periods. In order to explore the functional form of growth that best fit the data, a number of unconditional (without covariates) latent trajectory models were estimated. The analysis began by assuming a single group and applied a latent growth curve model with a linear growth function only. Given our knowledge of the age-crime curve, we then fitted a quadratic growth function to allow for curvilinear trends across the ages. In addition to an intercept factor (which we defined as the frequency/severity of criminal behaviour during the second age period of late adolescence) and a linear factor, the quadratic growth model also contains a quadratic factor.

The estimator for the latent growth curve analyses was maximum likelihood with standard errors and a chi-square test statistic that are robust to non-normality (MLR). Some of the characteristics of the models were that the path loadings from the latent intercept to the outcome measure were fixed at 1.0 while the fixed loadings from the latent growth factors to each of the five waves of outcome were -1, 0, 1, 2 and 3 for the linear factor, and 1, 0, 1, 4 and 9 for the quadratic factor. The means of the growth factors as well as their variances and covariances were estimated because the growth factors are exogenous (i.e., independent) variables, and as such do not influence any variable in the model except their own indicators. Residual variances across the assessment waves were also estimated and free to vary over time. However, the intercepts of the observed dependent variable were not estimated, but fixed to zero.

The individual and comparative fit of the growth curve models were evaluated using several indices, including the likelihood ratio statistic T_{ML} (or chi-square test), the Tucker-Lewis index (TLI; Tucker and Lewis 1973), the comparative fit index (CFI; Bentler 1990), the root-mean-square error of approximation index (RMSEA; Steiger and Lind 1980), and the Bayes Information Criterion (BIC; Raftery 1993; Schwartz 1978). We also screened for “improper solutions” (e.g., negative residual variances), and examined the proportion of the variability in the observed variables accounted for by the underlying latent trajectory factors ($R^2_{y,t}$).

The results showed that the latent growth curve model specified with a quadratic function best fit the data. In fact, the general aggregated pattern of criminal activity generated for the sample mirrored the classic age-crime curve in that the rate of offending peaked in late adolescence and declined gradually into adulthood. Furthermore, there was significant variability around the mean in the intercept and slope components of the quadratic latent growth curve model, which implies that the juvenile offenders differed in their average criminal behaviour ratings during late adolescence, as well as in their rates of change in criminal behaviour over time. The subsequent growth mixture analyses thus attempted to explain this variability.

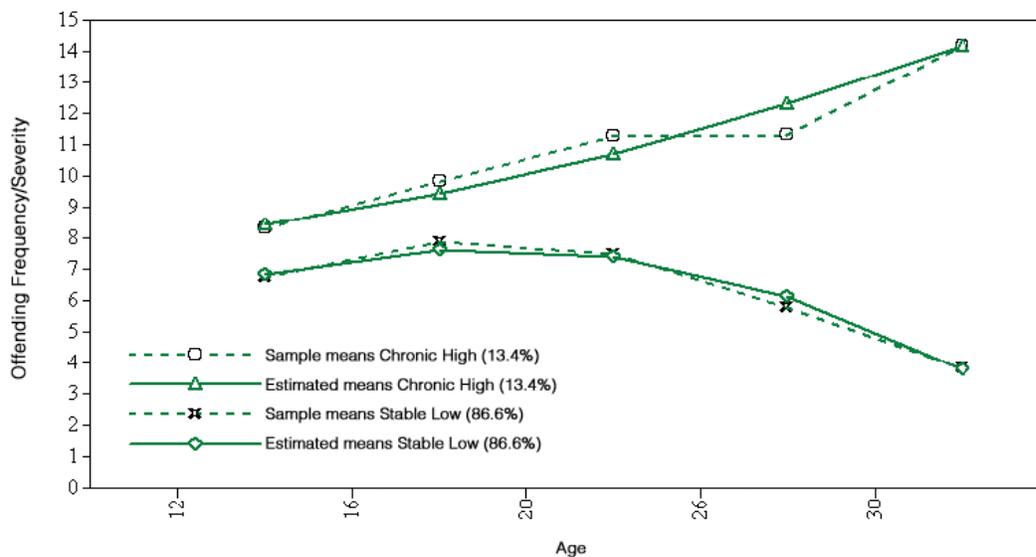
Identifying the Number and Types of Offending Trajectories

There was significant intra-individual variance in status and growth factors on the best fitting model using a one-group solution, justifying the extraction of additional groups to account for this heterogeneity. Thus, after specifying a single group, two-group through four-group growth mixture solutions were tested to determine the optimal number of trajectory groups to extract. In the parameterization of the growth mixture analyses, growth factor variances and covariances, as well as residual variances of the observed outcome variable (adjusted CSI scores) were constrained to be equal across groups. However, the mean parameters of the growth factors were allowed to vary across groups.

In growth mixture modeling, model selection requires determination of the number of groups that best describes the data. However, it is not appropriate to use the standard log likelihood ratio (chi-square difference) test for model comparison because a k group model is not nested within a $k + 1$ group model. Several statistics are available to help determine the optimal number of groups to extract. In the present study, model fit was evaluated using one of the more popular selection factors, the Bayes Information Criterion (BIC) as it can be used for comparison of both nested and unnested models (Kass and Raftery 1995; Raftery 1995). The model with the smallest absolute BIC value is generally chosen. It should be noted that the BIC formula rewards parsimony, and therefore tends to favour models with fewer groups. In the current study, the growth mixture models failed to converge to a reliable solution when more than two groups were specified, suggesting that the specification of additional groups (beyond two) did not improve the fit of the model for the data. However, the two-group solution produced substantial improvement in fit statistics over the one-group solution (BIC was minimized for the two-group solution; 12 766 vs. 13 026).

Following model selection, offenders were assigned to the group that best conformed to their criminal behaviour according to the maximum posterior probabilities of group membership. For each offender in the sample, the posterior probabilities of group membership estimated the probability of belonging to each trajectory group. This procedure is based on the assumption that the error in classification made when placing an offender into only one trajectory group is small, and thus does not bias the parameter estimates of the standard errors to an important degree. This assumption appeared reasonable in the present study as the average probabilities of group membership for offenders falling into each group were .929 and .975. Furthermore, less than 5% of the sample could be considered “difficult to classify” in the sense that they had an above .25 / below .75 probability of being assigned to the other group. A graphical depiction of the resulting solution is presented in Figure 1. Solid lines on the graphs represent model-implied (i.e., estimated or predicted) trajectories, whereas dashed lines represent average observed trajectories.

FIGURE 1. ESTIMATED AND OBSERVED GROWTH CURVES FOR THE CRIMINAL SERIOUSNESS INDEX WITH TWO OFFENDING TRAJECTORY GROUPS



Inspection of the fitted growth curves confirms the finding that the conditional two-group quadratic latent growth curve model performed well at reproducing the observed means (i.e., provided a good fit to the data). Moreover, we can see that the great majority of the offenders engaged in sporadic and relatively minor forms of offending over their life-course, while a minority of offenders committed more frequent, serious and persistent criminal activity. The latter group comprised 13.4% of the offenders and showed a chronic high level of offending behaviour over the years. The offending frequency/severity of this group increased steadily from adolescence onwards. The largest group consisted of 86.6% of the offenders in the sample. This group was characterized by infrequent and/or less serious involvement in criminal behaviour over the years. Their offending pattern remained relatively stable, although it tended to show a slight decline in frequency/severity, which was primarily evident during the last two periods of assessment (age 26 onwards). These two groups were labelled chronic high and stable low, respectively.

The actual recidivism rates of the two groups at each of the five waves of assessment are presented in Table 2. A few comments deserve mention. First, at each age period, the chronic high offenders recidivated at a much higher rate than the stable low offenders. Second, the differences in recidivism rates between the two offending groups became progressively more pronounced over time, with the largest dissimilarities evidenced during (middle) adulthood (age 26 onwards). After the age of 15, 80% to 90% of the chronic high offenders received at least one conviction in each of the last four assessment periods. In contrast, the recidivism rate for the stable low offenders declined from 70% during late adolescence (16-20 age period) to approximately 20% in the last wave of assessment when the offenders were 31 years or older. These findings are consistent with the fitted growth curves depicted in Figure 1, which shows that the offending pathways of the two groups are reasonably similar up to early adulthood, and then begin diverging in such a way that the chronic high offending trajectory group maintained an increasingly more frequent and/or serious level of offending throughout adulthood.

TABLE 2. RECIDIVISM RATES OF THE CHRONIC HIGH AND STABLE LOW OFFENDING TRAJECTORY GROUPS AT EACH TIME PERIOD (%/n)

	Time 1 (ages 12-15)	Time 2 (ages 16-20)	Time 3 (ages 21-25)	Time 4 (ages 26-30)	Time 5 (ages 31+)
Chronic High	40.0 (25)	85.5 (69)	82.6 (69)	81.2 (69)	91.9 (62)
Stable Low	31.1 (196)	69.4 (445)	60.5 (441)	46.1 (436)	17.9 (363)

As expected, all of the non-recidivist offenders were assigned to the stable low offending trajectory group. Also of interest, almost all of the chronic high offenders (95.7%), while only 56.0% of the stable low offenders, were convicted of at least one violent offence ($\chi^2(1, N = 510) = 39.55, p < .001$) during their adult years (age 21 onwards). Similarly, a significantly greater proportion of chronic high offenders received a conviction for a violent offence between the ages of 16 and 20, although the difference between the two groups during this earlier assessment period was a bit less marked. Specifically, 73.9% of the offenders in the chronic high trajectory group and 51.2% of the offenders in the stable low trajectory group were convicted for a violent offence during late adolescence ($\chi^2(1, N = 514) = 12.38, p < .001$).

In addition, there were statistically significant differences between the two groups in the numbers of convictions (both overall and violent) received following the index offence. In fact, the chronic high offenders were reconvicted more than twice as many times as the stable low offenders in general and for violent offences specifically. The actual number of reconvictions was slightly more than ten for the chronic high offenders (≈ 4 violent reconvictions), compared to about five for the stable low offenders (≈ 1.5 violent reconvictions). Independent samples *t*-statistics were $t(512) = 8.19$ for overall and $t(512) = 7.12$ for violent-only (both $ps < .001$). The two groups also differed in terms of criminal versatility, with the chronic high offenders averaging nearly five different offence types throughout their life-course and the stable low offenders only about three ($t(512) = 8.72, p < .001$).

Risk Factors Associated with Trajectory Membership

It seemed clear from these findings that the chronic high group was comprised of offenders who were at greater risk and needs than those assigned to the stable low group. To examine the relationships between the criminogenic risk/needs domains and group membership, we conducted a series of binary logistic regression analyses. The regression analyses tested multiple “univariate” predictor models to assess the unique effect of each risk factor separately. Associates differentiated offenders in the chronic high trajectory group from those in the stable low group. The odds of being classified in the chronic high rather than in the stable low offending trajectory group were three to four times greater for offenders who experienced some or major problems in terms of their association patterns, compared to those who had no problem (ORs were 2.89 for some and 4.29 for major). Moreover, substance use problems predicted increased odds of membership in the chronic high offending trajectory group relative to the stable low group (ORs were 2.08 for some problems and 2.90 for major problems). That is, there was a greater proportion of the juvenile probationers who had substance use problems in the chronic high offending trajectory group (47.8% for some and 11.6% for major) than was found in the stable low group (33.9% for some and 6.1% for major).

Discussion

A primary objective of the present study was to enhance the growing body of empirical evidence that calls for more differentiated theoretical models of offending trajectories and address the dispute regarding the number of identified offending trajectory groups, their sizes, and the shapes of the distinctive developmental courses. This objective was achieved by taking advantage of the strengths and capabilities of the newest generation of growth modeling techniques. A secondary objective was to examine the relationships between adolescent criminogenic risk/needs factors and offending trajectory group membership.

Two subgroups of offenders who differed statistically in their patterns of offending frequency and/or severity over time were identified. The minority of youths ($\approx 13\%$) engaged in frequent and/or serious levels of offending behaviour throughout their life-course. The frequency/severity of offending behaviour for offenders within that group escalated gradually from early adolescence (ages 12-15) onwards, and showed very little evidence of decline. Also found was a much more common trajectory ($\approx 87\%$) characterized by less frequent and/or serious offending behaviour over time. As expected, the chronic high offenders disproportionately engaged in a wider variety of offence types as well as more of the violent crimes, compared to the stable low offenders. They were also more likely than their more transient counterparts to have negative and unconstructive ties with their peers and to have substance use problems.

An important finding was that the offenders assigned to the chronic high group did not desist from crime, but rather continued to engage in relatively frequent and/or serious criminal activity over the years. The identification of a high risk group that persists in offending through to the mid-adult years is consistent with several other studies (e.g., Blockland et al. 2005; Schaffer, Petras, Jalongo, Poduska and Kellam 2003). Whether a longer follow-up would find some chronic offenders to desist as suggested by Laub and Sampson (2003) remains to be confirmed.

Another finding central to the present investigation concerns the link with the broader developmental criminological literature. Although detailed information on the frequency and/or severity of the antisocial activities during the pre-adolescence and early childhood years is lacking, the two offending trajectories found in the present study corresponded closely to the early onset persisters and late onset desisters proposed by Loeber and Stouthamer-Loeber (1996), Moffitt (1993) and Patterson et al. (1992). Moreover, the current findings contrasted with the outcomes of recent empirical studies that suggested the presence of more than two distinct offending trajectory groups (e.g., Day, Beve, Duschene, Rosenthal, Sun and Theodor 2007; Blockland et al. 2005; Moffitt 2003; Wiesner and Silbereisen 2003).

In evaluating and comparing the current results with those of other studies, it is essential to draw attention to some methodological and analytical differences. We have previously discussed the importance of the type of statistical analyses used, but there are other explanatory factors for the noticeable incongruence. In general, research sampling youths from a normative population find three to four trajectories compared to four to six typically found with adjudicated populations (Piquero 2008). However, we only found two trajectories and recently, Livingston and his colleagues (Livingston, Stewart, Allard and Ogilvie 2008) found only three trajectory groups with a youth offender cohort of the same age as in this study. Our findings and those of Livingston et al. (2008) implies Piquero's (2008) review of offender samples may need to be revisited. It appears that possible differences in the sample composition may be an important moderator of trajectory membership.

We feel reasonably confident that the youths sampled in this study comprised an at-risk group of adolescents with multiple needs. Many of the teenagers were clients of a number of different social agencies before coming to the attention of the criminal justice system. Fourteen percents of the adolescents had been placed in a foster or group home, about half had one or more address change(s) in the year prior to their probation term, and almost one-third were relying on social assistance at the time they were admitted to supervision. In addition, as many as 30% of the youths had a criminal history record before they reached their fifteenth birthday, and more than three quarters were classified as either medium or high risk and needs on the Primary Risk Assessment – Version 1 when admitted to supervision. Thus, it was not surprising to find that the size of our chronic high group was slightly larger than the 3%-8% of the population hypothesized to show sustained criminal careers (e.g., Cohen and Vila 1996; Farrington, Coid, Harnett, Jolliffe, Soteriou, Turner and West 2006; Moffitt 1993) and/or that comprised high-rate chronic offender groups in other empirical studies (e.g., Chung et al. 2002; D'Unger, Land and McCall 2002; Farrington et al. 2006). Neither was it unexpected to observe that the actual percentages of violent crimes for both offending trajectory groups were appreciably higher than those reported in other longitudinal studies that used a comparable methodology and/or follow-up period (e.g., Eklund and af Klinteberg 2006).

Other potential explanations that can have an impact on the optimal number of offending trajectories to be drawn and on their characteristics (e.g., size, shape) include differences in the measurement of offending behaviour (e.g., self-reports vs. official convictions, frequency vs. severity, scale/range of scores, number of waves of assessment) as well as in the age span covered by the study. Additionally, the decision to take or not incarceration time into account may yield divergent findings. Piquero et al. (2001) demonstrated that the failure to control for time-at-risk in the community could underestimate the number of persisting offenders (e.g., result in the improper identification of chronic high offenders as moderate-rate offenders).

Risk Factors Associated with Offending Trajectories

Evidence that the present sample consisted of high-risk offenders with several needs was provided from an examination of the Primary Risk Assessment – Version 1. In the current study, not only was the PRA – V1 found to be a significant predictor of offending trajectory group membership, but more than three quarters of the offenders were categorized as either medium or high risk and needs. Given that this actuarial assessment instrument draws its total score from a variety of constructs linked to criminal behaviour, these results suggest that the majority of the offenders in the sample had multiple risk factors, placing them at risk for reoffending.

Taking these findings as a whole, it appears reasonable to presume that the offending trajectory groups generated in this study were reliably distinctive such that the patterns of offending could be usefully examined for characteristics that may reflect different etiological pathways. Accordingly, it is interesting to consider what characterized the juvenile probationers assigned to the chronic high offending trajectory group apart from their more transient counterparts.

Of the risk/needs domains studied, only Associates reliably predicted group membership across the two outcome measures and after controlling for other competing risk/needs factors. Not surprisingly, the chronic high offending trajectory group comprised more offenders who had negative and unconstructive ties with their peers than the stable low group. Compared to the youths who had a generally prosocial pattern of associations, the odds of membership in the chronic high group were significantly increased (roughly three to four times higher) for the juvenile probationers who experienced problems in terms of their association patterns.

Although not measured directly, it is logical to deduce that the offenders who followed a chronic high offending trajectory received social support from their peers to engage in criminal behaviour and other related deviant acts. As expected from a social learning perspective and from the principles of differential association theory, interacting with peers who tolerate or even commit antisocial behaviour and who function as sources of reinforcement and role models, increases the risk for criminal behaviour (Coie, Terry, Zakrski and Lochman 1995; Dishion and Patterson 1997; Tremblay, Masse, Vitaro and Dobkin 1995). The importance of antisocial peer support is not only theoretically relevant, but has also been repeatedly validated. In fact, numerous studies have demonstrated that the role of associates is one of the most important risk factors in the study of delinquency and persistent criminality, especially when dealing with the behaviour of youths (e.g., Brendgen, Vitaro and Bukowski 1998; Chung et al. 2002; Farrington et al. 2006; Lacourse, Nagin, Tremblay, Vitaro and Claes 2003; Wiesner and Silbereisen 2003).

Despite demonstrating a less convincing association with group membership, it should be noted that Substance Use also distinguished offenders in the chronic high and stable low offending trajectory groups. Specifically, a greater proportion of young probationers who had substance use problems were identified as chronic high offenders, compared to those who did not evidence difficulty in this area. The statistically significant effect of this risk factor, however, disappeared when considered in conjunction with Associates. Surprisingly, none of the other relatively well-established juvenile risk/needs factors significantly and reliably predicted membership in the chronic high and stable low offending trajectory groups.

As noted earlier, the chronic high group comprised a medium to high risk group as measured by the PRA – V1. Although they had problems related to many different aspects of their personal and social lives, the current results highlighted the peer group as a predominant influence that made the juvenile probationers vulnerable to recurrent and enduring contacts with the criminal justice system. This finding suggests that patterns of association are so closely entrenched in other areas of a youth's daily life (e.g., family, school) and other potential risk factors (e.g., substance abuse, attitudes) that it indirectly accounts for a good share of the influence attributable to these other criminogenic risk/needs factors.

Implications, Limitations and Directions for Future Research

Overall, this study contributes to the mounting volume of research on the heterogeneity of criminal behaviour, but additional research is needed to resolve the debate about the optimal number and types of distinct developmental trajectories that best describes the offending population. Besides, the current results must be interpreted in light of some limitations.

The finding that the chronic high offenders did not desist from crime despite having received numerous and sometimes lengthy custodial sentences is in line with the literature on offender rehabilitation, which suggests that sanctions and punishment do not have any suppressive impact on recidivism (Andrews and Bonta 2006; Pratt and Cullen 2005; Smith, Goggin and Gendreau 2002; von Hirsch, Bottoms, Burney and Wikström 1999). Cognizant of Piquero's (2008) warning that policy makers "do something" with chronic offenders and that this "something" will be harsher punishment, we take the view that such knowledge is useful for the delivery of rehabilitative services to those who need it the most. The correctional rehabilitation literature clearly shows that treatment works best with the higher risk offenders and not with the low risk offenders (Andrews, Bonta and Hoge 1990; Andrews and Bonta 2006).

Earlier, we raised the idea that extending the data collection period to include the pre-adolescence years would provide valuable information on age of onset. The information collected during earlier stages in the life-course would also convey precious guidance for intervention strategies. The present findings clearly suggest that services should be offered in the early developmental stages of an offender's criminal career (i.e., early and middle adolescent years), but the need to intervene at an even earlier time could have been invoked had data been collected on a normative sample during developmental periods that cover childhood. Chung et al. (2002) demonstrated that a number of social developmental constructs such as antisocial peers, school bonding, and drug availability measured in late childhood (ages 10 to 12) influenced offending pathways from adolescence to young adulthood. Similarly, Côté, Vaillancourt, LeBlanc, Nagin and Tremblay (2006) found that family risk factors traditionally associated with antisocial behaviour during adolescence (e.g., hostile/ineffective parenting strategies) were associated with the use of frequent and regular physical aggression during early and middle childhood (ages 2 to 11). These latter results are noteworthy given that physical aggression between the ages of 6 and 12 predicts physical violence at age 17 (Kokko, Tremblay, Lacourse, Nagin and Vitaro 2006).

In addition to tracking offenders from an earlier age, there is a need for longitudinal studies that track offenders over follow-up periods that extend into later adulthood. Not only would this produce greater confidence that desisters have been genuinely identified, but it would also allow researchers to examine different phases in the desistance process. As suggested by Loeber and Stouthamer-Loeber (1998), it cannot be assumed that the causes of desisting from crime are the same across different developmental periods. A detailed discussion of the possible causes for the age-related decline in crime observed for the majority of the sample is beyond the scope of this study. Future research however could clarify the role that a deep-seated psychological change (i.e., growth and maturity) that relates to Moffitt's (1993) notion of social mimicry, and that changes in an individual's attachment to social institutions (e.g., marriage, employment, childrearing; Laub and Sampson 2003) and opportunities play in the process.

The current literature would also benefit from broadening the scope of research by including time-varying predictors (i.e., dynamic variables whose actual scores for some individuals fluctuate across the assessment periods). Contemporary growth curve modeling techniques offer the possibility to investigate the relationships between distinct offending trajectories and time-varying predictors, but these growth curve models are complex and to our knowledge, there has not been any published study to date that has made use of such a methodology and analytical strategy. The closest piece of work was executed by Wiesner and Silbereisen (2003) who explored associations between trajectories of juvenile delinquency and *time-averaged* risk factors. The inclusion of time-varying predictors could help researchers establish whether changes in some variables are associated with offending (or desistance) during various developmental stages of the life-course. Moreover, it could allow a more precise and thorough investigation of both cause and effect relations and person-by-situation interactions.

Closely related is the type of predictor variables. This study only assessed factors that reflected the person and his/her social environment. Had information on social-cognitive indicators (e.g., goals, motives) been collected, the relations between underlying psychological processes and offending behaviour could have been examined, which would have provided a more representative and comprehensive picture of the phenomenon under study. For instance, it could help explain why early onset persisters (chronic high offenders) are more violent, or why late onset desisters (stable low offenders) become relatively crime-free. To attend to the abovementioned unresolved issues would also address a number of central themes on Moffitt's (2003) research agenda such as investigating the effect of serious and chronic criminal behaviour on other generally negative patterns of behaviour or life outcomes (e.g., employment/educational success, overall physical/mental health).

Finally, we wish to note that we relied on official conviction records as the sole measure of offending behaviour, even though prior research suggested that predicting serious and/or persistent offending is at least somewhat dependent on the measurement strategy used (see Brennan, Grekin and Mednick 1999;

Piquero 2008; Piquero, Blumstein, Brame, Haapanen, Mulvey and Nagin 2001). The use of self-report questionnaires in conjunction with official police records could have provided a more accurate (less biased) representation of recidivism rates as well as valuable information relating to goals, motives and contexts. Nonetheless, by employing a state-of-the-art analytical strategy that allowed the capture of the complex patterns of stability and change in criminal behaviour across developmental periods, we made full use of the longitudinal data, and therefore advanced knowledge about developmental trajectories of offending.



References

- Aalsma, Matthew C. and Daniel K. Lapsley.** 2001. "A typology of adolescent delinquency: Sex differences and implications for treatment". *Criminal Behaviour and Mental Health*, 11: 173-191.
- Ægisdóttir, Stefanía., Michael J. White, Paul M. Spengler, Alan S. Maugherman, Linda Anderson and Robert S. Cook.** 2006. "The meta-analysis of clinical judgment project: Fifty-six years of accumulated research on clinical versus statistical prediction". *Counseling Psychologist*, 34: 341-382.
- Anderson, David D.** 2010. "Finding the path to optimal deterrence by tracking the path that leads to crime: An introduction to "Studying the costs of crime across offender trajectories". *Criminology and Public Policy*, 9: 275-277.
- Anderson, Theodore W.** 1957. "Maximum-likelihood estimates for a multivariate normal distribution when some observations are missing". *Journal of the American Statistical Association*, 52: 200-203.
- Andrews, Don A. and James Bonta.** 2006. *The Psychology of Criminal Conduct*. 4th ed. Newark, NJ: LexisNexis.
- Andrews, Don A., James Bonta and Robert D. Hoge.** 1990. "Classification for effective rehabilitation: Rediscovering psychology". *Criminal Justice and Behavior*, 17: 19-52.
- Andrews, Don A., James Bonta and Stephen J. Wormith.** 2006. "The recent past and near future of risk and/or need assessment". *Crime and Delinquency*, 52: 7-27.
- Barkwell, Lawrence.** 1991. *Offender Classification and Risk Assessment*. Winnipeg: Community and Youth Corrections.
- Bentler, Peter M.** 1990. "Comparative fit indexes in structural models". *Psychological Bulletin*, 107: 238-246.
- Blockland, Arjan A., Daniel S. Nagin and Paul Nieuwebeerta.** 2005. "Life span offending trajectories of a Dutch conviction cohort". *Criminology*, 43: 919-954.
- Blumstein, Alfred and Jacqueline Cohen.** 1987. "Characterizing criminal careers". *Science*, 237: 985-991.
- Bonta, James.** 2002. "Offender risk assessment: Guidelines for selection and use". *Criminal Justice and Behavior*, 29: 335-379.
- Bonta, James and Stephen J. Wormith.** 2006. "Risk and need assessment". In G. McIvor and P. Raynor (Eds.), *Development in Social Work with Offenders* (pp. 131-152). Jessica Kingsley Publishers, Philadelphia.
- Bonta, James, Ron Parkinson, Bessie Pang, Lawrence Barkwell and Suzanne Wallace-Capretta.** 1994. *The Revised Manitoba Classification System for Probationers. Research Report*. Ottawa: Solicitor General Canada.
- Bonta, James, Ron Parkinson, Lawrence Barkwell and Suzanne Wallace-Capretta.** 1994. *The classification of young offenders in Manitoba: Post-probation recidivism. Research Report*. Ottawa: Solicitor General Canada.
- Brendgen, Mara, Frank Vitaro and William M. Bukowski.** 1998. "Affiliation with delinquent friends: Contributions of parents, self-esteem, delinquent behavior, and rejection by peers". *Journal of Early Adolescence*, 18: 244-265.

- Brennan, Patricia, Emily R. Grekin and Sarnoff A. Mednick.** 1999. "Maternal smoking during pregnancy and adult male criminal outcomes". *Archives of General Psychiatry*, 56: 215-219.
- Campbell, Mary A., Sheila French and Paul Gendreau.** 2009. "The prediction of violence in adult offenders: A meta-analytic comparison of instruments and methods of assessment". *Criminal Justice and Behavior*, 36: 567-590.
- Chassin, Laurie, David B. Flora and Kevin M. King.** 2004. "Trajectories of alcohol and drug use and dependence from adolescence to adulthood: The effects of familial alcoholism and personality". *Journal of Abnormal Psychology*, 113: 483-498.
- Chung, Ick-Joong, Karl G. Hill, David J. Hawkins, Lewayne D. Gilchrist and Daniel S. Nagin.** 2002. "Childhood predictors of offense trajectories". *Journal of Research in Crime and Delinquency*, 39: 60-90.
- Cohen, Lawrence E. and Bryan J. Vila.** 1996. "Self-control and social control: An exposition of the Gottfredson-Hirschi/Sampson-Laub debate". *Studies on Crime & Crime Prevention*, 5: 125-150.
- Côté, Sylvana M., Tracy Vaillancourt, John C. LeBlanc, Daniel S. Nagin and Richard E. Tremblay.** 2006. "The development of physical aggression from toddlerhood to pre-adolescence: A nation wide longitudinal study of Canadian children". *Journal of Abnormal Child Psychology*, 34: 71-85.
- Day, David M., Irene Bevc, Thierry Duschene, Jeffrey S. Rosenthal, Ye Sun and Frances Theodor.** 2008. "Criminal trajectories from adolescence to adulthood in an Ontario sample of offenders". In G. Bourgon, R. K. Hanson, K. E. Morton-Bourgon, C. L. Tanasichuk and J. D. Pozzulo, (Eds.), *The Proceedings of the 2007 North American Correctional & Criminal Justice Psychology Conference* (User Report 2008-02) (pp. 143-148). Ottawa, ON: Public Safety Canada.
- Dishion, Thomas J. and Gerald R. Patterson.** 1997. "The timing and severity of antisocial behaviour: Three hypotheses within an ecological framework". In D. M. Stoff, J. Breiling and J. D. Maser (Eds.), *Handbook of Antisocial Behavior* (pp. 205-217). Hoboken, NJ, US: John Wiley & Sons Inc.
- D'Unger, Amy V., Kenneth C. Land and Patricia L. McCall.** 2002. "Sex differences in age patterns of delinquent/criminal careers: Results from Poisson latent class analyses of the Philadelphia cohort study". *Journal of Quantitative Criminology*, 18: 349-375.
- Eklund, Jenny M and Britt af Klinteberg.** 2006. "Stability and change in criminal behavior: A prospective study of young male lawbreakers and controls". *International Journal of Forensic Mental Health Services*, 5: 83-95.
- Elliott, Delbert S.** 1994. "Serious violent offenders: Onset, developmental course, and termination. The American Society of Criminology 1993 Presidential Address". *Criminology*, 32: 1-21.
- Farrington, David P., Jeremy W. Coid, Louise Harnett, Darrick Jolliffe, Nadine Soteriou, Richard Turner and Donald J. West.** 2006. *Criminal Careers and Life Success: New Findings from the Cambridge Study in Delinquent Development*, 2nd Edition. Research Study No. 299. London: Home Office Research.
- Farrington, David P., Sandra Lambert and Donald J. West.** 1998. "Criminal careers of two generations of family members in the Cambridge study in delinquent development". *Studies on Crime and Crime Prevention*, 7: 85-106.
- Fergusson, David M., John L. Horwood and Daniel S. Nagin.** 2000. "Offending trajectories in a New Zealand birth cohort". *Criminology*, 38: 525-551.

- Gendreau, Paul, Tracy Little and C. Goggin.** 1996. "A meta-analysis of the predictors of adult recidivism: What works!" *Criminology*, 34: 401-433.
- Gottfredson, Micheal and Travis Hirschi.** 1990. *A General Theory of Crime*. Stanford, CA: Stanford University Press.
- Greenbaum, Paul E., Frances K. Del Boca, Jack Darkes, Chen-Pin Wang and Mark S. Goldman.** 2005. "Variation in the drinking trajectories of freshman college students". *Journal of Consulting and Clinical Psychology*, 73: 229-238.
- Grove, William M., David H. Zald, Boyd S. Lebow, Beth E. Snitz and Chad Nelson.** 2000. "Clinical versus mechanical prediction: A meta-analysis". *Psychological Assessment*, 12: 19-30.
- Jedidi, Kamel, Harsharanjeet S. Jagpal and Wayne S. DeSarbo.** 1997. "STEMM: A general finite mixture structural equation model". *Journal of Classification*, 14: 23-50.
- Kass, Robert E. and Adrian E. Raftery.** 1995. "Bayes factor". *Journal of the American Statistical Association*, 90: 773-795.
- Kokko, Katja, Richard E. Tremblay, Eric Lacourse, Daniel S. Nagin and Frank Vitaro.** 2006. "Trajectories of prosocial behavior and physical aggression in middle childhood: Links to adolescent school dropout and physical violence". *Journal of Research on Adolescence*, 16: 430-428.
- Kreuter, Frauke and Bengt O. Muthén.** 2008. "Analyzing criminal trajectory profiles: Bridging multilevel and group-based approaches using growth mixture modeling". *Journal of Quantitative Criminology*, 24: 1-31.
- Lacourse, Eric, Daniel Nagin, Richard E. Tremblay, Frank Vitaro and Michel Claes.** 2003. "Developmental trajectories of boys' delinquent group membership and facilitation of violent behaviors during adolescence". *Development and Psychopathology*, 15: 183-197.
- Laub, John H., Daniel S. Nagin and Robert J. Sampson.** 1998. "Trajectories of change in criminal offending: Good marriages and the desistance process". *American Sociological Review*, 63: 225-238.
- Laub, John H. and Robert J. Sampson.** 2003. *Shared Beginnings, Divergent Lives: Delinquent Boys to Age 70*. Cambridge, MA: Harvard University Press.
- LeBlanc, Marc.** 1996. "Changing patterns in the perpetration of offenses over time: Trajectories from early adolescence to the early 30's". *Studies on Crime and Crime Prevention*, 5: 151-165.
- Li, Fuzhong, Terry E. Duncan and Susan C. Duncan.** 2001. "Latent growth modeling of longitudinal data: A finite growth mixture modeling approach". *Structural Equation Modeling*, 8: 493-530.
- Livingston, Michael, Anna Stewart, Troy Allard and James Ogilvie.** 2008. "Understanding juvenile offending trajectories". *Australian and New Zealand Journal of Criminology*, 41: 345-363.
- Loeber, Rolf, David P Farrington, Magda Stouthamer-Loeber, Terrie E. Moffitt and Avshalom Caspi.** 1998. "The development of male offending: Key findings from the first decade of the Pittsburgh Youth Study". *Studies on Crime and Crime Prevention*, 7: 141-171.
- Loeber, Rolf and Magda Stouthamer-Loeber.** 1996. Development of juvenile aggression and violence: Some common misconceptions and controversies. *American Psychologist*, 53: 242-259.

- Loeber, Rolf, Evelyn Wei, Magda Stouthamer-Loeber, David Huizinga and Terence P. Thornberry.** 1999. "Behavioral antecedents to serious and violent offending: Joint analyses from the Denver youth survey, Pittsburgh youth study and the Rochester youth development study". *Studies on Crime and Crime Prevention*, 8: 245-263.
- Moffitt, Terrie E.** 1993. "Adolescence-limited and life-course-persistent antisocial behaviour: A developmental taxonomy". *Psychological Review*, 100: 674-701.
- Moffitt, Terrie E.** 2003. "Causes of conduct disorder and juvenile delinquency". In B. Lahey, T. E. Moffitt & A. Caspi (Eds.), *Life-Course-Persistent and Adolescent-Limited Antisocial Behavior: A 10-Year Research Review and a Research Agenda* (pp. 49-75). New York, NY: Guilford Press.
- Moffitt, Terrie E., Avshalom Caspi, Nigel Dickson, Phil Silva and Warren Stanton.** 1996. "Childhood-onset versus adolescent-onset antisocial conduct problems in males: Natural history from ages 13 to 18 years". *Development and Psychopathology*, 8: 399-424.
- Moffitt, Terrie E., Avshalom Caspi, Honalee Harrington and Barry J. Milne.** 2002. "Males on the life-course persistent and adolescence-limited antisocial pathways: Follow-up at age 26 years". *Development and Psychopathology*, 14: 179-207.
- Muthén, Bengt O., Hendricks C. Brown, Katherine Masyn, Booil Jo, Siek-Toon Khoo, Chih-Chien Yang, Chen-Pin P. Wang, Sheppard Kellam, John Carlin and Jason Liao.** 2002. "General growth mixture modeling for randomized preventive interventions". *Biostatistics*, 3: 459-475.
- Muthén, Linda K. and Bengt O. Muthén.** 1998. 2006. *Mplus User's Guide*, 4th Ed. Los Angeles, CA: Muthén & Muthén.
- Muthén, Bengt O. and Kerby Shedden.** 1999. "Finite mixture modeling with mixture outcomes using the EM algorithm". *Biometrics*, 55: 463-469.
- Nagin, Daniel S.** 1999. "Analyzing developmental trajectories: A semi-parametric, group-based approach". *Psychological Methods*, 4: 139-157.
- Nagin, Daniel S. and Richard E. Tremblay.** 2005. "Developmental trajectory groups: Fact or a useful statistical fiction?" *Criminology*, 43: 873-904.
- Nagin, Daniel S. and Richard E. Tremblay.** 2001. "Analyzing developmental trajectories of distinct but related behaviors: A group-based method". *Psychological Methods*, 6: 18-34.
- Patterson, Gerald R., John B. Reid and Thomas J. Dishion.** 1992. "A Social Interactional Approach: Vol. 4". *Antisocial Boys*. Castalia, Eugene, OR.
- Piquero, Alex R.** 2008. "Taking stock of developmental trajectories of criminal activity over the life course". In A. M. Liberman (Ed.), *The Long view of Crime: A Synthesis of Longitudinal Research* (pp. 23-78). New York, NY: Springer.
- Piquero, Alex R., Alfred Blumstein, Robert Brame, Rudy Haapanen, Edward P. Mulvey and Daniel S. Nagin.** 2001. "Assessing the impact of exposure time and incapacitation on longitudinal trajectories of criminal offending". *Journal of Adolescent Research*, 16: 54-74.
- Pratt, Travis C. and Francis T. Cullen.** 2005. "Assessing macro-level predictors and theories of crime: A Meta-analysis". In M. Tonry (Ed.), *Crime and Justice: A Review of Research*, (Vol. 32) (pp. 373-450). University of Chicago Press, Chicago.

- Raftery, Adrian E.** 1993. "Bayesian model selection in structural equation models". In K. A. Bollen & J. S. Long (Eds.), *Testing Structural Equation Models* (pp. 163-180). Newbury Park, CA: Sage.
- Raftery, Adrian E.** 1995. "Bayesian model selection in social research". *Sociological Methodology*, 25, 111-164.
- Raine, Adrian E., Terrie E. Moffitt, Avshalom Caspi, Rolf Loeber, Magda Stouthamer-Loeber and Donald Lynam.** 2005. "Neurocognitive impairments in boys on the life-course persistent antisocial path". *Journal of Abnormal Psychology*, 114: 38-49.
- Raykov, Tenko.** 1997. "Growth curve analysis of ability means and variances in measures of fluid intelligence of older adults". *Structural Equation Modeling*, 4: 283-319.
- Rice, Marnie E. and Grant T. Harris.** 1997. "Cross-validation and extension of the Violence Risk Appraisal Guide for child molesters and rapists". *Law and Human Behavior*, 21: 231-241.
- Roeder, Kathryn, Kevin G. Lynch and Daniel S. Nagin.** 1999. "Modeling uncertainty in latent class membership: A case study in criminology". *Journal of the American Statistical Association*, 94: 766-776.
- Sabourin, David.** 1986. *Validation of Manitoba Probation Risk Assessment Scale*. Winnipeg: Community and Youth Corrections.
- Sampson, Robert J. and John H. Laub.** 2003. "Life-course desisters? Trajectories of crime among delinquent boys followed to age 70". *Criminology*, 41: 555-592.
- Schaffer, Cindy M., Hanno Petras, Nicholas Ialongo, Jeanne Poduska and Sheppard Kellam.** 2003. "Modeling growth in boys' aggressive behavior across elementary school: Links to later criminal involvement, conduct disorder, and antisocial personality disorder". *Developmental Psychology*, 39: 1020-1035.
- Schwartz, Gideon.** 1978. "Estimating the dimension of a model". *The Annals of Statistics*, 6: 461-464.
- Skilling, Tracey A., Vernon L. Quinsey and Wendy M. Craig.** 2001. "Evidence of a taxon underlying serious antisocial behavior in boys". *Criminal Justice and Behavior*, 28: 450-470.
- Simons-Morton, Bruce and Rusan S. Chen.** 2006. "Overtime relationships between early adolescent and peer substance use". *Addictive Behavior*, 31: 1211-1223.
- Smith, Paula, Claire Goggin and Paul Gendreau.** 2002. *The Effects of Prison Sentences and Intermediate Sanctions on Recidivism: General Effects and Individual Differences*. (Research Report No. 2002-01). Ottawa: Public Safety Canada.
- Stattin, Håkan and David Magnusson.** 1991. "Stability and change in criminal behaviour up to age 30". *The British Journal of Criminology*, 31: 327-346.
- Steiger, James H. and John C. Lind.** 1980. *Statistically based tests for the number of common factors*. Presented at the Psychometric Society, Iowa City, IA.
- Tolan, Patrick H. and Deborah Gorman-Smith.** 1998. "Development of serious and violent offending careers". In R. Loeber & D. P. Farrington (Eds.), *Serious and Violent Juvenile Offenders: Risk Factors and Successful Interventions* (pp. 68-85). Thousand Oaks, CA: Sage.
- Tremblay, Richard E., Louise C. Masse, Frank Vitaro and Patricia L. Dobkin.** 1995. "The impact of friends' deviant behavior on early onset of delinquency: Longitudinal data from 6 to 13 years of age". *Development and Psychopathology*, 7: 649-661.

Tucker, Ledyard R. and Charles Lewis. 1973. "A reliability coefficient for maximum likelihood factor analysis". *Psychometrika*, 38: 1-10.

Vincent, Gina M., Michael J. Vitacco, Thomas Grisso and Raymond R. Corrado. 2003. "Subtypes of adolescent offenders: Affective traits and antisocial behavior patterns". *Behavioral Sciences and the Law*, 21: 695-712.

von Hirsch, Andrew, Anthony E. Bottoms, Elizabeth Burney and Per-Olof Wikström. 1999. *Criminal Deterrence and Sentence Severity: An Analysis of Recent Research*. Hart, Oxford, UK.

Wiesner, Margit and Deborah M. Capaldi. 2003. "Relations of childhood and adolescent factors to offending trajectories of young men". *Journal of Research in Crime and Delinquency*, 40: 231-262.

Wiesner, Margit and Rainer K. Silbereisen. 2003. "Trajectories of delinquent behaviour in adolescence and their covariates: Relations with initial and time-averaged factors". *Journal of Adolescence*, 26: 753-771.

Wiesner, Margit and M. Windle. 2004. "Assessing covariates of adolescent delinquency trajectories: A latent growth mixture modeling approach". *Journal of Youth and Adolescence*, 33: 431-442.



End Notes

1. One primary alternative to semi-parametric group-based modeling is grouping based on subjective classification rules. Using this latter analytical strategy, individuals are sorted into groups based on certain classification criteria (e.g., placing individuals who are one standard deviation above the mean in four of five assessment periods into a chronic high group). However, because they do not allow researchers to formally test whether the groups exist within a given population, a priori taxonomies are more susceptible to misclassification error (Nagin, 1999) and may overlook other naturally occurring subgroups of offenders (Wiesner & Capaldi, 2003). Furthermore, such classification schemes do not provide a metric that is equivalent to the posterior probability of group membership in mixture modeling, and as such do not provide any way to assess how well an individual fits in a group. Nagin and Tremblay (2005) recently noted that trajectory group-based definitions identify a substantively far more interesting and distinctive group than static, subjective definitions. Moreover, there are some suggestions in the literature that it is better to simultaneously model the latent classes and the structural equation modeling relations than to use alternative methods that analyze the data successively (e.g., Jedidi et al., 1997).
2. When the sample was selected, young offenders were defined by the Young Offender Act (YOA; 1984) as between the ages of 12 to 17 years. However, to account for delays between the actual date of occurrence and date of conviction for the index offence, the cut-off age for inclusion in the study was set at 19 rather than 17.
3. The original Wisconsin instrument (Baird, Heinz and Bemus 1979) consisted of 11 risk items and 12 needs items summated to yield two separate total scores that placed the offenders into either a low, medium or high risk and needs category, respectively. A study investigating the predictive validity of the risk and need measures yielded mixed findings, pointing out to weaknesses for their use with young offenders (Sabourin 1986). Following Sabourin's (1986) evaluation, some revisions were brought about to both the adult and youth version of the scales. Despite these modifications, a second study (Barkwell 1991) on the revised risk and needs instruments still revealed limitations with the youth version. In light of these studies, Bonta and his colleagues (Bonta, Parkinson, Pang et al. 1994) undertook a set of studies to examine the psychometric properties and predictive validity of the scales. The findings from their evaluation suggested a number of modifications, which included the removal of items that showed no predictive validity, the simplification of many of the scoring rules, and combining the risk and needs items into one scale rather than two individual assessments. It is the youth version of the classification instrument that resulted from these modifications that was used in the present study as it demonstrated improved predictive validity among young probationers (Bonta, Parkinson, Barkwell and Wallace-Capretta 1994). We called this instrument the Primary Risk Assessment – Version 1 (PRA – V1, 1994; the instrument was further revised for youths in the late 1990s with considerably more items added).
4. The sample selection was originally designed so that 100 offenders came from each cohort year. However, nine cases from the later years were dropped from the study as they represented recidivist offenders who were already in the database for a previous probation term (i.e., duplicates). Moreover, four offenders were excluded from the initial sample due to their age (age 20 years or more), reducing the sample size to 587 offenders.
5. Six Manitoba criminal history records were, however, discarded for having no entries but just names, allowing coding of the criminal careers for an additional 32 juvenile probationers for whom the RCMP had no record.
6. The overall attrition rate due to missing data or incomplete/unavailable recidivism information was 12.4% (73/587), which seems reasonable for a longitudinal study conducted on an offender population. Preliminary analyses comparing the present sample (N = 514) to the group of juvenile offenders who were excluded from the study due to incompleteness/unavailability of recidivism data (n = 73) revealed a slight systematic attrition effect such that the offenders excluded from the study were less likely to follow a violent and persistent criminal pathway than those included in the study. Although the two groups were similar on most of the personal-social and demographic variables (e.g., age, educational level, substance use problems), the offenders who were included in the study were significantly more likely to be male, Aboriginal and to have higher risk/needs PRA – V1 scores.
7. The natural log of, rather than the raw, scores were used to augment the influence of actual outcome ratings (or reduce the influence of the time-at-risk indicator). By taking the natural log of the number of months, however, offenders' scores for whom time-at-risk equalled one month during a particular assessment period were treated as missing values. It should also be noted that the follow-up period during the last wave of assessment was greater than 60 months for approximately 80 offenders, roughly two-thirds of whom did not commit an offence during that time period. Although the effect is likely minimal, using a natural logarithmic function on those "non-recidivist" offenders would be expected to have a small impact on underestimating their offending frequency/severity scores during that last assessment period.