Prevention of criminal offending: Disentangling the role of education in the pathway from childhood risk factors to adult criminal charges

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Abstract

Prevention of criminal offending: Disentangling the role of education in the pathway from childhood risk factors to adult criminal charges

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Education plays an important role in reducing the probability of criminal offending. Although research has shown that having more education is associated with reduced criminalization, very few studies have examined whether education plays an intervening or protective role from childhood risk factors to criminal charges in adulthood. This dissertation was designed to examine two main questions in a series of two studies: 1) Does education intervene and/or protect against childhood risk factors in the pathway to criminal offending? 2) Which of the childhood risk and protective factors contribute to the vital roles education plays in the pathway to criminalization?

In both Studies 1 and 2, childhood aggression, withdrawal, and likeability, neighborhood disadvantage, and years of education were examined as predictors of criminal charges in adulthood, within mediational models. In Study 2, academic achievement, and school absences were added as mediators. In Study 1, we found that higher childhood aggression and neighborhood disadvantage were associated with fewer years of education, which in turn was associated with an increased probability of criminal charges. Additionally, the participants at highest risk were those who had high childhood aggression and less education. There was a unique protective effect for some of the participants, such that those with high childhood aggression but more years of education had a reduced probability of criminal charges.

Study 2 investigated the effects of academic achievement and school absences on the relations between variables observed in Study 1. We observed that aggression contributed to achievement but not absences, whereas being liked by others contributed to both. Achievement and absences in turn predicted years of education which then predicted criminal charges. Achievement was moderated by gender such that males who were high achieving had reduced criminal charges. Absences were a risk factor for both males and females, but the highest risk was for males with high absences. Results from this dissertation highlight the importance of

examining education in the trajectory to criminal offending. By understanding the factors that contribute to education, its protective effects can be utilized to help the most at risk children avoid a trajectory towards criminalization.

Acknowledgments

For my fur-babies, my family, and my friends

From the beginning, I knew I wanted to answer some complex questions about youth characteristics and criminality. However, at the time I was unsure as to how I was going to do this. It has been a struggle since the first poster I made for the CRDH conference day to now when I am preparing to present my doctoral dissertation. I could not have done this alone. These are the people/creatures that have helped me above and beyond what was needed.

There were a lot of people that have gone in and out of my life in the last four years. This journey has been a tough one, with many very large life changes. Throughout the process, close friends and my family have stuck with me and saw it through. You know who you are, and you are all important to me. My dog, Zooey, is also a creature I would like to thank. She has provided the consistent emotional support I have needed throughout this journey. I appreciate her presence as my fur-baby, and I am so thankful to have her in my life. Recently, I added two more fur-babies to my family and they too have provided great support, and entertainment, especially during some of the tougher situations life has brought me.

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Contribution of Authors

Kathleen Kennedy-Turner developed the research questions and hypotheses for the dissertation. She performed all the statistical analyses, interpreted all the results, and wrote and edited all the chapters. Dr. Lisa A. Serbin and Dr. Dale M. Stack contributed to the data collection and design within the larger Concordia Longitudinal Research Project, where the data for this dissertation was obtained. As the supervisors of Kathleen Kennedy-Turner, they provided comments, feedback, and guidance throughout the course of the dissertation. They also both read revised versions of the dissertation manuscripts.

Table of Contents

List of Tables

Chapter 3

Appendix

Chapter 5

List of Figures

Chapter 1: General Introduction

Risk factors for crime are numerous. They extend beyond the individual and can include family background and environment as well as the neighborhood and peers that surround the child. Some of the well-established risk factors for adult criminal offending are aggression in childhood, having a teenage mother, having parents or grandparents involved in crime, living in a disadvantaged neighborhood, family dissolution, and having low educational attainment (Besemer, 2014; Huesmann et al., 2002; Kendler et al., 2015; Kennedy-Turner et al., 2020; Loeber & Farrington, 2001; Pratt & Cullen, 2005; Skardhamer, 2009; Sourander et al., 2006; Sourander et al., 2007). Although risk factors such as aggression and low educational attainment have been associated with later criminality, it is equally important to examine factors that may protect an at-risk child (i.e. a child with multiple environment and psychological risk factors) Extant research examining protective effects against poor outcomes have included characteristics such as being liked by others, having both parents present, opportunities for prosocial involvement, cognitive abilities, higher social class, and others (Biggar et al., 2016; Dodgeon et al., 2020; Martin-Storey et al., 2011; Stack et al., 2015; Serbin et al., 2011; Temcheff et al., 2011). In addition to likeability, there are other variables that are rarely examined as protective factors. For example, education is traditionally used as a control variable when establishing factors that contribute to crime. There is a paucity of research that examines education as a variable that could mediate or moderate the relations between established risk factors, protective factors, and crime. Further, the contribution of these individual and environmental factors to education will undoubtedly have an impact on criminalization. The goal of the current dissertation studies was to examine education in this unique capacity (i.e. as potentially part of a longitudinal process, rather than a control variable), while also examining the contribution of other risk and protective factors to educational attainment in the context of criminal offending.

Conceptual framework

Developmental model of risk

Given the complex relations between childhood risk factors and the development of criminalization in adulthood, it is important to understand why these factors can have such far reaching effects. There are several theories from both psychology and criminology that take developmental approaches. However, these models tend to focus on macro level (environmental)

factors or on micro level (individual) factors, and rarely the two together. To have a complete picture of the development of criminalization, it is imperative to combine both. In the developmental model of risk, theories from developmental psychology and from criminology are combined to provide an overarching framework for understanding the influence of risk and protective factors on the trajectory to offending in adulthood.

Ecological Systems Theory

Several factors in the surrounding environment and at the individual level can affect the child. Bronfenbrenner's (1979) ecological systems theory describes these influences in terms of their effect on behaviour development. This theory underwent several phases and changes across time. In the final phase, the model was called the *Bioecological model of Human Development*. Across the phases, Bronfenbrenner maintained the general core of his original concept but clarified important aspects (e.g. human as a complex biopsychological individual) (Rosa & Tudge, 2013). In the initial phases of the model, Bronfenbrenner describes different systems. The microsystem is outside the individual child and includes the neighborhood, school, and family members. These factors can contribute to risk later in life (Bronfenbrenner, 1979; Bronfenbrenner & Morris, 2006). The mesosystem is the interaction between the systems which can also influence the child. For example, the neighborhood may interact with other factors such as the child's peer choice or the child's own characteristics to affect the child's development. The chronosystem became clarified in the later phases and incorporates time as a key factor in human development. In the last phase, the main concepts included Process-Person-Context-Time (PPCT), where these interacted with each other and are not additive in their influence (Rosa & Tudge, 2013). These interconnected systems can also affect the child in terms of criminal outcomes.

Criminological theories

In criminology, the microsystem factors are referred to as macro factors. These factors, like those in Bronfenbrenner's theory, include the neighborhood and other non-individual factors, such as family socioeconomic status (Pratt & Cullen, 2005). Macro-level criminology theories seek to explain why crime outcomes differ based on non-individual factors. For example, living in poor neighborhoods is a macro level influence that contributes to an increased probability of criminal offending (Kohen et al., 2008). Sampson and Laub (1993) take this one step further, acknowledging that environmental influences change with age. In their age-grade

theory of informal social control, Sampson and Laub (1993) suggest that crime has a negative association with attachment to macro-level structures such as the school environment. They theorize that these influences change in importance with time to affect the probabilities of criminal offending in adulthood. For example, Sampson and Laub (1993) describe how despite early risks in childhood, attachment to informal social controls (e.g. education, employment) in adulthood can alter the probabilities of criminal offending. Further, macro-level theories acknowledge that other non-macro factors (i.e. individual characteristics) also interact with macro factors across time.

The theories of Bronfenbrenner's (1979) ecological systems, criminological theories, and Sampson's and Laub's (1993) informal social bonds, provide a strong framework for understanding the contribution of external factors across the lifespan that affect the probabilities of criminal offending.

Combining environmental and individual level factors

In addition to proposing explanations for environmental level influences, these theories acknowledge the contribution of individual factors and even the interaction between environmental factors and individual factors (Agnew, 1992; Bronfenbrenner, 1979; Loeber & Farrington, 2001; Pyle et al., 2016; Wasserman et al., 2003). Further, macro factors may directly affect the child in terms of their own individual characteristics (Martin-Storey et al., 2013; Serbin & Karp, 2004; van Oort et al., 2011). For example, in a recent meta-analysis, researchers identified that neighborhood disadvantage was significantly and positively associated with childhood aggression (Chang et al., 2016).

These results give evidence of the dynamic systems of factors and characteristics that influence children and their subsequent behaviour in adulthood. Examining both individual and environmental factors, as well as their interactions across the life-course is the goal of the *Developmental Model of Risk* (see Figure 1 for a depiction of this theoretical developmental model). Taking a combined developmental psychology and criminology approach with this theoretical developmental model will provide a guiding framework to elucidate the mechanisms in the trajectory to criminal offending. Risk and protective factors for criminal charges within this model include neighborhood disadvantage, aggression, social withdrawal, school absences, likeability, educational attainment, mental health diagnosis, absences, and academic

achievement. Examining the influence of these factors will contribute to a more comprehensive understanding of the development of crime.

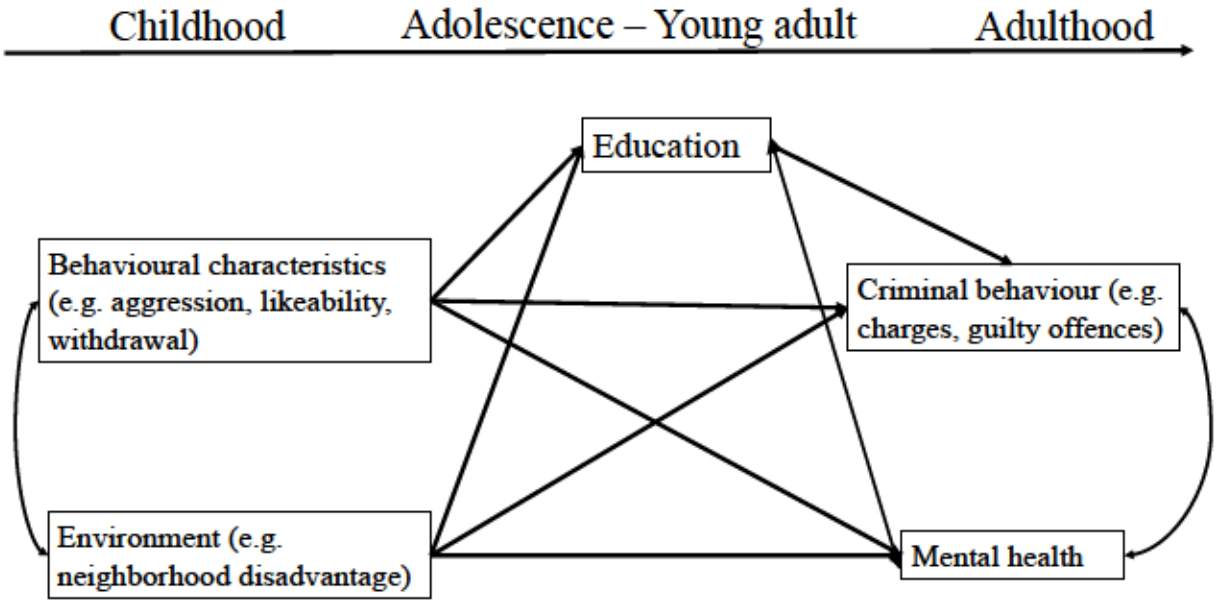
Risk factors for crime

Neighborhood disadvantage

Disadvantage in the neighbourhood has a relation with crime such that the higher the disadvantage, the more crimes one is likely to commit (Pratt & Cullen, 2005). For example, a moving voucher study, where participants were given the opportunity to move to a more affluent neighborhood, showed a reduction in probability of criminal offending when participants moved to a better neighborhood (Kling et al., 2005).

Figure 1

Theoretical developmental model



Note. Adapted from Kennedy-Turner, K., Serbin, L.A., Stack, D.M., Dickson, D.J., Ledingham, J.E. & Schwartzman, A.E. (2020). Prevention of Criminal Offending: The Intervening and Protective Effects of Education for Aggressive Youth. The British Journal of Criminology, 60(3), 537–558. https://doi.org/10.1093/bjc/azz053

Risk factors in the environment (macro factors) can also affect the child directly and contribute to problems later in adulthood. More explicitly, the neighborhood can influence the child directly such that it affects later mental health problems. For example, Martin-Storey and colleagues (2013), demonstrated that neighborhood SES was associated with alcoholism later in adulthood. Although, alcoholism is not a crime, this research speaks to the direct influence macro factors contribute to child development (Martin-Storey et al., 2013). Furthermore, neighborhood disadvantage may affect the child's ability to achieve positively valued goals (e.g. higher education), or monetary goals, therefore indirectly increasing the probability of criminal offending (Agnew, 1992; Baron, 2006; Eitle & McNulty-Eitle, 2016; Merton, 1938).

Aggression

Individual characteristics can affect the probability of committing a crime later in adulthood. Aggression in childhood is one such individual factor, and is defined as a child or adolescent who causes harm (verbal, emotional, and physical) to others, including other people and animals (Alink, et al., 2006). Researchers have found that aggressive behavior in childhood can lead to poor outcomes such as depression, abuse of drugs, and alcohol later in life (Martin-Storey et al., 2011; Moore at al., 2014). More specifically, Martin-Story and colleagues (2011) examined childhood aggressive behavior and its association with later substance abuse in 676 participants from the Concordia Longitudinal Research project. They found that higher levels of peer perceptions of aggression were associated with drug and alcohol abuse in mid-adulthood. Similarly, Moore and colleagues (2014) examined aggression towards peers and this influence on poor outcomes later in life. These researchers found that in their sample of 1590 that those whom perpetuated aggression were at risk for depression and alcohol abuse.

It has also been established that higher aggression in childhood is linked to crimes later in life, especially violent crimes (Andershed et al., 2016; Farrington, 1991; Huesmann et al., 2002; Kennedy-Turner et al., 2020; Loeber & Dishion, 1983). Aggression in childhood can be a robust predictor for later criminality. Although aggression seems to be an obvious characteristic in terms of crime, especially violent crime, there are also other individual characteristics that should be examined in the context of criminality in adulthood.

Social withdrawal

Aggression is a very overt behaviour observed in childhood. However, social withdrawal in childhood could have numerous long term effects. Socially withdrawn children are

characterized by spending time alone and shyness. Social withdrawal in childhood can be considered a less troubling characteristic as it usually results in the child being alone and having fewer friends, which are not overt behaviors warranting attention (Rubin et al., 2009). However, there can be negative effects of being socially withdrawn. For example, social withdrawal has been associated with difficulties in school, such as poor peer and teacher relationships, and lower academic achievement (Rubin et al., 2009; Rubin et al., 2002; Serbin et al., 2011).

Although social withdrawal may be a risk factor for some children, it is also possible that it may serve as a protective characteristic in the context of low family SES, especially for males. For example, Martin-Storey and colleagues (2013) found that social withdrawal was a protective factor for males against substance use. Specifically, higher social withdrawal in males was associated with a reduction in probability of having a history of drug abuse (Martin-Storey et al., 2013). Additionally, Jolliffe and colleagues (2016) found that social withdrawal among children who repeated a grade was protective in reducing violence later in life. There is a paucity of research examining how social withdrawal may affect criminality in adulthood, and the role it may play (risk or protective) is unclear.

Both social withdrawal and aggression may be considered individual level risk factors for crime in adulthood. Social withdrawal may be a risk factor, but possibly less consistently than factors such as aggression. This could be due to gender differences in the risk associated with withdrawal (Martin-Storey et al., 2013).

Relatedly, poor mental health is associated with lower educational and criminal outcomes among males and females. It has been shown that there are higher incidences of mental health problems among incarcerated individuals (Fazel & Seewald, 2012). Further the gender gap is especially important in the association among mental health and criminalization. Specifically, young female offenders with mental health problems are more likely to be incarcerated later in life (Caufmann, 2008). Although the factors listed above are important factors there are several other ones that contribute to criminalization. For example, lower intelligence, chronic absenteeism, and having parents with criminal charges increase the probability of a criminal charge in later life (Besemer, 2014; DfEE & Home Office, 2001; Huesmann et al., 2002).

There has been a heavy focus in the extant literature on the risk factors for crime, with very little focus on protective factors in terms of childhood characteristics and environmental

factors. Examining the effects of protective factors is also imperative in understanding the development of criminalization.

Protective factors against crime

Likeability

Certain aspects of childhood characteristics can also exhibit protective effects. For example, likeability has been shown to be a positive influence on development (Anthonysamy & Simmer-Gembeck, 2007; Martin-Storey et al., 2013; Véronneau et al., 2015). Researchers studying "likeability" have focused on characteristics such as being outgoing, liked by many, and those who help others (Pekarik at al., 1976). Being likeable may also serve as a protective factor for an at-risk child. For example, Martin-Storey and colleagues (2013) found that girls who were rated as likeable by peers in childhood were less likely to abuse alcohol in adulthood. Being likeable might also be protective against other risk factors such as social withdrawal, aggression (Anthonysamy & Simmer-Gembeck, 2007), and low socioeconomic status (Véronneau et al., 2015).

In addition, likeability may have an interesting protective effect in terms of increasing attachment to informal social controls such as the educational environment. Véronneau and colleagues (2015) found that being rated as more likeable by peers in childhood was associated with higher educational attainment later in life. To summarize, being liked by others protects against a variety of negative outcomes, but the direct and indirect role that likeability might play in the development of criminal offending is unclear.

Education

There is a well-established link between number of years of education and the probability of committing a crime in adulthood. Current empirical literature confirms that the more education a person attains, the less likely they are to commit crimes (Ford & Shroeder, 2011; Lochner & Moretti, 2004; Machin et al., 2011; Meghir et al., 2012; Sabates, 2008). Age-graded informal social control theory (Sampson & Laub, 1993) can help clarify how education may play a role in criminalization. School attachment is considered an important informal social bond that allows the child to develop positively. Sampson and Laub (1993) argue that children develop bonds to school through school performance, providing a negative association with crime. This can even curb the effects of childhood risk if the informal social bond is maintained into adulthood. The stronger the informal social bond to the school system, the less likely the child is

to commit crime later in life. The mechanism through which education reduces criminalization might be through attachment to school. Given the inverse relationship between educational attainment and crime, researchers examining risk factors in childhood for crimes later in adulthood, typically control for education (e.g., Andershed et al., 2016). What this means is that the effects of education are co-varied out and are not necessarily considered as a potential main effect within the design of analyses. In addition, education is often included in measures of SES as part of a composite variable, which is also used as a control variable. However, these two practices could be masking the contribution of educational attainment to later criminal outcomes in the context of other risk factors. Average educational attainment has also been shown to be different for boys and girls, especially in the secondary schooling years, where girls tend to attain more years of education (Kingdon et al., 2017). This may play a role in gender differences observed in poor outcomes such as low educational attainment and criminal offending. By not examining education as a main effect, the researcher is also neglecting these gender differences, as well as the contribution of education to criminal outcomes. Further, factors contributing to crime are also likely contributing to attachment to school and therefore educational attainment. Including education as well as the factors that contribute to educational attainment in models predicting criminal offending will provide a more comprehensive picture for understanding developmental processes leading to criminalization.

Contributors to education

Several of the risk and protective factors for crime already discussed above are also factors that contribute to educational attainment (Chesters, 2019; Huesmann et al., 2009; Ronda et al., 2019) For example, aggression and neighborhood disadvantage have been negatively associated with educational attainment (Chesters, 2019; Huesmann et al., 2009). Recently, social withdrawal has also been observed as a moderator of educational attainment in the context of low parental occupational prestige. More specifically, children who were approximately two standard deviations above the mean of social withdrawal were affected by their parent's low occupational status, such that their educational attainment was lower than their low withdrawal counter parts (Véronneau et al., 2015).

Absences from school

In addition to the risk factors presented already, absences from school can also be problematic in terms of educational attainment. A child may be frequently absent from school for

a wide variety of reasons, including poor physical or mental health, behavioral problems, and others (Garcia & Weiss, 2018; Ready 2010). Being frequently absent due to behavioral problems, including aggressive behaviour, is known as truancy. Truancy has been associated with poor educational attainment (Garcia & Weiss, 2018), adolescent delinquency and subsequent adult criminalization (DfEE & Home Office, 2001). Although in many cases absences might be for multiple reasons and not necessarily related to delinquency, frequent absence from school may disrupt attachment and loosen informal social bonds between the child and their school environment (Sampson & Laub, 1993). In this way, frequent school absence may indirectly increase the risk of criminal offending. There are risk factors discussed above that also contribute to frequent absences, including aggression and neighborhood disadvantage. Children who are aggressive towards peers and popular too are more likely to be absent more often (Schwartz et al., 2006). Similarly, those living in disadvantaged neighborhoods are more likely to be more frequently absent (Garcia & Weiss, 2018).

As discussed above, protective factors for educational attainment include being liked by others, where children who are more likeable are more likely to complete their high school degree or higher (Lleras, 2008; Véronneau et al., 2015). Additionally, there are strong predictors of educational attainment linked to intellectual ability and academic learning, including IQ, tests of specific cognitive abilities, and academic achievement scores.

Achievement

As mentioned earlier, certain abilities (e.g. higher intelligence) are often found to be associated with positive outcomes such as higher educational attainment (Ou et al., 2007; Véronneau et al., 2015). Academic achievement scores are obtained from standardized tests in specific subjects, typically including language arts and mathematics, that are normed and standardized by subject and grade level. Though these are not standardized intelligence tests (i.e. WISC or WIAT tests) they are correlated with IQ, and other tests of cognitive ability, and are strong predictors of both school evaluations (e.g. report card marks) and subsequent educational outcomes (Ou et al., 2007; Véronneau et al., 2015).

Because higher academic achievement has been associated with both higher educational attainment and reduced probability of criminal offending (Andershed et al., 2016), it may be an important pathway in the developmental sequence between childhood risk variables (e.g. aggression, neighbourhood disadvantage), educational attainment, and criminal outcomes. For

example, aggression has been associated with poor academic achievement (Stipek & Miles, 2008), while likeability has been associated with better academic achievement (Bukowski et al., 2019). This is consistent with the theory proposed by Sampson and Laub (1993) that increased attachment to school performance might be associated with higher attainment and ultimately less criminal offending. Being liked by others might increase attachment to school via academic achievement. Further, including achievement within models predicting criminal outcomes is important to control for possible confounding of the link between aggressive behavior and poor school performance, both of which are correlated with lower cognitive abilities and specific academic skills.

Taken together, environmental and individual factors can have long reaching effects into adulthood. The *Developmental Model of Risk* combines developmental psychology theories and criminology theories providing a framework in which to examine the developmental process from childhood to adult criminal offending. This includes examining environmental and individual factors in childhood, the influence of these factors directly onto crime, and their influence on education as an indirect pathway towards adult outcomes. In this dissertation, these childhood factors and their complex processes and interactions were investigated by examining their effects on educational attainment, and subsequently the development of criminalization in adulthood.

Current Dissertation: Research Questions and Hypotheses

There is abundant literature on risk factors that contribute to criminal offending. There is also a consensus that education plays a positive role in reducing this probability. However, there are gaps that remain in the literature. The main goal of this dissertation was to look beyond specific risk factors relating to the individual or the environment in order to combine both individual and environmental influences that would have both risk and protective effects via developmental processes. By including both risk and protective effects in the same model, a more comprehensive picture of the development of crime could be provided. Such a step addresses a major gap in the literature, where researchers typically focus on risk or protective factors and rarely both.

In addition, most research isolating either the risk or protective effects of childhood experiences and characteristics on criminal outcomes in adulthood tend to include education as a control variable. Given the theories that were integrated presented in the *Developmental Model*

of Risk, it is imperative to examine the effects of education from an intervening and protective point of view, rather than just parsing out its effects via statistical control. Another gap in the literature is examining the developmental process from childhood characteristics and environments to criminal offending while including variables that may foster informal social bonding to educational systems. Risk and protective factors will affect the probability of criminal offending directly but also indirectly through their effects on educational attainment. This dissertation with its two studies is one of very few investigations that attempt to capture these effects in a comprehensive developmental model. The studies in this dissertation addressed two main questions. Study 1 sought to answer the question: "*Does education intervene and/or protect against childhood risk factors in the pathway to criminalization?*" and Study 2 addressed the question "*Which of the childhood risk and protective factors contribute to the vital roles education plays in the pathway to criminalization?*". We hypothesized that education would play an intervening and protective role in the pathway from environmental and behavioral childhood risk factors to criminal offending. Further, we hypothesized that education would be affected by an array of factors including, neighborhood disadvantage, aggression, likeability, withdrawal, achievement, and absences. These factors were also expected to exert a longitudinal effect on the outcome of criminal charges either directly or indirectly through their effects on education.

Concordia Longitudinal Research Project

The data for this dissertation were collected by the Concordia Longitudinal Research Project (Concordia Project: Hastings et al., 2019; Schwartzman et al., 1985). This project started in 1976, in Montreal, Quebec, Canada. The participants were recruited from schools in disadvantaged Montreal neighborhoods. The goal of this project was to examine questions related to psychosocial risk for psychopathology and subsequently, the intergenerational transfer of risk. The participants were recruited from grades 1,4, and 7. The final sample had 4,109 participants, with a subsample of 1769 who were selected for more intensive, periodic follow up based on peer ratings of problem behavior at the time the sample was identified. The initial selection was done using the Pupil Evaluation Inventory (Pekarik et al., 1976). This is a peer nomination survey that yields 3 factors: aggression, withdrawal, and likeability. The total nominations for each participant were added up and standardized within gender and within class. The subsample of 1769 participants made up three classifications. The aggressive classification was for children that scored in the 95th percentile on the aggressive factor and below the 75th

percentile of withdrawal. The withdrawn classification was those that scored in the 95th percentile on withdrawal and below the 75th percentile on aggression. The third classification was designated as aggressive-withdrawn and were those that scored at or above the 75th percentile on both aggression and withdrawal. There were also those that did not score high on either aggression or withdrawal and were included in the full sample ($N = 4,109$) The subsample of high-risk (the three classifications mentioned above) individuals was followed for over 30 years with in-depth interviews and testing. Government educational, health, and criminal data were obtained for all participants from the original sample of 4,109. Most of the original sample was used in Study 1 of this dissertation. For Study 2, only the subset of participants involved in follow-ups were used as records of achievement and absences records were only available for that sample.

The children in the original Concordia Project sample might be at risk for later poor outcomes due to a number of reasons. Several publications from this project have demonstrated that living in disadvantaged neighborhoods and being aggressive in childhood, has far reaching effects into adulthood (see Stack et al., 2015, Serbin & Karp, 2004). This rich dataset allowed for complex statistical modelling of criminal outcomes that have relatively low frequency within community-based samples.

Rare outcomes can be challenging to predict and analyze. Very few large-scale longitudinal studies exist using objective criminal records. In the Concordia Project dataset, there were only about 800 people with at least one charge, out of the 4,109 original participants. At about 20% of the sample, the number of people with a charge is higher than the general population of Quebec. This is likely due to the participants being originally recruited from disadvantaged neighborhoods. The high percentage of participants with a criminal charge in the Concordia Project sample allowed us to model mediation and moderation, while still working with a naturally zero-inflated outcome. That is, it is important to acknowledge that crime outcomes are typically mostly "zeros" in that most of the sample will not have a charge. This is to be expected because most populations show a zero-inflated distribution of crime. This richness of this dataset, as well as complex modelling tools allowed us to keep the distribution of charges in its natural state (i.e. a community sample, with a low frequency, zero-inflated distribution). In this way, the use of the Concordia Project dataset permitted a comprehensive investigation

examining risk and protective factors for education and criminal charges within a developmental model.

Overview

The current dissertation includes two studies addressing the main research questions mentioned above. Before presenting the studies, Chapter 2 gives a more in-depth overview of the causal mediation method used in Study 1 (Chapter 3) and the rationale and limitations of its use. In Chapter 3, Study 1 is presented, which involved the use of causal mediation based on counterfactuals (see Chapter 2), allowing for the use of mediation and moderation analyses with a rare (i.e. low frequency) outcome. Study 1 addressed the issue of whether education played an intervening role, and whether it was moderated by childhood aggression or neighborhood disadvantage (See Figure 1, in Study 1, for the theoretical developmental model). Years of education was used as the mediating variable. Criminal charges were coded as a binary outcome (1=had a charge in that category, 0=did not have a charge) which allowed us to interpret probabilities of having a criminal outcome by using odds ratios (see Chapter 2). Mental health and age at the time of the original assessment with the PEI were included in the models as control variables.

Study 2 (Chapter 5) sought to expand Study 1 by including factors particularly salient to educational attainment. Specifically, in Study 2 we added school absences and academic achievement to the model observed in Study 1. We also examined the effects of likeability and withdrawal on education and on achievement and absences, within a smaller subsample of the Concordia Project for whom these childhood measures were available. This allowed a more comprehensive understanding of what might be protective about education, while also accounting for the potential confounding effect of academic achievement (i.e. specific skills and related cognitive abilities) on both educational and criminal outcomes. Study 2 included criminal charges as a count variable, so that variability could be maintained in the outcome, especially given the reduced sample size. The outcome was still zero-inflated and therefore needed robust models to account for this distribution.

Combined, the design and results from these studies provide more detailed information pertaining to the role of education in the trajectory to criminal offending. Researchers examining risk factors for crime are often "controlling" for education. This is because it is well known that higher education results in a lower probability of criminal charges. There are several reasons

why that might be, but the current studies sought to give a more comprehensive overview of the influence of childhood risk and protective factors in the trajectories through education and other factors to criminalization. These studies were intended lay the groundwork for future research that seeks to include education as an intervening or protective factor. Going forward these studies could be expanded upon to incorporate other elements of the childhood environment, including built environmental data (e.g. lighting, green space) as well as family environment and parental behavioral influences. Furthermore, these studies were intended to provide a starting point for incorporating other mechanisms (including biological) in the trajectory to poor outcomes in adulthood. Ultimately, this research may help to inform policy aiming to reduce crime rates via early preventive intervention, as well as policies designed to keep children in school and prevent drop out.

Chapter 2: Keeping the zeros as zeros: Causal mediation based on counterfactuals

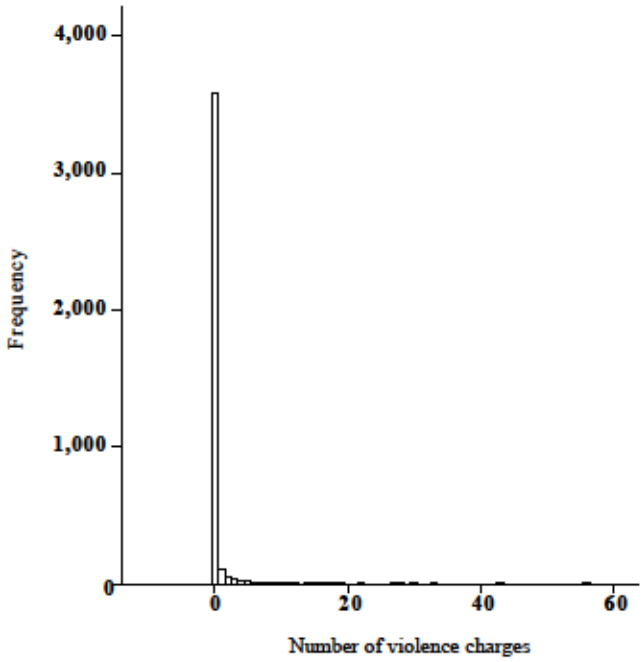
To be able to better understand the design of Study 1, its statistical analysis merits some preliminary explanation. This chapter will focus on the technique of causal mediation based on counterfactuals and the rationale for using it with observational data.

One of the main goals of psychological science is to infer causation. However, methods designed to estimate causal inference within non-experimental designs are largely neglected in the social sciences and attempts to do so are often avoided by psychology researchers because of the strict assumptions. Causal inference has its roots in philosophy and has been expanded and developed in math and statistics but is rarely used in the social sciences (Pearl, 2009). This could be because the assumptions seem impossible to meet, unless the methods involve strict experimental paradigms. However, despite these strict assumptions, which will be reviewed below, researchers across many domains, including psychology and epidemiology, are starting to use causal modelling even with non-experimental, observational data (Pearce & Lawlor, 2016). With more rigorous practice and increased understanding of causal models, psychological science is approaching many questions about behaviour from a causal inference perspective.

When beginning analyses for a research question, it is imperative to examine the distribution of the variables. As can be seen from Figure 1 describing the distribution of criminal charges (e.g. violent charges), these distributions are 'zero-inflated'. This means that most participants in the sample do not have a charge. This is what we would expect as an estimate of the general population. In other words, we expect that most of the population are not offenders, and therefore do not have a charge. Despite knowing that this is what we expect from the population, researchers often transform zero-inflated distributions to normalize them. Typically, this is done through a log transformation (Cohen et al., 2003). This can be a feasible option for analysis, but back transforming the results into their original units can often result in convoluted and hard to interpret outcomes, especially in the case when the outcome is rare (O'Hara & Kotze, 2010). Many researchers will do this transformation because statistical techniques that use ordinary least squares (OLS) functions have certain assumptions, one of which is that data points (specifically the residuals) are distributed normally (Atkins & Gallop, 2007). As such, one of the goals in carrying out this dissertation was to maintain the nature and distribution of the data, and to not force it into a normal distribution, as is typically done with criminal data.

Figure 1

Frequency distribution of violence charges



In Study 1, we asked the basic question of what predicts an individual having a criminal charge (y=1) or not (y=0). Leaving the criminal charges in this binary nature facilitates interpretation and keeps the distribution true to the expected population distribution.

There are statistical models that account for zero-inflated distributions (e.g. zero-inflated binomial regression). These types of models use logit links (e.g. log odds of the outcome being 1) Generalized Linear Models (GLMs) and do not require the data to be normally distributed (Agresti, 2002). This model is sufficient for assessing direct effects from exogenous variables (e.g. aggression, neighbourhood disadvantage), but was not adequate given the specific research questions for the present set of studies, which included both mediation and moderation.

Researchers can model mediation with binary outcomes using OLS, however the binary y is estimated as a continuous outcome (Kline, 2015). This can be especially problematic when the binary data is zero-inflated. The product mediation method will overestimate the outcome effect (Kline, 2015). Another problem is that the product mediation method requires the assumption that the exposure variable (predictor) and the mediator do not interact. In other words, although

we could assess one part of the research question using OLS methods, we would run into two problems. First, we would likely overestimate the outcome, given the zero-inflated nature of the data, and second, we would not be able to answer the second part of the research question as it would involve an interaction between childhood predictors (exposure) and educational attainment (mediator). Running the mediation model using OLS would violate two assumptions: first, that the data are normally distributed and second, that the exposure and mediator variables do not interact.

Since the early 2000s there has been significant advancement in casual inference and related statistical modelling. For the research questions in this dissertation, a causal mediation model was the most appropriate. In the causal inference framework, there is a model called *Causal Mediation based on Counterfactuals* (Vansteelandt & VanderWeele, 2012). This model has several strict assumptions which must be met to be able to infer causality (VanderWeele, 2015). However, as a mediation model, it is more liberal than OLS-based models in assumptions about distributions and interactions. It allows for an interaction between the exposure and the mediator and it maintains the binary nature of the outcome, producing odds ratios for direct, indirect, and total effects.

First it is important to define "counterfactuals" and explain why are they important for the model in the current studies. In the book, *Causal Inference in Statistics: A Primer,* Pearl and colleagues (2016) explain a counterfactual by describing reaching a fork in the road after driving home from work. The driver has the choice of the freeway (X=1), or a side road (X=0) which will determine how long it will take to get home. Let us say the driver takes the side road and hits traffic. The driver says to themselves "I should have taken the freeway" or "I wonder how long it would have taken to get home if I took the freeway". Imagining what it would have been like to take the choice that was not chosen is imagining a counterfactual condition. In other words, the condition that was taken is considered the factual condition, while the condition that was not taken (but could have been taken) is considered the counterfactual condition. This condition is often known as the hypothetical condition (Pearl et al., 2016). When a researcher wants to compare two outcomes under the exact same conditions, they are indeed hypothesizing about a counterfactual condition. It assumes that whatever mechanism is behaving in the factual condition might not be the same as in the counterfactual condition. In terms of Study 1, the factual condition would be having a charge while not having a charge would be the

counterfactual condition. Essentially it is asking "I wonder if I would have had a charge if I had a lower aggression score, or more years of education?". Often these counterfactual conditions are used when the exposure variable (X) can be randomly assigned. In other words, if the participants can be randomly assigned to take the freeway (X=1) or the side road (X=0), the counterfactual outcome of how long it would have taken could be modelled. However, as will be demonstrated in Study 1 observational data can also be used, where the model applies the values of 0 and 1 to the exposure variable. We could not randomly assign participants to be more aggressive compared to others. In Study 1 the values of "0" and "1" are meaningful values as they represent the mean of aggression compared to 1 standard deviation above the mean.

Using randomized exposure conditions helps to reduce bias in the model. However, meeting the assumptions while using observational data can also help to avoid bias in the outcome estimates. According to VanderWeele (2015) the four assumptions are:

A1: There are no outcome-exposure confounds

A2: There are no mediator-outcome confounds

A3: There are no exposure-mediator confounds

A4: That none of the mediator-outcome confounds are descendants of the exposure

These four assumptions are expected for the proper estimate of indirect and direct effects in all mediation analyses. Violation of these assumptions can lead to bias in the estimates. Some of these assumptions can be loosened depending on length of time between variables. For example, if the gap between the exposure variable and the mediator is relatively small, then the influence of confounds that are descendants of the exposure have very little impact. However, if a larger gap exists, then there should not be any other variables between the exposure and the mediator that can contribute independently to the outcome. A confound here could impact the "a" path in a mediation model, where a covariate in that path could be responsible for some of the variance in the outcome, resulting in a biased estimate of the direct and indirect effects from the exposure variable. In Study 1, I did not meet the assumptions required for causal inference. This means that the outcome estimates might be biased and possibly higher than would be expected if the unmeasured confounds could be estimated in the model. However, given the robustness of the effects observed, it is unlikely. The causal inference framework makes these assumptions clear while also allowing for exposure-mediator interactions. This ability to interact

the exposure variable and the mediator is something that is not allowed in traditional OLS mediation analysis. In fact, bias is introduced in OLS mediation when the exposure and the mediator interact (Kline, 2015). Causal mediation based on counterfactuals accounts for this bias when decomposing the total effect.

The Total Effect (TE) in these models can be decomposed into the Total Natural Indirect Effect (TNIE) and the Pure Natural Direct Effect (PNDE). The PNDE does not hold the mediator constant. It allows the mediator to vary to be the condition if the exposure was in the counterfactual condition. Another way to think of this is that the PNDE is the effect that would occur if the exposure variable was the factual condition (e.g. aggression = 1), but somehow the effect from the exposure to the mediator was blocked. This is essentially the effect as if the exposure was in the counterfactual (e.g. aggression = 0). The TNIE is the proportion of the total effect explained by the mediation mechanism while allowing the mediator to change (Kline, 2015; Muthén & Asparouhov 2015).

In Study 1, the TNIE and the PNDE were used. I was able to calculate the proportion mediated based on the formula for rare outcomes in VanderWeele (2015). This gave an indication of the degree to which the mediated effect accounted for the total effect. In the cases where total mediation was observed the proportion mediated could not be computed. Despite being able to estimate these effects, causal inference was not possible in Study 1. An attempt was made to account for the mediator-outcome confound: mental health was co-varied with criminal charges. This was not adequate because confounds cannot be descendants of the exposure variable. In this work, almost all confounds are predicted by aggression or neighborhood disadvantage, making causal inference under these assumptions impossible. Relaxing the assumptions has been discussed, however the best way to deal with unmeasured confounds is to run a sensitivity analysis (VanderWeele, 2010) which yields a threshold in which unmeasured confounds would need to exist to disrupt the observed effects. In Study 1, the observed effects were quite robust, and it is unlikely that unmeasured confounds would reduce the effects to zero.

To summarize, the problem of transforming naturally occurring zeros is that it neglects effects that cannot be observed using methods that assume continuous normally distributed outcomes. Finding an alternative method was a major goal of the dissertation. I wanted to keep the outcome zero-inflated because, we expected that most of the study's population would not have a criminal charge. Applying causal mediation based on counterfactuals is not typically done

using observational outcomes, as was done in Study 1. This is due to the strict assumptions that are required for causal inference. However, psychologists should not be afraid of making use of causal inference methods despite the strong assumptions. Instead, sensitivity analyses and measuring confounds in the study can satisfy those requirements. Further, this method allows for the mediator and the exposure variable to interact. This is a particularly salient point for psychology researchers because nearly all exposure variables interact with mediators in their studies. Violating these assumptions makes using OLS methods inadequate, and these should be avoided if the researcher suspects that the exposure and the mediator might interact.

Chapter 3: Study 1
Prevention of Criminal Offending: The Intervening and Protective Effects of Education for Aggressive Youth

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Abstract

Children from poor neighbourhoods showing early aggressive behaviour are at risk for criminal offending. The role of education as a mediator, neighbourhood disadvantage and aggression as moderators for criminal offending were examined in a lower-income, community sample (n = 3,521; 48% males), across a 40-year period from childhood to mid-adulthood. Educational attainment accounted for 15–59% of the effect from childhood risk factors. Aggression was found to be a mod- erator such that aggressive children with low education had the highest odds of criminal offending. A protective effect was found where aggressive children who managed to obtain more education had reduced odds of offending. Research conceptualizing education as a 'control' variable does not address its role in the processes leading to criminal offending.

Keywords: Neighborhood disadvantage, childhood aggression, education, criminal charges, causal mediation

Prevention of Criminal Offending: The Intervening and Protective Effects of Education for Aggressive, Lower-Income Youth

Childhood risk factors for adult crime are numerous. They extend beyond individual characteristics, and may include the family environment and neighbourhood that sur- round the child. Some of the established risk factors for adult criminality include living in a disadvantaged neighbourhood (Pratt and Cullen 2005), aggression in childhood (Huesmann et al. 2002), having a teenage mother, having parents or grandparents involved in crime (Besemer, 2014), family dissolution (Skardhamer, 2009), mental health problems (Fazel and Seewald 2012) and low educational attainment (Loeber and Farrington 2001; Sourander et al., 2006).

Although risk factors such as childhood aggressive behaviour and low educational attainment have been associated with later criminality (Huesmann et al. 2002; Sourander et al. 2006), it is equally important to examine factors that may act in the processes leading to adult criminal offending. From a prevention perspective, it is important to observe whether factors that have a negative association with crime, such as educational attainment, can protect an at-risk child. Despite the association between education and crime, education is rarely examined from the perspective of a potential intervening mechanism or as a protective factor against criminal outcomes. Education is typically utilized and conceptualized as a control variable, which would overlook the potential intervening or protective effects for at-risk populations (e.g. aggressive children). The goal of this article was to examine education in these unique capacities within a longitudinal study, using advanced statistical modelling.

Developmental Model of Risk

Several factors in the child's environment affect the likelihood of criminal offending. These factors make up systems that are outside the individual child and include the neighbourhood,

school and peer interactions. These factors each contribute to development and risk (e.g. criminal offending) later in the lifespan (Bronfenbrenner 1979; Bronfenbrenner and Morris 2006). The interaction between these systems, including interactions with individual characteristics, can also influence the child's development (Rosa & Tudge, 2013). Further, criminologists note that environmental factors contribute to changes in an individual's informal social bonds throughout the life- span (Sampson and Laub, 1993). For example, education, a factor traditionally viewed as social bond (Hirschi, 1969) can contribute to a reduction in criminality across the lifespan. Through attachment to school performance, these informal social bonds will have an inverse relation with criminal offending (Sampson and Laub, 1993). The interaction between these external and informal factors and individual characteristics is dynamic, and reciprocal, ultimately affecting the child's development into adulthood.

The Ecological Systems Theory (Bronfenbrenner 1979; Bronfenbrenner and Morris 2006) integrated with theories of crime such as informal social control (Sampson and Laub 1993) provides an integrated developmental model of risk in which to examine the influence of external factors such as neighbourhood and education on the development of the child into adulthood. The contribution of each of these factors needs to be considered as both direct and indirect influences on the development of criminal behaviour. See Figure 1 for the theoretical developmental model.

Neighbourhood disadvantage

Specifically, in terms of risk factors related to the environment of the child, neighbourhood disadvantage (e.g. a high percentage of single family households, families living below poverty line, families with low education) has been associated with many poor outcomes, including criminal offending (Leventhal and Brooks-Gunn 2000; Kohen et al. 2008). For

example, in a moving-voucher study, people who had the opportunity to move to less impoverished neighbourhoods had lower incidences of arrests (Kling et al. 2005). Although neighbourhood contexts have been shown to be directly related to criminal offending, this effect might be further exacerbated by the environment's influence on other aspects of the child's development. Neighbourhood disadvantage was shown to influence education such that living in poorer neighbourhoods has been associated with lower educational attainment, through a variety of mechanisms (Galster et al. 2007). Further, schools in neighbourhoods with greater disadvantage have fewer resources, and often use disciplinary and punitive measures that include suspension or expulsion from schools, ultimately reducing the social bonds created, and increasing the risk of criminal behaviour (Sampson and Laub 1993; Brady et al. 2007). Given these relations, it is possible that the risk for criminal offending that is associated with neighbourhood disadvantage is through its impact on typically protective factors (e.g. education). Further, different levels of neighbourhood disadvantage might exacerbate or diminish the effect education has on criminal offending.

Following the developmental model of risk, these environmental factors also tend to correlate and interact with the child's individual characteristics (Serbin and Karp 2004; van Oort et al. 2011; Martin-Storey et al. 2013). For example, a recent meta-analysis showed that neighbourhood disadvantage was consistently associated with childhood aggression (Chang et al. 2016), which is an established risk factor for adult criminality. In constructing a developmental model of risk for criminal offending, neighbourhood disadvantage, education, childhood aggression and their interrelation should be included.

Childhood aggression

Researchers have found that aggressive behaviour towards peers in childhood is associated with poor outcomes such as criminal offending. Specifically, it has been demonstrated that aggression in childhood was associated with crimes later in life, especially violent crimes (Loeber and Dishion 1983; Farrington 1991; Huesmann et al. 2002; Andershed et al. 2016). Although the relation between aggression in childhood and criminal offending in adulthood is complex, it is possible that aggression, like neighbourhood disadvantage, is affecting other aspects of the child's development, further contributing to risk in adulthood. For example, aggression has been associated with fewer years of education, exacerbating risks associated with low educational attainment (Risi et al. 2003). Further, Kokko and Pulkkinen (2000) reported that aggression predicted poor school adjustment that was both directly and indirectly related to later unemployment, again contributing to increased risks associated with lower education (e.g. crime). As part of the developmental model of risk, aggression can be a risk factor on its own, but it can also have a broad effect on a child's development by affecting other important aspects of life, including education and employment. Many of these affected outcomes may also in turn relate to criminal offending. Further, different levels of aggression (i.e. children exhibit different degrees of aggressive behaviour) may have heterogeneous effects on positive factors such as education, resulting in differing probabilities of subsequent criminal offending.

Education

Education is affected by several factors, and in turn affects developmental outcomes, as would be expected by the interaction of systems in the developmental model of risk. For example, there is a well-established link between number of years of education and the probability of committing a crime later in adulthood. It has been established that the higher education a person obtains, the less likely they are to commit crimes (Lochner and Moretti 2004;

Sabates 2008; Ford and Shroeder 2011; Machin et al. 2011; Meghir et al. 2012). There has also been support for causal effects, where school reforms requiring implementing more years of education saw a reduction in criminal activity. Hjalmarsson et al. (2014) report that for each additional year of schooling the likelihood of conviction was reduced by 6.7%. Several studies have found that this link between education and crime might be due to increased employability, changed views on criminal behaviour and changes in cost-to-benefit ratios (Lochner 2004; 2011). As stated earlier, education itself is also predicted by an array of factors, such as neighbourhood disadvantage (Kokko and Pulkkinen 2000; Kling et al. 2005; Galster et al. 2007) and childhood behaviour (i.e. aggression; Véronneau et al. 2015). Given the relations between education and risk factors (e.g. neighbourhood disadvantage and aggression), and education and crime, researchers examining longitudinal associations between these factors in childhood and adult criminality typically control for education (e.g. in Andershed et al. 2016). This is usually achieved by including education as an individual control variable or as part of a composite descriptor of socio-economic status. However, by controlling this way, these practices could be masking or deemphasizing the specific contributions of education to later criminal outcomes, especially within the context of other risk factors. This approach also neglects any mediating effects education may have on the relations between aggression, neighbourhood disadvantage and adult criminal offending. Further, adult females are less likely to commit crimes compared to males, and, therefore, examining education and criminal offences in the context of gender is imperative (Rowe et al. 1995; Schwartz et al. 2009).

Despite the strong theoretical reasoning proposed by numerous crime theorists (Serin et al. 2016; see Farrington et al. 2017 for a summary of reviews), that these factors combine additively and interactively to lead to long-term adult outcomes (e.g. criminal offending), there is

a paucity of research examining education as an intervening and protective factor during development. Further, researchers that have examined mediators between risk and criminal outcomes have typically relied on the assumption that there is no interaction between the exposure variable (e.g. neighbourhood disadvantage and aggression) and the mediator (e.g. education), and is often done through the product mediation method (Kline 2015). Recent advances in structural equation modelling have allowed researchers to assess mediation in a counterfactual framework, maintaining the binary nature of the outcome, and allowing for an interaction between the exposure and mediator (Muthén and Asparouhov 2015).

Education may mediate and be moderated by risk factors, such as aggression and neighbourhood disadvantage, in the pathway to crime. This unique role of education will be examined in this study, giving valuable information about the mechanisms for the development of criminal offending.

Current Study

By using the developmental model of risk, we sought to address the dynamic relations between neighbourhood disadvantage, aggression, education and later criminal offending using a longitudinal framework. The specific aims of the study were to (1) examine the relation between neighbourhood disadvantage, aggression and criminal outcomes, while examining education as a mediating factor, and (2) explore neighbour- hood disadvantage and aggression as moderating factors of education in predicting adult criminal offending. This study was carried out using data from the Concordia Longitudinal Risk Project (Schwartzman et al. 1985; Stack et al. 2017), a 40-year study of children who were living in lower-income neighbourhoods in 1976, when the children were initially enrolled. By using a longitudinal design, combined with mediation and

moderation analyses, we assessed both the effects of education on the trajectory from childhood risk to adult criminal offending and the potential heterogeneity among these effects.

Hypotheses and specific predictions

We hypothesized that results would replicate previous findings that neighbourhood dis-advantage and childhood aggression would be positively associated with adult criminal outcomes in both males and females. We also hypothesized that higher educational attainment would result in fewer crimes as a direct main effect, but also as an intervening variable for both genders. More specifically, we expected a mediation effect such that higher neighbourhood disadvantage and higher aggression would predict lower educational attainment, which in turn would predict increased probabilities of criminal offending. We also hypothesized a moderation effect in which the levels of neighbour- hood disadvantage and aggression would interact with education to change the probabilities of being charged with a crime. Specifically, we expected that neighbourhood disadvantage and aggression would moderate education, such that both males and females with high neighbourhood disadvantage or high aggression when combined with low education would be have the highest probability of criminal offending. We also hypothesized that the probability of criminal charges would be lower, even for these at-risk children, if they achieved relatively higher levels of education, exhibiting a protective effect of education.

Method

Participants

The Concordia Longitudinal Risk Project (Schwartzman et al. 1985) is an ongoing longitudinal study that began in 1976. The original sample consisted of 4,109 children with 49% being male. The children were French-speaking, in grades 1, 4 and 7 in elementary schools serving lower-income neighbourhoods in Montréal, Québec, Canada. Participation was voluntary

with a participation rate of about 95%. Most of the parti- cipants were of French-Canadian descent. About 5% were from other ethnicities (e.g., Haitian, Vietnamese, Portuguese, Italian). The final sample used in this study included 85.69% of the original sample (see later), 52% were female. Participants had on average about 12 years of education (see later). Census data allowed us to estimate the average income for the neighbourhood in which participants lived. This was 13% lower than the average Montréal household income for all family types (Statistics Canada 2016). Other descriptive statistics are found in Table 1.

Design

In this study, three time points were included. Time 1 (1976–78) was in childhood, when the children were aged 6–16 years old (M = 10.53, SD = 2.53). Census-based measures of disadvantage for the neighbourhoods in which the participants lived at that time were obtained (Statistics Canada 1986). In addition, for this time point, peer evaluations of aggression were also obtained (see later). Time 2, which was cumulative to 2006, in- volved obtaining final diploma codes, based on highest level of education attained for all participants from the Ministry of Education of Québec. At time 2, the participants ranged in age from 34 to 45 years old (M = 39.05, SD = 2.56). Time 3, in 2010, included cumulative criminal records from late adolescence (age 18 years) to mid-adulthood. Participants ranged in age from 38 to 49 years (M = 43.05, SD = 2.56) in 2010, the latest possible collection point of criminal records.

Measures

Neighbourhood disadvantage

Neighbourhood disadvantage was a factor score, based on enumerated census data for the sortation code, based on postal codes, of the neighbourhood in which the child lived, and attended school when originally enrolled in the study in 1976 (Statistics Canada 1986). In

Québec, families lived near the school the child attended, by using the postal code of the school, this measure of neighbourhood disadvantage captures the relative disadvantage of the areas in which these children spent most of their time. The measure of neighbourhood disadvantage included the following items: (1) pro- portion of households with a single parent, (2) proportion of households with a total income lower than CAD10,000, (3) proportion of households with a head of the house- hold having grade 10 education level or less and (4) the proportion of households with whom the head of the household was unemployed (Roos et al. 2004). A neighbour- hood disadvantage factor was created combining these scores (for a description, see Véronneau et al. 2015). The higher the score, the higher the neighbourhood disadvantage. See the descriptive statistics in Table 1.

Childhood aggression

To assess childhood aggression, a French translation of the Pupil Evaluation Inventory (PEI; Pekarik et al. 1976) was used. The PEI includes peer nominations of classmates on three scales: aggression, social withdrawal and likeability. In this study, social withdrawal and likeability were included as covariates (see section Covariates). The PEI consists of 35 items on which the participants are asked to nominate up to four classmates. There are 20 items for aggression (e.g. those who are mean or cruel to other children). The scores were summed for each scale and standardized according to age, gender and classroom (grade). Higher z-scores on the specific scale indicate that they were more often nominated within the same class and gender. This measure has shown strong validity and reliability across several samples that are comparable to the current sample (Pekarik et al. 1976; Tessier et al. 1997). The internal consistencies (Cronbach's alpha) of the scales for the current sample were aggression, $\alpha = .97$; social withdrawal, $\alpha = .91$ and likeability, $\alpha = .90$. See the descriptive statistics in Table 1.

Educational attainment

Education was assessed by using the diploma records from the Ministère de L'Éducation, du Loisir et du Sport du Québec. Records were obtained for all participants, including the highest level of education achieved. This was converted into years of schooling, in which the average number of years for males was M = 11.61, SD = 2.72, and females was M = 11.96, SD = 2.910. Note that high school completion in Québec requires 11 years of schooling. In the male sample, approximately 40% did not complete high school (less than 11 years), 18% obtained a high school diploma, 42% obtained some college (including community college diploma) or university education, but less than 1% successfully graduated from a university program. In the female sample, approximately 30% had less than high school, 18% completed high school, 51% had some community college or university level schooling and less than 2% completed a university program. For further descriptive statistics, see Table 1.

Criminal charges

Criminal charge cumulative records were obtained in 2010 from the open access terminal at the criminal justice courthouse in Montréal, Québec. Similar to the categorization by Farrington et al. (2012), the different types of charges were compiled into the following main categories: violence, property, drug, traffic and miscellaneous. For this study, the focus was on charges considered to be more severe, with the charges being most likely to be considered felony charges (i.e. seriousness of crime is the highest). Therefore, only the categories of violence charges (males: 11.5%; females: 1.7%), prop- erty charges (males: 19.5%; females: 2.0%) and drug charges (males: 10.6%; females: 1.7%) were examined. Participants could have a charge in more than one category. Crime charges were coded as binary such that 1 was equal to being

charged for a crime in that category. Given the nature of the data, it was normal to expect a skewed distribution. See Table 1 for descriptive statistics.

Covariates

In this study, mental health status was included as a covariate due to its well-known associations with both aggression and criminal offending (Fazel and Seewald 2012). Scores were computed using archival medical records obtained for all participants from the Régie de l'assurance maladie du Québec. These records cover the period between 1981 and 2006 and, therefore, represent a diagnosis (e.g. depression, bipolar, schizophrenia) made at any time during this period. Diagnoses were coded as 0 = no mental health diagnosis, 1 = any mental health diagnosis.

In addition, three other individual characteristics were included as covariates. These were social withdrawal and likeability in childhood. These were selected as covariates, given results from previous research on the same data set indicating a relation between these variables and aggression (Schwartzman et al. 1985) and education (Véronneau et al. 2015). Social withdrawal and likeability were also obtained from the PEI (see section Childhood aggression). There are 10 items for social withdrawal (e.g. those who are too shy to make friends easily), and 4 items for assessing likeability (e.g. those who are especially nice). These covariates were computed in the same way aggression was (see section Childhood aggression). See Table 1 for the descriptive statistics for these covariates. Age at the time of the PEI assessment was also included in the model to control for time in the data set.

Statistical analyses

Two multi-group (grouped by gender) path models were conducted using Mplus 8 (Muthén and Muthén 1998–2017) and these models evaluated the relations between childhood aggression, neighbourhood disadvantage, years of education and criminal outcomes.

To test the hypothesis that education mediated the relation from aggression, and neighbourhood disadvantage to criminal charges, the first path model included edu- cation as a mediator. Given the potential for an exposure–mediator interaction (e.g. interaction between aggression and education), counterfactually defined effects were estimated (see Muthén 2011; Kline 2015; Muthén and Asparouhov 2015; VanderWeele 2015). This method allowed the estimates to be less biased by accounting for the exposure-mediator interaction (VanderWeele 2015).

Counterfactually defined effects include the pure natural direct effect (PNDE; direct effect), the total natural indirect effect (TNIE; indirect effect) and the total effect (TE). The PDNE (direct effect) represents the probability of the outcome as the predictor changes, subtracting the effect from the predictor via the mediating variable. In this study, the direct effect reflected the average probability of criminal offending as neigh- bourhood disadvantage or aggression changes from average to above average, while accounting for the mediated effect of each predictor through education.

The TNIE (indirect effect) is the indirect effect which is the portion of the total effect that is explained by the mediation mechanism (Vansteelandt and VanderWeele 2012; Muthén and Asparouhov 2015), allowing the mediator to change to represent the value under the counterfactual condition of the exposure (e.g. when aggression is equal to zero). In this study, the indirect effect reflected the extent to which education mediates the effect of neighbourhood disadvantage (or aggression) on later crimin- ality. Finally, the TE (total effect) is the

combination of the direct effect and indirect effect, and represented the total influence of the predictors (i.e. neighbourhood disadvantage, aggression) on the outcome (i.e. criminal charges).

To test the hypothesis that there would be heterogeneity in the effect education had on criminal charges, neighbourhood disadvantage and aggression were assessed as moderators of this relation, in a second path model. To this end, the predictors (neighbourhood disadvantage and aggression) were centred and were multiplied with the education variable (also centred) to create the interaction terms. To follow up the moderation analyses, simple slope analyses were conducted using 1 standard deviation below the mean and 1 standard deviation above the mean.

For both path models, unstandardized probit coefficients are reported for the associations predicting to criminal charges. All other associations are reported as unstandardized regression coefficients. Non-normal bootstrap (using 2,000 samples) intervals for the indirect effects are reported. The global fit statistics should be a non-significant chi-squared ($\chi 2$) test, a root mean square error of approximation (RMSEA) below .08 and a comparative fit index (CFI) of .95 or above (Hu and Bentler 1999; Kline 2016). As is appropriate for mediation models based on counterfactuals that also involve zero- inflated binary outcomes, the weighted least squares means and variance adjusted estimator was used to assess model fit (Brown 2006; Kline 2016) and odds ratios are reported for associations. Further, the proportion of the total effect that is mediated can be calculated based on guidelines in VanderWeele (2016).

In both models, gender was used as a grouping variable in all main analyses, allowing likelihoods and frequencies to vary across males and females. Non-significant relations involving covariates were trimmed for model parsimony.

Results

Missing data analysis

Of the original sample of 4,109, 3,521 participants were retained for analyses. A total of 324 participants (7.89%) were excluded due to missing data on key variables. Of these, 226 were missing data on variables of interest, namely education and neighbourhood data, five were missing scores on aggression. These cases were not available for inclusion in the analyses as the participants were dropped from follow-up studies. A further 93 cases were missing mental health data. Little's missing completely at random (MCAR) indicated that these mental health data were not missing at random ($p < .05$) and, therefore, using an estimation method would not be appropriate. Although using full information maximum likelihood was not recommended due to data not being MCAR, a follow-up analysis reveals that retaining these 93 cases in the analyses did not affect the observed results. Therefore, the original models without missing cases were retained ($N = 3,521$). A further 264 participants were excluded to maintain a clear chronological order of events. Of these, 215 participants were omitted because they committed a crime before their education was recorded, and 49 participants were omitted because they did not have a year for completion of education. The 215 participants make up a unique subset of the sample, where returning to school after a criminal offence is a great accomplishment. Examining these participants as part of this study was beyond the scope, despite their unique contributions to the understanding of criminal offending.

Correlations

Correlation coefficients from Mplus (version 8) were used to observe the preliminary relations between crime, aggression, years of education and the covariates. The correlations were computed within gender, with correlations for males shown in the upper half above the diagonal and females' results in the lower half of the matrix (reported in Table A1). All the correlations were in the expected direction. For example, childhood aggression in males was significantly and

positively associated with violent charges in adulthood, ($r = .217$, $p < .001$), and significantly and negatively correlated number of years of education ($r = -.253$, $p < .001$). Education was also negatively correlated with violence charges ($r = -.212$, $p < .001$). Similar correlations, albeit not as strong, were found for females. Correlations between predictors in the interaction terms were all less than .60, indicating that multicollinearity is not a concern for these models (see Table A1).

Mediation model

The global goodness of fit statistics for the mediation model for both neighbourhood disadvantage and aggression indicated a satisfactory model fit (see Figure 2). The overall model predicting criminal charges from neighbourhood disadvantage and aggression for males accounted for 17.6–24.3% of the variance in criminal charges, whereas for females the model accounted for 12.6–16.3% of the variance in criminal charges.

Specifically, for neighbourhood disadvantage predicting violence charges, the total effect was significant for females ($OR = 1.487$; $p < .05$), and for males ($OR = 1.265$; $p < .01$). The total effects for property and drug charges were not significant for either females or males. There was a significant direct effect for males, for predicting property charges ($OR = .846$; $p < .01$), but not for violence or drug charges. There were no significant direct effects for females. The indirect effects through education were significant for all three charges for both females and males, such that the mediation effect accounted for 34.4–59.3% of the effect for predicting criminal charges in females and males. This indicates that more neighbourhood disadvantage predicted lower educational attainment for both females and males, which in turn predicted greater odds of criminal charges (see Figure 2). These results did not support the hypothesis that neighbourhood disadvantage would directly predict criminal charges, as the predicted effect was in the opposite

direction as hypothesized. However, there was support for the hypothesis that education would mediate the effect from neighbourhood disadvantage to criminal charges for both males and females. For the remaining neighbourhood dis- advantage effects, their confidence intervals (CIs), and the proportion mediated, refer to Table 2.

For aggression, the total effects and the direct effects to criminal charges were significant for both males and females such that higher aggression predicted increased likelihoods of criminal charges (see Table 3). There were also significant mediation effects of education from aggression to criminal charges, for both males and females (OR = 1.079–1.162, all ps < .05), accounting for 15.0–37.9% of these effects. In other words, higher levels of aggression were associated with lower educational attainment for both females and males, which in turn was associated with increased risks for vio- lence charges (see Figure 2). Overall, these results are consistent with the hypothesis that aggression would directly predict criminal charges for both females and males, and provides support for the hypothesis that education would mediate this effect. For the remaining effects, their CIs, and the proportion mediated refer to Table 3.

Moderation model

The model fit with the education by neighbourhood disadvantage interaction was satisfactory ($\chi2(12) = 4.966$, $p = .9591$; RMSEA = .000 (90% CI = .000; .000); CFI = 1.000). This model accounted for 17.8–25.3% of the variance in criminal charges for males, whereas for females this model accounted for 12.3–16.1% of the variance in criminal charges. Contrary to expectations, there were no significant education by neighbourhood disadvantage interactions for males or for females.

The model fit including the education by aggression interaction indicated satisfactory model fit ($\chi2(12) = 5.621$, p = .9340; RMSEA = .000 (90% CI = .000; .006); CFI = 1.000).

Overall the moderation model, for males, accounted for 19.2–26.4% of the variance in criminal charges, whereas for females, the model accounted for 14.2–17.1% of the variance in criminal charges. Consistent with the hypothesis that education would be moderated by aggression, there was a significant education by aggression interaction in males for predicting violence charges ($b = -.098$, $p < .001$), such that those high on aggression but also high on education had similar probabilities in being charged with a violent crime as their low aggression counterparts, exhibiting a strong protective effect of higher education (see Figure 3). This held for property charges ($b = -.071$, $p = .001$; see Figure 4) and for drug charges ($b = -.076$, $p = .001$; see Figure 5). This was supported by simple slope analyses, indicating that the negative relation between education and criminal charges was stronger among highly aggressive boys ($b = -.302$ to $-.327$, all $ps < .001$) than among less aggressive boys ($b = -.124$ to $-.193$, all $ps < .001$). For males, aggression regardless of level impacted the relation between education and criminal offending. Regardless, a protective effect was observed where males with high aggression and who also had higher education, had similar probabilities to their low aggression peers.

For females, the hypothesis was only supported for property and drug charges. Having a high education resulted in similar probabilities of a property charge for females that are high in aggression compared to females that are low in aggression ($b = -.110$, $p < .001$; see Figure 4). A similar relation was observed for drug charges, such that females with high aggression had similar probabilities of having a property charge compared to their low aggression peers ($b = -.071$ $p < .05$; see Figure 5). This was supported by simple slope analyses where the relations between education and property/ drug charges were stronger among highly aggressive girls ($b = -.211$ to $-.248$, all $ps < .01$) than among less aggressive girls ($b = .038$ to $-.075$, all ns). In other words, for both property and drug charges, low levels of aggression did not affect the relation

between education and property charges for females. In contrast, higher levels of education exhibited a modest protective effect for highly aggressive females (see Figures 4 and 5).

Discussion

The developmental model of risk presented here combines the Ecological Systems Theory (Bronfenbrenner 1979; Bronfenbrenner and Morris 2006) and theories of crime such as informal social control (Sampson and Laub 1993). It hypothesizes multiple influences on an individual's trajectory towards criminal offending. There has been much research examining multiple risk factors for crime, and the impact of mediators and moderators on its development. However, despite this body of literature, very few researchers have examined education as a potential mediator in a developmental sequence of events. Given the potential role of the education system in informal social bonds, education plays an important role in the development of criminal offending (Sampson and Laub 1993). Further, examining aggression and neighbourhood dis- advantage as moderators that would affect the ability of education to protect against criminal offending has also been neglected in past research. Our results demonstrated support for the hypothesis that education is an intervening factor presenting a viable mechanism by which risk factors (e.g. aggression and neighbourhood disadvantage) may be acting to produce greater likelihoods of criminal offending. Further, it appears that aggression can impact the effect of education in both at-risk males and females on future criminal offending, and education itself can demonstrate a protective effect on aggressive children.

Mediation through education

In this study, neighbourhood disadvantage was mediated by education such that higher neighbourhood disadvantage predicted fewer years of education. This in turn predicted a greater probability of criminal charges. Similarly, higher aggression in both males and females predicted

lower education which in turn predicted increased odds of criminal offending (i.e. violence, drug and property charges). Given that the direct effects of aggression remained, there are likely several other pathways through which crime develops, some of which will be discussed here.

In terms of the development model of risk, it was demonstrated in this study that aggressive behaviour is, in some ways, a double risk. Aggression not only directly predicts criminal charges but also indirectly predicts criminal charges by predicting lower levels of education. Neighbourhood disadvantage in most cases did not have a direct effect on criminal charges, but it did affect education. Nevertheless, these results provide evidence for neighbourhood disadvantage and childhood aggression as a developmental precursor to criminal offending, partially because of the effects these risk factors have on education. This relation between childhood factors and environmental factors are expected by both Ecological Systems Theory and informal social controls theory. To further examine the degree to which these risk factors affected the relation between education and criminal offending, a moderation model was also tested.

Moderation of education

There was a moderation effect of aggression for males, for all three charges, such that those who were high on aggression and low on education (as would be expected from the mediation analyses) had the highest probability of criminal offending. For females, this effect was observed only for property and drug charges. Interestingly, these inter- actions also demonstrated that males and females who were high on aggression but somehow also managed to achieve more years of education had reduced odds of criminal charges. In some cases, the effect of higher education lowered the risk for highly aggressive children to probabilities comparable to those with low aggression. The observed moderation effects can be interpreted

and integrated with the mediation results. Specifically, the effect from education to criminal charges may be heterogeneous, depending on the level of childhood aggression (i.e. higher or lower aggression com- pared to peers). In other words, children who are highly aggressive will be more likely to have fewer years of education, but may have lower probabilities of criminal offending if they continue in school despite this risk. It may be that education can be protective for children who are aggressive, if they can be provided with resources for dealing with these early behavioural risks. Informal social controls theory could help to elucidate the importance of social bonds in the school environment, especially for those children that are aggressive (Sampson and Laub 1993).

Consistent with Ecological Systems Theory (Bronfenbrenner 1979; Bronfenbrenner and Morris 2006) and informal social control theory (Sampson and Laub 1993) the developing child can be adversely affected in a multitude of ways because the level of education they attain is affected by their level of aggression and the neighbourhood they live in. Further, this negative impact indirectly results in an increased probability of being charged with a crime. Although there is an emphasis on risk factors when at- tempting to understand criminal offending, the results from this study demonstrated that intervening and protective factors are important to consider when examining the developmental pathways to later risk outcomes.

Strengths, limitations and future directions

This study used a long-term prospective longitudinal design with a relatively large, low-income sample. The longitudinal design provided several strengths such as the use of archival data from multiple government sources and integration of observed behavioural data in childhood. The extended time frame (over 30 years) from childhood to mid-adulthood, allowed for the proper temporal sequence required for mediation analyses, a core requirement when

testing theories of crime (Walters and Mandracchia 2017). By using powerful statistical techniques, we determined that education is a mediator, and that it is moderated by aggression. The prevalence and frequency of criminal offending in any unselected community-based sample (even within a lower-income com- munity) is typically low (i.e. most people are not charged with crimes). In this sample, approximately 15% of the participants had any of the three charges (violent, property and drug); this is higher than population norms (e.g. approximately 4% of the Québec population had a criminal charge in 2016), but still relatively infrequent, making prediction and identification of specific risk and protective factors difficult. Even in this study, with a relatively large sample, the frequency of having a charge was low in female offenders, reducing the variability of the outcome for females, albeit this would be expected from population rates. In this study, however, similar effects were observed across both genders. The current study with the large sample size and extended time frame allowed us to determine that education can play a meaningful role in terms of the intervening mechanism and its potential for a protective role in development.

Despite these strengths, the level of education attained as well as rates of offending were likely affected by characteristics and contextual variables which were not included in the present models, such as family-level disadvantage (e.g. family-level income), personality characteristics, academic achievement and motivational factors, with some of these latter factors being known to contribute specifically to education (Véronneau et al. 2015). Further, there were different types of missingness in this study. Those that were theoretically missing at random but had a significant MCAR test (N = 93), did not affect the observed results, regardless of inclusion or not. There were also data that were theoretically missing at random but could not be included due to their exclusion from follow-up studies, making them unavailable for this study (N = 231).

In addition, those participants that were excluded as they obtained their education after they com- mitted a crime or did not have year of education data are a specific subgroup in which including them in the current model would have been inappropriate. With an overall missingness of 14.3%, and with data not MCAR, it was inappropriate to include all these cases using an estimation procedure, in the current model, and it would be expected that there would be little effect on the observed results.

Despite the robustness of the observed effects, future research should consider family-level characteristics, academic abilities, social/emotional skills, motivation and relationships within and outside of the school context when predicting criminal outcomes.

Aggression and neighbourhood disadvantage, as well as other factors discussed here, might play potentially different roles when predicting violent versus non-violent offences. Further, protective factors (such as education) might also act differentially in predicting different types of crimes. For example, there has been some research demonstrating that more education is associated with specific types of crime that would require higher intelligence and formal training, such as 'white collar crimes' (Lochner 2004). Theoretical models of differential aetiologies for violent versus non-violent offending show promising explanations for why some people commit the most heinous types of crime compared to those that commit other types of crime (Savage and Wozniak 2016). Although from the current results the mechanisms appear similar, statistical comparisons between violent and non-violent offences, especially in the case of white collar or financial-based crimes, were beyond the scope of this article. Nevertheless, the prospect of differential aetiology is an important concept that should be examined in future research.

Finally, mediation based on counterfactuals is often used in a causal inference frame-work. To make causal inferences there are strict assumptions that need to be adhered to (for a

review of these assumptions, see VanderWeele 2015). In this study, attempts were made to control for specific confounds to meet some of those assumptions. To control mediator–outcome confounds, mental health was covaried with criminal charges and education. The causal inference assumptions also require that the set of confounds for the mediator–outcome relation not be direct descendants of the exposure variable (i.e. neighbourhood disadvantage or aggression does not predict the confounders; VanderWeele 2015). This is a limitation in this study as virtually all the available con- founds (including mental health) are affected by early childhood risk factors, especially ones as strong as aggression. In addition, we could not control for confounds occurring before the exposure variables (i.e. neighbourhood disadvantage or aggression), nor could we randomize the levels of the exposure or mediator variables. Therefore, causal inferences need to be made with caution.

Implications for policy and intervention

Education has a strong negative association with criminal offending, but is typically used as a control variable in research on developmental and social risk factors. One implication of this study is that education should not be overlooked or used simply as a control variable: it may have a mediating or protective effect on the relations be- tween risk variables and criminal outcomes. Results from this study highlight the importance of education for children who are developing under conditions of risk. Early intervention strategies for crime prevention should include helping at-risk children to attain more years of education. Strengthening schools and programs in disadvantaged neighbourhoods, and targeting children with behavioural problems within these at-risk populations are essential elements in a prevention strategy. The results from this study have implications for many current intervention studies and policies that focus primarily on risk rather than protective factors. For example, changing the focus of interventions

from solely focusing on aggressive behaviour and other risk factors, to including protective factors such as strengthening the child's educational attainment (i.e. increasing academic skills, motivation and attitudes towards education, increased social, community and family support for education). A two-pronged approach, on both the quality of available educational programs, and the individual characteristics of the child is likely to be necessary for measurable success with vulnerable populations in preventing criminal offending.

Table 1. Descriptive Statistics for Females and Males

Variable	Females		Males	
	Mean (SD^2)	*Min – Max*	*M* (SD^2)	*Min – Max*
1. Age at PEI (years)	10.50 (6.34)	6.52–15.98	10.57 (6.41)	6.52–15.99
2. Aggression	-.02 (0.91)	-1.99–2.99	-.02 (0.90)	-2.10–2.99
3. Social Withdrawal	.01 (0.93)	-2.38–2.95	.01 (0.95)	-2.54–2.95
4. Likeability	.01 (0.93)	-2.88–2.92	.05 (0.93)	-2.88–2.92
5. Education (years)	11.98 (2.83)	6.00–20.00	11.62 (2.70)	6.00–21.00
6. Neighbourhood Disadvantage	-.03 (0.99)	-1.57–2.15	-.05 (0.67)	-1.56–2.15
	N	*Valid %*	*N*	*Valid %*
7. Mental Health				
1. No Diagnosis	673	36.68	967	57.19
2. Diagnosis	1162	63.32	719	42.52
8. Violence Charges	32	1.74	194	11.51
9. Property Charges	37	2.02	328	19.45
10. Drug Charges	32	1.74	178	10.56
N of participants	1835		1691[1]	

NOTE. [1] There were 5 missing male cases on the PEI measures resulting in a sample size of 1686 for those measures and for mediation analyses, but for all else, correlations, and for moderation analyses the *N* for males is as listed (1691); SD^2 = Variance

Table 2. Counterfactually-Defined Effects for Predicting Criminal Charges from Neighbourhood Disadvantage

		Females			Males		
Outcome	Effect	*OR* [95% *CI*]		Proportion Mediated	*OR* [95% *CI*]		Proportion Mediated
Violence	Total	1.487*	[1.044, 2.109]	34.4%	1.265**	[1.088, 1.4674	59.3%
	Direct	1.320	[0.936, 1.902]	–	1.108	[0.945, 1.290]	–
	Indirect	1.127*	[1.045, 1.223]	–	1.142***	[1.094, 1.197]	–
Property	Total	1.038	[0.718, 1.434]	N/A	0.992	[0.867, 1.129]	N/A
	Direct	0.923	[0.629, 1.288]	–	0.846**	[0.743, 0.968]	–
	Indirect	1.125**	[1.046, 1.209]	–	1.172***	[1.127, 1.222]	–
Drug	Total	1.337	[0.924, 1.928]	53.2%	1.162	[1.110, 1.215]	N/A
	Direct	1.158	[0.799, 1.691]	–	0.929	[0.776, 1.105]	–
	Indirect	1.155**	[1.073, 1.264]	–	1.162***	[1.110, 1.215]	–

NOTE: Females (*N*=1835) are on the left; Males (*N*=1686) are on the right.
ABBREVIATIONS: OR = odds ratio, CI = confidence interval, NA= not applicable (when a total effect was "fully" mediated. The indirect effect was larger than the total effect in those situations and the formula from VanderWeele (2015) can't be used.
* $p < .05$, ** $p < .01$, *** $p < .001$ (two tailed).

Table 3. Counterfactually-Defined Effects for Predicting Criminal Charges from Aggression

		Females		Males	
Outcome	Effect	*OR* [95% *CI*]	Proportion Mediated	*OR* [95% *CI*]	Proportion Mediated
Violence	Total	1.741** [1.206, 2.406]	18.4%	1.849*** [1.578, 2.177]	26.1%
	Direct	1.605* [1.126, 2.238]	–	1.627*** [1.381, 1.910]	–
	Indirect	1.085* [1.031, 1.162]	–	1.136*** [1.093, 1.192]	–
Property	Total	1.956*** [1.404, 2.812]	15.0%	1.764*** [1.551, 2.016]	32.2%
	Direct	1.814*** [1.290, 2.587]	–	1.518*** [1.334, 1.734]	–
	Indirect	1.079** [1.032, 1.143]	–	1.162*** [1.119, 1.209]	–
Drug	Total	1.803** [1.246, 2.562]	20.6%	1.549*** [1.311, 1.831]	37.9%
	Direct	1.637* [1.119, 2.315]	–	1.341** [1.136, 1.611]	–
	Indirect	1.101** [1.044, 1.188]	–	1.155*** [1.106, 1.210]	–

NOTE: Females (*N*=1835) are on the left; Males (*N*=1686) are on the right
ABBREVIATIONS: OR = odds ratio, CI = confidence interval
* $p < .05$, ** $p < .01$, *** $p < .001$ (two tailed).

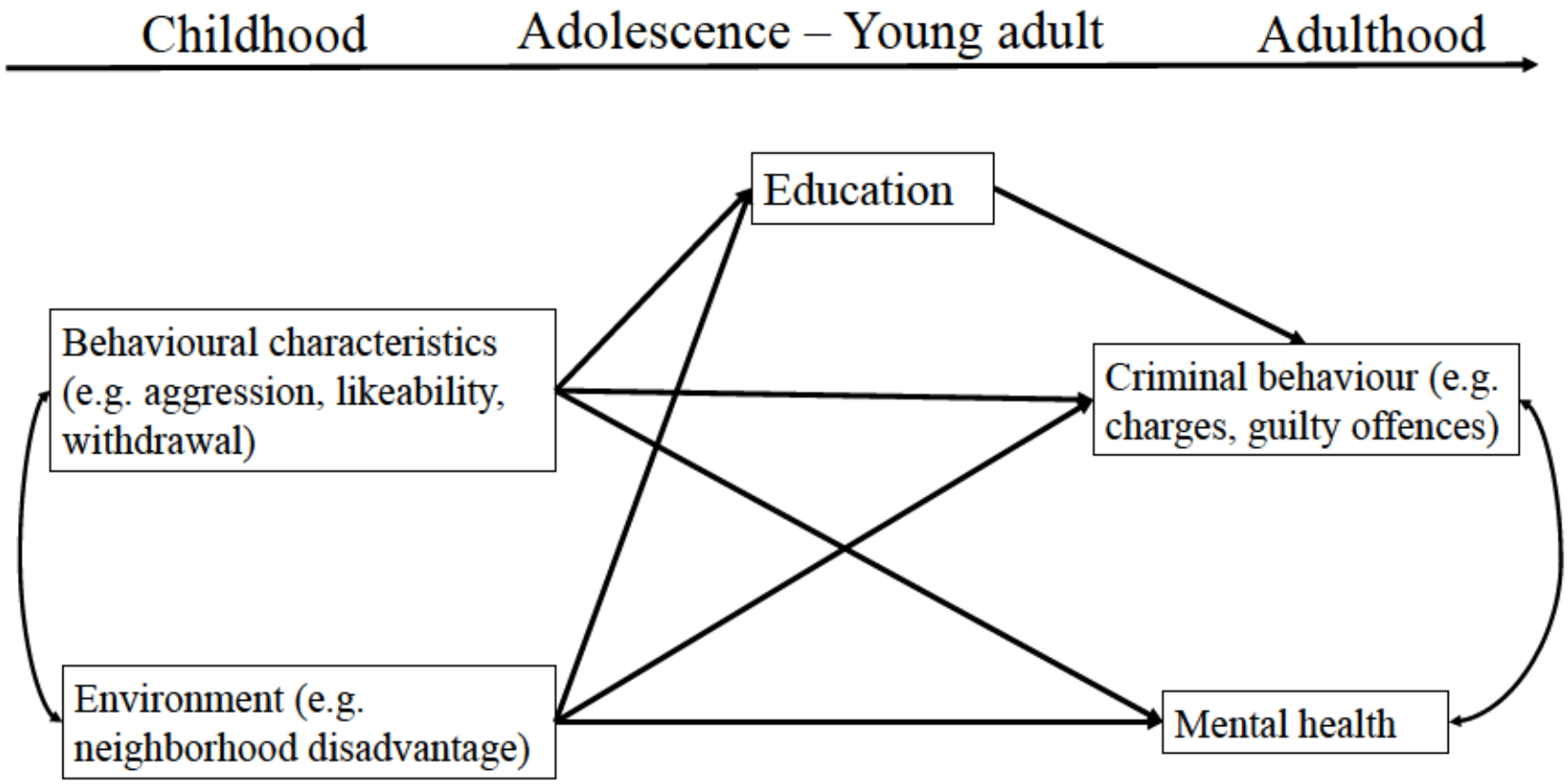

Figure 1. Theoretical developmental model

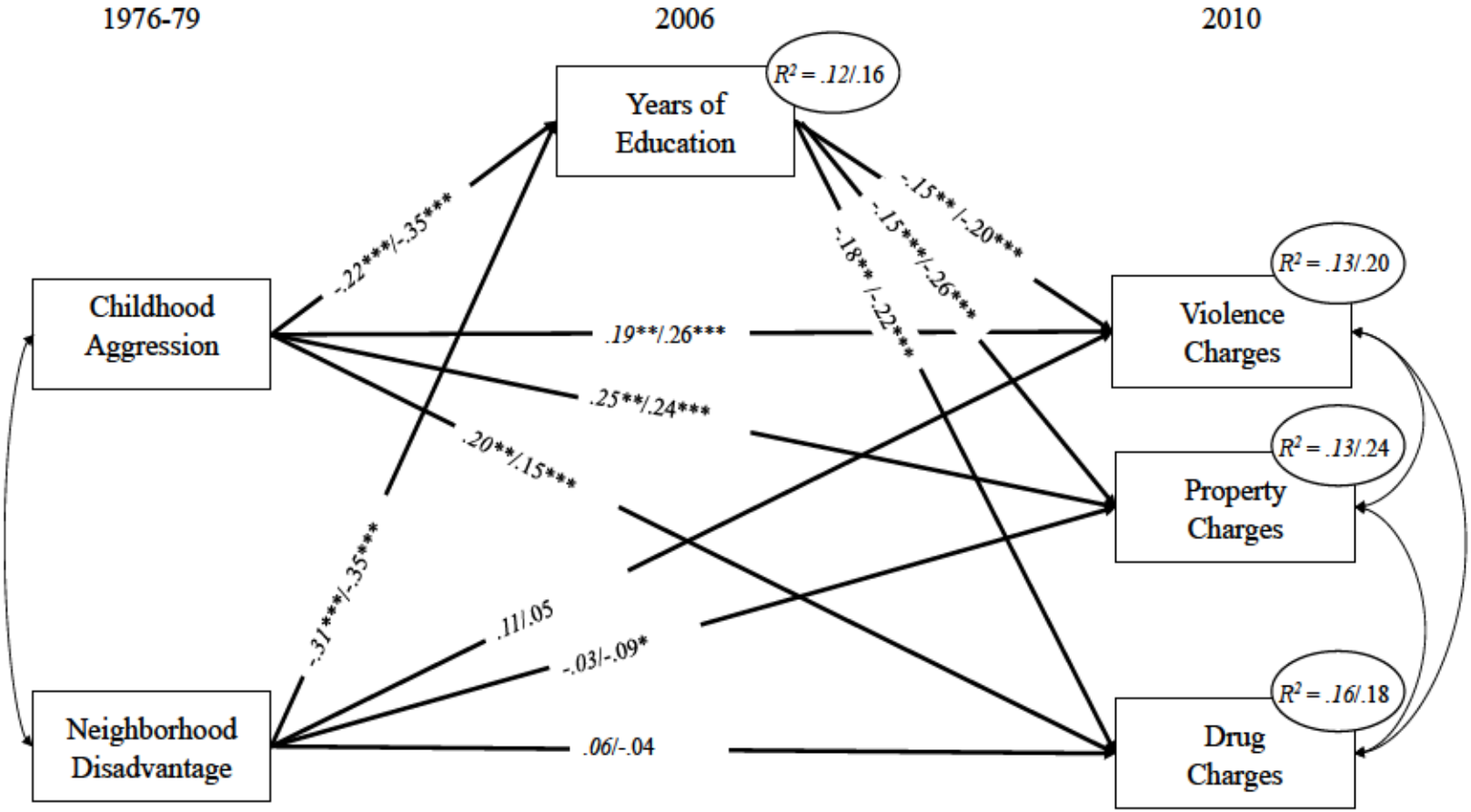

Figure 2. Mediation of aggression and neighbourhood disadvantage through education. The global goodness of fit statistics were: $\chi^2(12) = 6.108$, $p = .9105$; *RMSEA* = .000 (90% *CI* = .000; .010); *CFI* = 1.000. These are unstandardized path coefficients (probit for regressions to charges). Females (*N*=1835) are on the left and italicized, males (*N*=1686) are on the right. Mental health, likability, withdrawal, and age were covariates in these models. * $p < .05$, ** $p < .01$, *** $p < .001$ (two-tailed).

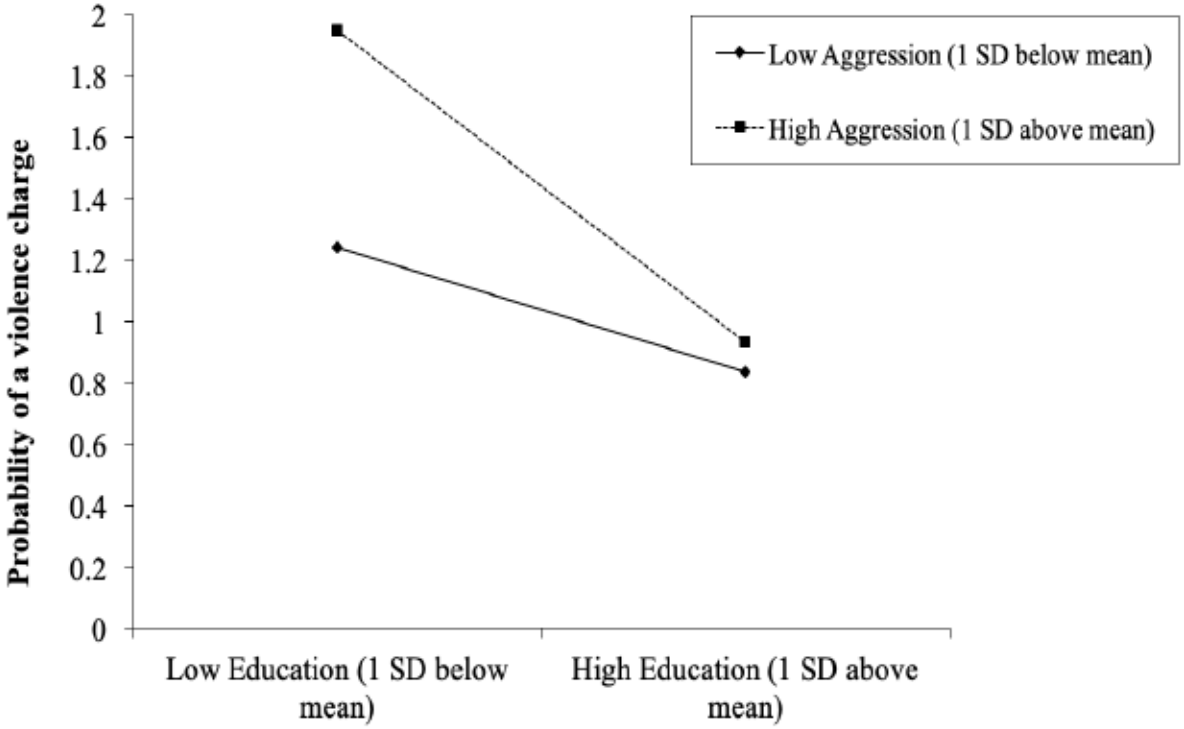

Figure 3. Interaction Between Aggression and Education for Predicting Violence Charges Among Males (N=1691)

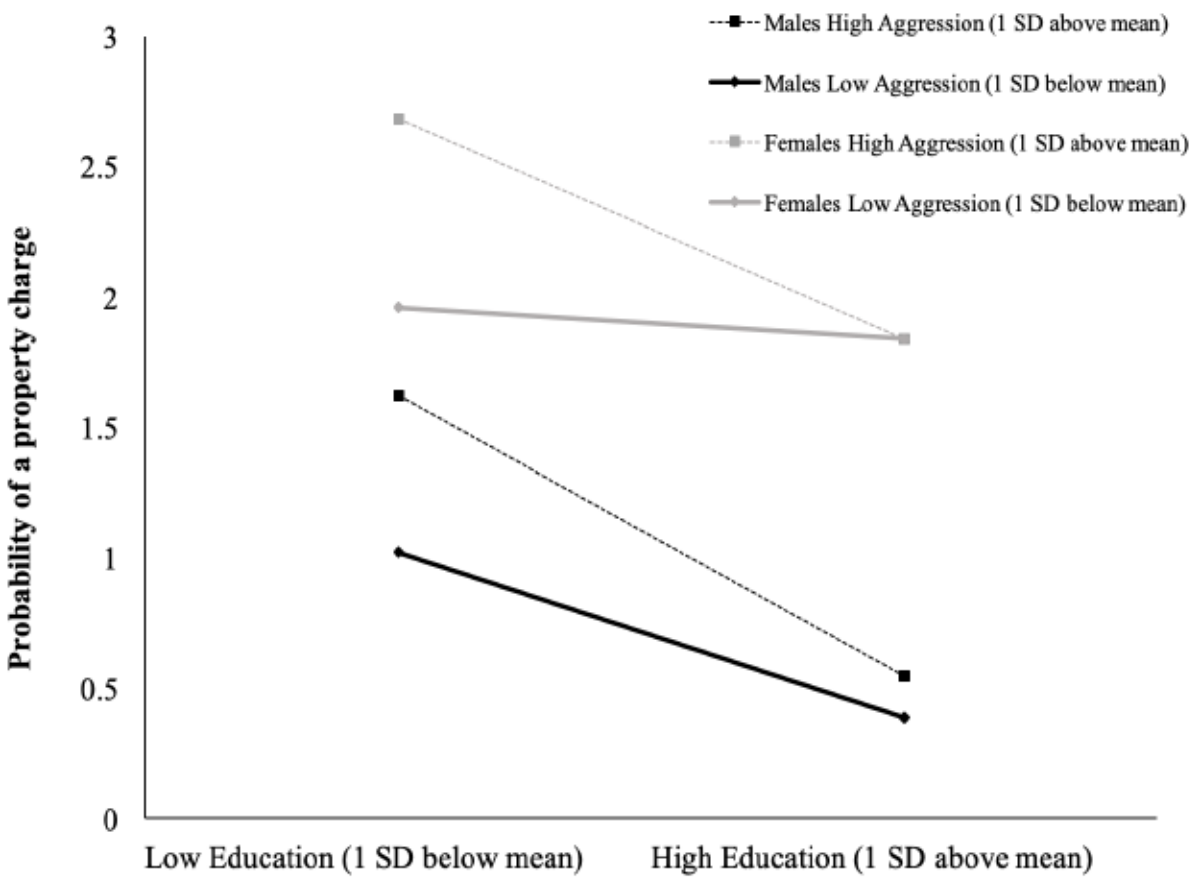

Figure 4. Interaction Between Aggression and Education for Predicting Property Charges Among Males (*N*=1691) and Females (*N*=1835)

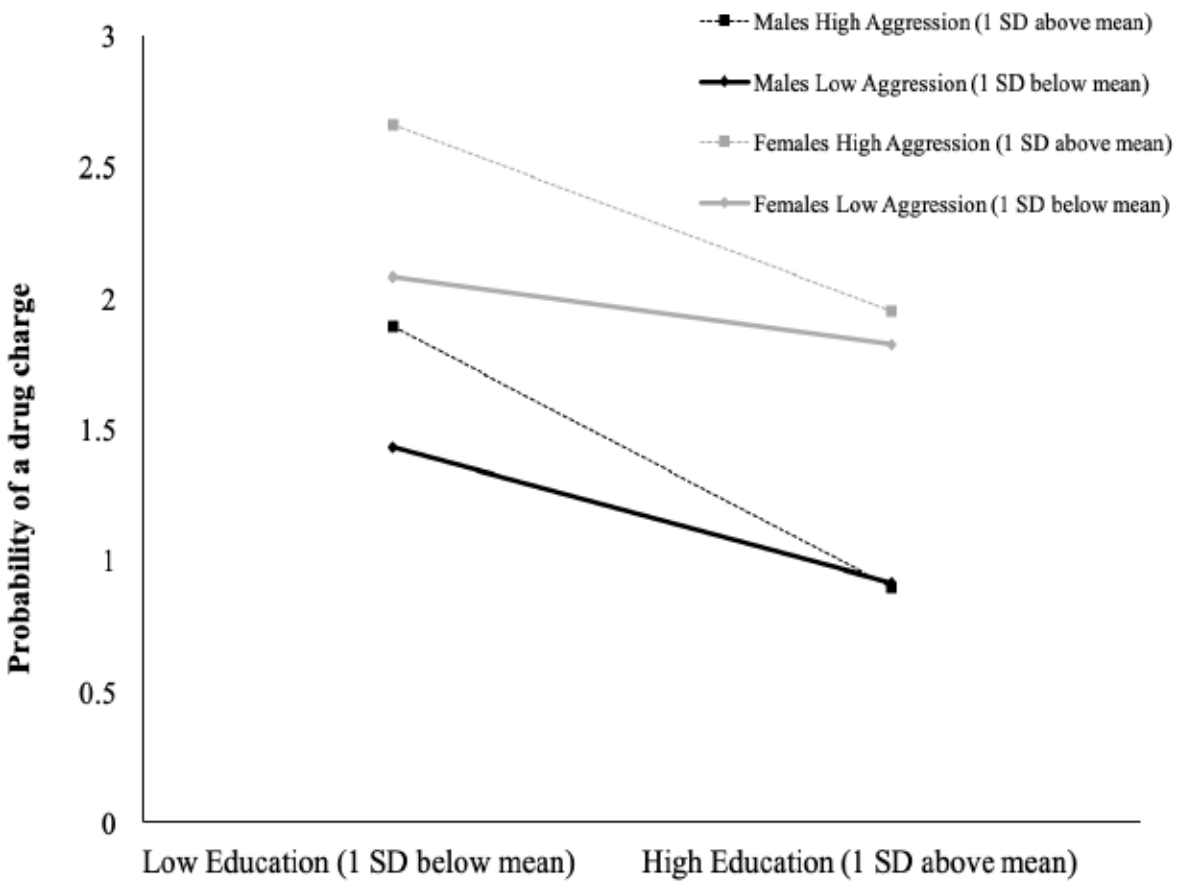

Figure 5. Interaction Between Aggression and Education for Predicting Drug Charges Among Males (N=1686) and Females (N=1835)

APPENDIX

Table A1. Standardized Correlations Between all Variables for Males and Females

Variable	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.
1. Age at PEI	–	-.008	.017	-.006	.021	.146***	.058*	-.012	.011	-.021
2. Aggression	***-.007***	–	-.040	-.211***	-.253***	.000	.069**	.217***	.241***	.151***
3. Social Withdrawal	***.008***	***.064****	–	-.056*	-.004	.008	.015	.011	-.007	-.053*
4. Likeability	***-.004***	***-.176*****	***-.136*****	–	.278***	.032	-.027	-.102***	-.113***	-.078***
5. Education	***-.055****	***-.169*****	***-.060****	***.269*****	–	-.198***	-.025	-.212***	-.281***	-.199***
6. Neigh. Disadv.	***.179*****	***.005***	***-.001***	***.003***	***-.185*****	–	.023	.069**	-.005	.021
7. Mental Health	***-.006***	***.080*****	***.013***	***-.028***	***-.108*****	***.003***	–	.092***	.071**	.075**
8. Violence Charges	***-.012****	***.078****	***-.016***	***-.049****	***-.090*****	***.050****	***.075*****	–	.443***	.378***
9. Property Charges	***-.004***	***.114*****	***.019***	***-.011***	***-.093*****	***.009***	***.061****	***.159****	–	.387***
10. Drug Charges	***.059****	***.094****	***.043***	***-.027***	***-.105*****	***.037***	***.050****	***.173****	***.099***	–

NOTE: Males (*N*=1691) are in upper half; Females (*N*=1835) are in the lower half diagonal and are in bold, italics.
* $p < .05$, ** $p < .01$, *** $p < .001$ (two tailed). Neigh. Disadv. = Neighbourhood Disadvantage

Chapter 4: Extending Study 1 and rationale for Study 2 — The argument for including achievement and absences in the pathway to criminal offending

In Study 1, my co-authors and I examined the vital role that education plays in the trajectory to criminal offending. The focus of this study was to demonstrate that education should not necessarily be designated solely as a control variable. In studies where education is controlled the effects of education are still included, but they are not the focus. However, as demonstrated in Study 1, examining risk factors for criminal offending while also examining the effects of education provides a more comprehensive understanding of these influences. One important limitation in Study 1 was that cognitive and academic abilities, which may be a confound between aggression and education, were not controlled. Unfortunately, measures of cognitive ability, such as IQ, or of specific academic abilities were not available for the full sample of the Concordia Project. Although measurements of academic ability were available for a subset of the sample (N=1769), this reduced sample size ran the risk of not having enough variability in criminal charges to detect predictive effects. Additionally, several questions became apparent in terms of the protective and intervening role of education, given the observed effects in Study 1.

The trajectory to criminal offending is complex. Study 1 highlighted the importance of education and staying in school. Understanding more in depth what contributes to education and ultimately criminal charges was the focus of Study 2. The main goal of Study 2 was to examine factors known to contribute to education in the context of criminal offending, including likeability, social withdrawal, academic achievement scores, and school absences. In Study 1 the focus was on aggression and neighborhood disadvantage as risk factors for criminal charges in adulthood. Study 2 expanded on Study 1, and aimed to demonstrate the robust effect of education while examining other factors (e.g. likeability and withdrawal) more in depth. For Study 2 it was important to include achievement scores to rule out academic performance as the driving force for the effects observed in the correlations of childhood risk factors with education. Adding school absences as a direct influence on how long an individual would stay in school would provide more information about the trajectory to criminal charges. Additionally, it was hypothesized that both achievement and absences would directly affect criminal charge

outcomes. It has also been observed that childhood factors, such as being liked by others, are associated with achievement and educational attainment (Véronneau et al., 2015). Achievement and absences were added in the model to elucidate the factors that keep children in school. As demonstrated in Study 1, we expected that prevention of criminal offending would rely on educational attainment. Therefore, understanding factors from childhood that contribute to educational attainment within the context of an at-risk community sample is important for preventing criminal offending.

Another goal of Study 2 was to examine potential gender differences in the roles of absences and achievement in the pathways to criminalization. This would also help to clarify gender differences in criminal charges. Additionally, it could help elucidate the observed protective effects of education that were mostly observed in males. Examining the moderating effect of gender was expected to yield a protective effect of achievement for males. This could be an important point for intervention when seeking to keep children in school and prevent criminal offending.

Together, Studies 1 and 2 provide information on the developmental contributors and processes leading to criminal charges in adulthood, both directly and via educational attainment. Study 2 moved beyond Study 1 by directly examining the contribution of elements (i.e. likeability, social withdrawal) that were treated as control variables in Study 1. Examining the effects of likeability and withdrawal on education were expected to add predictive variance to the previously observed effects. Furthermore, achievement and absences were added to help explain the various childhood factors that contribute to educational attainment and criminal offending. Combined, these studies were intended to identify specific areas that could be amenable to intervention to improve the outcomes for children with numerous risk factors.

Chapter 5: Study 2

Beyond educational attainment: The role of achievement and school absence in the development of criminality

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Abstract

Education plays an important role in lowering risk for criminal offending in adulthood. Further, education can be protective for children who are aggressive in childhood. It is unclear whether this might be due to a confound: i.e., children with strong academic skills would also be less likely to commit criminal offenses, or whether the protective effect is directly related to educational experience. Additionally, other risks (e.g. absences) may impact educational attainment, contributing to later criminal offending. The current study examined the role of academic achievement and school absences in the developmental trajectory from childhood behaviour and disadvantaged environments to adult criminal offending. This study included 1040 participants (51% female) from the Concordia Longitudinal Research Project. Using path modelling, we found that academic achievement and absences were important contributors to educational attainment. However, they did not directly predict criminal charges. The relations between childhood factors (e.g. aggression, likeability, withdrawal, and neighbourhood disadvantage) and criminalization were mediated by achievement, absences, and education. The specific paths from achievement and absences to criminal charges differed for males and females, whereby males with high absences or low achievement scores were at highest risk. Implications for early preventive intervention focused on educational attainment are discussed.

Keywords: childhood behaviour, achievement, absences, education, criminalization

Beyond educational attainment: The Role of Achievement and School Absence in the Development of Criminality

Research suggests that education is protective against criminal offending in adulthood, even in the presence of risk factors such as childhood aggression and neighborhood disadvantage (Ford & Shroeder, 2011; Kennedy-Turner et al., 2020; Lochner & Moretti, 2004; Nieuwenhuis & Hooimeijer, 2015). Specifically, the more education one has, the less likely they are to commit crimes (Groot & van den Brink, 2007; Sourander et al., 2007). Disentangling which aspects of education are protective, and the factors that contribute to staying in school for at-risk youth may help to delineate the complex relations between childhood risk factors and criminalization. The objective of this study was to examine whether factors highly related to educational attainment, such as early academic achievement and patterns of school attendance, contribute to criminal outcomes independently of the level attained. The study was also designed to identify specific environmental and behavioral predictors that contribute to long term educational and criminal outcomes by indirectly affecting early academic achievement and school absences.

Sampson and Laub's (1993) theory of informal social bonds postulates that the risk of committing a crime may be reduced across the life-course as people develop attachments to informal social controls such as school and school performance (Sampson & Laub, 1993). Similarly, ecological systems theory (Bronfenbrenner, 1979; Bronfenbrenner & Morris, 2006), suggests that development is dynamic and that there are several levels of influence on behaviour, including at the level of the school. Further, this theory provides a conceptual framework for examining interactions between these factors (Bronfenbrenner, 1979; Bronfenbrenner & Morris, 2006). Taken together, a complete model, combining informal social bonds and ecological systems theory, can be conceptualized as a theoretical developmental model (Kennedy-Turner et al., 2020; See Figure 1). This model examines criminal offending from a developmental

perspective, incorporating the influence of individual risk factors (e.g. aggression), and environmental factors (e.g. neighborhood disadvantage) and their effects in relation to educational attainment. Additionally, if these risk factors can be mitigated by a positive attachment to school, it is anticipated that there would be a reduction in crime, despite these early risk factors.

Recent results show that these risk factors (e.g. aggression, and neighborhood disadvantage) contribute to education and interact with each other (Kennedy-Turner et al., 2020). Specifically, despite higher aggression predicting fewer years of education, a subset of aggressive individuals managed to obtain more years of schooling, resulting in a decreased probability of criminal charges in adulthood (Kennedy-Turner et al., 2020). This heterogeneity in outcomes for aggressive individuals leads to the question of what exactly is contributing to more years of schooling among at-risk youth, ultimately reducing the probability of criminal offending. Given the important impact education has on criminal offending (b =-.15 to -.26, Kennedy-Turner et al., 2020), examining factors that contribute to educational attainment in the context of established childhood risk factors may facilitate the planning of targeted intervention and policy changes to benefit at-risk individuals and society.

Achievement and absences

School performance. Time spent in formal education is affected by an array of factors (Ou et al., 2007). If individuals can form informal social bonds with educational structures and environments, they are likely to obtain more education, and reduce the probability of criminal offending. One possible explanation is that attachment to school performance will result in an informal social bond between the individual and their education, ultimately reducing the probability of criminal offending (Sampson & Laub, 1993). Additionally, school performance on

standardized tests (i.e. academic achievement) at an early age can be an indicator for how long the individual will be in school. Specifically, the higher their academic achievement on these tests, the higher their educational attainment (Ou et al., 2007; Véronneau et al., 2015). Therefore, higher academic achievement scores could be working through attachment to school structures and indirectly reduce criminal offending through its effect on educational attainment.

Academic achievement itself is affected by many factors, further complicating its potential influence on education and on criminal offending. For example, it has been shown that childhood aggression (Stipek & Miles, 2008), social withdrawal (Rubin et al., 2009), and neighborhood disadvantage (Greenman et al., 2011) predict lower academic achievement scores. Conversely, likeability, exhibits a positive effect where the more a child is liked by peers, the higher their academic achievement scores (Bukowski et al., 2019; Véronneau et al., 2015). Further, there are gender differences in achievement where girls tend to perform better than boys in certain subjects and under certain conditions (Kingdon et al, 2017; Reardon et al., 2019), and in overall educational attainment (Aud et al., 2010).

Given these relations, it would be expected that achievement would contribute to educational attainment. This would then indirectly reduce the subsequent likelihood of criminal offending. Academic achievement would also be indicative of skills (both intellectual and social) that would directly reduce criminal offending. Achievement might also influence criminal offending differently for males and females. However, achievement is just one contributor to these outcomes.

School attendance. Absences from school are sometimes used as a proxy for truancy in childhood and adolescence, especially in the case where there is chronic absenteeism (Sutphen et al., 2010). Truancy has been directly implicated in criminal offending. Specifically, the more

truant an individual is during childhood and adolescence, the more likely they are to commit a criminal offense (DfEE & Home Office, 2001). Frequent absences can break attachment to school, ultimately making it a risk factor for criminal offending (Garcia & Weiss, 2018; Sampson & Laub, 1993). The exact reasons why absences would break attachment to school and ultimately impact educational attainment are not well understood but likely include less learning, less skill development, increased dropout rates, reduced positive social bonds, and ultimately less access to resources and support over time (Ginsburg et al., 2014). Absences from school are affected by many variables, including socioeconomic factors, child behaviour factors (e.g. aggression, withdrawal, likeability), race, achievement, poor health, and neighbourhood disadvantage (Garcia & Weiss, 2018; Ready 2010). Further boys are more likely to be absent than girls, further contributing to risk for males (Garcia & Weiss, 2018). Over time, childhood risk factors might ultimately decrease attachment to school, through their effects on absences.

Other risk and protective factors for education

Achievement and absences are important contributors to education and ultimately to the development of criminal offending. However, to understand the influence of these factors, they must be taken in context with well-established risk and protective variables for both education and criminal offending. Accounting for these levels of influence will delineate the processes involved in making education an important protective factor in the risk for criminalization.

Many other individual and environmental characteristics affect educational outcomes. Recent studies indicate that the more aggressive (Kennedy-Turner et al., 2020), or withdrawn (Serbin et al., 2011), or the less liked by others a child is (Serbin et al., 2011; Véronneau et al., 2015), the fewer years of schooling they subsequently attained. In terms of community environments, greater neighborhood disadvantage also predicts fewer years of schooling

(Kennedy-Turner et al., 2020; Nieuwenhuis & Hooimeijer, 2015). These factors, in combination with achievement and absences can have cumulative effects on education, ultimately affecting the development of criminalization.

To summarize, the trajectory to criminal offending is complex. Many researchers have found factors that increase (e.g. aggression), or decrease (e.g. education) the probability of criminal offending, but the interplay between these factors is rarely examined together. Clarifying the factors that contribute to education in the context of the development of criminalization may provide specific targets and developmental periods for preventive intervention. In the current study, we examined whether academic achievement and school absences contributed to time spent in formal education, and how these affected criminal charges, while also examining gender effects. Further, we examined childhood factors that may contribute to achievement, absences, education, and ultimately criminal charges.

Current study and specific hypotheses

The current study was designed to expand a previous study (Kennedy-Turner et al., 2020), including a subsample of the participants from the Concordia Project (Schwartzman et al., 1985). Kennedy-Turner and colleagues (2020) found that years of education mediated the association between childhood aggression and criminal charges and between neighborhood disadvantage and criminal charges. Further, these authors found heterogeneity in the effects among high aggression children. It was therefore important to add key variables known to contribute to education (e.g. achievement and absences) and to further explore the relations between childhood risk and criminalization. Further, very few studies have examined achievement and absences in the context of educational attainment as a mediator and with predicting criminal outcomes.

We expected that the childhood risk factors would have a negative association with achievement, and a positive association with absences. Further, we expected protective factors to have the opposite association. We also hypothesized a positive association between achievement and education, and absences would have a negative association. Additionally, we expected that achievement would have a negative association with criminal charges, and absences would have the opposite association.

Given that the gaps between the genders in achievement and absences and in the overall differences in criminality (Schwartz et al., 2009), we hypothesized that gender would moderate the relations between achievement, absences, and criminal charges, where it was expected that males would be at most risk.

Method

Participants

The Concordia Longitudinal Research Project (Hastings et al., 2019; Schwartzman et al., 1985; Stack et al, 2017) is an ongoing longitudinal study that began in 1976. The original sample consisted of 4,109 children, 49% male. The children were French-speaking, in grades 1, 4, and 7, attending elementary schools serving lower-income neighborhoods in Montreal, Québec, Canada. Participation was voluntary with a participation rate of about 95%. Most of the participants were of French-Canadian descent. About 5% were from other ethnicities (e.g., Haitian, Vietnamese, Portuguese, Italian). At the time of recruitment, family income for the neighborhoods in which participants lived was approximately 13% lower than the average Montréal household income (Statistics Canada, 2016).

A follow-up sample (N=1769) was selected, providing a broad distribution of scores on peer-rated measures of social functioning (see Schwartzman et al., 1985 for selection criteria). A

final sample of 1040 (51.7% female) was used in this study, including 58.8% of the original follow-up sample for whom archival records of academic achievement and school attendance during the year following recruitment were available (see Results: *missing data*). By adulthood, participants had on average about 12 years of education (see Table 1). Other descriptive statistics are provided in Table 1.

Design

Four time-points were included in the current study. Time 1 (1976–78) was in childhood. At this first time point the participants averaged 10.83 years old ($SD = 2.60$ years). Census-based measures of disadvantage for the neighborhoods in which the participants lived at that time were obtained (Statistics Canada, 1986). Additionally, peer evaluations of aggression, social withdrawal, and likeability were carried out (see Measures section below). Time 2 was approximately one year after enrollment in the study. Achievement and absences were obtained at that time from records provided by the school boards. Time 3, in 2006 ($M = 39.51$ years old, $SD = 2.60$ years) involved obtaining final diploma codes (cumulative to 2006), based on highest level of education attained. Time 4, in 2010, included cumulative criminal records from late adolescence (age 18) to mid-adulthood that were obtained from the courthouse. Participants averaged 43.51 years old ($SD = 2.60$ years) at the latest possible collection point of criminal records at the time of this study.

Measures

Childhood aggression, social withdrawal, and likeability. Childhood aggression, social withdrawal, and likeability were assessed using a French translation of the *Pupil Evaluation Inventory* (PEI; Pekarik et al., 1976). The PEI includes peer nominations of classmates on three scales: aggression, social withdrawal, and likeability. The PEI consists of 34

items on which the participants are asked to nominate up to four classmates. There are 20 items for aggression (e.g. *those who are mean or cruel to other children*). There are 9 items for social withdrawal (e.g. *those who are too shy to make friends easily*), and 5 items for assessing likeability (e.g. *those who are especially nice*). The scores were summed for each scale and standardized according to age, gender, and classroom (grade). Higher *z-scores* on the specific scale indicate that they were more often nominated within the same class and gender. This measure has shown strong validity and reliability across several samples that are comparable to the current sample (Pekarik et al., 1976; Tessier et al., 1997). The internal consistencies (Chronbach's alpha) of the scales for this sample were: aggression, $\alpha = .97$, social withdrawal, $\alpha = .84$, and likeability, $\alpha = .74$. See Table 1 for the descriptive statistics.

Neighborhood Disadvantage. Neighborhood disadvantage is based on census data for the postal sortation code of the neighbourhood in which the child attended school when they were originally enrolled in the study in 1976 (Statistics Canada, 1986). This measure of neighborhood disadvantage reflects the relative disadvantage of the areas in which these participants lived, as primary schools were within walking distance of the child's home. The factor score of neighborhood disadvantage included the following items: (a) proportion of households with a single parent; (b) proportion of households with a total income lower than $10,000 CAD; (c) proportion of households with a head of the household having grade 10 education level or less, and (d) the proportion of households in which the head of the household was unemployed (Roos et al., 2004). Higher scores indicate greater neighborhood disadvantage. The descriptive statistics are provided in Table 1.

Achievement and School Absences. Records of achievement and absences were obtained from the records of the participants. These records were obtained a year after selection

of the participants and they are objective measures from the school board. The achievement scores are based on standardized tests of mathematics and language arts (French first language reading and writing). Achievement scores reflect academic ability and skill, and are highly correlated with IQ (Finn et al., 2014). Population scores for achievement are reported in stanines with a mean of 5 and a standard deviation of 1. The statistics for the current sample were M=4.63, SD=1.62. Absences are the number of absent days reported for the year following the initial recruitment, which could include partial days. It is important to note that the absences are for one year only and are not cumulative to the date of diploma attainment. There was a range of 0–99.5 days absent for the current sample (M=9.428, SD=11.214). Descriptive statistics are provided in Table 1.

Education. Years of schooling were obtained from diploma codes from the Ministry of education. The sample averaged 11.69 years, SD = 1.66. Note that secondary school completion in Québec requires 11 years of schooling. Approximately 37% did not complete high school (less than 11 years), 19% obtained a high school diploma, 43% obtained some college (including community college diploma) or university education, but less than 2% successfully graduated from a university program. For further descriptive statistics, see Table 1.

Criminal Charges. Records of criminal charges were obtained from the criminal justice courthouse in Montréal, Québec. The charges were cumulative from the age of 18 to the year 2010, when participants ranged in age from 38 to 49 years of age. The charges were compiled into the following main categories: violence, property, drug, traffic, and miscellaneous. These categories were similar to the categorization themes used in Farrington and colleagues (2012). For this study, the categories of violence charges (7.4% with one or more violence charges of total sample), property charges (11.4% with one or more property charges, of total sample) and

drug charges (6.3 % with one or more drug charges, of total sample) were examined, as they are more severe compared to other charges (i.e. traffic violations). The sample consisted of mostly male offenders (82.6% of the offenders in the sample). Participants could have multiple charges across different categories. Crime charges were a count variable with a zero-inflated distribution. No transformations were done to the criminal charge data despite its skewed distribution as this is the distribution that is expected in the population. See Table 1 for descriptive statistics.

Covariates and other predictors. In the present study, mental health status was included as a covariate due to its well-known associations with education (Needham, 2009) and criminal offending (Fazel and Seewald, 2012). Scores were computed using archival medical records from the Régie de l'Assurance-Maladie du Québec (Hastings et al., 2019). These records represent a diagnosis (e.g. depression, bipolar, schizophrenia) made at any time from 1981–2006. Diagnoses were coded as 0 = no mental health diagnosis, 1 = any mental health diagnosis. In addition, two other individual characteristics were included as covariates. These were age at the time of the PEI assessment and gender. As there was a possibility of cohort effects given the range of grades in which the participants were recruited, a preliminary test was conducted for a moderation effect of grade cohort, but these were not significant. The models were therefore retained as a single group model with age as a control variable. See Table 1 for the descriptive statistics for these covariates.

Statistical Analyses

Three path models were conducted using MPlus 8 (Muthén & Muthén, 2017) to evaluate the relations between childhood aggression, neighborhood disadvantage, achievement, absences, years of education, and criminal outcomes. The coefficients presented in the figure are the standardized regression coefficients, but with the *p*-values from the unstandardized coefficients.

The chi-square can be sensitive to sample size and should be interpreted within the context of the other fit statistics (i.e. RMSEA <.08, and CFI> .95; Bergh, 2015). Both maximum-likelihood and maximum-likelihood with robust standard errors, yielded identical results despite the skewed distributions of the outcomes. As such, the ML estimator was retained to facilitate any model comparisons. The first model tested the direct and indirect effects on criminal charges through the effects on achievement and absences. A bootstrap with 2000 samples was used for the indirect effects. The bias-corrected confidence intervals are provided for the indirect effects (MacKinnon, et al., 2004). To test the secondary hypothesis that gender has a moderating effect on how absences and achievement contribute to criminal charges, a second and third model were run to assess the interaction between gender and achievement and for gender and absences. For model parsimony, non-significant relations involving covariates were trimmed.

Results

Missing data and outliers

Of the 1,769 participants from the follow-up sample, 1,040 were retained for analyses (58.8%), because achievement data at time 2 were only available for 1336 participants. An additional 78 were removed because they received their diploma after their criminal charge or did not have a year of diploma code in the records, to maintain the temporal sequence of education before crime. There were 18 participants who were excluded because they were missing mental health data. There were also 200 participants for whom absence records were missing. These participants were not missing at random (Little's *MCAR* test: $(\chi^2(32) = 101.359\ p = .0000)$, therefore estimation methods would not have been appropriate. Finally, there were 24 outliers (M+3SD) on the absences variable. The models presented here were run with and

without the outliers and the results were maintained. Therefore, these outliers were retained in the models ($N = 1040$).

Correlations

Correlation coefficients from SPSS (version 21) were used to observe the preliminary relations between crime, aggression, years of education, and the covariates (reported in Table 2). All the correlations were in the expected direction. For example, achievement was positively correlated with education ($r = .440$, $p < .001$) and negatively correlated with violence charges ($r = -.122$, $p < .001$). Absences were negatively correlated with education ($r = -.184$, $p < .001$) and positively correlated with violence charges ($r = .104$, $p = .001$). Correlations between predictors in the interaction terms were all less than .60, indicating that multicollinearity was not a concern for these models (see Table 2).

Gender differences

Although the model was run as a single group, statistics concerning mean level differences between the genders were conducted. For achievement and absences there were no significant mean level differences between male and female. In the present sample, females had significantly more years of education ($t(1038) = -4.34$, $p < .001$)).

Mediation through achievement and absences

To assess the hypothesis that achievement and absences mediated childhood variables and education and then subsequently crime, a path model was used. Overall the fit for this model was satisfactory (see Figure 2). This model accounted for 31% of the variance in achievement, 5.2% in absences, 24.3% in years of education, 8.3% of the variance in violence charges, 6.1% in property charges, and 4.7% in drug charges. Achievement and absences did not directly predict criminal charges as expected; instead achievement and absences exerted their effects through

years of education. The mediation effects from childhood factors through achievement and absences and education are described below.

Effects from aggression. There was a direct effect from aggression to violence charges ($b = .276, p < .001$), to property charges ($b = .411, p < .001$), and to drug charges ($b = .122, p = .003$). The main indirect effect of interest was from aggression to achievement to education to violence charges ($b = .006, p = .001$; CI:.003,011). As hypothesized, higher aggression exhibited its effects not only on education directly, replicating findings from Kennedy-Turner and colleagues (2020), but also through its effect on achievement. Specifically, higher aggression predicted lower achievement scores, which predicted fewer years of education which then predicted more violence charges. There were no significant indirect effects from aggression through achievement or absences alone without passing through educational attainment. Similar effects were observed from aggression to property charges and drug charges.

Effects from likeability. There were no direct effects from likeability to any of the three charges. The indirect effect from likeability to education to violence charges was significant ($b=-.006, p=.032$; CI: −.014, −.002). Additionally, likeability to achievement to education to violence charges was significant ($b=-.010, p<.001$; CI: −.017, −.005). Finally, likeability to absences to education to violence charges was significant ($b=-.001, p=.018$; CI: −.003, .000). In other words, higher likeability predicted more years of education directly, which then in turn predicted fewer violence charges. Further, higher likeability also predicted higher achievement and lower absences which in turn predicted more years of education, which then predicted fewer violence charges. There were no significant indirect effects from likeability to violence charges through achievement or absences alone. Similar effects were observed for drug charges and property charges.

Effects from social withdrawal. There were no direct effects from social withdrawal to any of the criminal charges. The indirect effect from withdrawal to education to violence charges was significant ($b = -.006$, $p = .041$; CI: $-.013$, $-.001$). Further, withdrawal to achievement to education to violence charges was significant ($b = .003$, $p < .001$; CI:.001, .005). That is, higher social withdrawal during childhood predicted more years of education directly, which then in turn predicted fewer violence charges. In contrast, higher withdrawal predicted lower achievement which in turn predicted fewer years of education, which in turn predicted more violence charges. These seemingly contradictory effects are discussed later but this is likely due to a suppression effect. There were no significant indirect effects from withdrawal through achievement or absences alone. Similar effects were observed for drug charges and property charges.

Effects from neighborhood disadvantage. There were no direct effects from neighborhood disadvantage to any of the criminal charges. There was a significant indirect effect from neighborhood disadvantage to achievement to education to violence charges ($b = .009$, $p <$ .001; CI:.004, .011) and from neighborhood disadvantage to absences to education to violence charges ($b = .001$, $p = .037$; CI:.000, .003). That is, greater neighborhood disadvantage predicted lower achievement and higher absences which in turn predicted fewer years of education, which then predicted more violence charges. Neighborhood disadvantage appears to be fully mediated through achievement and absences and education for violence charges. Similar mediation effects were observed for property charges and drug charges.

Moderation by gender

To assess the hypothesis of gender moderating effects on the relation between achievement and criminal charges and absences and criminal charges, two separate models with two interactions were used.

Moderation of achievement by gender. The model for moderation of achievement had an adequate model fit: $\chi^2(10) = 18.851, p = .0422$; $RMSEA = .029$ (90% $CI = .005; .049$). There was a significant interaction between gender and achievement for predicting violence charges ($b = -.141, p < .001$; see Figures 3) and property charges ($b = -.089, p = .003$). Simple slopes analysis indicated that achievement is only protective for males. The higher the achievement scores the fewer violence charges ($b = -.329, p < .001$), and property charges ($b = -.367, p < .001$) males had compared to their lower achieving counterparts. For females, it was a non-significant slope. Overall, females had fewer charges ($N = 35$) than males ($N = 166$). Further the variability was lower for females than males in all three types of charges (e.g. $SD = .68$ vs 1.21 for drug charges). This may have resulted in non-significant slopes, despite the slopes being in the same general direction as males.

Moderation of absences by gender. The model for moderation of absences had an adequate model fit: $\chi^2(10) = 14.671, p = .1445$; $RMSEA = .021$ (90% $CI = .000; .043$). There was a significant interaction between gender and absences for predicting violence charges ($b = .087$, $p = .004$) (see Figure 5). The effect of absences on males was stronger than for females. Simple slopes analysis indicated that absences are a risk for both males ($b = .036, p < .001$) and females ($b = .010, p = .032$). For both males and females, the more absences they had, the more violence charges they had compared to their peers with fewer absences.

Discussion

It has been shown that education lowers the probability of having a criminal charge in adulthood, demonstrating a protective effect (Sourander et al., 2006). However, it is not clear *how* education plays a role in reducing the probability of criminal offending. For example, Kennedy-Turner and colleagues (2020) found that some aggressive children could reduce the probability of a charge in adulthood if they managed to complete secondary school. In the current study, we sought to understand these observed trajectories and to rule out potential confounding variables (e.g. achievement and school absences) between childhood behavior and education, while exploring possible mediating effects. In addition, this study also recognized the importance of gender gaps, both in achievement and absences (Garcia & Weiss, 2018; OECD, 2015; Véronneau et al., 2015).

In the current study, higher aggression predicted criminal charges while having achievement and absences in the model, indicating that aggression has an impact on criminal offending above and beyond its impact on other factors. Additionally, aggression negatively predicted achievement. Conversely, being likeable predicted higher achievement scores. This has also been shown in co-temporaneous analyses of childhood behavior and achievement in the same year, indicating that peer interaction and environmental constructs likely play a role in the development of skills (i.e., language and math) measured in standardized academic testing (see Véronneau et al., 2015). Aggression and likeability affect educational attainment over time and, subsequently, reduce the risk of criminalization. For absences, it was expected that these same variables would be predictors, however all but aggression predicted absences. Measurable risk for criminalization seems to extend back, at least, to peer interactions in childhood. These factors may have far reaching implications through their effects on achievement tests and absences, and educational attainment.

Interestingly, even with achievement and absences in the model, several pathways from childhood behavior to education and criminality remained significant. First, as in the previous study, aggressive behavior in childhood continued to predict adult criminal outcomes directly and not only through mediational pathways involving education. Higher likeability predicted more years of education. Interestingly, social withdrawal also contributed to years of education directly, but not in the expected direction. The more socially withdrawn participants were, the more years of schooling they had. Given the bivariate correlations this may be a suppression effect. Suppression occurs when the effect from a variable (e.g. achievement) increases the predictive effect of another variable (e.g. withdrawal) (MacKinnon et al., 2000).

In terms of potential mediating mechanisms from childhood behaviours and environments to criminalization, several mediational pathways were observed. First, the mediation from aggression to years of education to criminal charges that was reported in Kennedy-Turner and colleagues (2020), was replicated after accounting statistically for achievement and absences. In other words, aggression predicted education independently beyond its relation with achievement and school absences. However, higher aggression also predicted lower achievement scores. That is, childhood aggression presents several risks. Both pathways can ultimately lead to more criminal charges.

Likeability impacted criminal charges in several ways. Likeability directly predicted years of schooling, when accounting for achievement and absences in the model for violence and drug charges, but it didn't when examining property charges. It is unclear why likeability would act directly through education in the cases of violence and drug charges. It is possible that the effects of being liked by peers exhibits protective effects on educational attainment beyond achievement or absences for these charges. These effects might be explained by the fact that

positive peer relations would likely increase informal social bonds with the school environment itself, ultimately reducing the risk of criminalization, especially for more serious crimes such as violent and drug (Sampson & Laub, 1993).

Interestingly, the mediation pathway from neighborhood disadvantage to years of education to criminal charges reported by Kennedy-Turner and colleagues (2020) was reduced to statistical non-significance when accounting for achievement and absences. Although the sample size was smaller and could have contributed to the reduction in significance, other effects in the model remained, indicating that neighborhood disadvantage might have a different causal trajectory than other child behavior variables. In this case, higher neighborhood disadvantage predicted lower achievement scores and higher absences, which then predicted years of education, which in turn predicted charges. Living in a disadvantaged neighborhood has a negative impact on education and this appears to be due at least in part to its early effect on the development of standardized academic skills and on school absences. It is possible that a disadvantaged neighborhood provides fewer resources and school environments may be less academically stimulating. This is the first study to demonstrate that neighborhood disadvantage embeds some of its negative effects on education and crime through impacts on academic skills and reduced school attendance.

In the current study, moderations by gender were also observed. Specifically, males who were high achieving or with a low number of absences were protected against having criminal charges more than their low achieving or frequently absent peers. For females, however, level of achievement did not affect the number of violence or property charges. Although few mean level gender differences existed, one possible reason why females might have fewer charges overall could be due to their higher level of education. Additionally, the gender difference might be due

to females having different mechanisms in their trajectory to offending, especially for violence charges. For example, it has been found that mental health among female juvenile delinquents is a risk factor for later incarceration and chronic behaviour problems (Cauffman, 2008). Further mental health diagnoses are well known risk factors for later poor life outcomes (Hastings et al., 2019). In the present sample, females (n =337) had significantly ($t(1038) = -6.72$, $p < .001$) more mental health diagnoses than males ($n = 212$). Although mental health was included in these models as a covariate, it would have been interesting to examine the differential effects between genders for this variable and its relation to criminal outcomes. Given the restricted variance in the outcomes and in conjunction with the unknown timeline of the diagnosis, including mental health as a covariate was the best option. Researchers should examine mental health beyond its effects as a covariate in the future. Nevertheless, this is one of few studies of a non-clinical sample that includes mental health for females as a predictor of criminal outcomes.

In contrast, there were significant slopes for both genders when examining the interaction with absences in predicting violent charges. This was found despite the overall low rates of criminal offending for females. Both males and females who had more absences subsequently had more violence charges compared to their lower absence counterparts. Frequent absenteeism from school for both genders could be indicative of several risk factors (Howell & Egley, 2005; Schram & Gaines, 2005).

Strengths, limitations, and future directions

The study design allowed the use of multiple sources of information across a timespan of about 30 years. This community-based sample was not selected specifically for criminal charges which (as expected) resulted in a low prevalence of charges. Another strength of this study is that we could observe effects of achievement and absences for females within a community-based

sample, who would be expected to have a much lower number of charges relative to males. This adds to the literature on criminal offending by including females that may be at risk for criminal offending within the study of developmental trajectories.

By including academic achievement scores and school absences in the design, it was observed that staying in school plays a meaningful role in the development of criminal offending, which is not fully explained by academic ability or frequent school absences. This adds to the literature that demonstrates educational attainment is protective for later criminalization. Further, by examining pathways with different types of peer interactions (i.e. withdrawal and likeability), in addition to aggressive childhood behavior, this study elucidates the trajectories from early peer relationships and social skills to educational attainment and subsequent criminalization.

This study also has specific limitations. For example, although neighborhood level disadvantage was examined, it would be important to include measures of family disadvantage as part of the mediation model. Family socioeconomic variables could not be included in the main analyses (as a mediator) because we would likely over identify the model (e.g. zero degrees of freedom), and reduce the variance in the outcomes. Post hoc-analyses ($n = 701$) including a proxy for family level income (e.g. occupational prestige) as a control variable was carried out. There were no changes in terms of direction of the effects observed, but there were some changes in significance levels. This is likely due to loss of power. For example, the coefficient for the mediation from likeability to absences to education to violence charges remained the same in both models ($B = -.001$) although it was no longer statistically significant in the post-hoc model. Future research should include family socioeconomic variables because it might be especially important in understanding how economic disadvantage contributes to achievement

and to absences, perhaps by explaining at a micro level what resources may not be available to individuals. Another limitation is that the reason for absences was unknown. Reasons range from medical, to familial conflict and obligations, and to truant behaviour. There are also likely to be heterogeneous effects amongst those with very high number of absences versus those with a lower number. Further, absences was for one year and were not cumulative to educational attainment level. A more complete record of absences over time might reveal interactive or sequential effects linking school attendance, peer relationships, and academic abilities.

Although including gender within the design presents us with several strengths, it is also important to note that there were gender differences in the number of charges, where males had the majority of charges in the sample. This could mean that the males were driving the observed effects given the low frequency of female offenders.

Another limitation is that education in this study was examined as years of education. It is possible that staying in school only matters to a certain point (e.g. high school diploma, vocational diploma) and that the effects are less heterogeneous after those points. Future research should examine these potential cut points to more clearly elucidate the path to criminal offending.

Future research should examine other factors that contribute to variability in school absences. For example, if individuals are missing school because they are suspended or skipping, then these are very different reasons compared to those that are absent due to medical or social (e.g. poverty, frequent moving, familial obligations) reasons. Additionally, the reasons for absences may be different for girls and boys, complicating the etiology of educational attainment and criminal offending. Although the outcome might be similar, understanding why people are missing school would help to target interventions to specific subgroups.

Implications for policy and conclusions

This study adds to the body of research highlighting the importance of education in the prevention of crime. Interventions to reduce criminal offending should be directed to males who are low achieving and/or frequently absent, and for females who are frequently absent. Although there are several reasons why males might be low achieving or why either males or females might be frequently absent, given the effects observed here, targeting poor neighborhoods, and social interactions between peers in school might improve both academic abilities and reduce absences. It is also possible that children with poor peer relationships end up in a vicious cycle of not performing well and/or being frequently absent which then impacts their peer relationships. Therefore, interventions to improve neighborhoods and peer relationships will ultimately have several positive benefits.

Preventing criminalization will also require policy changes to ensure that all children are able to attend school for as long as possible, at least through secondary or vocational program completion. In conclusion, these results demonstrate the importance of keeping at-risk children in school and supporting successful academic performance. These changes and interventions could have far-reaching positive effects into adulthood, for both individuals and for society

Table 1

Descriptive statistics

Variable	Females		Males		Combined (Males and Females)	
	Mean (SD^2)	*Min – Max*	*M (SD^2)*	*Min – Max*	*M (SD^2)*	*Min – Max*
11. Age at PEI (years)	10.68 (2.60)	6.52–15.47	10.99 (2.59)	6.53–15.28	10.83 (6.75)	6.52–15.47
12. Aggression (*z*-scores)	.28 (1.02)	-1.47–2.99	.24 (0.98)	-1.76–2.99	.26 (1.01)	−1.76–2.99
13. Social With. (*z*-scores)	.35 (0.92)	-1.36–2.89	.40 (1.00)	-2.95–2.95	.37 (0.92)	−1.84–2.95
14. Likeability (*z*-scores)	-.06 (0.97)	-2.50–2.65	-.08 (0.92)	-2.20–2.92	−.07 (0.89)	−2.51–2.92
15. Achiev. (stanine)	4.72 (1.71)	1.00–9.00	4.54 (1.51)	1.00–8.50	4.53 (2.62)	1.00–9.00
16. Absences (days)	9.32 (10.52)	0.00–91.50	9.54 (11.93)	0.00–99.50	9.43 (125.75)	0.00–99.50
17. Education (years)	11.90 (1.68)	10.00–20.00	11.46 (1.60)	6.00–20.00	11.98 (2.83)	6.00–20.00
18. Neigh. Dis. (*z*-score)	.04 (1.04)	-1.56–2.15	.02 (1.01)	-1.56–2.15	.03 (1.05)	−1.56–2.15
19. Violence Charges	.02 (.22)	0.00–3.00	.62 (2.39)	0.00–27.00	.31 (2.87)	0.00–27.00
20. Property Charges	.05 (.40)	0.00–6.00	1.08 (4.35)	0.00–62.00	.55 (9.46)	0.00–62.00
21. Drug Charges	.08 (.67)	0.00–12.00	.31 (1.21)	0.00–13.00	.19 (0.96)	0.00–13.00
	N	*Valid %*	*N*	*Valid %*	*N*	*Valid %*
22. Mental Health						
3. No Diagnosis	201	37.40	290	57.80	491	48.27
4. Diagnosis	337	62.60	212	42.20	538	51.73
N of participants	538		502		1040	

Note. SD^2 = Variance; Social With. = Social Withdrawal Neigh.Dis. = Neighborhood Disadvantage; Acheiv. =Achievement

Table 2.

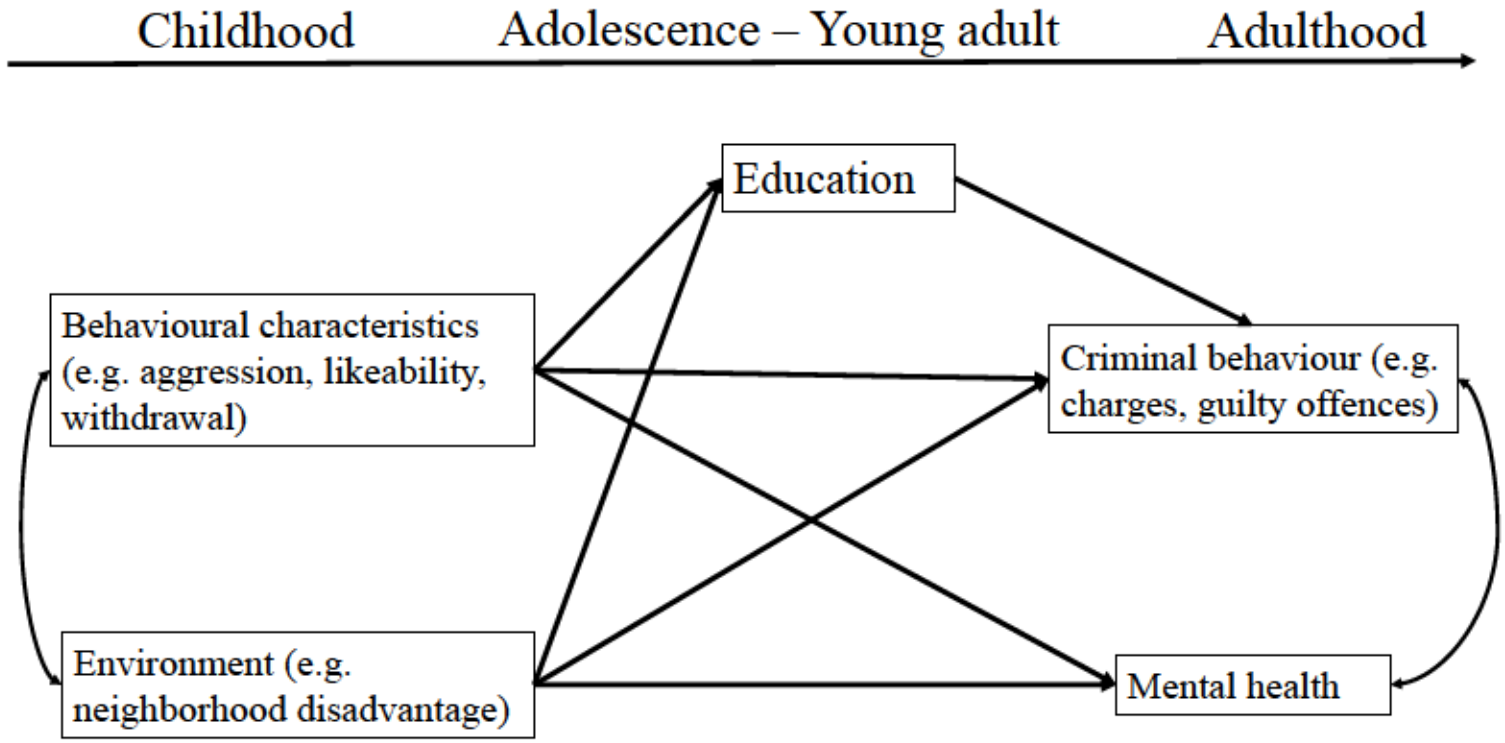
Correlations among all variables

Variable	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.
1. Age at PEI	–												
2. Gender (0, 1)	.061*	–											
3. Aggression	−.090**	−.022	–										
4. Withdrawal	−.024	.026	−.049	–									
5. Likeability	−.034	−.010	−.105**	−.155***	–								
6. Achievement	−.120***	−.055	−.260***	−.138***	.388**	–							
7. Absences	.176***	.010	.041	.089**	−.171***	−.177***	–						
8. Education	−.034	−.133***	−.230***	.007	.232***	.440***	−.184***	–					
9. Neigh. Disadv.	.200***	−.013	.009	−.004	.036	−.290***	.123***	−.166***	–				
10. Mental Health	.051	−.204***	.132***	−.016	−.028	−.054	−.094**	−.026	.020	–			
11. Violence Charges	.005	.177***	.185***	.023	−.052	−.122***	.104**	−.163***	.030	.035	–		
12. Property Charges	−.029	.168***	.152***	.025	−.052	−.091**	.022	−.141***	−.007	−.027	.490***	–	
13. Drug Charges	.004	.122***	.139***	−.029	.000	−.038	.025	−.138***	−.010	.053	.207***	.267***	–

Note. * $p < .05$, ** $p < .01$, *** $p < .001$ (two tailed). Neigh. Disadv. = Neighbourhood Disadvantage, F=Female (0), M=Male (1),

Figure 1

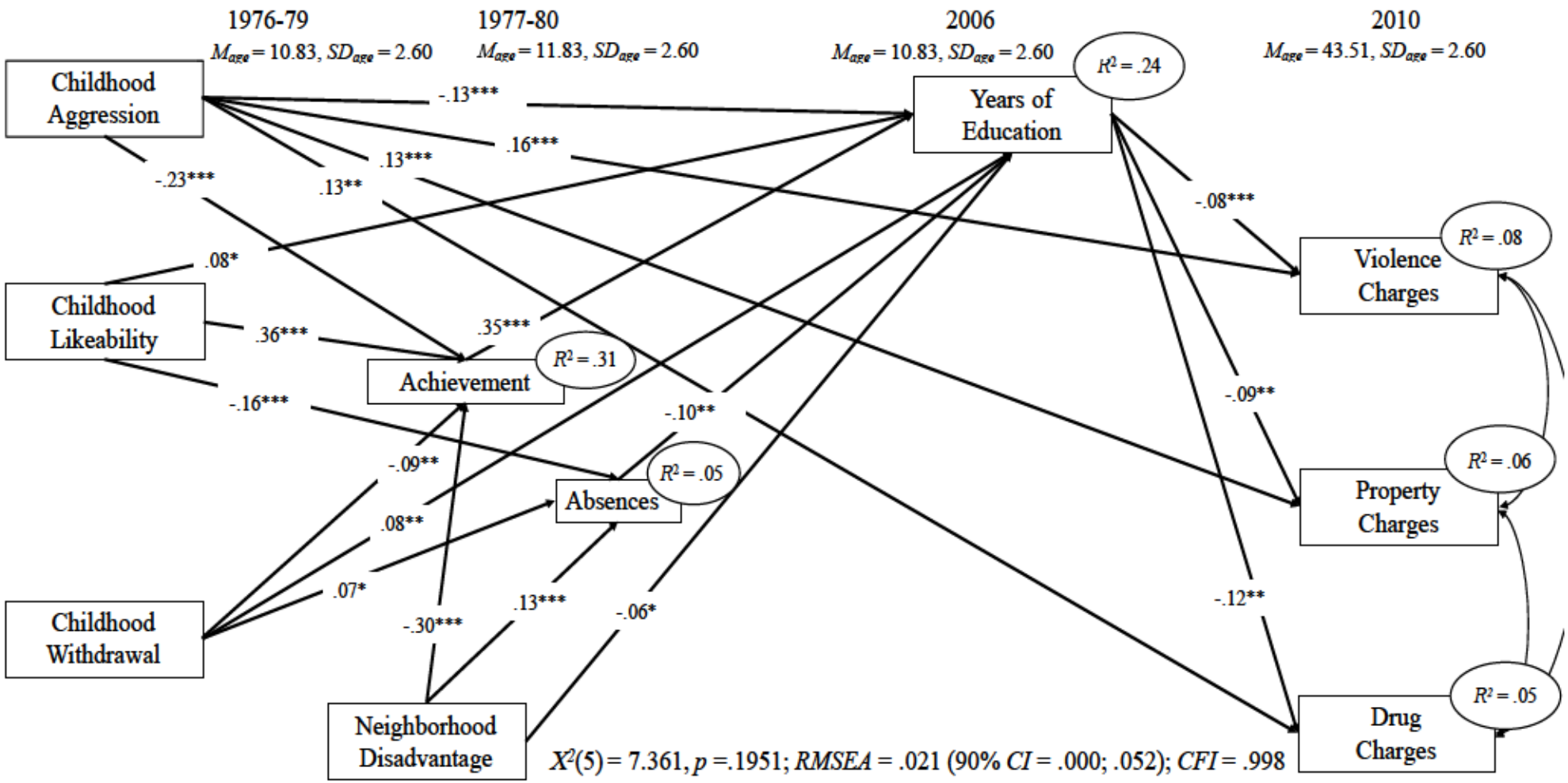
Theoretical model



Note. Reprinted from Kennedy-Turner, K., Serbin, L.A., Stack, D.M., Dickson, D.J., Ledingham, J.E. & Schwartzman, A.E. (2020). Prevention of Criminal Offending: The Intervening and Protective Effects of Education for Aggressive Youth. *The British Journal of Criminology*, *60*(3), 537–558. https://doi.org/10.1093/bjc/azz053

Figure 2

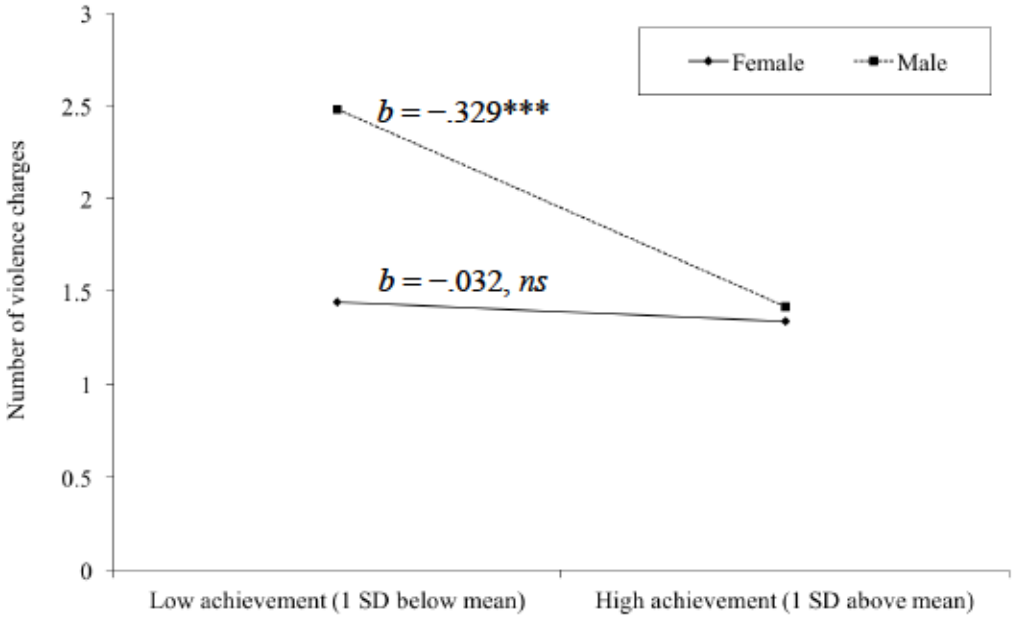
Path model with absences and achievement



Note. * $p < .05$, ** $p < .01$, *** $p < .001$ (two-tailed). These are standardized coefficients with p-values based on unstandardized coefficients. Non-significant paths were removed from the diagram for clarity. Mental health, age and gender are included in the statistical model but are not shown here for clarity.

Figure 3

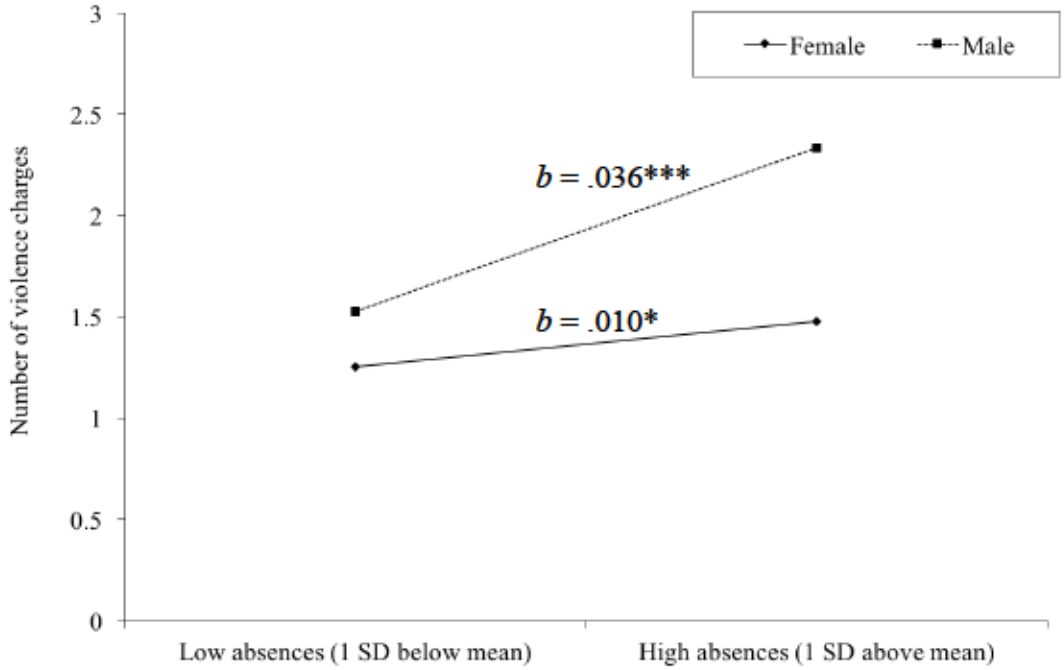
Moderation of achievement by gender predicting violence charges.



Note. * $p < .05$, ** $p < .01$, *** $p < .001$.

Figure 4

Moderation of absences by gender predicting violence charges.



Note. * $p < .05$, ** $p < .01$, *** $p < .001$.

Chapter 6: General Discussion

Effects from variables in childhood can have far reaching effects on several domains in adulthood, including quality of life, education (Dodgeon et al. 2020) and criminal offending (Kennedy-Turner et al., 2020). The current dissertation examined the role of education in the pathways from childhood risk and protective factors to criminalization in adulthood. Given that education is often used as a control variable because it reduces the probability of criminal offending, in this dissertation I sought to examine the role of education as a process variable within a developmental model. The first study examined educational attainment in two unique roles. The first was in the role of mediator between childhood aggression and neighborhood disadvantage and criminal charges. The second role was examining education as a variable moderated by childhood aggression and neighborhood disadvantage. Study 1 also used causal modelling methods with observational data (i.e. non-experimental), which has not often been applied to this type of data. In the second study, education was maintained as a mediator, while including variables known to contribute directly to education to help understand the processes whereby childhood risk impacts education, subsequently increasing the probability of criminal offending. Study 2 included the addition of achievement scores and school absences. It also included the pathways from social withdrawal and likeability as factors that contribute to educational attainment and subsequent criminal charges in adulthood.

The results from these two studies demonstrate that formal education plays an important role in reducing the probability of criminal charges. The role of education remains beyond the impact of achievement abilities under certain circumstances. For example, aggression acts both directly and indirectly on the level of educational attainment, which in turn impacts the probability of criminal offending. However, neighborhood disadvantage seems to only exert its effect on educational attainment and ultimately criminalization through achievement and absences. Together the results from these studies provide valuable information about the role education plays in the developmental trajectory towards criminalization.

The specific research question addressed in Study 1 was "*Does education intervene and/or protect against childhood risk factors in the pathway to criminalization?*". The results from this study are consistent with previous findings demonstrating that education reduces the probability of criminal offending (Lochner, 2011; Sabates, 2008). Specifically, higher aggression and neighborhood disadvantage contribute to lower educational attainment (less time spent in

formal schooling). This in turn predicted a higher probability of criminal charges. Not only did aggression act on criminal charges through education, it also moderated it, such that children with higher levels of aggression and with low education had the highest risk of a criminal charge, while a subgroup (approximately 36% of those above 1*SD*) of aggressive children who were able to complete more years (12 or more) of education were protected and had probabilities of criminal offending near their peers with low levels of aggression. This provided evidence that aggression has far reaching effects into adulthood through various mechanisms, including educational attainment.

Study 2 sought to delineate the relation between childhood aggression and other childhood behaviours and education, and ultimately criminal offending, through effects on achievement skills and absences. The specific research question for Study 2 was "*Which of the childhood risk and protective factors contribute to the role education plays in the pathway to criminalization?*". Recent research has highlighted the importance of factors (i.e. intelligence and truancy) that contribute not only directly to criminal offending but also to education (Nieuwenhuis, & Hooimeijer, 2015; Ou et al., 2007; Stipek & Miles, 2008). In Study 2, we used a variable derived from the participants' scores on standardized math and French achievement tests. Although this is not a direct measure of intelligence, it is correlated with similar measures and has been predictive of educational outcomes (Ou et al., 2007; Véronneau et al., 2015). We also included absences in this model. Participants could have been absent for any number of reasons, and not just due to suspension for severe behavioural problems. Regardless, the impact of achievement and absences was as expected. Additionally, we examined the effects of other childhood behaviours including likeability and social withdrawal. Neighborhood disadvantage was also included in this model.

The results of Study 2 suggest that childhood aggression has strong and far reaching effects that act both directly on criminal offending (B =.13–.16) and indirectly through lowered achievement scores (B =-.23) and education (B =-.13). Interestingly, aggression did not predict absences in our sample. Given the non-significant correlation, it is unlikely that this was a suppression effect. However, both likeability and social withdrawal predicted achievement and absences in the expected directions. These effects, in turn, predicted education and subsequently criminal charges.

An unexpected result that emerged from Study 2 was that the mediated path from neighborhood disadvantage to education to criminal charges observed in Study 1 dissolved to non-significance when including achievement and absences in the model. Neighborhood disadvantage seemed to exhibit its long-term effects on educational attainment and criminal charges primarily through its effects on variables that can be measured during childhood, including academic achievement and absences, especially for violent charges. This is consistent with research that demonstrates poorer neighborhoods are associated with more absences from school (Garcia & Weiss, 2018; Ready 2010) and lower performance on academic tests (Greenman et al., 2011). In addition, the effects of achievement and absences were moderated by gender. Specifically, males with low achievement had a higher probability of criminal charges. For both males and females having high absences was a risk for offending. These results provide a clearer understanding of the factors that affect males and females differentially.

Study 2 provides evidence that educational attainment, even after including achievement and absences in the model, still has strong reductive effects on the probability of criminal charges in adulthood. Given the relations between childhood behaviour such as aggression and likeability, and educational attainment, it is possible that peer relations and social competencies play a large role in both positive (e.g. higher educational attainment) and negative (e.g. criminal charges) outcomes in adulthood. Interventions to reduce criminal offending in a population need to focus on childhood interactions amongst peers especially those who are aggressive or less likeable.

It is widely acknowledged that education reduces the probability of criminal offending. As such, education is typically used as a control variable to help researchers establish a relation between risk factors, such as aggression or economic disadvantage and criminal offending. However, when education is included in models either as a control variable or as a composite variable including other socio-economic measures (e.g. income, occupational prestige), the effects of education are ignored. Although the statistical model is considering the statistical effect of education, researchers will often isolate the results from their risk factor of interest. This dissertation, therefore, offers two main novel contributions to the literature on risk and criminal offending. First, it addresses the issue of neglecting the effects of education beyond that of a control variable. In fact, as was observed in this dissertation, education, specifically the level of attainment, plays not only an intervening (mediating) role but also exhibits a protective effect for

aggressive children. Second, this dissertation contributes to research making use of causal mediation methods with observational (i.e. non-experimental) data.

The results from this dissertation provide new information on the role education plays in the trajectory to criminal offending. The studies also highlight the importance of peer relations in childhood as contributors to both education and criminal offending. Further, these studies add to our understanding of the way in which risk factors such as neighborhood disadvantage and aggression impact children, with far reaching effects into adulthood.

The long reaching effects of childhood experiences and characteristics are incorporated in conceptual developmental models such as the Ecological Systems Theory proposed by Bronfenbrenner (1979). Further, these results align with this theory in that the factors from different levels of the system (i.e. individual to neighborhood to school) interact and affect each other. The models proposed in this dissertation also align with several criminology theories, including those examining the risk for violent crime. Taken together the results of this dissertation demonstrate the important contributions of childhood peer relations, neighborhood disadvantage, and educational attainment. Although there are other factors that can contribute to both educational attainment and criminal charges, this dissertation provides a starting point for research that would include other levels of analysis to better understand the etiology of not only crime, but other outcomes (e.g. educational attainment, mental and physical health outcomes) in adulthood.

Strengths and Limitations

This dissertation utilized a longitudinal data set that spans over 30 years. This allowed my co-investigators and I to obtain measures of participants from across much of their life-course. Additionally, the data for this research included criminal data that was objective, as it was retrieved from the courthouse. This is especially important because asking participants how many charges they had would likely have underestimated the number of charges they received. By obtaining objective data from court records, we are avoiding that bias. This is also the case for the education records (including attainment, achievement scores, and absences). These records were obtained from government agency records dating as far back as 1976, when the participants were first identified, and therefore avoids the bias associated with self-report. Further, these studies used peer-nomination surveys for the assessment of aggression, likeability, and social withdrawal. These provide valuable information about how the child is seen by peers and the

relationships that exist between them. This type of measure gives researchers an indication of how that participant is viewed by others in the class, providing this valuable information from the perspective of multiple raters. The results speak extensively to the impact that early peer relationships may have on outcomes across the lifespan.

Another major strength of this dissertation is the use of sophisticated statistical modelling in both studies. With these methods, the criminal charge outcomes could be kept in their expected distribution (zero-inflated). Study 1 used causal mediation based on counterfactuals, allowing access to the same variable (educational attainment) as part of a mediation and as part of a moderation. Other commonly used least squares methods for mediation assume no moderation between the exposure (e.g. aggression) and the mediator (e.g. education). However, since it is hypothesized that education can both mediate, and be moderated by, aggression, it is important to apply techniques that allow for this. There are limitations to the interpretation of causal effects which are discussed below. In Study 2, the outcome was a Poisson-type of distribution for number of criminal charges. Both maximum-likelihood (ML) and maximum-likelihood with robust standard errors (MLR) estimators were tested, however they yielded similar results and for ease of interpretation, the results from the ML estimator were retained.

Although this dissertation had many strengths, there were also several limitations. First is the interpretation of causal effects from Study 1. Although causal mediation was used, causal statements could not be made. The biggest factor impacting those interpretations is unmeasured confounds which could be affected by the exposure variable and could affect the mediator variable (VanderWeele, 2016). There are potential solutions (e.g. sensitivity analyses; VanderWeele, 2010), however these were beyond the scope of this dissertation especially given that the effects appear to be robust in the models. It is important to acknowledge that without identifying and including these confounds or using sensitivity analyses the results of Study 1 may appear stronger than they are. Despite this, the results from Study 1 appear to be robust and would likely not be impacted by unmeasured confounds.

In Study 2, the variable of absences was included. There were some limitations of using this variable and in the interpretation of its effects. First, the variable was absences for one year only. Although patterns of absences could be associated across several years it needs to be acknowledged that a snapshot of absences may not provide as rich a source of information as examining patterns across multiple years. Second, the reason for absence was not recorded.

Although being absent from school regardless of the reason will have impacts on the child (DfEE & Home Office, 2001), understanding the reason why could help target intervention. Absences related to illness or lack of financial/health resources could be different in impact from absence due to suspension or truancy.

Another limitation of this dissertation is the assumption that educational attainment preceded a criminal charge. As stated in both studies, participants who had a year of attainment registered after their first charge, were excluded from the studies. However, these participants who appear to have obtained education after their first charge present us with a unique subset of individuals who may desist from further criminal offending. Although looking at those who desist from crime would further elucidate the impact of positive factors (i.e. likeability, educational attainment), examining these participants would have significantly reduced the sample size and power to run the models with such complex research questions. Factors that contribute to the trajectory for these specific individuals could be important in designing interventions targeting first-time offenders and should be examined in future research.

This dissertation is unique in that it includes data from participants that were recruited in grades 1,4, and 7. This, however, presents a limitation through the effects of cohort. Although age was included in both studies, and Study 2 examined the effect of cohort on the outcomes (with little change to outcomes), it is possible that trajectories are slightly different amongst these three different recruitment age groups.

Finally, no biological measures were included in this dissertation. Although this might seem out of place for a study on behavioural outcomes, it is important to acknowledge that behaviour does not occur in a vacuum and has several layers of influence. Specifically, a proximate cause of behaviour could include underlying biological mechanisms (e.g. the stress response system). As will be discussed in the future directions section below, developmental models that include examining biological changes throughout the lifespan give this as a proximate cause as part of the life course trajectory. One such model that includes the stress response system is the adaptive calibration model (see below; ACM; Del Giudice et al., 2011).

Future Directions

Results from the current dissertation provide information on behavioural and environmental factors that impact education and criminality in adulthood. From these results, there are several questions that could be addressed and further examined in future studies. In both

studies participants were removed if they had their education attainment year the same year or later than their first charge. Within these participants, there could be criminals who desist after their first charge, especially if they returned to school. Recently, Jäggi and colleagues (2019) found that young offenders with positive school attachment had a decrease in offending 12 months after release. Interestingly, grades were not a predictor of this same outcome. Attachment to school, as hypothesized in this dissertation is a strong factor not only in preventing criminal offending but it also likely contributes to desistance from crime. A report prepared for the National Institute of Justice demonstrated that one of the key factors for reducing recidivism was completion of high school (Lattimore et al., 2018). Future studies should examine those that return to school after committing a crime and/or those that stop after the very first charge, as they have a very particular trajectory that may include returning to school as a protective factor against subsequent crimes.

This dissertation examined three different types of crimes: violent, property, and drug charges. Although the trajectories appeared similar for violent versus non-violent offenses, examining the characteristics of these groups of offenders was beyond the scope of the current dissertation. There are likely several differences between violent and non-violent offenders. Savage and Wozniak (2016) proposed the "differential etiology of violence" hypothesis. This hypothesis suggests that there are different predictors in the trajectory to violent offences compared to non-violent offences. Factors such as early first offenses, lower educational attainment, and childhood aggression are all strong predictors of violent offenses (Farrington et al., 2012). These factors also overlap with non-violent offenses but crimes are rarely compared in this way, as many researchers assume a general tendency towards criminality regardless of type of crime, as the main driving outcome. Recently however, Savage and Ellis (2019) sought to examine this differential etiology more closely. Interestingly they found that academic achievement was a strong negative predictor of violent crimes, while school attachment did not. Given the strong relations between peer interactions and academic achievement in the present dissertation, examining these variables in the context of violent vs non-violent trajectories is essential in determining protective factors against the most heinous of crimes.

Although this dissertation included several behavioural and objective variables, physical environment was not included. The measurements for neighborhood disadvantage in the current dissertation used census data. This is considered an objective measure of relative social and

economic disadvantage for neighborhood of the school of the participant, who probably lived within walking distance, and the same sortation code. However, these measures do not necessarily relate to the physical environment. Recently the use of physical environments has demonstrated that poor physical environments contribute to poor behavioural and health outcomes (Renalds et al., 2010). Specifically, built environment could include lighting, green space, walkability, noise pollution, residential density, and availability of resources (Nordbø, et al., 2018). Poorer built environments (e.g. more noise, less green space, less resources) have been associated with criminalization (Anderson et al., 2013), and increased stress (Matthews & Yang, 2010). Physical environments provide information about neighborhood disorder (e.g. Karb et al., 2012), while socio-economic measures tend to provide information about neighborhood disadvantage (Diez-Roux, 2001; Carpiano, 2007). Disorder and disadvantage appear to be related but distinct constructs. Including physical measures of environment (e.g. disorder, geographic information) alongside measures of disadvantage (e.g. census tract data) will add another layer to understanding the trajectory towards poor outcomes including criminalization.

Stress-related outcomes have recently been studied across several disciplines. As mentioned previously, the stress response system is a viable proximate cause for behaviour across the lifespan. This dissertation did not include measures of physical stress, but future research should consider the stress response system as an important long term contributor to criminal behaviour. To understand the links between environments, physical systems, and behavioural outcomes, the adaptive calibration model (ACM) can be used to incorporate these different levels of influence (Del Giudice et al., 2011). The ACM highlights that early environments influence the stress response system which in turn calibrates the behavioural response of the individual. The stress response system acts as a proximate cause for behaviour. A model could be derived using the basis of the ACM and incorporating the physical neighborhood environment and behavioural outcomes such as criminal offending. Future research could conceptualize and test a model where neighborhood disadvantage and the built environment predict indicators of the stress response system (e.g. diurnal cortisol slope), which in turn predict educational, physical health, and criminal outcomes. See Figure 1 for a diagram of this future study conceptualization.

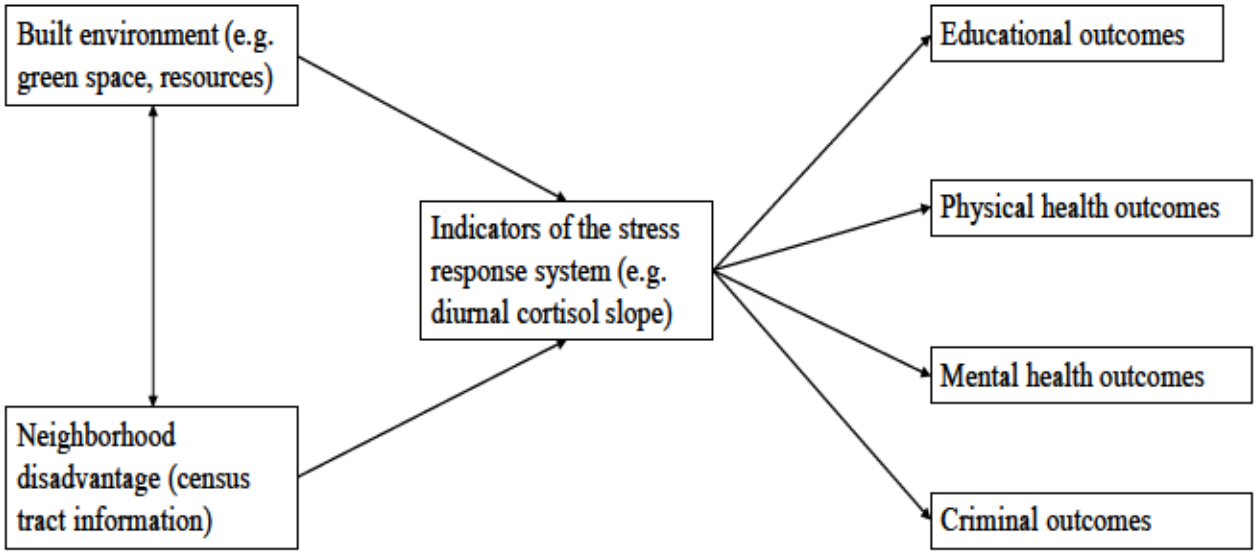
Implications for research and practical interventions

The findings of this dissertation have implications for both future research and practical interventions. First, the most important implication is that the researchers examining both risk

and protective factors for criminal offending should not use all socio-demographic variables as "controls" in their analyses. As observed in the present studies, educational attainment can play an important role in the structural model of the development of criminal offending. Second, researchers should not avoid using causal modelling if they have observational data. This type of modelling is robust especially for zero-inflated outcomes like criminal charges. Instead of converting these types of outcomes to a more "normal" distribution, it is recommended to maintain the distribution as it would naturally occur in the population. Indeed, we expect there to be fewer criminals than non-criminals in most populations.

Figure 1

Future Study Conceptualization



Although causal modelling has strict assumptions that have to be met, sensitivity analyses as described in VanderWeele (2010) can be utilized to assess the robustness of the observed effects and under what conditions confounds would need to exist to disrupt the observed effects. The results of this dissertation demonstrate the usefulness of sophisticated modelling in understanding the developmental processes leading to criminal offending. The findings also demonstrate the importance of including factors like education as variables that are part of the structural mechanism examined in studying trajectories leading to criminal offending.

This dissertation underscores the potential importance of early intervention for adult criminal outcomes. As has been observed in other studies, childhood aggression has far reaching effects (Huesman et al., 2009; Serbin et al., 2011; Stack et al., 2017; Stipek & Miles, 2008).

Based on the current findings, it appears that social withdrawal may have negative impacts on child development as well. From the positive side, likeability in childhood appears to contribute positively to academic skills, fewer absences, and overall higher educational attainment. This speaks to the importance of positive peer relations and social competencies early on. Interventions directed at keeping youth in school for longer will improve outcomes in many domains. It will also likely reduce the probability of criminal offending. Specifically, interventions could improve social skills of aggressive and withdrawn children. The resulting improvement in peer relations could be protective for these at-risk children. For example, Wilson and Lipsey (2007) found that many programs (including social skills training) improved behaviour in childhood. Further, policy requiring a standard level of enrichment (i.e. providing schools with resources and materials to improve learning) in the school or to provide a better physical environment at the school (e.g. increased green space) could promote attachment to the school environment. This would also help directly with students' achievement, given the enriched environments. The results of these studies demonstrate that childhood behaviour does not need to be a lifelong risk. Instead, these studies raise the possibility that with proper early intervention youth displaying aggressive behaviour and/or social withdrawal could develop the skills necessary to maintain positive relationships throughout their schooling and adult years.

To conclude, the results from the two studies making up this dissertation provide valuable contributions on the role educational attainment plays in the trajectory from childhood risk to criminal offending. Education appears to play an intervening and protective role for at-risk children. Even when academic skills and absences are included, educational attainment stands out as a strong factor in reducing the probability of criminal offending. Relatedly, students who drop out and do not attain education past a certain level (e.g. incomplete high school diploma) are at risk and would benefit from intervention to help them continue in school to a point that reduces their risk level (Serbin et al., 2011). Further, the importance of peer relations stands out as a strong contributor to academic abilities, educational attainment, and ultimately criminal offending. These findings support theories that conceptualize the trajectory to adult outcomes as a complex, multi-level process. Understanding these complex relations through models like those employed in the present dissertation will further elucidate potential developmental opportunities for early intervention, improving overall outcomes both for the individual and for society.

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