ABSTRACT

Title of dissertation: CAN SELF-CONTROL CHANGE SUBSTANTIALLY OVER TIME?: RETHINGKING THE NATURE AND ROLE OF SELF-CONTROL IN GOTTFREDSON AND HIRSCHI'S GENERAL THEORY OF CRIME

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The primary goal of this study is to verify if the changing level of structural and situational 'sensitivity' to costs and benefits associated with deviant behaviors (e.g., Hirschi (2004) and Gottfredson (2006)'s redefined self-control, Tittle, Ward, and Grasmick's (2004) "desire to exercise self-control," Wikström and Treiber's (2007) "situationally-based" self-control) is associated with the changing level of more general 'ability' to measure costs and benefits within individuals (e.g., Gottfredson and Hirschi's (1990) trait-like self-control, Tittle, Ward, and Grasmick's (2004) "capacity for self-control," Wikström and Treiber's (2007) "executive capability"). More importantly, to better disentangle the causal mechanisms underlying stability and change in offending behaviors over time, This study examines how low self-control as one of the constituent elements of offending propensity changes over time in the general population and across different study groups using both a hierarchical linear model (HLM) and a second-order

latent growth model (LGM). Then, structural equation modeling (SEM) is employed to examine the on-going processes of cumulative advantage and disadvantage by more explicitly testing the bidirectional relationship of key theoretical constructs (e.g., self-control vs. social control/bond) over time.

In contrast to the Gottfredson and Hirschi's prediction, this study found meaningful differences in the growth pattern of self-control among individuals in the population in general and especially across different study groups. Interestingly, the changing level of social control/bond triggered by experimental conditions accounted for the between-group difference observed. The same pattern persists when different analytic techniques and model specifications are applied to test the same research hypotheses, which suggests that the results are not an artifact of measurement error, model specification, or statistical methods. Most of all, this study was able to better disentangle the 'long-term' relationship between self- and social control variables, which is found to be more dynamic and bidirectional than previously hypothesized.

CAN SELF-CONTROL CHANGE SUBSTANTIALLY OVER TIME?: RETHINKING THE NATURE AND ROLE OF SELF-CONTROL IN GOTTFREDSON AND HIRSCHI'S GENERAL THEORY OF CRIME

by

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Dedication

To Yun Jung (Angela), Grace, and Andrew

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1 Introduction

1.1 Statement of the Problem

1.1.1 Theoretical Issue

Every discipline in the behavioral and social sciences seeks to understand the patterns and sources of stability and change in the key variables of interest because such efforts could be meaningful not only for theoretical development, but also for policy. In the field of criminology one of the on-going debates that are not easily resolved is why some people continue to commit criminal and deviant acts while others desist. For the past two decades or so, therefore, criminologists began to address more explicitly the question of what drives stability and change in an individual's pattern of offending behavior drawing on their key theoretical concepts and propositions, sometimes through theoretical elaboration or modification. Basically, most theoretical perspectives focus on *either* the stable *or* dynamic nature and role of individual characteristics or social environments. While most recent theory and research begin to emphasize the dynamic interaction of both internal and external factors (e.g., Le Blanc 2006; Wikström and Treiber 2009), the role played by *both* individuals *and* their environment in promoting persistent offending or desistence from criminal career has been for the most part neglected and unexplored.

The on-going controversy between self- and social control theories as two different perspectives based on the same control tradition best exemplifies the current criminological thinking regarding the patterns and sources of stability and change in offending over time. Gottfredson and Hirschi's (1990) general theory of crime has been

very successful in generating empirical research for the past two decades largely because of their bold statements about the theory's 1) predictive ability (e.g., "trait-like" low self-control is the primary cause of criminal and analogous behaviors), 2) pure population heterogeneity argument (e.g., once the level of self-control is established in the early childhood, it remains relatively stable over time, not being influenced by subsequent social experiences and circumstances), and 3) generalizability (e.g., self-control has very general manifestation on not just crime but also most of other behaviors, across all times and places). At a glance, the causal mechanisms which link key inhibiting factors (e.g., self-control, informal social control) to offending are similar for both control perspectives because each affects individual's rational reasoning process of deciding whether to engage in crime or not. However, Gottfredson and Hirschi's (1990) new theorizing contrasts sharply with Hirschi's (1969) earlier work of social control theory[1] and its modified version of Sampson and Laub's (1993) age-graded informal social control theory, especially in explaining the stability and change of offending behavior over time. For example, Gottfredson and Hirschi (1990: p.107) claimed that "differences between people in the likelihood that they will commit criminal acts persist over time," which suggests that relative rankings of self-control between individuals remain stable over time (Sampson and Laub 1993: p.16) and dynamic social factors over the life-course such as accumulating experience, situational contingencies, and changing life circumstances can

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[1] Although Gottfredson (2006) in his redefinition and re-operationalization of self-control emphasizes that "self-control theory is not an implicit rejection of the earlier social control theory upon which it is founded" (p.78) and they have become reconciled by their empirical treatment because "they are very difficult to discriminate empirically and, under some circumstances, may amount to the same thing" (p.86), we cannot deny that Gottfredson and Hirschi (1990)'s original conceptualization of the nature and role of self-control was a departure from Hirschi (1969)'s control perspective for the reasons that follow.

have only trivial effects on the propensity to offend such as is captured by low self-control (Hirschi and Gottfredson 1995). This 'relative stability' postulate of the theory has sparked one of the greatest controversies within criminology for the past decade or so (e.g., Hirschi and Gottfredson 1995 vs. Sampson and Laub 1995). When we consider that this issue of stability and change is deeply embedded not only in the ongoing debates within contemporary criminological theories (e.g., population heterogeneity vs. state dependence; self-selection vs. social causation) but also in the utility of prevention/intervention efforts that explicitly target individual offending propensity such as self-control after the formative period of early childhood, such contradicting positions have significant implications for the future development of criminological theories and crime prevention policies. Especially if self-control, as one of the strongest predictors of crime and deviance, is fixed early stages of life, the role of other time-varying social factors during adolescence and adulthood that most criminological theories emphasize would be completely dismissed or simply reduced to be functioning as criminal opportunity, which Gottfredson and Hirschi (1990: pp.22-44) identified as a necessary factor for low self-control to manifest itself into criminal acts[2].

Although these two control perspectives have both contributed markedly to the present state of knowledge regarding the sources and patterns of stability and change in offending over time, they still leave several important issues underdeveloped or even unaddressed. Most of all, largely due to the incomplete description in the original theory,

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[2] However, Gottfredson and Hirschi (2003) later even discounted the value of criminal opportunity in explaining the occurrence of criminal acts because such opportunities are ample and ubiquitous. Thus, they argue that those with low self-control can easily create criminal opportunities to manifest their criminality into actual crime, which is consistent with their 'self-selection' argument.

the nature of self-control as a crime-inhibiting factor is still under controversy (see Tittle, Ward, and Grasmick 2004; Wikström and Treiber 2007), and recently Hirschi (2004) and Gottfredson (2006) themselves also came to redefine self-control as "the tendency to consider the full range of potential costs of a particular act," suggesting that such inhibiting factors vary in both number and salience in how they are related to criminal activity. Given the lack of such a systematic conceptualization and operationalization that capture the nature and quality of self-control, it is not surprising that extant research cannot provide a definite conclusion about the stability postulate of self-control theory and underlying causal mechanism of both stability and change in offending trajectory over time (e.g., Can the level of self-control change substantially and significantly over time? If so, what explains such variability after controlling for the effects of aging, maturational, or historical processes that are being shared by a general population?).

Therefore, ascertaining the accuracy of self-control theory's stability postulate and further investigation of the possible link between self-control and social control in the explanation of stability and change of offending behaviors could be a critical starting point, not only for the evaluation of the theory itself, but for the future theoretical development of control perspectives and the advancement of larger theoretical enterprise within contemporary criminology (e.g., population heterogeneity vs. state dependence; self-selection vs. social causation). Moreover, a logical extension based on the cumulative evidence of the malleable nature of self-control and dynamic interaction between self and social control mechanisms would be the explicit efforts to reconcile two conflicting perspectives that are based on the same domain assumptions and control tradition but explain the nature of the control mechanism in some fundamentally different

ways. Such efforts will advance theory and research by building on the strengths and

addressing the weaknesses of separate approaches. Although some have already explored

the possibilities of such a theoretical reconciliation[3], they propose an incomplete and

sometimes contradicting picture by trying to incorporate inherently different

understandings of the nature of control without any modification from the original

conceptualization. However, I think if we make a substantive effort to modify the concept

of control to explicitly account for the mechanisms of how the internal and external

elements of control interact with each other over relatively longer periods of time, there

might not be an inherent incompatibility between self and social control perspectives[4]. I

believe that such efforts for reconceptualization of self-control and theory integration can

offer more conceptual richness and greater predictive power, especially in explaining the

nature of stability and change of offending behaviors[5], than each theory can do by

resolving disparate conceptual approaches.

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[3] For example, Longshore, Chang, and Messina (2005) suggested that social bonds mediate the relationship between self-control and juvenile offending. Wright et al. (1999), after finding that the social causation effects remained significant even when controlling for the preexisting level of self-control, also suggested that theoretical models that incorporate both social-selection and social-causation processes are preferred.

[4] In this vein, Taylor (2001: p.383) also suggested that "the difficult task for future research is to provide a coherent conceptualization of control that clearly specifies the elements of both social and self-control, highlighting how they interact and relate to one another, rather than setting them up as contradictory concepts."

[5] In a similar vein, by highlighting that even the most current theory and research focuses only on individual factors but neglects the role of the wider social environment and its impact on how individuals develop, Wikstrom and Treiber (2009) proposed that stability and change in crime involvement are driven by stability and change in the interplay between an individual's propensity to offend (e.g., morality, ability to exercise self-control) and the social environments they are exposed to.

1.1.2 Practical Issue

Rigorous research (e.g., experimental, longitudinal) consistently suggests that early aggression and disruptive behaviors are key predictors for violence and crime throughout the life course (Piquero et al. 2009). Because of this strong linkage or pattern of "cumulative continuity" of antisocial behaviors over the life course and across life domains (Sampson and Laub 1997), early prevention/intervention programs have been developed as an important policy prescription to reduce violence and crime (Farrington and Welsh 2007). Based on population heterogeneity theories that suggest children exhibiting antisocial propensity become increasingly resistant to change over the life course (e.g., Gottfredson and Hirschi 1990), many scholars and practitioners have argued for the cost-effectiveness of such programs being implemented as early in life as possible targeting high-risk children and their families.

Despite the widespread attention devoted to early prevention/intervention programs based on the multiple risk factor approach and substantial amount of empirical evidence that supports their effectiveness, research is surprisingly limited on the issue of disentangling more explicitly the causal mechanisms by which such programs reduce violence and crime. However, we cannot emphasize enough how important such 'process-based,' not just 'outcome-focused,' approach is when we consider that such a more rigorous attempt to assess the efficacy of programs focusing on the question of 'how' and 'why,' not just 'whether,' will better inform program developers and policy makers about the elements and conditions of programs that are related to successful outcomes.

Although most criminological theories emphasize the importance of early childhood

socialization within family and school, Gottfredson and Hirschi's (1990) general theory of crime explicitly points to the theoretical relevance of effective parenting as a key determinant of child socialization, including the notion that the quality of the parent-child relation will facilitate the development of self-control over impulsive, oppositional, and aggressive behavior, thus reducing aggressive and disruptive behavior over the life course. One thing we need to note is that if the theory's 'stability postulate' – which is one of the key theoretical propositions of Gottfredson and Hirschi's theory – holds, any effort targeting at the changing level of self-control after the formative period of early childhood would be meaningless or less cost-effective.

Nonetheless, prevention approaches still seek to reduce or eliminate factors that predict a greater probability of crime and deviance in adolescence and young adulthood, and research has identified inappropriate parenting practices as one of the key predictors of not only early behavioral problems but also later violent, serious, and chronic offending behaviors. Therefore, prevention/intervention programs have explicitly sought to address not just the immediate and situational risk factors but to enhance preventive factors that mediate or moderate exposure to risk such as self-control. However, with current evaluations that simply analyze the mean difference of outcome variables before and after the introduction of preventive intervention programs, it is difficult to identify what features of the programs are responsible for the observed effects, especially when there are multiple interventions operating at the same time. Therefore, more effort should be made to determine the links in the causal chain between family process and antisocial behavior highlighting the nature and role of mediating factors such as offending propensity (e.g., self-control). Such basic research is likely to generate insight and clues

into the sorts of applied programs that need to be developed.

1.2 Current Research Aims

Despite the substantive implications for theory and policy, empirical scrutiny into the malleable nature and role of self-control has been rare and restricted. Although most studies support the central proposition of Gottfredson and Hirschi's theory – low self-control is the one of the strongest and significant correlates of crime and deviance (see Pratt and Cullen 2000), little is known about the pattern and process of how self-control develops over longer period of time. I think such limited understanding results partially from the lack of valid and reliable longitudinal data with long-term follow-ups that take repeated measures of key variables from the same individuals over time. None of the available studies that attempted to test the stability postulate of the Gottfredson and Hirschi's theory appears to be ideal largely because of the absence of such data and appropriate analytic techniques (e.g., Arneklev, Cochran, and Gainey 1998; Turner and Piquero 2002; Raffaelli, Crokett, and Shen 2005; Burt, Simons, and Simons 2006; Hay and Forest 2006). Moreover, none of the extant research explicitly assessed the dynamic interaction between self- and social control variables across multiple time points covering not just early childhood but also adolescence.

Given the unavailability of such methodologically advanced data in the field of criminology and difficulties of collecting them in a short period of time, the primary goal of this study is to directly test Gottfredson and Hirschi's (1990) stability hypothesis and further disentangle the underlying causal mechanism of stability and change of offending behaviors using data collected in the field of public health research (Johns Hopkins

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Prevention Intervention Research Center, JHU PIRC) to which most criminologists have

not had access. Fortunately, current field trials data that I secured permission from JHU

PIRC collected multiple items of key theoretical constructs relevant to test key

hypotheses of this study (e.g., trait-like self-control, social control/bond) from the same

individuals for a relatively long period of time. Therefore, these data allow for the

creation of composite scales or latent constructs of self- and social control by combining

the measures taken from multiple sources including children, parents, and teachers, which

most other studies have been unable to accomplish. Especially, two things are notable;

First, randomized field trial controls for the effects of potential confounding factors and

separate out the pure effects of treatment (e.g., the enhancement of informal social

control and support) that are exogenous to the existing level of self-control[6]. Second, the

current sample of high risk youth with relatively low level of self-control allows for more

robust findings than those obtained from a sample of the general population. Because the

distribution of offending in the general population is highly skewed, the distribution of

self-control must itself be comparably skewed. The skewed distribution of self-control

implies that differences between offenders and average individuals may be large.

Especially, those with low self-control may have more 'room to change' through a

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[6] In doing so, I do not exclude the possibility that genetic/biological factors might substantially influence offending propensity such as what Gottfredson and Hirschi (1990) call low self-control (Unnever, Cullen, and Pratt 2003; Barkeley 1997; Guo, Roettger, and Cai 2008; Wright and Beaver 2005; Rowe 1994). Similarly, I do not exclude the possibility that community factors might also either directly or indirectly influence the formation and development of self-control (Lynam et al. 2000; Pratt, Turner, and Piquero 2004). Nonetheless, random assignment controls not only for such common confounders but also for aging, maturational, or historical processes that are being shared by subjects within different study groups.

changing level and quality of relational attachment and conventional commitments than those with relatively high self-control[7].

More importantly, this study is the first attempt to explore the causal mechanism of how trait-like self-control and social control/bonds might mutually influence each other over longer periods of time. By focusing on the within-individual changes of key constructs within a longitudinal panel design framework, this study investigates more explicitly and precisely the causal process of how self-control (as an individual's propensity to offend) facilitates the differential exposure to social control/bond (as a structural/situational inhibiting factor) which, in turn, might influence the future development of self-control over time. That is, contrary to Gottfredson and Hirschi's strict 'self-selection' postulate, this study explores the possibility that improvement in social relationship and attachment/commitment to conventional others can influence the changing the level of self-control substantially beyond the natural process of aging. In addition to such 'changing' process, this study can also better specify the underlying causal mechanism of 'stability' by taking similar approach (e.g., the effect of life experience on personality development is to deepen the characteristics that lead people to those experiences in the first place). In doing so, compared with other research on self-selection/social causation models, this study will better assess the 'mixed' model by highlighting how such a bidirectional causation takes place *slowly* but *steadily* over longer periods of time.

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[7] Gottfredson and Hirschi (1990: p.106) also assert that "it is easier to develop self-control among people lacking it than to undermine or destroy self-control among those possessing it," although they also acknowledge that it is difficult to improve the level of self-control appreciably because the traits comprising low self-control "impede educational and occupational achievement, destroy interpersonal relations, and undermine physical health and economic well-being" (p. 96).

After finding the evidence that supports the malleable nature of self-control over the life course and its close linkage to time-varying social control/bond variables, a more explicit attempt is made to reconceptualize the nature and role of both self- and social controls to better explain the underlying causal mechanism of stability and change in offending over time within a unified control perspective. Although some already tried to explore the possible link between self-control and other social variables such as those from social control, social learning, stress, and labeling theories (e.g., Tittle, Ward, and Grasmick 2004), I will focus only on the interaction of self- and social control variables which are founded on the same domain assumptions (e.g., hedonistic nature of human being, rational choice perspective) and developed under the similar control tradition. That is, both theories assume that individuals seek self-interest by nature and rely on the principles of rational choice and control perspectives that assume that all individuals perceive and value actions and potential outcomes the same way but differ in how they perceive and value possible consequences depending upon different inhibiting factors the theory rests on. Thus, all individuals will be similarly motivated to commit crime, but differentially restrained by either internal or external constraints[8]. I attempt to redefine the nature and role of control mechanisms in general by specifying how both internal and external control mechanisms might influence each other in a cumulative and mutually reinforcing fashion.

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[8] However, some criticize control theories largely because they rely on inflated assumptions about behaviors. For example, Wikstrom (2005; 2006) argues that motivation is a situational concept and therefore presuming that all individuals will be equally motivated to commit a certain act in all settings provides a false simplification of behavior that undermines the explanations of cause of crime.

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To achieve these goals, two hypotheses regarding the stability or malleability of self-control are tested. The first involves a more rigorous and straightforward test of the stability hypothesis: whether subjects within two study groups – that are randomly assigned and therefore equivalent in other theoretically important variables including the initial level of self-control – exhibit significantly stable trajectories in their level of self-control over time. Although some argue that self-control may not develop in a uniform pattern for all individuals in the sample and the aggregate pattern of the sample may obscure the significant variation among individuals (Hay and Forrest 2006: p.741), detecting distinctive patterns of trajectories (e.g., a significantly different rate of change) of self-control among two initially equivalent groups would open the possibility of the malleable nature of self-control even during adolescence, the period when self-control are claimed to be stable unaffected by the social experiences. Gottfredson and Hirschi's stability postulate implies that, although the absolute level of self-control may change over time, the relative level of self-control (e.g., "relative ranking" or "observed differences" of self-control among individual over different time points) should remain stable over time (Hirschi and Gottfredson 2001: p.90). Therefore, a significantly different rate of change among different individuals or groups over time, especially in combination with the evidence of significant interaction between initial level and growth rate, will provide the evidence that reputes the strict stability postulate of Gottfredson and Hirschi's theory.

A second hypothesis involves the role that parental socialization plays during adolescence in explaining the changing level of self-control. While Gottfredson and Hirschi (1990) argue that parental socialization is the primary source of self-control in the

formative period of early childhood, this study provides a more rigorous test of whether parental socialization during adolescence still has a substantial impact on self-control in a cumulative fashion by adopting a reciprocal causation model. Although some of the most recent studies do explore the possible link between them, they predominantly focused on the cross-sectional or short-term relationship. This study explicitly assesses the relative strength of two rival models of unidirectional and bidirectional causation by assessing which model fits the data better. In doing so, contrary to Gotffredson and Hirschi's explanation that focused primarily on the control dimension of parental socialization, other important aspects of parenting that are known to gain more relevance as children move into adolescence (e.g., support dimension) are also incorporated. That is, this study includes not only the negative reinforcement from parents when individuals are engaged in prohibited behaviors, but also the positive reinforcement they receive when they avoid bad behaviors and produce good behavioral and academic outcomes.

1.3 Outline of the Study

In the chapter 2, I first review three major contemporary criminological theories that are developed based on the control perspectives, highlighting how each theory is compatible with either or both positions of population heterogeneity and state dependence and how they explain stability and change in offending over time. In addition, more recent efforts to provide a coherent conceptualization of self-control than Gottfredson and Hirschi did in their original theory are fully discussed. This will be followed by the extensive review of the current empirical research on the stability postulate of self-control theory and the self-selection/social causation hypotheses in the

fields of both criminology and psychology. In the next, I will anticipate research questions for this study and describe the data, measurements, and statistical methods to address them. This will be followed by my conclusion of anticipated outcomes and expected contributions to the field.

2 Literature Review

Considering that one of the qualities that constitute good theory is the capacity to explain the 'known facts,' theories of crime should be able to present a convincing account for the moderately strong positive correlation between past and future offending, which perhaps is known to be the most robust finding in criminological research. While there may be little debate about the existence of such correlation, however, there is far less agreement about its interpretation and meaning. Especially, with the emergence of a life-course perspective[9], a static socialization paradigm as a theoretical and research framework became increasingly less adequate for explaining the nature and the process of continuity and change by linking past life events and experiences to present behaviors[10]. Therefore, one of the challenges that contemporary theories have to meet is to elaborate and extend the basic theoretical concepts and propositions to better account for the stability and change in patterns of offending behaviors over time.

Typically, criminologists have taken two distinctive and largely segregated approaches to explain the patterns and sources of stability and/or change in offending over time (see Nagin and Paternoster 1991; 2000 for more details). Theories of

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[9] Although the idea of life-course perspective goes back to the early 20th century, Elder (1974) merged two lines of approaches to the study of human development over the life course: 1) generation-based model and 2) age-based model. Life course perspective represents a major paradigm shift in how we think about and study human lives by making time, context, and process more salient dimensions of theory (see Sampson and Laub 1993 for more details).

[10] In this vein, Robin (1978) suggested that one of the interesting "known facts" within criminology is that, although adult antisocial behavior requires childhood antisocial behaviors, most antisocial children do not become antisocial adults, which could not be easily explained by static socialization theories.

population heterogeneity emphasize enduring individual characteristics (e.g., criminal disposition and criminal propensity such as physical/mental deficiency and antisocial personality) that predispose persons to engage in crime throughout the life course. That is, there is a time-stable characteristic that affects the probability of criminal acts early in life and at all subsequent stages of life. While such theories do not preclude the possibility of change in offending patterns over time, they assert that any change observed does not result from criminal or conventional events and experiences that are exogenous to the individual propensity to offend, but from other factors that cannot be explained by existing criminological theories (e.g., aging, maturation). Theories of state dependence emphasize (both time-stable and time-variant) circumstances and situations that are external and temporally proximate to individuals. That is, the state dependence process posits that an observed correlation between past and future criminal behavior reflects the fact that the act of committing a crime transforms the offender's life circumstances in such a profound way that it alters the probability that subsequent criminal acts will occur. Similarly, state dependency assumes that avoiding crime and establishing conventional relationships and investing in commitments decrease the probability of offending through the same process.

While not incompatible with each other and therefore the observed positive correlation between past and current offending might reflect a mixture of the two (Nagin and Paternoster 1991; 2000)[11], we cannot ignore the fact that they are grounded on some

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[11] For example, Nagin and Paternoster (2000: p.119) assert "Theories of population heterogeneity and state dependence are not hostile to one another. There can, therefore, be mixed explanations for the relationship between past and future offending that allow for both stable individual differences in criminal propensity and for the fact that criminal and conventional behavior can causally alter the risk of future crime. Such a mixed

fundamentally different principles that cannot be easily reconciled. For example,

population heterogeneity theories, which assume that sources of stability are established

during early childhood, focus on individual characteristics (e.g., traits, propensities,

deficiencies, etc.) and their implication primarily rests on the "stability" of offending

behaviors. That is, some individuals exhibit criminogenic characteristics which manifest

themselves into the stable patterns of offending regardless of the circumstances and

situations individuals are exposed to. Thus, contexts in which individuals are situated are

of secondary importance in these theories because propensities exert their influence

independent of settings or by making individuals select into such criminogenic settings

that facilitate individuals to act in a predetermined manner. On the other hand, state

dependence theories, which presume that sources of change are prevalent even at later

stages of life, focus on the effects of social events and experiences and their implication

rests not only on 'stable' but also on 'changing' patterns of behaviors. While some state

dependence theories acknowledge the role played by stable individual characteristics,

therefore, they emphasize the predominant roles played by life events and experiences in

explaining both stability and change without any reference to the changing nature of

individual characteristic.

　　While there has been a substantial body of empirical work devoted to discerning the

extent to which criminal offending over the life course might be attributed to either or

both of these two processes, they are superficial by focusing primarily on the pure effect

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theory would be friendly to the fact that continuity and change in offending over time are
due to the differences in criminal propensity established early in life and the possibility
that one's behavior later in life can both accelerate and diminish one's involvement in
crime net of those early individual differences."

of one variable after controlling for the other, or on the conditional effects of each other, still separating them as *distinctive* and *independent* theoretical constructs. Despite a number of efforts to integrate these two competing but not contradictory perspectives, they still fail to present a more complete picture of underlying causal mechanism of stability and change in offending pattern by adhering to the original theoretical constructs without further efforts to modify the theoretical concepts and propositions.

In this chapter, I first discuss some of the major criminological theories that are grounded on the control perspective to illustrate how each of them is compatible with population heterogeneity and state dependence perspectives. Then, a systemic review of more recent efforts that attempted to better specify the nature of self-control as both/either general ability and/or as more situationally-based inhibiting factors is presented. Such theoretical discussions are followed by an extensive review of extant empirical research on the stability postulate of Gottfredson and Hirschi's theory and some of the pioneering literature that assesses the validity of self-selection and social-causation models, highlighting the gap in the extant research on the issue of possible dynamic interaction between population heterogeneity and state dependence variables to better explain the continuity and change in offending over time.

2.1 Population Heterogeneity, State Dependence, or Both?

Various criminological theories have incorporated the notion of population heterogeneity (e.g., Wilson and Herrnstein 1985; Gottfredson and Hirschi 1990; Moffitt 1993), state dependence (e.g., Lemert 1972; Akers 1985; Agnew 1992; Thornberry 1987), or both of them (e.g., Sampson and Laub 1993; Nagin and Paternoster 1994;

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Wikström 2006) into their explanatory models. In this section, three theoretical positions that best exemplify each position are presented to demonstrate how they diverge in their explanation of stability and change of offending over time drawing on the key theoretical concepts and propositions.

2.1.1 Gottfredson and Hirschi's General Theory of Crime

One of the unique advantages of the developmental/life-course perspective is that it brings the formative period of early childhood back into the picture by emphasizing the impact of early life events and experiences on offending behavior in later stages of the life course. In this vein, Gottfredson and Hirschi (1990)'s theory – although they continue to refute the utility of longitudinal data in studying causes of crime – has played a key role in drawing criminological interest on the role of individual differences in crime involvement by bringing the concept of self-control, which is hypothesized to be formed in the early stage of life primarily through early socialization experiences and remain relatively stable for the rest of life, to the forefront of criminological inquiry. That is, they attribute the individual's differential probability of offending to the individual-level differences in the level of offending propensity they term "self-control," which in their original theory was defined as the 'capacity' to resist the temptation of immediate and easy gratification and is presumed to be the result of effective socialization by primary caregivers in early childhood. Thus, it represents a major paradigm shift in how we view the etiology of crime by departing from the emphasis on more immediate and proximate causes of crime (e.g., Surtherland and Cressey 1992; Lemert 1972; Cohen and Felson

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1979; Cornish and Clarke 1986; Akers 1992; Agnew 1992) to more distal and enduring causes of crime.

Because the theory focuses on explaining the propensity to offend and its role in determining between-individual differences in crime involvement which remain relatively stable over the life course, the notion of population heterogeneity plays a central role in Gottfredson and Hirschi's theory by assuming that any observed correlation between later life events/experiences and crime is spurious rather than causal due to the fact that it all results from the self-selection process of a common cause – time-stable offending propensity such as low self-control[12]. Moreover, although they initially noted that situational factors like criminal opportunity are also important because they impact the actual manifestation of low self-control, Gottfredson and Hirchi (2003) later asserted that the relationship between self-control and criminal involvement can be studied "without undue concern for differences in opportunities to commit criminal, deviant, or reckless acts" (p.18). In this vein, Gottfredson and Hirschi are clear in asserting that, while differences in self-control affect later life events/experiences and crime, these events/experiences have no effect on criminal involvement, not to mention, on the level of self-control itself. Thus, the variability of self-control formulated at the earlier stage of life must explain both stability and change in the patterns of offending behaviors for the rest of life. While they are successful in explaining the stability of

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[12] However, they adopt a "semi-typological" approach by arguing that, although those with relatively lower level of self-control have higher probability of crime involvement in any given situation than those with higher level of self-control, different kinds of people should be placed along a continuum rather than distinct categories of offender groups. Thus, it is a probabilistic theory in a sense that having low self-control increases the probability of offending in any situation at any time (See Wikstrom and Treiber 2009 for more details).

offending by placing low self-control as a stable offending propensity at the core of their

theory, however, they present much incomplete explanation of the sources of change.

While they suggest that the notion of 'relative' stability over time touches upon the issue

of gradual and age-related change, and that any decline in criminality is the direct effect

of the aging process that cannot be explained by existing criminological theories, it is

clear that the theory is more interested in and therefore provides a better explanation for

the *stability* in offending. Specifically, while the theory takes a little bit more dynamic

approach than that of Wilson and Herrnstein (1985) – who imply that the level of

socialization is immutable once established early in life – by arguing that "socialization

continues to occur throughout life" (1990: p.107) and, therefore, it is the relative stability

in the distribution of the level of self-control among population, they still dispute the

possibility of different rates of change at the level of socialization between individuals in

order to square it with the stability postulate of the theory.

In sum, Gottfredson and Hirschi's theory is a pure population heterogeneity theory of

crime that focuses primarily on stable offending propensity and the stability of offending

patterns, but fails to integrate other social explanations to better account for not only

stable but also changing patterns of offending behaviors over the life course. Moreover, it

further evolves into more static theory that disregards the role of environmental factors in

the expression, not to speak of reformation, of offending propensity (see Gottfredson and

Hirschi 2003).

2.1.2 Sampson and Laub's Age-Graded Theory of Informal Social Control

Based on the same domain assumptions of a control tradition, Sampson and Laub's original theory (1993) and its revised theory (2003) present a better account for not only stable but also changing patterns of offending behaviors over the life course. In doing so, the notions of state dependence and population heterogeneity are integrated in such a creative way that Nagin and Paternoster (2000) even categorize it as a "mixed" theory of population heterogeneity and state dependence. As in Gottfredson and Hirschi's theory, Sampson and Laub also presume that self-interested individuals are universally motivated to commit crime because criminal acts provide easy gratification, and that all individuals utilize a rational choice process of evaluating the costs and benefits associated with any given behavior. However, they clearly present a very different approach from Gottfredson and Hirschi's theorization by focusing primarily on external rather than internal constraints. That is, the general organizing principle of the theory is that delinquency or crime is more likely to occur when an individual's bond to society (as an external inhibiting factor) is attenuated. In addition, their theory integrates a life-course perspective to meet the challenge of explaining the stability and change of offending over the life course focusing on time-variant nature of social bonds over the life course, which was a fundamental departure from Hirschi's (1969) static version of social control theory.

In their initial theorizing, Sampson and Laub (1993) are clear that their theory involves a mixture of population heterogeneity and state dependence by conceding that

the self-selection process cannot be dismissed.[13] In other words, they acknowledge that

individuals who differ with respect to criminal propensity at an early stage sort

themselves into environments consistent with that individual characteristic, and therefore

part of the observed continuity in offending is due to time stable differences in criminal

propensity. At the same time, however, they also contend that there is another mechanism

that can account for some of the observed stability in offending over time. That is, early

antisocial behavior will at times serve to weaken social bonds or reduce the offender's

stakes in conformity in a conventional life, which entraps individuals into the vicious

circle of the cumulative continuity of disadvantage. Therefore, prior criminal behavior in

and of itself also has a causal impact on future criminal behavior *independent* of prior

offending propensity. Especially, by acknowledging the role played by external factors as

exogenous to the existing level of offending propensity, they also open the possibility of

change by the process of cumulative advantage when there is an improvement in the

condition in life (e.g., good marriages, stable jobs, successful military experiences)

because such life events and experiences "increase social capital and investment within

social relations and institutions'' (Sampson and Laub 1993: p.21).

While the foundation of Sampson and Laub's theory is an amalgam of population

heterogeneity and state dependence, however, the theory evolves into a more dynamic

version where the notion of state dependence plays a central role than that of population

heterogeneity in explaining both stability and change in offending over time. Especially,

Sampson and Laub (1997) proposed a developmental model of "cumulative continuity"

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[13] Laub and Sampson (1993: p.306) assert that "the cumulative continuity of
disadvantage is thus not only a result of stable individual differences in criminal
propensity, but a dynamic process whereby childhood antisocial behavior and adolescent
delinquency foster adult crime through the severance of adult social bonds."

suggesting that continuity can be explained by negative consequences of early antisocial behavior for future life chances (for example, arrest, conviction, incarceration, and other negative life events may lead to decreased life opportunities, including school failure and unemployment). Similarly, early antisocial behavior is also likely to sever informal social bonds to family, school, friends, and jeopardize the development of adult social bonds, which in turn, enhance the chances of continuity. Years later, Laub and Sampson (2003) took a more explicit position by arguing that, while individuals who experience weaker social control during early childhood tend to develop an antisocial propensity which shapes their behavioral patterns well into adulthood, their offending is then perpetuated by cumulative disadvantage via the accumulation of negative consequences from their earlier offending, and interactional continuity via adverse responses to the adverse responses from others. At the same time, however, some life events and experiences that can change the quality of social bonds may trigger the process of cumulative advantage via altering short-term and long-term inducements to offend such as direct supervision, routine activities, and commitment to additional social capital.

Therefore, while both population heterogeneity and state dependence arguments are employed to explain continuity and change in Sampson and Laub's theory, they weigh more on the state dependence account. This is especially true when they explain changing patterns of behavior because they argue that salient life events and socialization experiences in adulthood can counteract the negative consequences of early antisocial behavior, and informal social control in adulthood explains changes in criminal behavior over the life course, *independent* of prior individual differences in criminal propensity. Especially, they remain silent on the role of changing levels of offending propensity in

explaining the changes in offending trajectories over time, which in my opinion is one of the unclear and underdeveloped propositions in the Laub and Sampson's revised theory. Therefore, further theoretical and empirical exploration to better clarify and specify the possible link between self-control and informal social control/bond over the life course would provide a more complete understanding of stability and change of offending behaviors within the life course framework.

In sum, by recognizing that the concepts of continuity and change are not mutually exclusive and can be explained by single framework of cumulative advantage/disadvantage, the theory incorporates both explanations of population heterogeneity and state dependence. However, focusing primarily on external factors and remaining silent on the role of offending propensity in explaining both stability and (especially) change, the theory is evolving into a model that places greater emphasis on the state dependence account.

2.1.3 Wikström's Situational Action Theory

The notions of population heterogeneity and state dependence are best integrated in the most recent theorizing of Wikström (2004; 2005), with both explanations playing central roles in explaining stability and change in offending over time. Highlighting that current criminological theories say little about the interaction between individual and environment, especially how differential exposure to external factors may impact the internal propensity to offend, Wikström proposed situational action theory to advance the study of the sources of stability and change in individual's crime involvement. By criticizing Gottfredson and Hirschi's (1990) theory as primarily built on a static and

unmalleable nature of offending propensity, and Sampson and Laub's (1993; 2003)

theory as relying exclusively on external sources for behavioral change, Wikström (2004;

2005) suggests that, because behavior is driven by the interaction of individuals and their

environment, there are three potential sources to account for the change in behavioral

patterns: 1) change in the individual, 2) change in the environment, and 3) change in the

individual's exposure to certain environments[14]. In this vein, Wikström and Treiber

(2009: p.408) argue that, "although some authors allude to the importance of the

interaction between individuals and environments (and even misleadingly label their

theories "interactional"), few adequately detail how (via what mechanisms) this

interaction ultimately produces acts of crime." They attempted to achieve this by

proposing a situational mechanism (a process of perception and choice) that links

individuals (their characteristics and experiences) and environments (their inducements

and constraints) to actions. Therefore, a central argument of the situational action theory

is that an act of crime is the outcome of a process by which an individual perceives

alternatives for action and chooses (either habitually or deliberately) which alternative to

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[14] In doing so, however, Wikstrom view crime as moral action and primary attention is
focused on the importance of individual's moral values and accordingly self-control as
offending propensity is not the central explanation of cause of crime. That is, while the
situational action theory also accepts that self-interest and rationality play a role in
guiding human actions, it reasons that, on a more fundamental level, human behavior is
guided by rules about what is right or wrong to do which simplify the process of choice.
Therefore, the situational action theory suggests that the perception of alternatives is
more fundamental to the explanation of action and more important than the process of
choice because individuals who do not perceive an action as an alternative will not even
need to engage in rational process of calculating and selecting best option among
alternatives available. Accordingly, the situational action theory considers morality as the
most important offending propensity and the moral context of the settings in which an
individual operates as the most important environmental factor in crime causation,
because their interaction largely determines what action alternatives an individual
perceives and whether any of those alternatives represents acts of crime.

pursue. This process is moderated by the interplay between an individual's propensity to offend and criminogenic features of the social context to which he or she is exposed. Although the role of self-control is substantially reduced in the situational action theory because "the ability to exercise self-control" is *only* important when an individual perceives crime as an alternative (and only then self-control plays an active role and exerts its effects through the process of rational choice), they make it clear that a broad range of social factors can still play a role in individual development and change in the ability to exercise self-control. In their discussion of the causes of stability and change in crime involvement, Wikström and Treiber (2009: pp.412-14) suggest that stability and change in offending is ultimately caused by stability and change in individual factors (e.g., morality and self-control) and environmental factors (e.g., the moral context). Most importantly, they (p.413) also emphasize that their theory does not propose a simple additive model of propensity and exposure but that propensity and exposure interact to determine individual crime involvement (cross-sectionally) and the shape of individual trajectories of crime involvement (longitudinally). For example, the relative importance of an individual's exposure to criminogenic contexts may vary depending on his or her current propensity to offend (cross-sectionally). Moreover, changes in exposure to criminogenic contexts may in the long run affect an individual's propensity to offend (longitudinally). At the same time, changes in an individual's propensity to offend may change how often he or she takes part in criminogenic moral contexts. Therefore, specific combinations of change in an individual's propensity and exposure are likely to produce specific changes in his or her level of crime involvement (Wikström 2005).

In sum, Wistrom and Treiber take a well-balanced view of both population heterogeneity and state dependence, and suggest that a key challenge for developmental and life-course criminology will be to better understand the dynamics of this interaction between propensity and exposure over the life course and how it impacts upon patterns of stability and change in individual's crime involvement, not only cross-sectionally but also longitudinally.

2.2 The Nature and Source of the Self-Control

Gottfredson and Hirschi (1990) argue that there are individual differences in the propensity to commit criminal acts and analogous behaviors and such general offending propensity peaks in the late teens and early 20s, then declining rapidly and steadily to the end of life. It appears to do so for everyone and therefore the age distribution of crime is invariant across social and demographic groups. Accordingly, individual and group differences in crime rates are stable across the life course. The central issues would appear to be the nature and source of such stable individual differences in offending propensity. Drawing on the common elements (commonalities) in the large variety of delinquent, criminal, and deviant acts – in that each provides immediate benefit at the risk of long-term pain, – Gottfredson and Hirschi (1990) argued that individual differences in offending propensity can best be accounted for by an individual level trait such as what they call "low self-control." In the traditional control perspective, social settings that are external and proximate to the offender have long been theorized to affect conformity, functioning as inhibiting factors in the individuals' rational calculation of potential, non-legal costs and benefits associated with the commission of offenses. In addition, it may

do so by influencing more proximate and immediate opportunities for misconduct. However, Gottfredson and Hirschi's theory focuses more on internal propensity to offend as a time-stable individual characteristic and its role in determining between-individual variations in offending. While their conceptualization of self-control is similar to personality traits and therefore one may be attempted to characterize their theory as hard deterministic, they are sociologists and still clear on their assertion that personality traits have proved to be of little value in the explanation of crime. In addition, while sociological view was originally emerged as a reaction to the indeterministic view of classical school or rational choice tradition, their sociological view is less deterministic in that their theory incorporates key assumptions of the rational choice perspective in explaining the individual's probability of crime involvement (Hirschi 2004). That is, while the theory seeks the source of inhibiting factors (especially, within stable individual characteristics rather than more proximate and situational factors outside individuals), contrary to other sociological explanation of crime (e.g., strain, social learning theory), the theory retains much room for notion of human agency because it brings the calculation of costs and benefits explicitly into consideration of cause of crime.

Most of controversies over the theory arise from the absence of the description of the nature of key theoretical concept – 'low self-control.' They simply describe the key defining elements of low self-control based on the common characteristics of criminal, deviant, and analogous behaviors. That is, "people lack self-control will tend to be impulsive, insensitive, physical, risk-seeking, short-sighted, and nonverbal (Gottfredson and Hirschi 1990: 89-90). Given that crime by nature brings immediate gratification of desires at the sacrifice of long-term benefits or commitment, often results in pain or

discomfort for the others, requires little skill or planning, and involves immediate
pleasure, it is not surprising at all that people with low self-control have higher
probability of crime engagement. More recently, however, they seem to be unhappy with
this original conceptualization by acknowledging that "the Big Five (plus one) introduced
a language I did not understand, championed ideas contradicting our theory, and
otherwise muddied the waters … and now we can see the errors introduced by our
excursion into psychology and by the measured of self-control stemming from it"
(Hirschi 2004: 541-42). Most of all, as most of criminologists summarized in this section
(Tittle, Ward, and Grasmick 2004; Wikström and Treiber 2007) including Hirschi
himself (2004: 542) note, they fail to define the nature and role of self-control in general
and to explain how self-control operates within the framework of rational choice decision
making process in specific. That is, the theory simply suggest that "offenders act as they
do because they are what they are (impulsive, hot-headed, selfish, physical risk takers)"
(p.542). Wikström and Treiber (2007: 243) also assert that "Gottfredson and Hirschi do
not provide a stringent definition of concept of self-control … they tell us (most
behaviorally) what characterizes people with low self-control, what differentiates people
with high and low self-control, and why people with low self-control tend to engage in
acts of crime, but never what (low) self-control actually *is*."

Although Gottfredson and Hirschi later redefined self-control as "the tendency to
avoid acts whose long-term costs exceed their momentary advantages" (Hirschi and
Gottfredson 1994: 3) by incorporating the rational choice elements as key cognitive and
reasoning processes in decision making and as "the tendency to consider the full range of
potential costs of a particular act" (Hirschi 2004: 543) by shifting the focus from the

long-term implications of the act to its broader and often contemporaneous implications, they still assume trait-like nature of self-control as a general tendency for rational decision making. The only modification and elaboration they made include how we should operationalize this stable tendency in terms of "a set of inhibiting factors one carries with one wherever one happens to go" (2004: 543). This also implies that they still believe that self-selection process prevails after the formative period of self-control negating the possibility of social causation process. Since individuals with low self-control provoke, select into weak social bond (e.g., less attachment resulting from indifference or insensitivity to the feelings or opinions of others; less commitment to family, friends, marriages, jobs – all of which are manifest variables of latent construct of self-control), social control should also remain relatively stable over time.

Therefore, they continue to take extremely ontological position by asserting that stable differences in offending rates are established before adolescence and persist through life and that differences in self-control between individuals are unaffected by subsequent experience. That is, they still posit that criminal and delinquent acts are made possible by the absence of an *enduring* tendency to avoid them. They clearly decline to reject the assumption of the stability of individual differences central to self-control theory by asserting that "we cannot reject what we believe to be true." Instead, they abandon the instability assumption of social control theory to "save" their theory and argue that social and self-controls are the "same thing" (Hirschi 2004: 543). In sum, even after their redefinition and operationalization of self-control, they maintain core elements of theory's key elements intact. Individuals still have stable self-control as the tendency

to consider the full range of potential costs of particular act, which is best manifested by a broad set of inhibiting factors such as social bond.

While the attempts from the original authors to adequately theorize the concept of self-control still appear to be vague and imprecise, there are increasing efforts to provide a coherent conceptualization of control that more clearly specify how both self- and social controls as constituent elements of the same control mechanism may interact and relate to each other rather than setting them up as contradictory concepts. As an initial effort, Taylor (2001: p.383) suggested that, while the social and self-control theories are based on fundamentally different principles and that integration does not appear to be a plausible option as they are currently conceptualized in each theory (e.g., relational and variable vs. individualistic and invariant), she also asserted that there is no inherent incompatibility between all theories of control because the heritage of control theory reveals social and self-control theories share many of the same intellectual roots emphasizing the interplay between internal and external controls[15].

More recently, Tittle, Ward, and Grasmick (2004) presented a possible link between two theoretical constructs emphasizing that both theories try to explain the inhibiting factors to control deviant acts in an attempt to understand individual's conformity. First of all, they point out that Gottfredson and Hirschi (1990) say little about the inherent quality of self-control per se but simply cataloged the behavioral patterns that those with low self-control would manifest. When they do directly discuss the quality of self-

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[15] For example, Reiss (1951) combined concepts of personality (internal control) with socialization (external control), arguing that delinquency could be seen as a failure of both. Reckless (1955; 1961) also emphasized the interplay between internal and external control.

control, they suggest that it consists mainly of the lack of 'capability' for controlling behaviors (e.g., those with low self-control lack the general "ability" to calculate potential negative consequences and, therefore, are less "capable" of delaying easy and immediate gratification). Tittle, Ward, and Grasmick (2004), by distinguishing self-control 'capability' and self-control 'desire,' however, suggest that self-control theory could be improved by recognizing that the individual's capacity for self-control is distinct from his/her interest in restraining themselves. Especially, it is noteworthy that their redefinition of self-control contributed to the clarification of the quality of self-control by linking self-control to other theoretical variables. That is, they further suggested that various theories (e.g., self theories, social learning theory, social bonds or social control theory, and rational choice theory), though ostensibly different, actually deal with a common central theme that seems to concern the individual's *desire* to exercise self-restraint in the face of temptation from easy and immediate gratification[16].

While they acknowledged that both the capacity and desire to exercise self-control are important in explaining offending behaviors, however, they still suggest that they are *distinct* concepts and vary *independently* over time. That is, since self-control ability and interest in exercising self-control interact in producing crime, some people may have a strong capacity for self-control but may not always want to exercise it, while others may have weak self-control ability but have such a keen interest in controlling their criminal impulses depending on the contextual contingencies. They believe therefore that this desire to exercise self-control can be extracted and treated as a unified, central concept

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[16] Accordingly, they posit that measure of self-control desire is indirect, composed of indicators of internal and external variables that influence individuals to want to restrain their impulses for immediate gratification.

serving as a key variable to be used in conjunction with the capacity for self-control to better explain and predict deviant behaviors. By assuming that self-control desire is another core constituent element of self-control that is distinct and independent from self-control capacity, however, they still fail to conceptualize and fully specify the possible linkage between Gottfredson and Hirschi's original version of self-control and other theoretical variables. In other words, they still argue that whereas capacity is a stable or inherent quality which is internally driven, desire is partly externally linked and more responsive to immediate social stimuli. Whether the interest in self-regulation manifests itself probably depends on many contextual contingencies, and accordingly what explains the variation in offending behaviors is not the change in the capacity to self-control but the desire to exercise self-control. In this vein, this position might be viewed simply as a more systematic conceptualization of what Gottfredson and Hirschi (1990) have already implied in their theory[17]. Most of all, just like Gottfredson and Hirschi, they also remain silent not only on the defining characteristics of the capacity for self-control itself, but also on the possible mechanisms that, as people become more socialized by informal social control and accumulate social bonds from a variety of social institutions (e.g., parents, teachers, and peers), they become more likely to refrain from immediate gratification in the anticipation of bad consequences likely to follow. Most of all, they do

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[17] Gottfredson and Hirschi (1990) argued that once formed, self-control is totally in the person, lacking connection with future social environments or situational contexts. That is, people with less capacity for self-control tend to be less able to anticipate or appreciate the long range consequences of their actions, and therefore more likely to yield to the temptation for immediate gratification of needs and desires. However, they still acknowledge that those with same level of self control may respond to the temptation in different ways, not because of the change in the level of self-control but same level of self-control may be less likely to manifest itself because of the change in the rational choice calculus and opportunity structure.

not go further to specify how such changing level of desire to exercise self-control might ultimately affect the level of the individuals' capacity for self-control, and vice versa.

Similarly, Hirschi (2004) also redefined self-control as "the tendency to consider the full range of potential costs of a particular act" suggesting that such inhibiting factors vary in both number and salience in how they relate to criminal activity. By doing so, he explicitly recognizes that the offender considers the full range of potential costs and not necessarily and solely the long-term implications of the acts. This is a remarkable departure from his original position because Hirschi once again moved the focus of control mechanism from the long-term implications of act to its broader and often contemporaneous implications. Most of all, it also moves rational choice at the center stage of the theory because this new definition emphasizes how self-control affects would-be offender's calculation of the consequences of their acts at the point of decision making. Accordingly, it is less deterministic than his original position in a sense that, by emphasizing the cognitive evaluation of competing interests, he claims self-control must contain elements of both cognizance and rational choice (Hirschi 2004: p.543). In this vein, Hirschi further suggests that individuals return to the four original bonds identified in classic social control theory and newly conceived notion of self-control begins and probably ends with inhibitions. Following rational choice models of crime, Hirschi fully expects that such inhibitions enter into the decision-making process of individuals when deciding whether to commit a criminal act or not. However, these factors may not be far reaching and are not latent or hidden to the offender. Instead, Hirschi turns back to social control theory and offers that a principal source of control is "concern for the opinion of

others."[18] While leaving their original theory essentially intact, therefore, Hirschi argues that it makes us rethink the definition and measurement issue once again because of: 1) tautology concerns (e.g., original measures of self-control they suggested imply differences in motives for crime, or are synonymous with criminal propensity), 2) the concerns that personality traits have proved to be of little value in explaining crime, and 3) their original theory's failure to explain how self-control operates ("muddied the water" because personality-oriented approach to measuring self-control did more to confuse rather than clarify matters regarding the measurement of self-control).

In a similar vein, Gottfredson (2006) also asserts that self-control theory is neither an abandonment of a sociological view nor an implicit rejection of the earlier social control theory upon which it is founded. In a brief discussion of varieties of control theories, he points out how different forms of control might be related. That is, control theories begin with the basic assumption that all people are alike in that they tend to pursue self-interest and therefore assume relatively constant motivation for crime. These domain assumptions distinguish control theory from other perspectives, and these root assumptions of control theories can find expression in many different ways, depending on the type of control

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[18] Using data from Richmond, California Youth Project, Hirschi (2004, p.545) constructed a redefined self-control scale by counting the self-control responses for nine items.
(1) do you like or dislike school?
(2) how important is getting good grades to you personally?
(3) do you finish your home work?
(4) do you care what teachers think of you?
(5) it is none of the school's business if a student wants to smoke outside of the classroom
(6) does your mother know where you are when you are away from home?
(7) does your mother know who you are with when you are away from home?
(8) do you share your thoughts and feelings with your mother?
(9) would you like to be the kind of person your mother is?

thought to be critical, on conceptualization of the nature of control themselves, and on the

perceived relations among types of control (pp.78-79)[19]. In any event, control theories

differ in the extent to which self-controls are relatively firmly established and in which

social controls may continue to operate independently of self-control. And, this could

vary depending on the basis for the bond (e.g., some become pronounced at different

stages of life).

Therefore, Gottfredson (2006) points out that a substantial amount of empirical

literature supporting the validity of both self- and social control theories can be accounted

for by the fact that, although self-control and social control are two different theories

rather than two interpretations of the control mechanism, it is almost impossible to

measure their central constructs in different ways. For example, it is very likely that the

social bonds among parents and children, and the self-control in the child, will be very

difficult to discriminate empirically and, under some circumstances, may amount to the

same thing (e.g., when we consider how socialization of children generates self-control:

1) parental affection (attachment) for the child establishes a long-term interest in the

success of the child; 2) which enables a parenting style characterized by positive efforts

to monitor conduct and appropriately sanction deviance; 3) which creates self-control; 4)

which is expressed by affection (attachment) from the child to the parent and, by logical

extension, to other socializing institutions like schools and friends). Therefore,

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[19] However, Gottfredson (2006: p.79) asserts that, "although the strength of the bonds
may be relatively stable over time for individuals or groups (Gottfredson and Hirschi
1990) or may be thought of as highly variable over time or somewhat situationally
dependent (Sampson and Laub 1995) … there must be at least some level of "stability"
in the bond for there to be any predictability from control theory concepts in the first
place – the absence of such stability is probably more aptly the province of – and if
empirically justified, support for – labeling theories."

monitoring and sanctioning of children are, *at this stage of child development*, evidence of parental affection, a bond from parent to child. If a strong, capable bond is present from the parent to the child, self-control is much more likely to develop in the child than if it is not. Taking this relationship further down the developmental path, parental affection (attachment) for the child during adolescence could be measuring not only the same concepts – monitoring, care, sanctioning appropriately – but also efforts to force or encourage the child to attend to long-term obligations, such as school, health, and safety. Therefore, these measures of early parental attachment, which create self-control, are indistinguishable from measures of self-control in the child when applied later in life. In this vein, he argues that, if self-control and social control share indicators for children and adolescents and are said to be caused by the same factors (largely parental and secondarily friend and school influences), then the old view in criminology that there are two types of control – internal and external – may well be incorrect and misleading. The correct view may be that although conceptually distinct, self and social controls cannot be separately measured during the critical formative years and even later they can be studied by identical indicators. If so, then some important questions are: 1) whether and to what extent later changes in social controls affect the social bond, either due to increased attachments, self-control, or supervision; 2) whether and to what extent such bonds can compete with early bonds in influencing behavior over the life-course. In doing so, however, care must be taken in the interpretation of evidence because social control effects might be construed as "monitoring" effects or reduced opportunity effects ("incapacitation effects"), or social bonding effects. Because opportunities are required for crime, social institutions that restrict interaction with the times, places, and

temptations for crime, such as some marriage and jobs, might reduce individual offending rates, even while self-control or bonding does not change appreciably[20].

However, they still don't believe that the individual's bond to social institutions during later stages of life is the inhibiting factor that continues to define the nature of individual differences in offending propensity. Accordingly, they still perceive trait-like self-control as a stable individual difference in offending propensity. Given the difficulty in the conceptualization and operationalization of trait-like self-control, however, they suggest us to measure two theoretical concepts in same ways. Again, this is because social control/bond is the direct source of self-control, and therefore it is almost impossible to measure them separately. Especially, Gottfredson (2006) modified the assumption of social bond theory as also a relatively stable construct over time to make the stability postulate of their original theory in tact. Therefore, both Hirschi (2004) and Gottfredson (2006) still believe that stable differences in offending propensity are established before adolescence and persist throughout life. But they still remain silent on the nature and quality of self-control as an inhibiting factor and avoid the possibility that differences in self-control between individuals can be affected by subsequent life events and experiences.

In sum, although Tittle, Ward, and Grasmick (2004) and Hirschi (2004) and Gottfredson (2006) themselves redefined the concept of self-control in a way that some

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[20] However, although some measures (both attitudinal and behavioral) of social bond – affection from child to parent – expressed as a desire to accommodate to their parents' wishes and expectations (e.g., lying to parent) – would also essentially be an indicator of self-control, I think other elements of trait-like self-control (e.g., ability to exercise self-control such as impulsivity, hyperactivity, aggression) are still distinctive concepts and can be measured separately from social bond (This study will test it by principle component analysis or confirmatory factor analysis).

elements of self-control (e.g., interests in exercising self-restraint, tendency to consider the full range of potential costs) are conceptualized as having strong linkages with the immediate social world, little remains known about the subtleties and complexities of the development of both elements of self-control over time. Accordingly, more efforts are needed to disentangle the possible link that capacity and desire for self-control not only interact cross-sectionally (conditioning the effects of each other on crime), but also influence each other longitudinally in a mutually reinforcing manner. That is, (1) social bonds variables (e.g., seeking social approval, fearing loss of investment, caring about others, and preserving a good self-concept) and (2) rational choice variables (e.g., fear of getting caught for misbehaviors – "parental discipline," anticipating praise from others for avoiding criminal conduct – "praise for grade and behavior") that are hypothesized to function as the mechanisms generating conformity could function not only as a desire to exercise self-control but also influence the capacity for self-control, and vice versa. As Hirschi (2004: p.540) also acknowledge, however, that even life course theories, which emphasize the possibility of change and in principle should accept individual variation in self-control, "tend to avoid it because of the analytic and empirical complications it brings with it."

Based on the theoretical framework proposed in his situational action theory (Wikström 2004; 2005), Wikström in collaboration with Treiber (2007) even goes further to suggest an alternative conception of self-control and its role in crime causation by arguing that self-control is best analyzed as a situational concept ("a factor in the process of choice") rather than as an individual trait. Because individual's ability to exercise self-control is an outcome of the interaction between "executive capability" and the settings in

which he/she takes part, they argue that the individual's general ability to exercise self-control and the actual exercising of self-control itself should be distinguished, which is consistent with Tittle, Ward, and Grasmick's (2004) distinction between capacity and interest in exercising self-control. However, contrary to Gottfredson and Hirschi's (1990) original conceptualization of self-control as a summary construct of individual traits and Tittle, Ward, and Grasmick's (2004) idea of "capacity to self-control" as one of the key elements of self-control, Wistrom and Treiber (2007) suggest that the core individual trait influencing an individual's ability to exercise self-control is what is often referred to as "*executive capability*." In doing so, contrary to Gottfredson and Hirschi (1990) and Tittle, Ward, and Grasmick (2004) who did not provide a clear defining concept of trait-like self-control[21], they clearly explain what is the nature or quality of executive capability is, how it functions, and why it should influence an individual's decision making process and corresponding behaviors[22] (see Wikström and Treiber 2007: pp.251-257 for more

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[21] Gottfredson and Hirschi (1990) only tell us the characteristics of people with low self-control (e.g., impulsivity, insensitivity, risk taking, short-sightedness) and individuals with such characteristics are vulnerable to the temptations of the moment because they fail to consider the negative or painful consequences of their acts. Similarly, Tittle, Ward, and Grasmick (2004) also suggest that their concept of capacity for self-control is almost same individual characteristics as Gottfredson and Hirschi's trait-like self control, but do not provide or discuss the quality of self-control itself.

[22] In brief, executive capability refers to the effectiveness of an individual's executive functions, the cognitive processes responsible for purposeful behavior. Although the definition of executive capabilities is still problematic and few researchers have posited their defining characteristic, they clearly posit that frontal lobe allows an individual to create and use internal representations to guide the decision making process. Elements of the setting that are more salient to the individual are allocated greater activation and will carry greater weight during the process of choice. This activation pattern may change as the information an individual is aware of and attending to changes, which makes internal representations flexible and adaptable to changing circumstances. Most importantly, internal representation allows an individual to integrate past experiences with sensory information from the present environment to evaluate elements of a setting and consider how they may influence action outcomes.

details). I think this line of thinking is useful in understanding the process of how individuals internalize self-control interacting with external contingencies over time. Especially, this opens the possibility that differences in executive capabilities continue to develop because internal representation remains flexible and adaptable to changing circumstances. Wikström and Treiber (2007: p.258) also clearly assert that an "individual's general ability to exercise self-control (as determined by this executive capabilities) is not fully developed until early adulthood and that this development is influenced by environmental factors." Contrary to Gottfredson and Hirschi's original position that the direct role of the environment in crime causation is reduced to providing opportunities for the manifestation of self-control, Wikström and Treiber (2007) maintain that there are also important environmental influences on an individuals' ability to exercise self-control. Therefore, stability and change in an individuals' ability to exercise self-control depend not only on the stability and change in his/her executive capabilities (individual trait) but also on the stability and change in the environmental factors in which he/she operates.

More explicitly, Wikström and Treiber (2009) further suggest the possibility of an integrated control perspective by claiming that, while Sampson and Laub's theory differs substantially from Gottfredson and Hirschi's theory in many respects, there also is a remarkable consistency when we consider that Sampson and Laub also ultimately emphasize the individual differences in internalized social constraints (e.g., informal social control arising from social bonds, commitment to conventional institutions) to account for the variation in offending behaviors. Therefore, this is the same causal mechanism purported by Gottfredson and Hirschi simply working through a different

medium (informal social, rather than self control). Therefore, Wikström and Treiber (2009) believe that it is fair to say that Laub and Sampson's theory has provided an alternative route for thinking about sources of stability and change in offending from Gottfredson and Hirschi's, presenting complementary, and not always contradictory, explanations.

In sum, no matter it is what Gottfredson Hirschi (1990) originally referred to as trait-like self-control, what Tittle, Ward, and Grasmick (2004) calls "self-control capability," or what Wikström and Treiber (2007) calls "executive capability," those theories and corresponding research still do not present a definite answer to the question of whether "self-control" as an internal offending propensity remains stable throughout life course totally *independent* of and *uninfluenced* by other time-varying environmentally-based inhibiting factors that are also found to play an important role in restraining individuals' criminal impulses. I think this is an important gap in the literature because such evidence that supports a more dynamic relation between the two theoretical constructs has implications not only for the empirical assessments of Gottfredson and Hirschi's theory itself, but also can somehow resolve the enduring controversy between population heterogeneity and state dependency, or social selection and social causation. Moreover, it can also shed more light on the precise causal mechanism of stability and change of offending behavior over time by disentangling what really causes sustaining or reshaping of offending trajectories over time. As I discuss in the following section – although it is an area that has been under-researched – limited evidence suggests that: 1) the general ability for self-control may remain malleable at least until the period of adolescence and, 2) not only the effect of self-control is mediated by social control/bonds variables, but the

impact of social control/bonds on individuals' offending is also mediated by the changing

level of criminal propensity such as self-control.

2.3 Empirical Research

Almost by definition, personality theories are thought to assume stable individual

differences and make no explicit explanation for personality change over time. To better

account for the pattern of the age-crime curve that manifests a gradual decrease in

criminality after peaking at late adolescence and early adulthood, which appears to be

similar across times and places, Gottfredson and Hirschi (1990) adopt the notion of

"relative stability" highlighting that, while within-individual self-control may change

over time by direct influence of aging or socialization that continue to occur, the relative

rankings or differences between-individuals' self-control remain stable over time. On the

other hand, developmental/life course theories focus primarily on the change in

both/either criminal behavior and/or offending propensity. Existing longitudinal studies

in the field of criminology or psychology do not support either of these positions (e.g.,

Caspi, Roberts, and Shiner 2005; Turner and Piquero 2002). One thing we need to notice

is that even in the field of psychology, where is it well established that genetic/biological

factors contribute to the stability of personality throughout the life course (Bouchard and

Loehlin 2001; Johnson, McGue, and Kruger 2005), there is a growing evidence for

personality change in the later stages of life, emphasizing the importance of life changes

and role transitions in personality development (Helson et al. 2002). Contrary to the

behavioral genetics research that has uncovered increasingly reliable and robust evidence

that genetic factors substantially influence personality traits (see Bouchard and Loehlin

2001, for a comprehensive review of this research), "population heterogeneity" theories in criminology such as Gottfredson and Hirschi's (1990) theory maintain that low self-control as a trait-like criminal propensity is exclusively formulated by external factors (e.g., parental socialization) discounting the importance of genetic/biological factors. Interestingly enough, although such sociological explanations of the origin and development of individual differences in offending propensity should be less deterministic and leave more room for the continued change over the life course influenced by later social experiences and environment than genetic/biological explanation, Gottfredson and Hirschi (2000: pp.62-64) still adopt a very static approach by arguing that individual differences emerging in the early childhood persist over the life course discounting the role of social institutions in the later stages of life. This is noteworthy when we consider that even behavioral genetics research continues to emphasize that both genetic and environmental influence on personality functioning across life course (Boosma, Busjahn, and Peltonen 2002; see also Muraven, Maumeister, and Tice 1999, for "moral muscle" explanation).

In the following sections, I will review the longitudinal studies in the field of both criminology and psychology that have investigated the development of individual traits (especially, self-regulation traits such as self-control) to come to some conclusions about the state of knowledge in the issue of stability and change of self-control over time. More specifically, I will focus on research that attempted to answer the question of whether offending propensity such as low self-control can change substantially over time by being influenced by time-varying social factors during adolescence or adulthood.

2.3.1 Stability Postulate of Self-Control Theory

Criminological Research

One of the controversial propositions of Gottfredson and Hirschi's theory that has important theoretical and policy implications but have been largely neglected in empirical scrutiny is the stability in the relative distance or ranking of self-control between individuals over long periods of time. While many scholars have already examined stability and change of criminal behavior over the life course (e.g., Sampson and Laub 1993), only four published studies in the field of criminology – to my best knowledge – have purportedly tested the stability hypotheses of Gottfredson and Hirschi's theory. Interestingly, contrary to Gottfredson and Hirschi's proposition, those limited findings suggest that there is evidence of substantial instability or even "reshuffling" in the individual trajectories of self-control over time.

The rank-order stability of self-control is often tested by examining correlations between self-control scores across more than two points in time. Arneklev and colleagues (1998) initially attempted to evaluate the theory's invariance proposition with longitudinal data across the two samples of individuals. In both samples, the correlations among each of the four Likert items for each of the six low self-control dimensions (24 items in total) were statistically significant at the 0.001 level, and the strengths of the correlations appear to be of similar magnitude when compared across the samples. Although these comparisons support Gottfredson and Hirschi's invariance proposition and ultimately "population heterogeneity thesis" (Nagin and Paternoster 1991; 2000), their findings preclude generalization largely because they used a convenience sample of

college students, who are assumed to be high self-control population and accordingly not to exhibit the greatest self-control differences (Turner and Piquero 2002: p.459). In addition, their measure of self-control relied solely on self-reported attitudinal aspect, which makes it very difficult for us to determine if different measures of self-control would result in similar conclusions. More importantly, since their two wave test-retest captures a very short period of time (4 months), it does not assess the extent to which self-control changes over longer period of time[23].

Turner and Piquero (2002) extended the Arneklev, Cochran, and Gainey's (1998) work to explore the similar stability hypothesis: whether relative ranking of self-control between individuals changes over time across offenders and non-offenders[24]. For a more critical examination of Gottfredson and Hirschi's stability postulate, however, they used a national probability sample with multi-method (both behavioral and attitudinal) measures of self-control, each of which was measured at multiple time periods covering from childhood to early adulthood. In addition, by clearly acknowledging that Gottfredson and Hirschi (1990: p.107) did not discount the possibility that absolute levels of self-control within individuals could change over the life-course[25], they also tested whether individual

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[23] The authors (Arneklev, Grasmick, and Bursik 1999: p.326) also acknowledged the inherent limitations of their findings, saying that "they cannot be taken as strong evidence that low self-control is an invariant characteristic."

[24] Although the stability postulate does not necessarily involve distinctions among distinctive offender groups (e.g., offenders vs. non-offenders) and Gottfredson and Hirschi (1990: p.227) argue that their model "does not make distinctions among offenders," Turner and Piquero (2002: p.459) assert that the key comparison of between group differences in self-control lies between offenders and non-offenders because the level of self-control for non-offenders should always and everywhere be higher than the level of self-control for offenders (Gottfredson and Hirschi 1990: pp.130-131; see also Hirschi and Gottfredson 2001).

[25] Gottfredson and Hirsch (1990: pp.107-108) argue "combining little or no movement from high self-control to low self-control with the fact that socialization continues to

levels of self-control increase over time among both offenders and non-offenders, while relative ranking between individuals should remain constant. Contrary to the Gottfredson and Hirschi's stability postulate, they found that the relative ranking of self-control between offenders and non-offenders remained significantly different across six of the seven waves of data collection. That is, although non-offenders gained more self-control than offenders during childhood and into early adolescence, the trend was reversed in late adolescence and into early adulthood (p.466).

Although Arneklev, Cochran, and Gainey (1998) and Tuner and Piquero (2002) have reached somewhat conflicting conclusions regarding the stability proposition with that of Gottfredson and Hirschi's theory, they failed to examine what explains such substantial and significant changes in individuals' propensity to offend. More recently, Burt, Simons, and Simons (2006) and Hay and Forest (2006) directly investigated this second core and controversial proposition of Gottfredson and Hirschi's (1990) stability hypothesis. After finding substantial instability in self-control across two waves[26] – the children were between 10 to 12 years of age at wave 1 and 12 to 14 at wave 2, – Burt, Simons, and Simons (2006: p.376) concluded that "shifts in individual rankings of self-control are not the exception, but the norm" and explicitly explored whether social factors can explicate these within-individual changes in self-control. Consistent with their prediction drawing

occur throughout life produces the conclusion that the proportion of the population in the potential offender pool should tend to decline as cohorts age"

[26] Although Burt, Simons, and Simons (2006) found the substantial vacillation in between-individual rankings in self-control, their study also has inherent limitation because of the relative short period (2 years) between measures of self-control. They authors also acknowledged this issue: "this paper's test of stability is relatively conservative….does not address the contentious issue of long-term stability." (p.374)

on "the strength model of self-control" (see Baumeister, Heatherton, and Tice 1994)[27], they found that four social relationships – improvements in parenting, attachment to teachers, association with pro-social peers, and association with deviant peers – are all independently and significantly associated with changes in the level of self-control, which explained a substantial portion of the variation in the levels of self-control across two waves even after controlling for the effect of wave 1 self-control. This finding contrasts starkly with Gottfredson and Hirschi's (1990) strict stability proposition and implies that social relationships with both conventional and unconventional others are not merely social consequences of latent individual traits such as low self-control but can have a independent impact on the individuals' level of self-control.

Similarly, Hay and Forrest (2006) also directly addressed both hypotheses of Gottfredson and Hirshi's stability postulate. First, they examined the stability and change in the relative ranking of self-control using a national sample of U.S. children from age 7 to age 15. Second, they tested whether parenting continues to affect self-control during adolescence – a period when self-control differences should be fixed and remain stable being not influenced by the external social environment. Interestingly, they found that, although more than 80 percent of the sample showed strong absolute and relative stability of self-control and this stability emerged as early as age 7, almost 16 percent of sample also experienced substantial absolute and relative change in self-control even after the age of 10. Moreover, parental socialization continued to affect the level of self-control during adolescence, even after accounting for both prior level of self-control and exposure to parental socialization, which contradicts the core proposition of Gottfredson

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[27] More elaboration of this hypothesis can be found in the remainder of this paper

and Hirschi's (1990) theory. Moreover, they also found that almost 11 percent of the sample revealed absolute decreases in self-control, which also contradicts Gottfredson and Hirschi's (1990: pp.107-108) argument that once gained, self-control is almost never lost. Although they focused on the decrease in parental socialization to explain such decreases in the level of self-control, it also has implications for the further research that decreases in informal social control can reduce self-control given the nature of enduring responsiveness of self-control to social relations (e.g., "late onsets").

In sum, in the field of criminology, though self-control clearly is a strong predictor of crime, little is known about the process by which it develops over time. Nonetheless, limited empirical evidence implies that Gottfredson and Hirschi's strict version of the stability proposition may require modification, and additional efforts for the reconceptualization of the nature and role of self-control over the life course may be desirable to explain the irregularities in the offending trajectories between individuals.

Psychological Research

In contrast to Gottfredson and Hirschi's (1990) static view of stability in self-control, psychological research suggests that there is a growing body of evidence for the possible change of personality traits such as self-regulation[28] throughout the life-course emphasizing the influence of life changes and role transitions in personality development in the later stages of life. However, because most of the research on the development of self-regulation involves cross-sectional or short-term longitudinal studies that almost

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[28] Although some argue that 'self-regulation' is a broader term that involves 'self-control' as one of its central features, I will use these terms interchangeably here by narrowly defining self-regulation as the self-control over impulses.

exclusively focuses on the early childhood (e.g., Tremblay et al. 1995; Murphy et al. 1999), little is known about the long-term stability of self-control in adolescence and adulthood. In other words, although there is a large body of literature on self-regulatory processes during the first 6 to 8 years of life (for reviews, see Bronson 2000; Grolnic and Farkas 2002), fewer scholars have examined if self-regulation continues to develop throughout later stages of the life-course. In response to this criticism, Raffaelli, Crokett, and Shen (2005) recently examined the development of children's self-regulation from early childhood through early adolescence using a large scale longitudinal sample drawn from the National Longitudinal Survey of Youth that have followed same individuals at three points across an 8 year period. While they found that individual differences in self-regulation were fairly stable across the 8-year span, – significant correlations between self-regulation scores from time 1 to time 2 ($r = .49$, $p < .01$) and from time 2 and time 3 ($r = .50$, $p < .01$) – they also focused only on children at the age of 4 to 5 until they become the age of 12 to 13, which falls into or is right after the formative period of self-control according to Gottfredson and Hirschi's theory. Moreover, the magnitude of such correlations across different ages (when the sample was aged 4 to 5 years and 12 to 13 years) showed little variation with no increasing stability after middle childhood as anticipated by Gottfredson and Hirschi (1990).

Nonetheless, recent systematic reviews or meta-analyses of personality development research[29] consistently suggest that there still are possibilities for self-control to change

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[29] Although there is an increasing consensus about the structure of personality at the level of higher-order, broad traits, there is little consensus about the lower-order traits subsumed within those superfactors (John and Srivastava 1999). Here I focus on the conscientiousness/constraint trait among "big five" traits (extraversion/positive emotionality, neuroticism/negative emotionality, conscientiousness/ constraint,

over time interacting with social environments and experiences. For example, Caspi, Roberts, and Shiner (2005: pp.466-470) in their recent review of personality development research suggest that, while personality traits are thought to reflect stable individual differences, there still is ongoing debate in the field over the issues such as (1) the rank-order stability of personality across time, (2) the mean-level changes in personality over time, (3) the personality development in adulthood. They argue that, although traditionally many researchers have doubted the possibility of personality changes in meaningful and systematic ways during adulthood, some recent trends in the studies of personality change – especially those that have been conducted for the past decade or so – show some clear patterns as follows[30].

First of all, while recognizing that individuals' traits play an active role in shaping their social environments and experiences, many researchers have also emphasized the person-environment interaction in explaining the underlying causal mechanism of stability and change in personality traits. That is, there are aspects of life that are beyond our control but still are considered to be critical for promoting stability and change of people's attitudes, behaviors, and feelings[31]. For example, Caspi and his colleagues (Caspi and Bem 1990; Caspi and Roberts 1999) emphasized 'reactive process,' which

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agreeableness, and openness-to-experience/intellect), that were presented by Caspi, Roberts, and Shiner (2005).

[30] Basically, the content and structure of the following section draws largely on the Caspi, Roberts, and Shiner's (2005) review. Nonetheless, I also attempted to reorganize them and add some more elaborations when necessary based on other studies that were not included in their review.

[31] This is consistent with Lewontin's (2000: pp.35-36) argument that, in Sampson and Laub's life-course theory of crime, development is conceived as the constant interaction between individuals and their environment, coupled with purposeful human agency and "random developmental noise." In this vein, Lewontin goes on to argue that "the organism is determined neither by its genes nor by its environment nor even by interaction between them, but bears a significant mark of random processes (2000: p.38).

reflects the tendency for people to react to similar environments in idiosyncratic but consistent ways. Accordingly, the social environment is filtered through the social-cognitive biases of the person, making it less likely that the person will be challenged to revise his or her views of the world. Roberts and DelVecchio 2000 (see also Fraley and Robert 2004) in their meta-analysis of 152 longitudinal studies with 3,217 test-retest correlation coefficients found that the rank-order stability of personality is moderate in magnitude, increases with age, and decrease as the time interval between observations increases. One thing that we need to note from their findings is that, the relative consistency of personality traits continues to increase throughout life span, peaking some time after age 50, and even then not being quite fixed.

Second, mean-level change, which refers to changes in the average trait level of a population, is typically assessed by mean-level differences in specific traits over time. Roberts, Caspi, and Moffitt (2003) in their recent review of over 80 longitudinal studies found evidence that supports a life-span developmental view of mean-level changes in personality traits. Interestingly, they found that the majority of personality change occurs in young adulthood, not in adolescence as one might suspect given traditional theories of psychological development. Moreover, the change also occurs well past young adulthood, demonstrating the malleable nature of personality well beyond typical age markers of maturity.

2.3.2 Self-Selection, Social Causation, or Both?

Criminological Research

The test of population heterogeneity and state dependence hypotheses in explaining criminal behaviors has been demonstrated via empirical assessment of the relative strength of self-selection and social-causation processes. For the past decades, many studies examined causation and selection issues by testing the extent to which the observed correlation between social relationships (or prior delinquency) and crime attenuate when controlling for individual differences (e.g., self-control, morality, self-esteem). Social causation models, in their pure form, would predict no attenuation, whereas self selection models, in their pure form, would predict complete attenuation. However, most of the studies found evidence of a "mixed model" which predicts partial attenuation. For example, Sampson and Laub (1993) found that, although prior delinquency predicted the problems in later social relationships and subsequent behaviors (e.g., self selection), the quality of social bonds in adulthood significantly predicted crime net of time-stable differences in criminal propensity (e.g., social causation). Paternoster et al. (1997) also found the evidence of both continuity and change in offending, and that the change could not be attributed solely to processes of self-selection.

In general, extant research in the field of criminology suggests that there seems to be a logical correspondence between self-control and the content and process involved in rational decision making (Nagin and Paternoster 1993; Piquero and Tibbetts 1996; Wright et al. 2004). For example, Nagin and Paternoster (1993) suggested that both stable

individual differences in criminal propensity (e.g., self-control) and situationally-relevant variables and perceived benefits and costs of crime (e.g., social bond) are important and the two criminological traditions should not be viewed as competing explanations but should be included in a complete understanding of crime. However, they still argued that both variables have *independent* influences on criminal behavior, and this failed linkage has become the subject of several critiques of self-control theory (Akers 1991; Taylor 2001; Wright et al. 2001; Doherty 2006). In other words, existing research has examined such relationship with respect to two analytical terms: moderation and mediation effects. Moderation effects research focused on the interaction between two theories in explaining deviant behaviors and suggested mixed findings. For example, Wright et al. (1999) found that, in support of both selection and causation explanations, social causation effects remained significant even when controlling for preexisting levels of self-control, but that their effects diminished. Therefore, they conclude that pure social selection and social causation models may not be workable as comprehensive theories. In their subsequent research, Wright et al. (2001) also found evidence of a moderating relationship between criminal propensity, operationalized as self-control, and prosocial ties on crime. Doherty (2006) by extending Wright et al.'s (2001) research focusing on this moderating relationships and the developmental process of desistance from crime found that there is no evidence of moderating relationship between these two factors on desistance although both self-control and social bonds are *independently* and strongly related to desistance from crime.

On the other hand, most mediation effects research has consistently found evidence that the effect of self-control on crime is mediated by social relationships. For example,

Nagin and Paternoster (1994), by expanding their original integrative model of rational choice and self-control theories (Nagin and Paternoster 1993), attempted to link more explicitly both theoretical traditions to better specify the causal mechanism underlying the process of calculation between costs and benefits by hypothesizing that individuals with low self-control tend to invest less in social bonds and accumulate social capital and, therefore, less likely to be deterred from committing crime by the possibility of damage to such social bonds and social capital (non-legal costs). In a similar vein, Longshore, Chang, and Messina (2005) also found that low self-control was negatively related to social bonding and positively related to delinquent peer association, which in turn led to increased offending. This line of research is also logically consistent with Paternoster and Pogarsky's (2009) recent idea that individuals with "thoughtfully reflective decision making" (TRDM) invest more in social capital and, therefore, more deterred from committing crime. These theoretical developments recognize how individuals' calculation of costs and benefits is embedded within a host of other personal and contextual factors.

Interestingly, however, few studies examined whether the effect of social relationships in the later stages of life on crime is mediated by the changing level of self-control. I think this gap results in part from the strict version of the "stability postulate" in Gottfredson and Hischi's (1990) theory, which strongly suggests that, once established in the early childhood, the level of self-control remains relatively stable over the time being uninfluenced by subsequent social events and experiences. Only recently, some emerging evidence suggests that social experiences in the later stages of life course (e.g., improvement in parenting, attachment to teachers, association with pro-social peers, and

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association with deviant peers) might also explain the changing level of self-control (Burt, Simons, and Simons 2006; Hay and Forrest 2006) as I have already discussed in the previous section. In this vein, Laub and Sampson (2003) also explicitly proposed that "criminality is a dynamic concept, especially viewed over long periods of time." By acknowledging that they had been silent as to whether individual's propensity to crime changes or remains stable over time (Sampson and Laub 1995), Laub and Sampson (2003) made their position more explicit by arguing that "individual propensity to crime can change over time because of a variety of factors (e.g., aging, changes in informal social control, the increasing deterrent effect of sanctions). More recently, in direct response to Gottfredson's (2005) question of "Is the effect of marriage propensity or event?" Sampson and Laub (2005) made their position even more explicit by arguing that "We believe marriage has an effect on both propensity and events or opportunities to offend." In a similar vein, Le Blanc (2006), by emphasizing that existing criminological theories are structural rather than developmental, proposed a dynamic process of how control mechanisms develop during the life span through the ongoing interaction between self and social controls in an environmental context. Similarly, Wikström and Treiber (2009) also argue that many current theories suffer key shortcomings in their explanation of the sources of stability and change that perpetuate or terminate criminal careers largely because they frequently fail to adequately address individual and environmental levels of explanation, and particularly the interaction of individual and environmental factors.

Psychological Research

Consistent with Laub and Sampson's (2003) perspective[32] (see also Sampson and Laub 1997), psychological research also suggests that personality trait development does not appear to be a continuity-versus-change proposition, but coexistence of continuity and change ("corresponsive principle" Caspi, Roberts, and Shiner 2005: p.470). That is, the effect of life experience on personality development is to deepen the characteristics that lead people to those experiences in the first place (Robert et al. 2003; Robert and Robins 2004). For example, Roberts, Caspi, and Moffitt (2003) in their analysis of the relationship between personality traits and work experiences in young adulthood found that, although measures of personality taken at age 18 predicted work experiences at age 26, work experiences were also related to changes in personality traits from age 18 to 26. Most of all, they found that predictive and change relations between personality traits and work experiences were "corresponsive," that is, traits that selected people into specific work experiences were the same traits that changed in response to those same work experiences. This corresponsive model opens a window to incorporate two seemingly distinctive but mutually supportive life-course dynamics: social selection and social causation – social selection, wherein people select environments that are correlated with their personality traits, and social causation, wherein environmental experiences affect personality functioning[33].

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[32] "Although at first it may seem counterintuitive, our fundamental beginning argument is that persistence and desistance can be meaningfully understood within the same theoretical framework…" (Laub and Sampon 2003: p.37)

[33] However, this model still differ from Laub and Sampson's (2003) model because, although it emphasizes that traits that people already possess are changed by trait-correlated experiences that they create, it discount the possibility that life experiences do

Although few researchers in the field of psychology have directly examined the

hypothesis that self-control continues to develop throughout life-course interacting with

external social factors, Baumeister and colleagues in a series of studies (e.g., Baumeister

2002; Baumeister, Heatherton, and Tice 1994; Baumeister, Muraven, and Tice 2000;

Baumeister and Exline 1999; Baumeister and Heartherton 1996; Muraven and

Baumeister 2000; Muraven, Baumeister, and Tice 1999) suggested and tested the validity

of their "the strength model of self-control," which contends that self-control operates

like a muscle: 1) if self-regulatory strength acts like a muscle, then temporary resource

fatigue ("ego depletion") should be a consequence of exertion. 2) Over time, however,

repeated exertion should lead to a stronger muscle[34]. Compared to the cumulative

empirical evidence that supports the "self-control depletion" hypothesis (e.g., Muraven,

Baumeister, and Tice 1999; Muraven and Baumeister 2000; Muraven, Pogarsky, and

Shumeli 2006), however, only one longitudinal study by Muraven, Baumeister, and Tice

(1999) explicitly addressed the second hypothesis, which is more relevant to the purpose

of this study. Although they found that people who performed a series of self-control

exercises over several weeks showed significant improvement in self-regulatory capacity,

the more and better research on long-term benefits of exercising self-control is required

to confirm this important implication of self-regulatory strength model[35]. Especially,

since it is unlikely that people can improve self-control skills without systematic and

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not impinge themselves on people in a 'random' fashion causing widespread personality
transformations.

[34] The logic of this model is very similar to the notion of "cumulative
advantage/disadvantage" explanation of continuity and change suggested by Sampson
and Laub (1997)

[35] Muraven, Baumeister, and Tice (1999) used a convenience sample of 69 college
students and experiment lasted only 2 weeks.

sustained practice (Strayhorn 2002: p.14), longitudinal studies focused on the longer effects of improvement in informal social control on the changing level of self-control could best shed light on this seemingly plausible hypothesis. Nonetheless, after summarizing the extensive research on self-control, Strayhorn (2002) concluded that self-control, like a muscle, appears to be fatigued in the short run and strengthened in the long run by exercise, emphasizing that "self-control is not so stable that hope of altering it should not be abandoned (p.10)." Compared to depletion hypothesis, however, "build-up" hypothesis cannot be tested in the context of traditional psychological experiments that assess the short-term effects of a variety of intervention conditions.

In sum, these studies imply that not only within-individual levels and between-individuals' rankings of self-control can change over time, but also individual and environmental factors might operate simultaneously to affect such changes in levels of self-control. It is noteworthy psychological research takes such dynamic views of personality traits when we consider that it is well established in psychology that genes and biological factors contribute to personality stability throughout the lifespan (Bouchard and Loehlin 2001; Johnson, McGue, and Kruger 2005), and accordingly should be more deterministic than the pure sociological explanation of the origin and development of self-control proposed by Gottfredson and Hirschi (1990). Especially, self-control strength model hold particular promise for advancing criminological perspective on the nature and role of control mechanisms, although it still is not and ideal theoretical framework that can incorporate a more comprehensive account of complex cognitive and reasoning processes.

2.3.3 Prior Evaluations on the Current Interventions

Ialongo and his colleagues (1999; 2001) have already reported on both the proximal and distal impact of the JHU prevention programs on a range of outcome variables of interest. In their assessment of the programs' immediate effects on some of the early risk behaviors for later substance use/abuse, affective disorder, and conduct disorder, Ialongo et al. (1999) found that the classroom-centered (CC) intervention designed to enhance teachers' behavior management and instructional skills produced the greatest degree of impact on its proximal targets, whereas the impact of family-school partnership (FSP) intervention designed to improve parent-teacher communication and parental teaching and child behavior management strategies was somewhat less. Despite the modest effects in general, some meaningful impact of FSP intervention on the early risk behaviors of attention or concentration problems and aggressive behaviors were observed, all of which are used as the measures of self-control in the current study. While this study evaluated the impact of the first-grade JHU preventive interventions on the proximal target outcomes at the end of first grade and second grade, Ialongo et al. (2001) also expanded the inquires into the investigation of the program's distal impact on conduct problems and disorder in early adolescence. In particular, based on the existing theory and empirical evidence that emphasize the influences exerted by the family on their children's academic success and social development, the FSP intervention (which is the primary focus of this study) sought to reduce these early risk behaviors by enhancing family-school communication and parenting practices associated with learning and behavior. Similar to their prior evaluation focusing only on the proximal effect of FSP intervention by comparing the outcomes before-and-after (first vs. second grade) the

introduction of the intervention, Ialongo et al. (2001) also found that, at grade 6 or age 12, FSP intervention children received significantly lower ratings from their teachers for conduct problems than control children. In addition, they also found that statistically significant effects of FSP intervention on antisocial behavior were mediated through improved parenting practices via improvement in the early risk behaviors of attention/concentration problems and aggressive behaviors. More specifically, they (2001: 155) tested the hypothesis that: (1) relative to controls, FSP intervention parents would be more likely to engage in reinforcing activities with their children and would be less likely to reject them and (2) FSP intervention parents would be more likely to monitor their children and less likely to engage in inconsistent discipline, all of which are used as the measures of social control/bond in the current study. While they did not find significant intervention effects on parent monitoring and inconsistent discipline, they did find significant FSP intervention effects on rejection and reinforcement in the expected direction.

In sum, early evaluations of the FSP intervention were limited to early adolescence and characterized by outcome-focused approach. Compared with CC intervention, which suggested a strong and significant impact on the behavioral disorders and problems, the FSP intervention is reported to have a modest impact on both behavioral outcomes and mediating variables of interest during the end of second or sixth grade. This finding may in part be due to measurement error in the measures of the immediate and distal impacts. In addition, it may be the case that the effects of the FSP intervention will be more apparent during the late adolescent years, when the rates of conduct disorder and antisocial behavior tend to increase dramatically (Ialongo et al. 2001: 158). Most of all,

such outcome-focused approaches that attempt to find statistically significant differences between study groups on the outcome variables of interest– sometimes after some statistical controls – do not involve an explicit test of the causal mechanism by which an intervention is designed to affect a certain group and accordingly cannot provide definitive answers to the intervention's long-term effect and implication. This study builds on and extends to the prior evaluations of the FSP intervention to address more explicitly the issues of the operative causal mechanism and long-term effects of an early preventive intervention using more recent and comprehensive data as well as rigorous and appropriate methods to answer such research questions. Such process-based approaches focusing on the long-term effects are relevant for answering not only some substantive questions for theoretical development but also appropriate policy questions for practitioners and policy makers.

3 The Current Study

3.1 Research Questions

- Are both capacity for self-control (measured by trait-like self-control) and desire to exercise self-control (measured by social control/bond) distinct latent constructs that constitute the offending propensity?

- What is the pattern of growth over time for the capacity of self-control at the aggregate level?

  - Is there a substantial variability between individuals in their growth rate?

  - Is there a significant interaction between individuals' initial level and growth rate?

- Do individuals within the treatment group have faster rates of change in the development of the capacity for self-control than those within the control group?

- Does the changing level of social control/bond at each time point account for the observed different rates of change in trait-like self-control across two study groups?

- What is the pattern of relationship over time between trait-like self-control and social control/bonds?

  - Are the magnitude and significance of relationship equivalent for both causal directions?

  - Does the same pattern persist across two study groups?

3.2 Data[36]

The data used in this study are part of second generation of the Johns Hopkins Prevention Intervention Research Center's (JHU PIRC) field trials. It involves enhancement and combination of the first generation "classroom-based universal preventive interventions" targeting early learning problems and aggressive behavior (treatment 1). Moreover, it goes further than the first generation intervention to include "family-school partnership intervention" directed at improving school achievement and reducing conduct problems such as early aggressive/disruptive behaviors by enhancing family-school communication and parenting practices (treatment 2). While this study focus exclusively on the effects of "treatment 2," and accordingly compares the subjects between control and "treatment 2" groups, a brief description of both intervention programs are introduced in the following section.

3.2.1 Intervention Programs

The Classroom-Centered (CC) Intervention

Classroom-centered (CC) intervention is composed of three main components: 1) curricular component to promote reading and mathematics achievement (e.g., "interactive read aloud" for increasing listening and comprehension skills, "the readers theater and journal writing" for increasing composition skills, "critique of the week" for increasing

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[36] This section summarizes the data documentation provided by JHU PIRC to the purpose of this study. For more detailed information about the data, please refer to the JHU PIRC website: http://www.jhsph.edu/prevention/Data/Cohort3/index

critical thinking skills, "MIMOSA" for increasing mathematics skills); 2) behavioral component to promote positive behavior and problem solving skills (e.g., "the Good Behavior Game" for promoting positive behavior; "weekly classroom meeting" for promoting group problem solving); and 3) special needs component to backup universal strategies for children not performing adequately (e.g., "alternative curriculum" or "individualized tutoring" for curricular backup strategies; "individual reinforcement" or "a continuum of individualized behavior management" for behavioral backup strategies).

The classroom-based prevention program provides a resource teacher to each classroom, who works within the classroom two hours per day. This professional former or retired teacher, who has BS/MS in Education and previous successful teaching experience in elementary school or primary education, works within the classroom two hours per day. He/she provides support and assistance to the classroom teacher in the implementation of the classroom program. The prevention program resource teacher works in collaboration with the classroom teacher to support the assessment, curricular, and behavior management components of the classroom intervention. This position is responsible for functions related to individual and small group instruction and tutoring; the implementation of back-up strategies for curriculum and behavior management; assessment and instructional planning; and the support to and assistance in the monitoring of classroom innovations. This position is supervised by the coordinator of classroom prevention programs collaboratively with the designated school site principal.

The Family-School Partnership Intervention

The family-school partnership intervention was designed to enhance parent-school communication and provide parents with effective teaching and child behavior management strategies via three main components: 1) training teachers/school mental health professionals and other relevant school staff in parent-school communication and partnership building; 2) weakly home-school learning and communication activities; and 3) a series of nine workshops for parents led by the first grade teacher and school psychologist or social worker. The workshop series for parents began immediately after the pretest assessments in the fall of first grade, and ran for seven consecutive weeks. Two follow-up or booster workshops were held in the winter and spring, respectively. The initial workshops were aimed at establishing an effective and enduring partnership between parents and school staff, and set the stage for parent-school collaboration in facilitating children's learning and behavior. Subsequent workshops focused on improving parents' teaching skills and supporting their child's academic achievement. The Parent and Children SERIES, a videotape modeling, group discussion program, formed the basis for the positive discipline component of the intervention. In addition to the workshops, a voice mail system, or "Warm Line," was put in place in each school to maintain parent involvement and to facilitate parent-school communication and collaboration around children's learning or behavior management difficulties.

Intervention Fidelity

Given the fact that monitoring and sustaining the integrity of the interventions are critical to achieve the goals of intervention as originally intended, JHU PIRC took several

measures to maintain intervention fidelity. For example, the training and intervention manuals were precisely delineated and codified, thus standardizing the content of each training and intervention. In addition, each intervener had available a number of materials designed to foster the correct execution of the interventions (e.g., detailed outlines and checklists that prescribe the necessary materials for each intervention contact, the specific themes or tasks that need to be covered, and related information). Finally, the intervener had extensive training prior to the initiation of the interventions, and received ongoing supervision, feedback, and training throughout the intervention period. In terms of implementation and/or participation checks specific to each intervention, the monitoring of fidelity of implementation for the classroom-based intervention involved three parts: 1) measures of setting up the classroom; 2) classroom observations; and 3) classroom visit record reviews. For the family-school partnership intervention, interveners were required to provide documentation of each contact with parents, including workshop attendance, level of parental participation, and compliance with homework assignments. Each of the nine classrooms was assigned a score from 0-100 representing the percentage of the teacher's implementation of the intervention as designed. Scores were based on the three sources of implementation data identified above. Classroom-based intervention implementation scores ranged from 30 to 78 %, with a median of 64.37 %, and a mean of 59.9 % (SD = 17.03 %). All but two of the nine classroom-based intervention teachers implemented more than 50% of the intervention protocol. For family-school partnership intervention, parents/caregivers attended on average 4.02 (SD = 2.38, Median 5.0, Range 0-7) of the seven core parenting sessions offered in the fall of first grade, or 57.14% of the available sessions. Just less than 13% (12.7%) of the parents/caregivers failed to

attend any of the core workshops, whereas just more than a third (35.3%) of the parents

attended at least six of the seven sessions. In terms of the rate of parent/caregiver

completion of weekly, take-home "read aloud" and "fun math" activities, on average

parents completed 39.15 (SD = 16.54) of the 64 activities or 60.93%. Once again, about

1/3 (35.7%) completed 75% or more of the activities, whereas only 2.3% failed to

complete any of the activities.

3.2.2. Subjects

The intervention design involved 678 first-graders and their families in nine

Baltimore City public elementary schools. In the fall of 1993, 678 urban first-graders

were recruited from 27 classrooms in 9 elementary schools primarily located in western

Baltimore. Of these 678 children, 53.2% were male, 86.8% were African American with

63.4% of the children were on free or reduced-cost lunch. At the entrance into first grade,

the age of children ranged from 5.3 to 7.7 years with a mean age of 6.2 years (SD =

.34)[37]. Of these 678 children available for participation in fall of 1st grade, written

parental consent was obtained for 97% (653) of the children. There were no significant

differences in terms of socio-demographic characteristics or intervention condition

between consenting and non-consenting children (Ialongo et al. 2001: 148). Almost

91.3% (597) of children remained enrolled in project schools through grade 1 and

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[37] Although subjects were interviewed at the different biological age, they were interviewed at the same sociological age (e.g., initially at the beginning of semester and at the spring semester thereafter). Given that this study is focused on socialization process and its implication on individual trait (and vice versa), I think the latter is more relevant to the purpose of this study.

completed the one-year of intervention in their assigned intervention or control condition. In grades 6-9, consent was obtained from parents for 81.6% (553) – 9.6 % (65) refused participation, 3.5% (24) were contacted but failed to respond, 4.9% (33) were unlocatable, and 0.4% (3) had died. In grades 10-12, consent was obtained from parents for 84.7% (574), 6.2% (42) refused to participate, 4.4% (30) were contacted but failed to respond, 4.3% (30) were unlocatable and 0.4% (3) had died. Fortunately, departure from Baltimore City Public Schools or transfer from an intervention to non-intervention school was unrelated to intervention condition from 1st through 12th grades. Moreover, there was no difference in attrition or refusal rates between or across intervention conditions from grade 1 to 12. Nor were there any between-condition differences in terms of socio-demographic characteristics (ethnicity, gender, age, or free lunch status) through the grade 12 assessments to the extent that might affect the substantive inferences given the amount of missing data. In terms of the percentage of participants with data on the key outcome measures at each assessment time point, nearly 75% of participants have teacher report data at 8 out of 11 possible time points through 12th grade. Similarly, 75% of the participants participant self-report data for at least 7 out of the 9 possible assessments from grade 6 to age 20 and 6 out of 9 possible parent interviews in grades 1 and 6-12. This study uses only 448 individuals assigned to only either family-school partnership intervention (treatment 2) or control conditions after excluding those who participated in the classroom-based intervention (treatment 1, n=230). The final sample size used in the analyses to follow is reduced to 399 after removing the 49 cases with missing on all variables from grade 6 to 12. There were no significant differences between those

missing cases in terms of socio-demographic characteristics or intervention conditions (see Appendix 4).

Although the study is based predominantly on the African American population with very low income level, such a high-risk sample might serve the purpose of this study better than does a more general and representative sample of student population for the reasons that follow: First, psychological research suggests that those with lower level of self-control have more room for improvement than those with higher self-control (Baumeister, Heatherton, and Tice 1994). Given the relatively stable nature of self-control hypothesized by Gottfredson and Hirschi's (1990) theory, more variation in the variables of interest would produce more robust findings. Second, when we consider that not only a relatively small number of serious and chronic offenders (Wolfgang, Figlio, and Sellin 1972) but also a relatively small number of schools (Cook, Gottfredson, and Na 2010a) account for the substantially large number of crimes committed, the interventions targeting selective areas, schools, or individuals would be more cost-effective than universally applied programs. Cook, Gottfredson, and Na (2010b) also found that schools located in urban, low SES areas with high percentage of minority population have the highest crime rates.

3.2.3 Study Design

A randomized block design was employed, with schools serving as the blocking factor. Three first grade classrooms in each of nine elementary schools (27 classrooms in total) were randomly assigned to one of the two intervention conditions or to a control condition. Teachers and children were randomly assigned to intervention conditions. The

interventions were limited to grade 1. Through 12th grade subjects were interviewed at 11

possible time points in the spring of grade 1-3 and 6-12), including the pre-test or

baseline assessment in the early fall of grade 1. Randomized field trial in the context of

longitudinal panel design that follows same subjects over time enables us to separate out

the 'pure' within-individual changes in key variables from those that result from other

confounding factors such as aging, maturational, or historical processes, all of which are

known to be a serious threat to the internal validity. Especially, randomization enables us

to overcome the problem of 'testing bias' that is inherent in longitudinal panel data. That

is, while it is well known that intra-individual change in longitudinal panel design does

not necessarily reflect the real change in variables of interest but may result from the

tendency that subjects respond to the same interviews in some distinct patterns, in the

randomized trials, we cannot expect that such bias would influence in some

systematically different ways between treatment and control group members. In sum, in a

randomized experiment, the treated-minus-control difference in mean outcomes (e.g.,

growth parameters such as intercept and slope in the HLM or growth factors in the

second-order LGM) is an unbiased and consistent estimate of the average effect of the

treatment on the subjects in the experiment.

3.2.4 Measurement

Since control theory assumes that characteristics of respondents, such as self-control,

affect the validity of responses to questionnaires, it is advisable to seek measures that are

assessed and collected independently of the respondent (Gottfredson 2006: p.94). In this

study, children's level of self-control measured by school teacher is used.

Trait-like Self-Control

Cognitive-based measures of self-control are often preferred to behavioral-based measures in testing Gottfredson and Hirschi's theory because they are less vulnerable to the issue of tautology. Some scholars, including Hirschi and Gottfredson (1993: 49) themselves, however, argue that behavioral measures better capture the theoretical construct of self-control with more construct validity and accordingly are more consistent with the theoretical propositions articulated by self-control theory. More recently, Gottfredson (2006) once again clearly articulated that, because self-control itself likely affects survey responses, behavioral measures – either respondent or informant based – are preferable to attitudinal survey responses[38]. In this study, I use behavioral measures of self-control taken from teachers, one of the primary informants who can best assess subjects' level of self-control unaffected by children's existing level of self-control. In addition, in response to the criticism that behavioral measures are inherently tautological, only specific behavioral measures that capture behavioral manifestations of self-control itself but inherently do not involve force or fraud for self-gratification are used. Most of all, this study utilizes a sufficient number of indicators for theoretical elements of self-control to increase the measurement reliability. To better picture the changing patterns of self-control that are presumed to increase over time as postulated in the Gottfredson and Hirschi's original theory, the responses are scored in such a way that higher values reflect

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[38] Of course, whether self-control is measured by self-reported tendencies or by actual behaviors, such measures will tend to correlate to the extent both measures contain some "true" variance. In this vein, Pratt and Cullen (2000) argued that "the fact the effect size estimates for attitudinal and behavioral measures of self-control are similar undermines the criticism that support for Gottfredson and Hirschi's theory lies primarily on data biased by the use of tautological measures"

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more self-control. As a preliminary step before moving on to more complex analysis (e.g., latent growth modeling, structural equation modeling), some preliminary steps were taken such as principle components analysis to identify valid and reliable indicators of self-control given the exploratory nature of this study. Then, to better specify the measurement models that are theoretically relevant and empirically fit the data, confirmatory factor analyses were conducted (see chapter 4 for more detail).

The Teacher Observation of Classroom Adaptation-Revised (TOCA-R) is a brief measure of each child's adequacy of performance on the core tasks in the classroom as defined by the teacher, which was first administered in grades 1-3 and then in grades 6-12 (in different version: see below). It is a structured interview administered by a trained member of the assessment staff and the interviewer records the teacher's ratings of the adequacy of each child's performance on six basic tasks: accepting authority (aggressive disruptive behaviors and oppositional-defiant behavior), social participation (shy or withdrawn behavior), self-regulation (impulsivity), motor control (hyperactivity), concentration (inattention), and peer likeability (rejection). Given the unavailability of item-level variables for TOCA-R, five subscales already created by JHU PIRC which appear to measure some combination of the defining elements of self-control used in Gottfredson and Hirschi (1990)'s original theory and Grasmick et al.'s (1993) subsequent research are selected: (1) Impulsivity – "impulsivity" and "self-centered," (2) Hyperactivity – "physical" and "risk seeking," (3) Concentration Problems – "impulsivity" and "simple task," (4) Oppositional-Defiant behavior – "self-centered" and "temper," and (5) Helpless Achievement Behaviors (available only after grade 6) –

"impulsivity" and "simple task." (see Appendix 1.1 for more details). Test-retest

correlations over a four month interval with different interviewers were .60 or higher for

each of these subscale. The 1-year test-retest intraclass reliability coefficients for the

oppositional-defiant subscale ranged from .65 to .79 over grades 2-3, 3-4, and 4-5. One-

year test-retest reliability coefficients ranged from .54 to .56 over grades 1-5 for the

Concentration problems subscale, .44 to .49 for the Impulsivity, and .41 to .46 for the

hyperactivity subscale. The overall coefficient alphas in the grade 1-3 were .75

(Impulsivity), .72 (Hyperactivity), .84 (Concentration Problems), .77 (Oppositional-

Defiant Behavior).

The Teacher Report of Classroom Behavior Checklist (TRCBC) was used in the

grades 6-12 follow-up. It is an adaptation of the TOCA-R which was used in grades 1-3.

The decision to go to a checklist format versus an interview reflected concerns over the

costs and logistical burden of interviewing upwards of 300-400 teachers in over 130

schools. Although most middle and high school students have a different teacher for each

of their academic subjects, TRCBC was administered only to youths' English/Language

Arts and Mathematics teachers for consistency. Like the TOCA-R, the domains assessed

in the TRCBC are: accepting authority (the maladaptive forms being conduct problems

and oppositional defiant behavior), social participation (shy or withdrawn behavior), self-

regulation (impulsivity), motor control (hyperactivity), concentration (inattention), and

peer likeability (rejection). Given a common set of items/indicators is necessary for

analysis of repeated measured in studies of growth and development and intervention

impact, the TOCA and the TRCBC items, respectively, have remained constant over the

course of the study. Especially, rather than delete or add items over time out of concern

for the age appropriateness of the items, the TOCA and the TRCBC included a number of items that represented the breadth of common maladaptive behaviors seen either in the child and/or adolescent years. This is important when we consider that measures of self-control need to be age-sensitive (e.g., self-control will be manifest differently for toddlers, teens, and adults: Gottfredson 2006: p.93). The coefficient alphas in the grade 6-12 ranged from .65 to .79 (Impulsivity), from .76 to .88 (Hyperactivity), from .90 to .93 (Concentration Problems), from .87 to 93 (Oppositional-Defiant Behavior), and from .83 to .86 (Helpless) (see Appendix 1.1 for details).

Social Control/Bonds

Gottfredson and Hirschi (1990: p.95) argue that all of the characteristics associated with low self-control tend to show themselves in the absence of nurturance, discipline, or training. While there will be little variability among individuals in their ability to see the pleasures of crime because crime by its nature is universally pleasurable and therefore the pleasures of crime are reasonably equally distributed over the population, there will be considerable variability in their ability to calculate potential pains. Accordingly, the causes of low self-control are negative rather than positive in a sense that self-control is unlikely to be formulated in the absence of an effort to create it[39]. So, there are two general sources of variation in self-control: The first is the variation among children in the degree to which they manifest such traits to begin with. The second is the variation

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[39] Gottfredson and Hirschi (1990: p.95) view that dimensions of self-control are factors affecting calculation of the consequences of behaviors (e.g., the impulsive or short-sighted person fails to consider the negative or painful consequences of his acts; the insensitive person has fewer negative consequences to consider because he/she care less about what others think; the less intelligent person also has fewer negative consequences to consider because he/she has less to lose).

among caretakers in the degree to which they recognize low self-control and its

consequences and the degree to which they are willing and able to correct it. Gottfredson

and Hirschi (1990: p.96) explicitly argue that people are not born criminals, do not inherit

a gene for criminality, or anything of the sort, but individual differences in offending

propensity appear later and seem to be largely products of ineffective or incomplete

socialization by primary caretakers. Although they clearly argue that attachment from

parent to child is a necessary condition for effective parenting practices, they primarily

emphasize the control dimension of socialization by arguing that "the ability and

willingness to delay immediate gratification for some larger purpose may therefore be

assumed to be a consequence of training. Much parental action is in fact geared toward

suppression of impulsive behavior, toward making the child consider the long-range

consequences of acts. Consistent sensitivity to the needs and feelings of others may also

be assumed to be a consequence of training." (pp.96-97, emphasis added)[40]. In sum, the

major cause of low self-control appears to be ineffective child-rearing and conditions

necessary for adequate child rearing to occur are: 1) monitor the child's behavior, 2)

recognize deviant behavior when it occurs, and 3) punish such behavior. In addition, 4)

affection or investment in the child (the attachment of the parent to the child) is also

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[40] According to social learning perspective, behavioral change is brought about through
reinforcement. When stimulus is presented as a consequence of a response and the rate of
that response increases or maintains as a result, the stimulus is called a positive reinforcer
(O'Leary and O'Leary 1977). Examples of positive reinforcer include praise, money, or
an enjoyable activity. A reinforcer is effective only if it increases the rate of a desirable
response or decreases the rate of an undesirable one. As children age, they might not
respond to typical reinforcers, which requires parent to pair the ineffective reinforcer with
the effective one (Sulzer-Azaroff and Mayer 1977). In this vein, while Gottfredson and
Hirschi emphasize negative reinforcer for misbehaviors as the primary source of self-
control, other dimension of parenting practices (e.g., positive reinforcers such as praise
for good behavior and support for conventional goals) may play a non-negligible role in
producing self-control especially during adolescence.

required as a necessary condition for successful child-rearing. The result may be a child more capable of delaying easy and immediate gratification, more sensitive to the interests and desires of others, more independent, more willing to accept restraints on his activity, and less likely to use force or violence to attain his ends, all of which are core elements of self-control.

However, Gottfredson and Hirschi (1990) focused primarily on the direct and immediate control mechanism rather than indirect and long-term inhibiting factors that result from the fear of losing or damaging relational/emotional attachment to significant others or commitment to conventional (e.g., educational or occupational) goals when they choose to engage in criminal acts. Moreover, they also focused only on how the traits composing low self-control can destroy interpersonal relations and impede educational and occupational achievement (self-selection), ignoring the possibility that improvement of relational attachment and conventional commitment can also continue to have an impact on the level of self-control over time (social-causation). In this study, parents in the treatment group received intervention program targeting at the improvement of parental disciplinary practices, all the elements of which are consistent with what Gottfredson and Hirschi emphasize as source of self-control. In addition, parents also learned how to improve relational attachment to and involvement with their children and better support academic achievement through treatment targeting at the enhancement of parent-teacher communication.

The Structured Interview of Parent Management Skills and Practices (SIPMSP) was designed to assess the major constructs included in Patterson et al.'s (1989) model of the development of antisocial behavior in children. That is SIMPSP includes the parent

disciplinary practices and practices associate with the development of antisocial behavior, which were targeted by the FSP intervention. The relevant parental disciplinary practice constructs are 1) parental monitoring, 2) discipline, 3) reinforcement, 4) rejection, and 5) problem solving. In collaboration with the Oregon Social Learning Center Prevention Center, JHU PIRC also modified SIMSP to include items assessing parent-teacher communication and involvement and support for the child's academic achievement. Based on the extant theories and research (Hirschi 2004; Tittle, Ward, and Grasmick 2004; Hay and Forrest 2006) and some exploratory factor analyses, I decided to create five subscales which represent the key elements of social control/bond that would function as sources of self-control, not just being constrained to those highlighted in Gottfredson and Hirschi's (1990) theory but also including other dimensions (e.g., support) that are known to be effective in changing individual trait and behavior: 1) Monitoring, 2) Punishment, 3) Attachment, 4) Involvement, and 5) Support (see Appendix 1.2 for more details). The coefficient alphas for the POCA subscales ranged from .25 to .67 (Monitoring), from .75 to .80 (Punishment), from .59 to .85 (Attachment), from .33 to .59 (Involvement), and from .50 to .72 (Support) (see Appendix 1.2 for more details).

Delinquency

Teacher's rating of conduct disorder problems, a subscale composed of a subset of multiple items measured by TRCBC, is used to measure the subjects' level of delinquency: Skipped school, coerced classmates with physical violence, bullied classmates into getting his/her way, used physical intimidation to get what s/he wanted,

started physical fights with classmates, lied, took others property, hurt others physically,

damaged other people's property on purpose. These items also represent the breadth of

common behavioral problems that are prevalent during the period of grade 6 to 12. The

coefficient alphas for the delinquency subscale range from .83 to .89.

3.2.5 Preliminary Analyses

Equivalence of the intervention conditions at baseline

In their prior evaluation of the same interventions, Ialongo et al. (1999; 2001) found

that the intervention conditions were equivalent with respect to child's age, gender,

ethnicity, free lunch status, achievement levels, and parenting practices at pretest, or

baseline, in the fall of first grade. However, significant differences ($p < .05$) were found

between the CC intervention and controls in terms of teacher ratings of the early risk

behaviors of attention/concentration problems and aggressive and shy behavior, some of

which are the measures of self-control in the current study (This explains the gap in the

initial level of self-control between two study groups observed in the Figure 1).

Attrition analyses

Ialongo et al. (2001: 151) also found that, of the 653 children with consent to

participate in the evaluation in the fall of first grade, 597 or 91.3% completed the fall and

spring of first-grade assessments and remained in their assigned intervention condition

over the first-grade year. In addition, 509 or 77.9% completed spring of sixth-grade

assessments. At the sixth-grade follow-up, there were no significant differences between

the intervention conditions in terms of rates of attrition. Nor were there any between-condition differences in terms of socio-demographic characteristics (ethnicity, gender, age, or free lunch status) in sixth grade. Finally, there were do differences in terms of socio-demographic characteristics or baseline levels of the early risk behaviors between the children with complete data at first and sixth grade and those with baseline data in first grade but missing data in the spring of sixth grade. Similarly, Bradshaw et al. (2009: 931) found that (1) a total of 574 students (84.7%) completed assessments during the spring of 12th grade and (2) there were no evidence of systematic loss through grade 12 that might affect the inferences given the existence of non-negligible missing data. That is, there were no significant differences between the intervention conditions in terms of rates of attrition at the 12th grade follow-up. Furthermore, there were no differences in the socio-demographic characteristics (ethnicity, gender, age, or free lunch status) in terms of rates of attrition at 12th grade across the intervention conditions.

4. Analytic Strategy

The investigation of the patterns and sources of stability and change in offending trajectories over time and the roles played by key mediating factors through an ongoing process of dynamic interaction involves the within-individual change of key variables over time. Thus, a longitudinal design is a necessity because cross-sectional design by definition treats all variables as time-invariant[41]. Past researchers, criminal career researchers and developmental/life course criminologists have been interested in describing and explaining the pattern of individual offending behavior over time and accordingly criminological research has accumulated a greater amount of longitudinal data with long-term follow up of the same individuals over time (Thornberry and Krohn 2003). Accompanying this growth of interest has been an interest in using the appropriate statistical methods to describe individual trajectories of interest over time and explain the different patterns and sources of development across individuals over the life course. These analyses require making decisions about the statistical model to be employed and longitudinal data with repeated measures can be approached in a variety of ways. Traditionally, some of the most frequently used approaches in the behavioral science have been repeated measures analysis of variance (ANOVA), and auto-regressive or cross-lagged multiple regression, with its rich tradition in human development field experiments (Bollen and Curran 2006). Some of the more modern approaches that are in

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[41] However, panel or longitudinal designs do not always guarantee an analysis of within-individual change because many analyses with longitudinal data do not necessarily track the same individuals repeatedly over time but are little more than repeated cross-sectional design for different subjects.

prominent use in the current literature and gaining popularity for modeling longitudinal panel data include hierarchical linear models/growth curve models/random coefficient models (HLM/GCM: Raudenbush and Bryk 2002; RCM: Fitzmaurice, Laird, and Ware 2004), latent growth models (LGM: Bollen and Curran 2006), group-based trajectory models (GBTM: Nagin 2005), and growth mixture models (GMM: Muthén 2001). These methodological approaches more directly address the age-crime relation using age-crime trajectories as the outcome of interest and attempting to identify the possible correlates of different trajectories. Basically, each of these different approaches addresses similar issues of interest with their own strengths and weaknesses depending on the particular research topics and contexts. Currently, HLM and GBTM are two statistical modeling techniques that are most commonly used for modeling longitudinal data with repeated measures in the field of criminology (Kreuter and Muthén 2008: 2).

Unlike HLM or LGM that assumes the existence of and makes assessment of a distinct functional form of individual trajectories that best represents the overall growth pattern across individuals based on theoretical and empirical rationales, GBTM attempts to identify distinct trajectories across groups emerging from the data for either exploratory or confirmatory purposes. A key difference between GBTM and the other approaches is that GBTM makes no parametric assumptions about the distribution of the trajectories in the population, but estimates a finite number of distinct groups and their trajectories that most closely approximate what may be a true continuous distribution (Nagin and Tremblay 2005). In other words, while HLM and LGM treat the population distribution as continuous, GBTM approximates this continuous distribution with groups and then identifies distinct developmental trajectories within the population to calibrate

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the probability of population members following the group trajectories identified. Therefore, while HLM and LGM estimate population differences in the developmental trajectories across *individuals* with the *same functional form*, GBTM focuses on the population variability across *groups* that might have *different functional forms*. While discrete distribution approximates a true continuous distribution with a higher number of "points of support" (Nagin and Tremblay 2005), these approaches are based on different assumptions[42] and the choice of model should be primarily driven by strong theoretical rationale, rather than by some practical or other concern. In this vein, Nagin and Piquero (2010: 109) suggest that GBTM is well-suited for research problems with a taxonomic dimension whose aim is to study distinct developmental trajectories and factors that account for their distinctiveness. Sampson and Laub (2005: 911) also recommend that GBTM should be "extricably the servant of theory" emphasizing a theory-driven approach.

To the best of my knowledge, Gottfredson and Hirschi's (1990) theory is claimed to be a 'general' theory of crime and therefore is strongly opposed to offender taxonomies. They never predict the existence of groups with distinct etiological implications for both theory and policy, but make a prediction about a more uniform developmental commonality in the population (e.g., positively linear or downward curvature growth) although there might exist substantial variability across individual trajectories. This study, therefore, employs both HLM and LGM approaches assuming that all subjects in

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[42] In HLM and GLM, the joint distribution of either observed or latent outcome variables of interest is assumed to be normally distributed and individual variation is expressed as random coefficient or growth factors that are allowed to vary across individuals. GBTM, however, does not rest on such distributional assumption but attempt to explain variations of individual trajectory by group membership with distinct developmental pathways (but there is not further variation within the groups)

the population are growing according to a common functional form, but that the growth

parameters or growth factors may vary in their magnitude. In addition, these approaches

are more relevant for the purpose of this study given the characteristics of the data being

analyzed. The data (1) involve a homogeneous sample with the subjects sharing similar

individual and environmental characteristics and (2) are limited only to relatively early

stages of life when individuals tend to share relatively similar life events and experiences

and therefore follow a similar developmental pattern. Most of all, a substantive interest of

the study is to identify and explain different growth rates of key *theoretical constructs*

over time across individuals that belong to the different study groups that are *a priori*

known[43]. Given that GBTM does not assume a priori known groups that manifest distinct

trajectories of interest and that GBTM can only use a *composite scale* instead of

preserving the actual items measuring the latent construct, HLM and LGM approaches

that are specially designed to answer such research questions are preferred[44]. By doing

so, this study can also advance the current understanding about trajectory analysis in the

field by explicitly comparing the results from a conventional HLM approach and a

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[43] While one of the strengths of GBTM is to identify groups that manifest important but unusual developmental patterns, this study does not seek to investigate the possibility of such meaningful groups but focuses solely on the comparison of developmental patterns between control and treatment groups.

[44] Alternative statistical technique to investigate the developmental trajectories of phenomena over time that is gaining popularity in the field is growth mixture models (GMM). Like GBTM, GMM also assume distinct groups in order to approximate unknown continuous distributions in the population. However, it is more flexible than GBTM in that individuals within each group are allowed to vary and therefore better approximate true continuous distributions (Brame, Nagin, and Wasserman 2006). While it is also known to perform well in identifying key features of the distribution function of parameter that is unusually distributed in the population, I think HLM and LGM are better suited for addressing the research hypotheses in this study for both theoretical (e.g., investigation of the different growth rate across members of a priori known study groups) and practical reasons (e.g., relatively small sample size).

second-order LGM approach that are considered to be more rigorous by directly

addressing the issues of measurement error and measurement invariance, which have

been less appreciated in the past research.

Although an emerging body of empirical evidence calls in question Gottfredson and

Hirschi's (1990) stability hypothesis, suggesting that there is evidence of substantial

instability or even "reshuffling" in the level of self-control across individuals over time,

extant research fails to directly test the core element of the stability postulate of the

theory as I discussed in the literature review section. Basically, the most frequently used

quantitative method in testing the stability hypothesis has focused primarily on the rank-

order stability, often tested by the correlation between self-control scores across two or

more points in time (e.g., Arneklev, Cochran, and Gainey 1998). However, such basic

statistical methods capturing a very short period of time fail to assess the extent to which

self-control changes over longer periods of time. Moreover, they cannot disentangle the

confounding effects of other variables (e.g., aging, cohort, history) that are shared by the

general population, not to mention explaining the source of variability over time. Most of

all, such crude methods fail to visualize the different trajectories of self-control across

individuals (or study groups) over time to better assess the validity of the "relative

stability" hypothesis of the theory. Therefore, this study conducts a more critical

examination of stability hypothesis by adopting HLM and second-order LGM

approaches. In these models, random intercepts and random slopes permit each subject in

the sample to have a unique trajectory over time. While both are conceptually taking a

similar approach, the main difference between HLM and LGM is that, in the latter, such

random coefficients are incorporated into a structural equation modeling (SEM) framework by considering the intercept and slope growth factors as latent variables. In addition, second-order LGM can go further than traditional LGM by combining longitudinal CFA into structural model which allows for the assessment of tenability of measurement model. In the following section, I more fully discuss HLM and LGM approaches in general and specifically why they are most appropriate for the purpose of this study.

First, HLM and LGM approaches can better describe the within-individual change of key variables in terms of reference levels and their growth trajectories to and from the reference levels, which enable the better assessment of such research questions as: 1) what is average initial level of self-control trajectory? (2) If self-control changes as a function of time, what is its functional form? (3) What is the rate of change over time? Assessment of such initial questions provides an insight into the characteristics of the *mean* trajectory of self-control for the entire sample – these mean values of intercept and slope estimates are sometimes called the 'fixed-effects' components of the trajectory model. In addition, the availability of multiple data points enables more accurate estimate and evaluation of the functional form of the developmental pattern. HLM and LGM are modeling frameworks that are flexible enough to model not only linear trajectories, but also nonlinear change patterns as well. Such flexibility and adaptability are some of the most remarkable properties of HLM and LGM approaches in studying longitudinal data with repeated measures considering that most kinds of psychological or behavioral developments of human beings tend to be nonlinear – the rate of change in one period

tends to be more or less rapid than in other period. Considering that the level of self-control might not necessarily change in a linear fashion, especially at the early stages of life, these approaches will better picture the precise pattern of change over time, permitting to verify if self-control actually changes as the theory hypothesized[45].

Most of all, these approaches are better suited for the direct test of whether the rates of change in the individual level of self-control differ significantly between individuals, which is one of the key research hypotheses in this study. While traditional methods can provide potentially interesting results at the aggregate level, they fail to address hypotheses regarding the nature and determinants of change at the level of the individual. While individuals' growth patterns may follow the same functional form (e.g., linear, curvilinear) reflecting a more fundamental assumption about human development (e.g., biological or socialization process), there might exist a substantial variability in the individuals' initial levels and growth rates. That is, while understanding the mean trajectory of self-control is important to picture the pattern of stability or change in the level of self-control at the aggregate level, there is another issue of more substantial interest in its growth pattern at the individual level such as whether there is a significant variability of self-control trajectories around the mean trajectory. Researchers might want to know if the mean trajectory is reflective of every subject in the sample, or if there are

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[45] However, a substantial exploratory work is required because theory is not clear about exact functional form of self-control development, not to mention the unavailability of commonly agree-upon functional forms from prior empirical evidence. Multiple models can be compared to assess competing hypotheses regarding growth's functional form (e.g., linear vs. quadratic – assuming that development of self-control may tamper off as individuals move into the period of late adolescence or early adulthood). In this vein, LGM is more flexible than HLM in that, instead of fixing all paths from the slope factor to self-control constructs, it allows for the estimation of those paths as parameters to be freely estimated.

cases that depart substantially and significantly from the mean trajectory. In HLM and

LGM, the variances and covariance of intercept and slope can be estimated to gain the

sense of the patterns of individual differences in growth trajectories – these variances at

the individual level are sometimes called the 'random-effect' component of the trajectory

model. If individuals' trajectories are within sampling fluctuations of mean trajectory,

there would be no evidence of significant variations across individuals in terms of initial

value and the rate of change. However, statistically significant slope variance would

imply that subjects do not necessarily have the same rate of change in self-control over

time[46]. That is, although the mean rate of change in the level of self-control follows a

specific functional form, some cases may be increasing at a more rapid rate while others

are not increasing at all or even decreasing. In addition, HLM enables a decomposition of

the variability in the repeated measures into within- and between individual components,

which conventional models could not achieve.

Last but not least, one of the powerful advantages of HLM and LGM over traditional

method is its ability to assess predictors of the growth parameters or latent growth

factors. This flexibility is critical especially in determining both time-invariant and time-

variant factors that might explain such substantial and significant variability observed

between individuals by allowing for the incorporation of theoretically and empirically

relevant measured variables (e.g., study group membership) or latent constructs with

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[46] Ideally, separate models for different study groups could be estimated to explore the possibility of distinct patterns of growth across groups. Otherwise, multi-group analyses enable the comparison of key growth parameters between groups by constraining them to be equal between two study groups and then examining the results of statistical tests of equality constraints. Relatively small sample size and complex model specification which entails a large number of parameters to be estimated at both measurement and structural phases, however, do not permit such group-specific analyses.

multiple indicators (e.g., social control/bond) that predict latent growth factors into the model. For example, a direct test can be conducted to assess if time-stable group membership and changing level of social control/bond significantly predict the variability in the initial level and growth rate. Non-significant impact of both covariates on the 'intercept' would suggest that successful randomization produced equivalent groups at the initial stage. A significant impact of group membership on slope factor would indicate that there are significantly different growth rate between individuals that belong to different study groups. Similarly, significant impact of social control/bond at each time point would reflect time specific influence of time-variant covariate on self-control above and beyond the influence of the random growth process.

Unlike other studies that used single variable or composite scale as outcome variables of interest, this study, given the availability of multiple items measuring same key theoretical constructs over time, goes further to test research hypotheses that other approaches could not test (e.g., convergent and discriminant validity of key theoretical constructs) and address the inherent problems in analyzing longitudinal panel data (e.g., measurement error, methods effects) within a "second-order LGM" framework (Hancock, Kuo, and Lawrence 2001). Originally, LGM has emerged as a tool for investigating longitudinal change in measured variables. However, its usage can be easily expanded to the modeling of longitudinal change in a latent construct where the theoretical construct of interest is assumed to be indicated by several measured variables. In other words, if multiple items are available at each time point that are believed to be indicators of the same constructs and the primary interest is to investigate the growth in

the latent construct underlying those measured variables rather than the growth in the individual measures themselves, a "second-order LGM" can be modeled, where the growth factors are modeled as a second-order factors influencing the first-order latent constructs whose longitudinal change is of interest. By doing so, LGM can draw on all of the strengths associated with the general factor analytic and SEM framework. These include the ability to have measures of model fit and diagnostics to determine the source of ill-fit, to include latent covariates and latent repeated variables, to use maximum likelihood techniques for missing data, and so on (see Bollen and Curran 2006: xi). In particular, second-order LGM would produce more robust findings than HLM with composite scale because it can better account for the measurement errors in the observed variables. While one of the strengths of both models is to allow each individual to have an unique intercept and slope, observed scores would not match with functional forms assumed in the models because of two primary sources of error: 1) model misspecification arising from incorrect assumption regarding the functional form of development and 2) measurement error arising from reliability of instrument. Although both models can reduce the first source of error by modifying functional form of change, only second-order LGM can address measurement error issue by incorporating latent factor approach instead of using measured variables or composite scales that are inherently error prone. In addition, only second-order LGM can address the issue of 'factorial non-invariance' that might lead to biased parameter estimates as I more fully discussed in the following section.

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After determining the distinct patterns and sources of stability and change in self-control, further attempts are made to disentangle the underlying causal mechanism of both stability and change in offending by directly testing the bidirectional longitudinal influences between self-control and social control/bonds over relatively long period of time. Although many control theorists have already examined the stability and change of criminal behavior over the life course (Sampson and Laub 1993; Laub and Sampson 2003), they did not directly model the underlying causal mechanism by specifying the dynamic relationship between internal and external constraints as mediating factors. Although some ambitious and pioneering studies attempted to examine the impact of external social factors in later life on self-control as an individual propensity to offend (Burt, Simons, and Simons 2006; Hay and Forest 2006), they simply focused on how social relationships at Time 1 are independently and significantly associated with changes of self-control at Time 2 (e.g., social relationships are not merely social consequences of latent traits such as low self-control but still can have a independent impact on the changing level of self-control), failing to examine the ongoing process of "cumulative" stability and change. Although Gottfredson and Hirschi (1990: p.107) did not discount the possibility that socialization continue to occur and absolute levels of self-control within individuals could change over the life-course, they did discount the possibility of substantial change in the relative rankings (or at least distance) of self-control between individuals and the role of social factors as exogenous variables in explaining such change. In this study, therefore, I attempt to examine latent variables' relations over time using a multi-year panel model with repeated measures taken from the same individuals. Specifically, I examine whether changing levels of informal social control/bonds from

parents continues to affect the changing level of self-control even after the formative period of early childhood. By doing so, I investigate whether social bonds built within family influence the level of self-control through the readjustment of short-and long-term risk/cost attached to the deviant behaviors. Consistent with the more dynamic model (Wikström and Treiber 2009) or "strength model" (Baumeister, Muraven, and Tice 1994) that emphasizes the nature of enduring responsiveness of self-control to social relations, the improvement in parenting practices might be associated with the substantial portion of variation in the level of self-control within individuals, which in turn influence the quality of subsequent social relationship with parent. To test this, I first build two latent constructs of social control/bond and trait-like self-control that represent structural and situational 'sensitivity' to costs and benefits associated with deviant behaviors (e.g., Hirschi's (2004) redefined self-control, Tittle, Ward, and Grasmick's (2004) "desire to exercise self-control," Wikström and Treiber's (2007) "situationally-based" self-control) and more general 'ability' to measure costs and benefits within individuals (e.g., Gottfredson and Hirschi's (1990) personality-like self-control, Tittle, Ward, and Grasmick's (2004) "capacity for self-control," Wikström and Treiber's (2007) "executive capability"), respectively. Then, using structural equation modeling (SEM), I examine if the there is a time-lagged bidirectional relationship between the two control mechanisms in a cumulative fashion over time. In particular, direct comparisons of the unidirectional model with the bidirectional model are made in terms of various fit indices and the significance and magnitude of parameter estimates in order to assess which model fits the data better.

4.1 HLM results

HLM affords an integrated approach for studying the structure and predictor of individual growth trajectories by treating multiple observations for the same individuals over time are nested within individuals. In two-level hierarchical model, level 1 variable becomes scores of outcome variables for each individual observed at different time points. Level 2 variable becomes time-stable characteristics of individuals that may affect an individual's change in the outcome variables over time. In particular, HLM is more flexible than LGM approaches in general because individual change can be analyzed even when the number and spacing of time points vary across individuals (e.g., incomplete and unbalanced design). That is, HLM allows the data to be missing at any point in time for an individual (which is similar to LGM) and the observations to be measured at the different time points across individuals (which is unique only to HLM). Most of all, HLM analysis is simpler and can provide more straightforward and easier-to-understand results than a more complex second-order LGM approach which involves a series of factorial invariance tests in order to ensure the tenability of measurement model within longitudinal CFA framework. Therefore, a growth curve modeling strategy within HLM framework by creating composite scales of self- and social control constructs is first adopted in this study as a preliminary step before estimating more accurate patterns and sources of growth trajectories within second-order LGM framework.

In HLM, individual change is analyzed by two-level hierarchical model. At level 1, each individual's development is represented by an individual growth trajectory that depends on a unique set of parameters (intercept and slope). That is, the observed status of variables of interest at time t for individual i is a function of a systematic growth

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trajectory or growth curve plus random error. The first step in growth curve modeling in HLM is to specify the within-person model in order to determine if the growth in the variable of interest follows a linear function (a straight line), a quadratic function (a curved line), or some other non-linear function. The level 1 model assuming a polynomial of degree P could be represented as:

$$Y_{ti} = \pi_{0i} + \pi_{1i}a_{ti} + \pi_{2i}a_{ti}^2 + \ldots + \pi_{Pi}a_{ti}^P + e_{ti} \quad \text{[Equation 1]}$$

For $i = 1, \ldots, n$ subjects, where

a_{ti} is the grade at time t for subject i

π_{pi} is the growth trajectory parameter p for subject i associated with the polynomial of degree P.

e_{ti} represents a deviation of an observation from the individual's growth prediction.

Each individual is observed on T_i occasions where a_{ti} is the grade at time t for subject i. Whereas a balanced design is required in LGM, the number and spacing of measurement occasions may vary across individuals in HLM. In addition, time-varying covariates at level 1 can be incorporated to rule out rival explanation and separate out the pure nature and extent of growth pattern of variables of interest. Once the within-individual (level 1) model has been specified, individual-level characteristics can be used to model the coefficients of level 1 model. An important feature of Equation 1 is the assumption that the growth curve coefficients for level 1 model can vary across individuals. At level 2 individuals' growth parameters become the outcome variables which can be predicted by a variety of between-individual characteristics as time-invariant covariates. This allows us to identify the distinct patterns of stability and change

among different individuals with distinct characteristics. The level 2 model with $P + 1$ individual growth parameters could be represented as:

$$\pi_{pi} = \beta_{p0} + \sum_{q=1}^{Q_P} \beta_{pq} X_{qi} + r_{pi} \text{ [Equation 2]}$$

Where

X_{qi} is either a measured characteristic of the individual's background (e.g., sex, race/ethnicity, SES) or of an experimental treatment (e.g., control, treatment)

β_{pq} represents the effect of X_q on the pth growth parameter

r_{pi} is a random effect with mean of 0. The set of $P+1$ random effects for individual i are assumed to be multivariate normally distributed with full covariance matrix, **T**, dimensioned $(P + 1) \times (P + 1)$ (see Raudenbush and Bryk 2002: 160-204 for more detail).

4.1.1 A Random-Coefficient Regression Model

In this study, student's level of self-control was observed by school teacher on eleven occasions at one-year intervals during the period from 1st to 3rd and 6th to 12th grade (including pretest during grade 1). Based on theoretical argument that self-control continues to develop through an ongoing process of socialization – especially the idea that self-control taught by parents or other responsible adults at an early age is highly resistant to extinction (Hirschi 2004: 541) – and exploratory investigation of individual pattern of self-control development, a non-linear functional form was first employed before proceeding to a simpler linear function. In particular, the availability of relatively enough number of time points of observations per individuals enabled the creation of a quadratic growth model at level 1 in order to capture both the instantaneous growth rate (a_{ti} = linear components) and the curvature or acceleration rate in each growth trajectory (a_{ti}^2 = curve-linear components).

$$Y_{ti} = \pi_{0i} + \pi_{1i}a_{ti} + \pi_{2i}a_{ti}^2 + e_{ti} \quad \text{[Equation 3]}$$

At level 2, I have a separate equation for each level 1 coefficient, π_{pi}, where $p = 0, 1, 2$

$$\pi_{0i} = \beta_{00} + \sum_{q=1}^{Q_0} \beta_{0q}X_{qi} + r_{0i} \quad \text{[Equation 4]}$$

$$\pi_{1i} = \beta_{10} + \sum_{q=1}^{Q_1} \beta_{1q}X_{qi} + r_{1i} \quad \text{[Equation 5]}$$

$$\pi_{2i} = \beta_{20} + \sum_{q=1}^{Q_2} \beta_{2q}X_{qi} + r_{2i} \quad \text{[Equation 6]}$$

However, model did not converge when π_{2i} was allowed to vary across individuals. Therefore, the unconditional model with no predictors for both intercept and slope is represented as

Level-1 Model
$$Selfcontrol_{ti} = \pi_{0i} + \pi_{1i}Grade_{ti} + \pi_{2i}Grade_{ti}^2 + e_{ti}$$

Level-2 Model
$$\pi_{0i} = \beta_{00} + r_{0i}$$
$$\pi_{1i} = \beta_{10} + r_{1i}$$
$$\pi_{2i} = \beta_{20}$$

Mixed Model
$$Selfcontrol_{ti} = \pi_{00} + \beta_{10}Grade_{ti} + \beta_{20}Grade_{ti}^2 + r_{0i} + r_{1j}Grade_{ti} + e_{ti}$$

This unconditional model provides useful empirical evidence for determining a proper specification for the individual growth pattern and baseline statistics to evaluate subsequent level 2 model. A visual examination of the individual student's self-control growth trajectories, displayed in Figure 1, clearly indicates a nonlinear growth pattern that follows upward curvature. In sharp contrast to Hirschi's (2004: 541) prediction that

"self-control taught by parents or other responsible adults at an early age is highly resistant to extinction," however, current data suggest that self-control in general continues to decrease from grade 1 to grade 6. I think such an unexpected pattern of change results from the fact that self-control subscales were created by different number and type of indicators that were observed by different data collection methods (interview vs. checklist format) during the periods of grade 1-3 and 6-12 for many substantive and practical concerns (see measurement section for more detail). Such a different nature and quality of self-control score across two time periods makes it difficult for us to compare these scores and analyze them within the same functional form. In addition, other key variables of interest in this study were measured only during grade 1 and grade 6-11 (social control/bond) or only after grade 6 (delinquency). With these inherent data limitations, I decided to limit the analyses using the data collected during grade 6-12 and focus only on the long-term effect of early prevention/intervention program administered during grade 1.
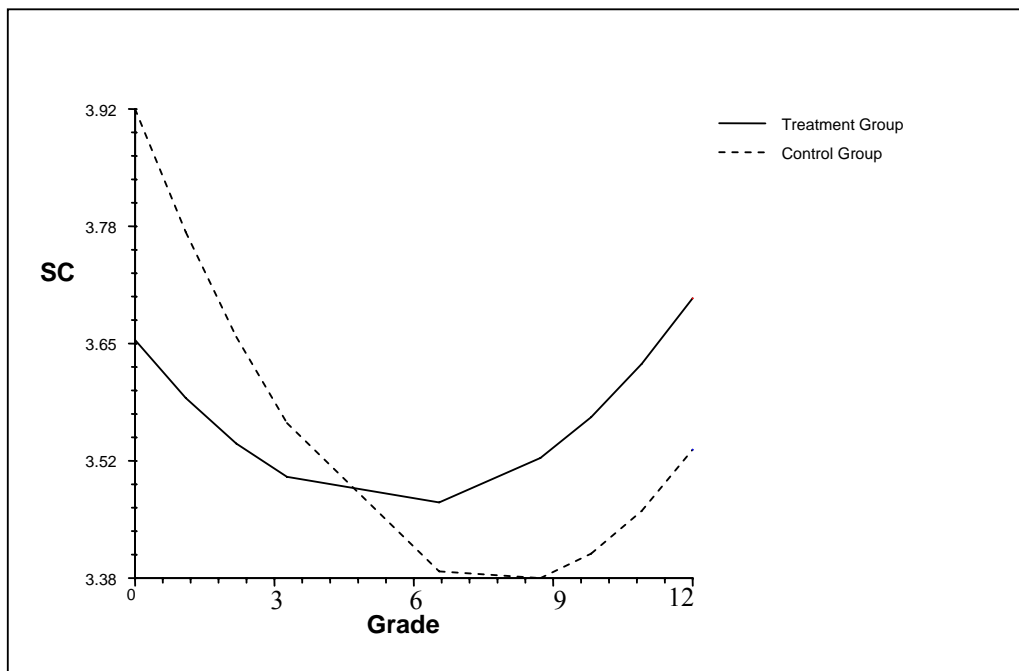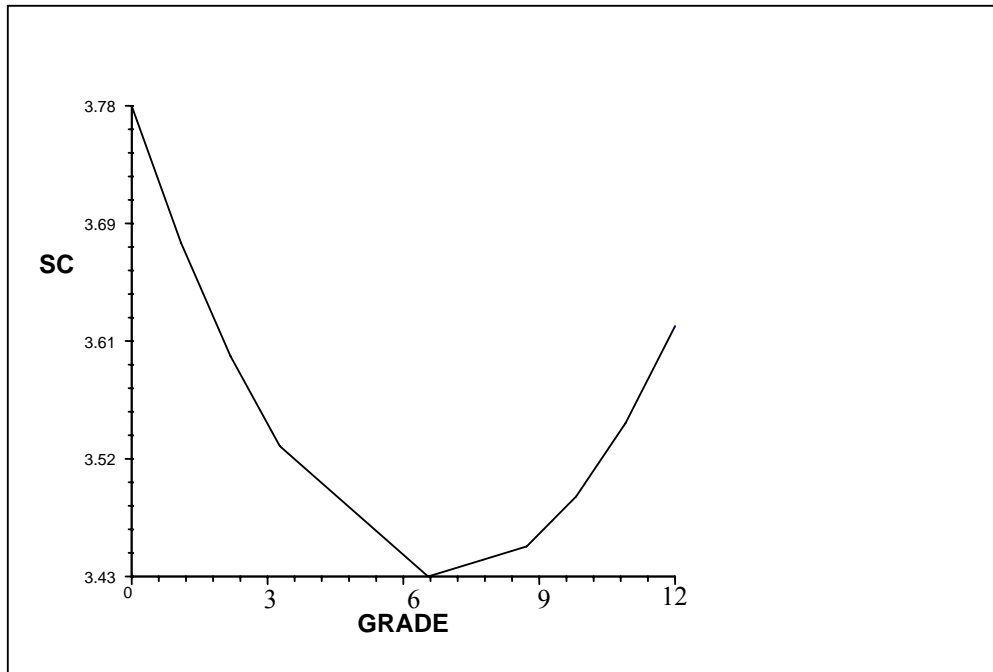
Figure 1. HLM with Mean Structure only (upper panel) and with Time-Invariant Covariate (lower panel), Grade 1-12

Figure 2 describes a pattern of self-control change at the aggregated level for the

entire sample and for each of study groups from grade 6 to 12. Overall, the mean level of

self-control continues to increase in both groups, but the treatment group appears to have higher level of self-control across different time points. Interestingly, the gap widens with age, which is consistent with the cumulative advantage (for the treatment group) and disadvantage (for the control group) models hypothesized in the previous section. While informative, however, the trend observed in fiture 2 does not reflect the pattern of individual trajectories over time but merely a linkage of mean levels taken cross-sectionally over multiple time points. Therefore, individual trajectories (and the mean trajectories of those individual trajectories) may deviate substantially from those identified in Figure 2.
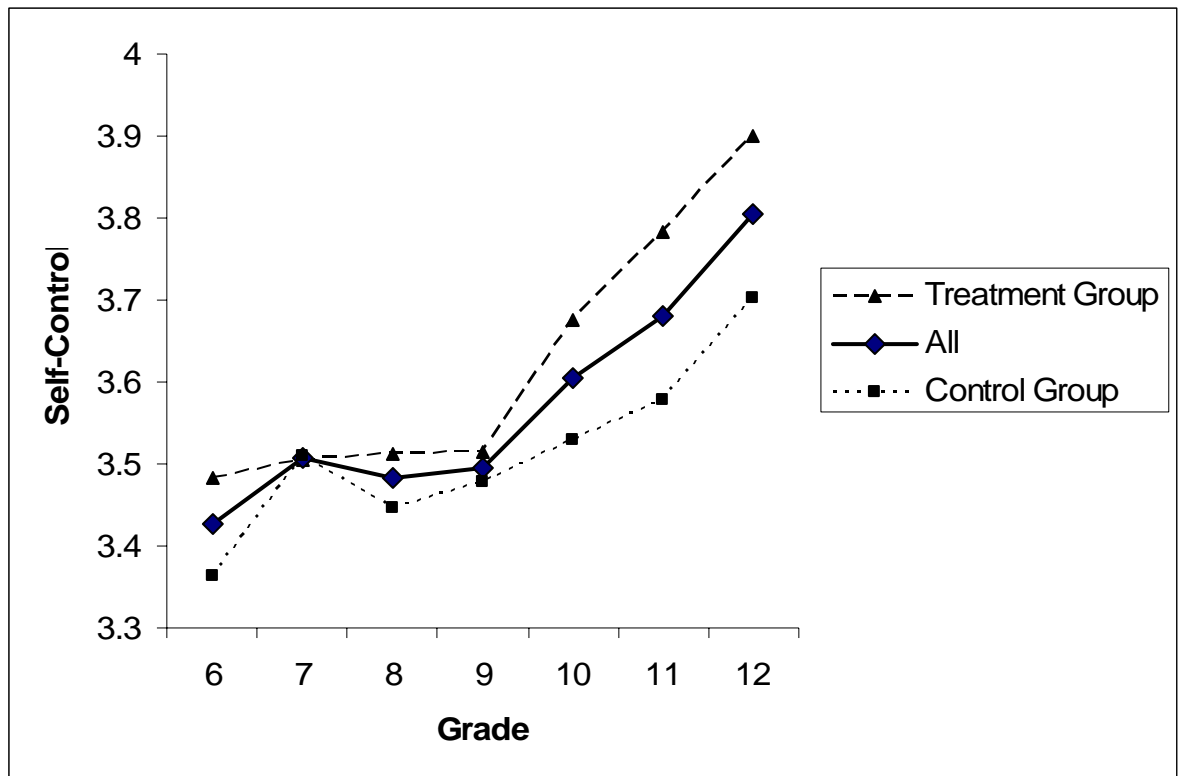
Figure 2. The Pattern of Mean Change (calculated cross-sectionally), Grade 6-12

The fully unconditional model (FUM), the simplest HLM with no predictors at either level, is equivalent to a one-way ANOVA with random effects. As a preliminary step in a series of HLM analyses that follow, FUM is often useful to determine whether there is significant variance in the outcome between individuals (level 2) because it partitions total variability of an outcome at each of the two levels. Moreover, the estimated total amount of variability within each level can be used later to determine the amount of variance explained by models with covariates included.

Summary of the model specified

Level-1 Model
$Selfcontrol_{ti} = \pi_{oi} + e_{ti}$

Level-2 Model
$\pi_{0i} = \beta_{00} + r_{0i}$

A useful parameter associated with the FUM is the 'intraclass correlation coefficient' (ICC). ICC is the proportion of between-individual variance in the outcome variable. This coefficient is given by the formula:

$$\rho = \tau_{00} / (\tau_{00} + \delta^2) \ [\text{Equation 7}]$$

The δ^2 parameter represents the within-individual variability and τ_{00} captures the between-individual variability. To estimate the "real" ICC assuming the perfectly reliable outcome, the adjusted ICC can be calculated by multiplying δ^2 by the reliability of the outcome.

$$\rho_{adj} = \tau_{00} / [\tau_{00} + (\delta^2 \times \lambda)] \ [\text{Equation 8}]$$

The estimated ICC value of .558 (= .43153/(.43153+.34155)) suggests that 55.8% of the total variance in self-control occurs between individuals. After incorporating the reliability estimates (.855) of self-control, the adjusted ICC becomes .596, which is an estimate of ICC when perfectly reliable measure of self-control is available. Such a relatively high ICC allows for further investigation of the source of variability in self-control between individuals.

Figure 1 suggested that self-control growth trajectory from grade 6 to 12 approximates linear growth but still follows nonlinear pattern. Figure 3 and Table 1, which focus only on grade 6-12, also indicate that the rate of self-control development is increasing overall but the growth rate is not increasing at a constant rate but accelerating over time.
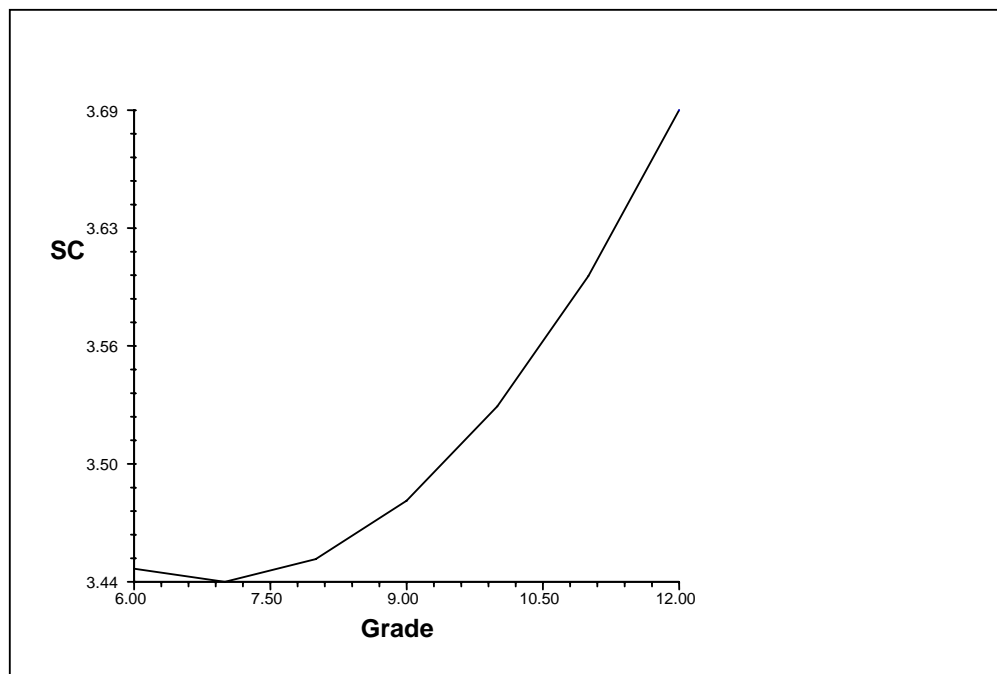

Figure 3. HLM without Covariates (Quadratic), Grade 6-12
Note: Quadratic functional form is used to specify the model

Table 1 indicates that both mean growth and acceleration rates are significant at $p =$ .05 level. In other words, the hypothesis tests for fixed effects suggest that the mean intercept and both growth rates (linear and quadratic) are necessary for describing the mean growth trajectory. In addition, the χ^2 statistics associated with both π_{0i} and π_{1i} indicate that the observed variability in both initial levels of self-control and its linear growth rates are significant at $p = .01$ level, which suggest that there are substantial and significant variability across individuals in where they start out on the outcome of interest (intercept) and its growth rate (linear slope).

Table 1. Fixed and Random Effects of HLM without Covariates

Fixed Effect	Coefficient	S.E.	t-ratio	d.f.	p-value
For π_0					
β_{00}	3.887819	0.283634	13.707	398	<0.001
For π_1					
β_{10}	-0.131722	0.063622	-2.070	398	0.039
For π_2					
β_{20}	0.009592	0.003488	2.750	2337	0.006
Random Effect	S.D	Var.	χ^2	d.f.	p-value
r_0	1.21308	1.47157	841.27300	379	<0.001
r_1	0.09533	0.00909	43.59143	379	<0.001
level-1, e	0.54693	0.29913			

4.1.2 An Intercept and Slope as Outcomes Model

The evidence of significant variability in both intercepts and slopes for individual self-control growth provides the rationale to proceed to test the formal hypothesis of this study: Whether subjects within control and treatment groups have significantly different initial level of self-control and, more importantly, different rate of change over time.

Summary of the model specified

Level-1 Model

$$Selfcontrol_{ti} = \pi_{oi} + \pi_{1i}Grade_{ti} + \pi_{2i}Grade_{ti}^2 + e_{ti}$$

Level-2 Model

$$\pi_{0i} = \beta_{00} + \beta_{01}Treatment + r_{0i}$$

$$\pi_{1i} = \beta_{10} + \beta_{11}Treatment + r_{1i}$$

$$\pi_{2i} = \beta_{20}$$

Mixed Model

$$Selfcontrol_{ti} = \pi_{00} + \beta_{01}Treatment_i + \beta_{10}Grade_{ti} + \beta_{11}Treatment_i * Grade_{ti} + \beta_{20}Grade_{ti}^2 + r_{0i} + r_{1j}Grade_{ti} + e_{ti}$$

In this model, the variation of both intercept and linear growth slope (since the variance of quadratic slope is constrained to be zero) are modeled as a function of treatment (0= control and 1= treatment). The results for this model appear in Figure 3 and Table 2. There is a significant difference in linear growth rates (but not in the initial level) between individuals within two study groups ($p < .1$), which provides marginally significant evidence of treatment effect on the changing level of self-control. That is, while there is not significant difference in the initial level of self-control for members of both groups at grade 6, the level of self-control increases significantly ($p < .1$) at higher rate for members of treatment group than for those within control group. In particular, the latter suggests clearer evidence for the possibility of reshuffling in relative rankings of self-control over time.
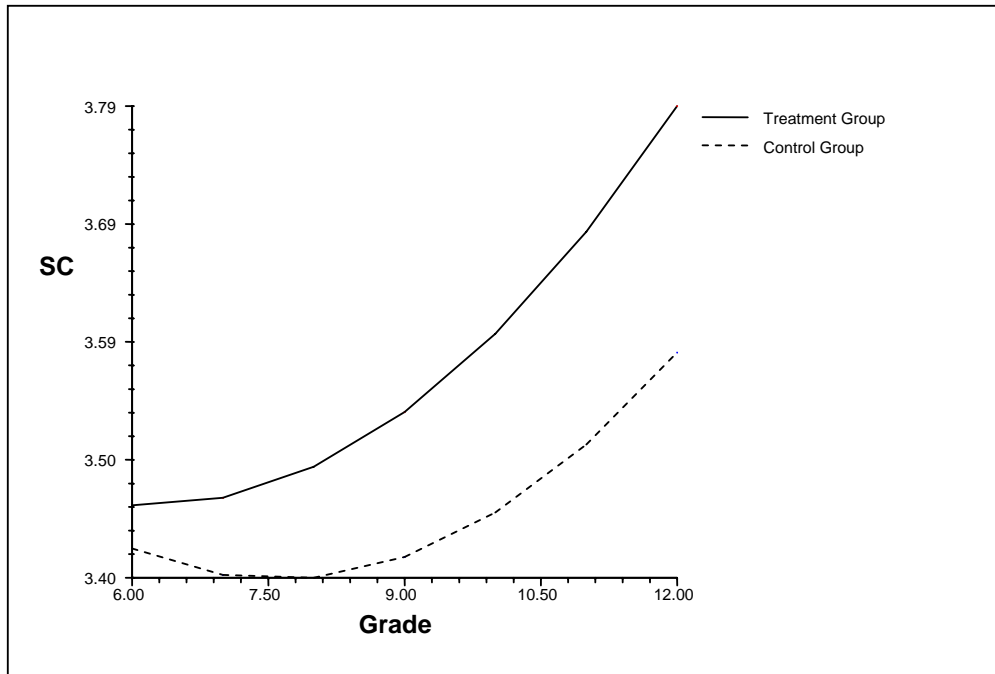
$\beta_{11} = .03$; $p=.083$ (two-tailed)

Figure 4. HLM with Time-Invariant Covariate (Quadratic), Grade 6-12
Note: Quadratic functional form is used to specify the model

Table 2. Fixed and Random Effects of HLM with Time-Invariant Covariate
(Quadratic)

Fixed Effect	Coefficient	S.E.	t-ratio	d.f.	p-value
For π_0					
β_{00}	3.961321	0.300044	13.202	397	<0.001
β_{01}	-0.131057	0.168508	-0.778	397	0.437
For π_1					
β_{10}	-0.147591	0.064544	-2.287	397	0.023
β_{11}	0.027747	0.015982	1.736	397	0.083
For π_2					
β_{20}	0.009685	0.003486	2.778	2337	0.006
Random Effect	S.D.	Var.	χ^2	d.f.	p-value
r_0	1.21181	1.46849	838.59749	379	<0.001
r_1	0.09420	0.00887	637.02235	379	<0.001
level-1, e	0.54701	0.29922			

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Although more complicated functional forms better capture meaningful pattern of variation, a simpler functional form can still provide an easy to understand, good approximation of the general pattern of growth trajectories of interest. Considering the primary goal of this study is to investigate different *rate* of change between individuals that belong to different study groups in order to assess whether relative ranking of self-control between individuals remain stable over time, a simplified model with only linear growth parameter at level 1 model is employed. The fixed effects results in Table 3 suggest that (1) children have a self-control score of 3.16 points on average at grade 6, and (2) the level of self-control increases on average by about .04 point with increasing grade. The random effects table indicates that both the intercept and the slope (linear growth) significantly vary between individuals ($p < .01$).

The covariance between initial status and rate of change is also an important characteristic of interest for the purpose of this study. The negative value of the estimated covariance between intercept and slope parameters (-.096) suggests that individuals with lower level of self-control at grade 6 tend to gain it at a faster rate[47] which also opens the possibility of reshuffling of self-control trajectories among individuals over time.

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[47] We need to note that the correlation between initial status and rate of change may vary depending on the specific time point selected for initial status (Raudenbush and Bryk 2002: 167)
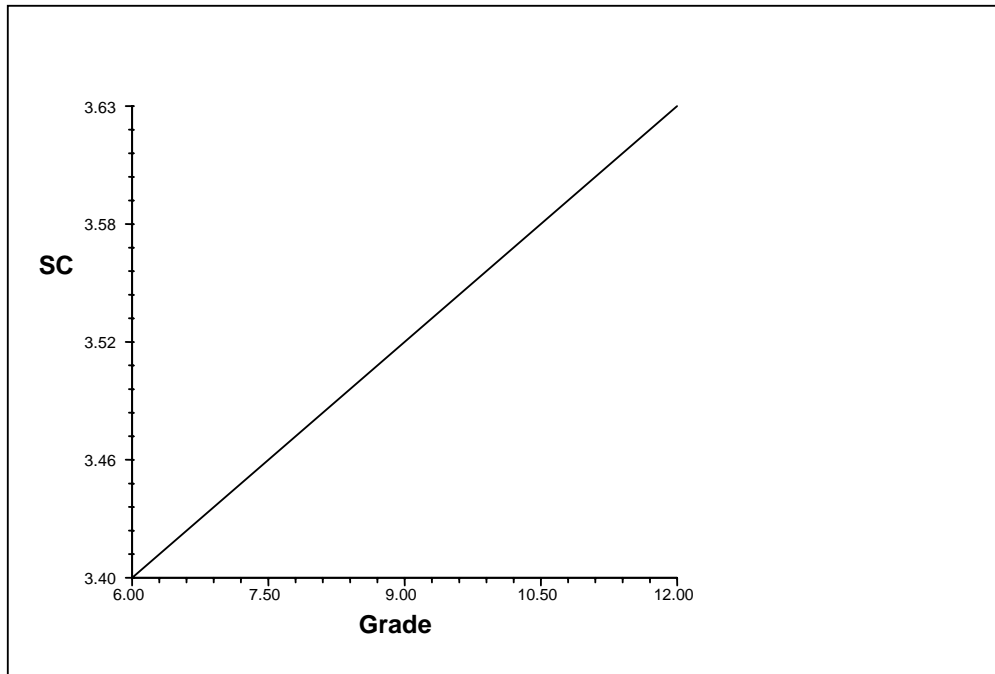
Figure 5. HLM without Covariates (Linear), Grade 6-12
Note: Linear functional form is used to specify the model

Table 3. Fixed and Random Effects of HLM without Covariates (Linear)

Fixed Effect	Coefficient	S.E.	t-ratio	$d.f.$	p-value
For π_0					
β_{00}	3.159790	0.083842	37.687	398	<0.001
For π_1					
β_{10}	0.039591	0.007992	4.954	398	<0.001
Random Effect	S.D	Var.	χ^2	$d.f.$	p-value
r_0	1.19737	1.43368	828.65794	379	<0.001
r_1	0.09387	0.00881	637.21052	379	<0.001
level-1, e	0.54829	0.30062			

Under the assumption of normal distribution of slope parameter, the estimated fixed

effect (mean growth rate) and random effect (standard deviation) for the slope can be

used to create the distributional representation for the growth pattern of self-control over

time. A relatively large and significant slope parameter variance ($u_1 = .01, p < .001$)

indicates that students' level of self-control change at greatly varied rates. Figure 6

indicates that approximately 95% of youths grow annually between -.145 and .224 points along the self-control continuum. Interestingly, almost 42% of individuals in fact manifest decreasing level of self-control over time, which was not predicted by Gottfredson and Hirschi ("self-control taught by parents or other responsible adults at an early age is highly resistant to extinction": Hirschi 2004: 541).
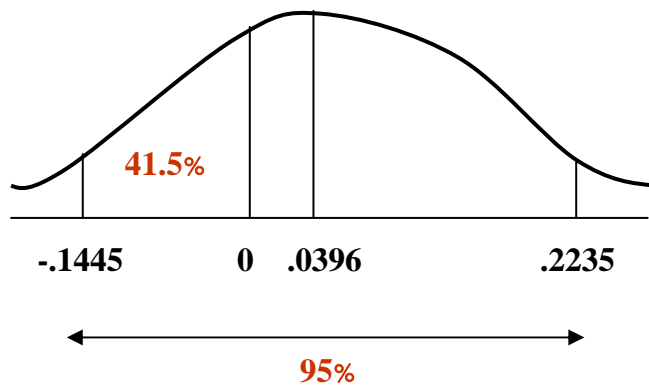

Figure 6. Distribution of Slope Parameter from HLM

As was the case in the previous quadratic growth model, in this "linear only" model, both the intercept and growth-rate parameters are allowed to vary at level 2 as a function of treatment.

Summary of the model specified

Level-1 Model
$Selfcontrol_{ti} = \pi_{oi} + \pi_{1i}Grade_{ti} + e_{ti}$

Level-2 Model
$\pi_{0i} = \beta_{00} + \beta_{01}Treatment + r_{0i}$
$\pi_{1i} = \beta_{10} + \beta_{11}Treatment + r_{1i}$

Mixed Model
$Selfcontrol_{ti} = \pi_{00} + \beta_{01}Treatment_i + \beta_{10}Grade_{ti} + \beta_{11}Treatment_i * Grade_{ti} + r_{0i} + r_{1j}Grade_{ti} + e_{ti}$

Figure 7 and Table 4 show that, while there is no difference in the initial level, there is a significant difference in the average linear growth rates between two groups ($p < .1$). Hierarchical analysis with only linear function provides even clearer and more interpretable evidence of treatment effect on the self-control improvement. A significant cross-level interaction effect between time-invariant covariate (group membership) at level 2 and time (grade) at level 1 suggests that the relation between time and self-control varies substantially across study groups. The level of self-control increases with time at a significantly higher rate ($p < .1$) for the members of treatment group than those within the control group by .027 points each year.

Combined with the evidence of negative correlation between initial status and growth rate, the significant interaction effect observed between treatment and grade represents more direct evidence for the possibility of reshuffling in the relative rankings of self-control over time than traditional approaches using bivariate correlation.
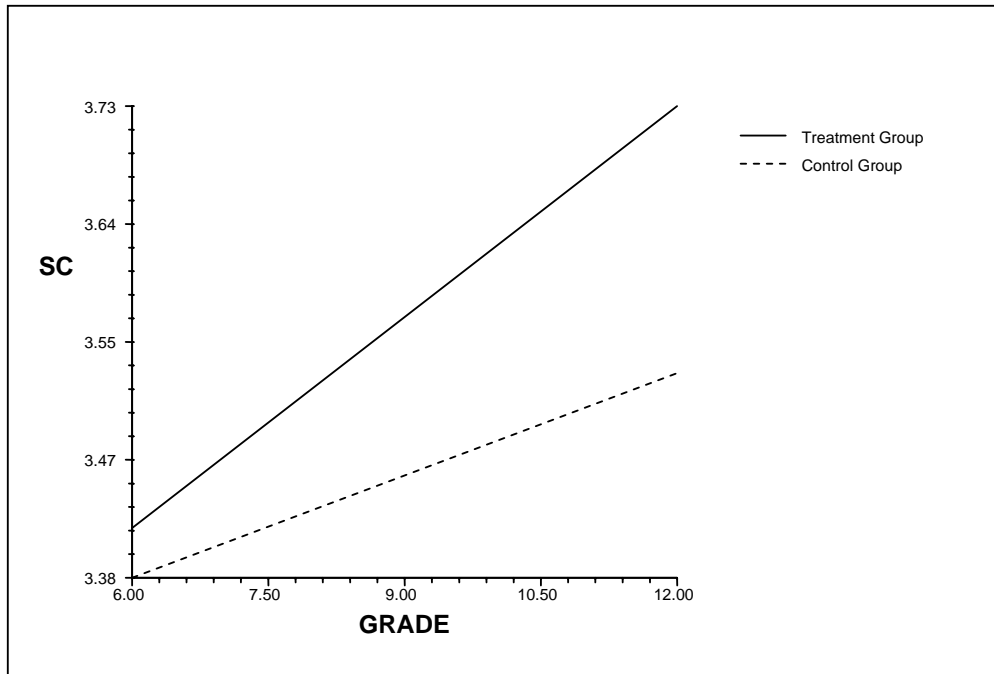
$\beta_{11} = .03$; $p=.087$ (two-tailed)

Figure 7. HLM with Time-Invariant Covariate, Grade 6-12
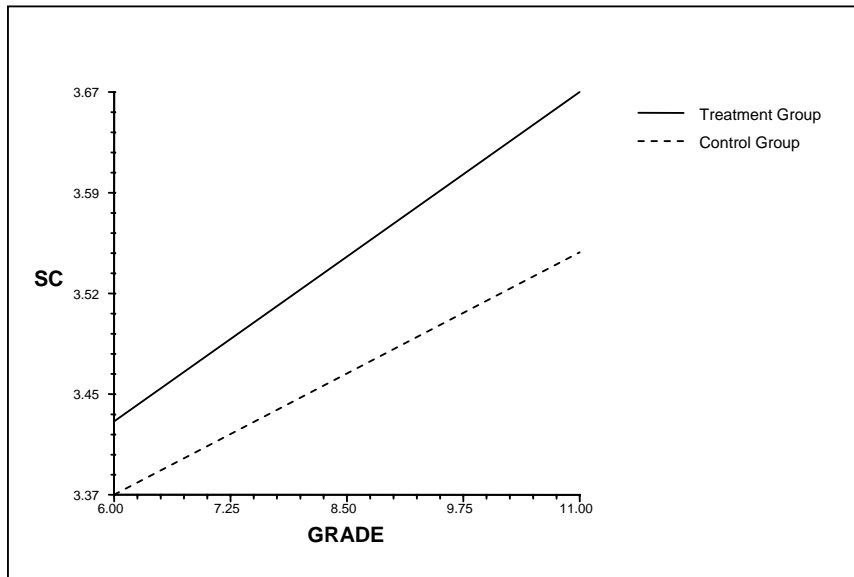Note: Linear functional form is used to specify the model

Table 4 Fixed and Random Effects of HLM with Time-Invariant Covariate (Linear)

Fixed Effect	Coefficient	S.E.	t-ratio	d.f.	p-value
For π_0					
β_{00}	3.223586	0.120863	26.671	397	<0.001
β_{01}	-0.126146	0.167434	-0.753	397	0.452
For π_1					
β_{10}	0.025650	0.011622	2.207	397	0.028
β_{11}	0.027255	0.015909	1.713	397	0.087
Random Effect	S.D.	Var.	d.f.	χ^2	p-value
r_0	1.19648	1.43157	378	826.05811	<0.001
r_1	0.09279	0.00861	378	630.83937	<0.001
Level-1, e	0.54837	0.30071			

Interestingly, after incorporating a changing level of social control/bond as a time-varying covariate at level 1, the different rates of change in self-control for both study groups become negligible in both magnitude and significance levels. This suggests that

the changing level of self-control is related to the changing level of social control/bond over time, even during the period of adolescence, which opens the possibility of a malleable nature of self-control and more dynamic relationship between two control mechanisms than the theory predicts.
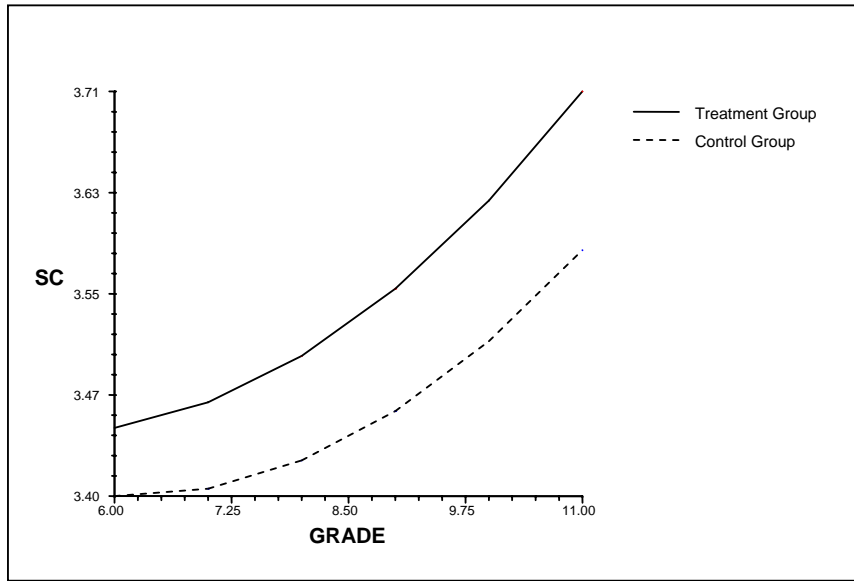

$\beta_{11} = .014$ $p=.493$ (two-tailed)

$\beta_{11} = .013, p=.524$ (two-tailed)

Figure 8. HLM with Both Time-Invariant and Time-Variant Covariates, Grade 6-12
Note: Quadratic (upper panel) and Linear (lower panel) functional forms are used to specify the model

So far, the analyses have been focused exclusively on the key mediating factors without relating them to the outcome variables of interest. As a final step in a series of analyses within HLM framework, therefore, the same procedure was followed to investigate the patterns and sources of stability and change in the level of delinquency to assess the effect of early prevention/intervention program on the actual behavioral outcome of interest over time. Figure 9 shows that individuals within treatment group in general manifest less delinquency over time whereas control group members remain stable with flat trajectory ($\beta_{11} = -.02$, $p = .061$). After controlling for the changing level of self-control as a time-varying covariate at level 1, however, delinquency level continues to increase in both groups until grade 12 but the observed different rate of change becomes smaller and non-significant ($\beta_{11} = -.01$, $p = .374$). This suggests that individuals within different study group manifest distinct delinquency trajectories and changing level of self-control – as a primary predictor of delinquency – mediates the changing level of delinquency over time even after the formative years of early childhood.
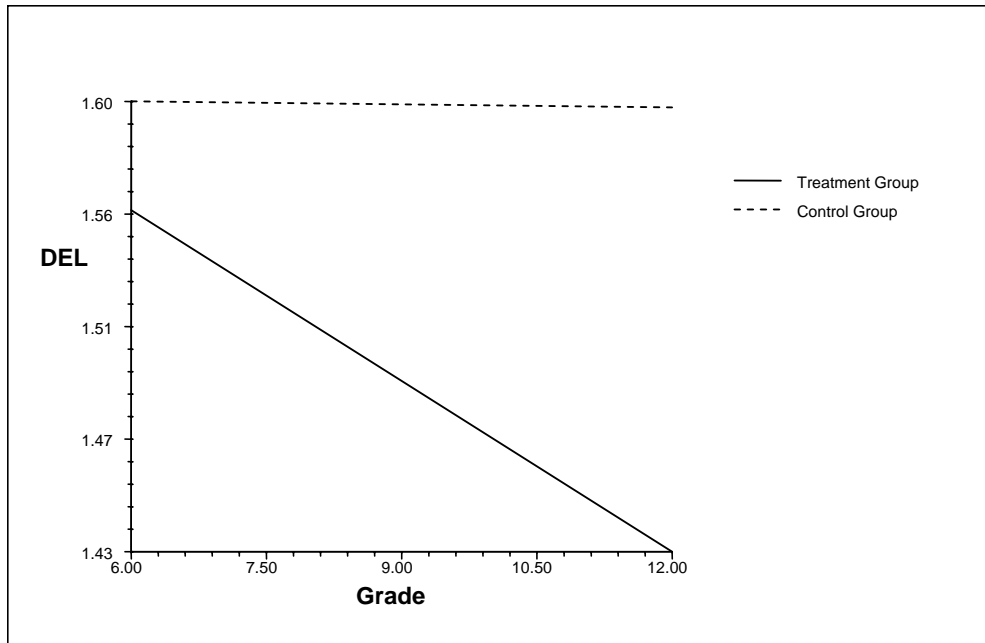
$\beta_{11} = -.02; p = .061$ (two-tailed)

Figure 9. HLM with Time-Invariant Covariate (Delinquency as an Outcome)
Note: the higher values of delinquency scale represent more delinquency
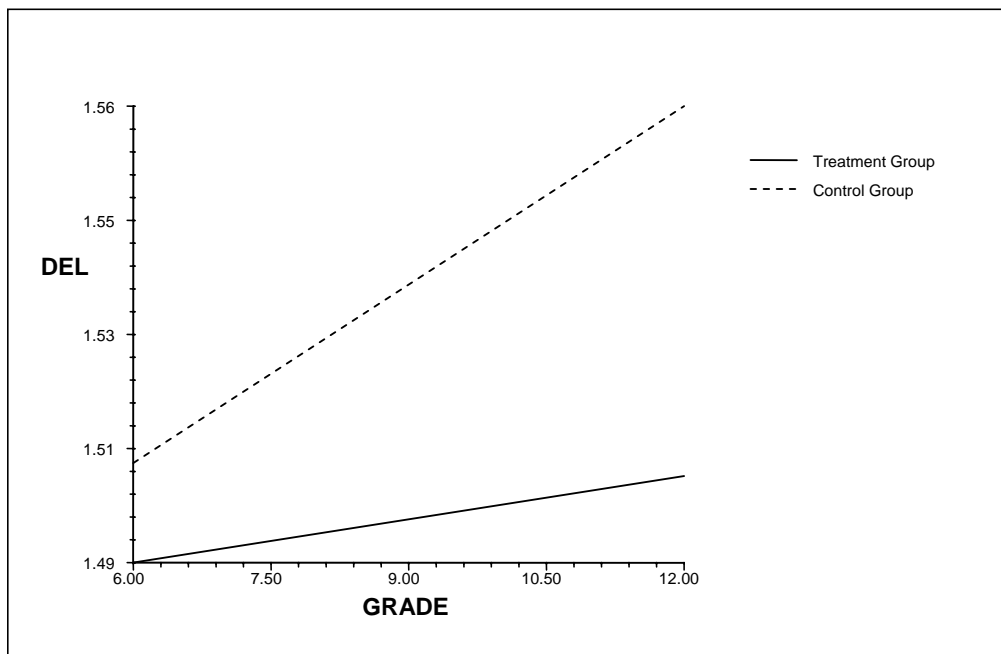
$\beta_{11} = -.01; p = .374$ (two-tailed)

Figure 10. HLM with Both Time-Invariant and Time Variant Covariates
(Delinquency as an Outcome)
Note: the higher values of delinquency scale represent more delinquency

4.2 Second-Order LGM results

Latent growth modeling (LGM), an application of structural equation modeling (SEM) that facilitates the analysis of longitudinal change of observed variable ('first-order LGM') or latent construct ('second-order LGM'), is an alternative approach to HLM in investigating different initial levels and the rates of change in the level of self-control over time. In particular, if researchers are interested in the growth pattern and source of a latent construct measured by multiple items – not of a composite scale – second-order LGM is preferred for many substantive and practical reasons. In general, second-order LGM approach focusing on the growth of latent constructs is more likely to produce unbiased parameter estimates, standard errors, chi-square statistics, and model fit indexes than HLM approach which investigates the growth pattern of a composite of multiple items[48]. The growth of composite model assumes that the factor loadings, error variances, and intercepts of the indicators are equivalent at different time points. If these very restrictive and unrealistic assumptions are not met, however, the composite scales are contaminated and the estimated growth parameters maybe biased, which makes it very difficult to distinguish between changes in the scales measuring latent constructs and true longitudinal changes of latent constructs (Leite 2007: 582). In this section, the factor loadings, measurement errors, and intercepts of multiple items are estimated using "second-order LGM" (Hancock, Kuo, and Lawrence 2001) or "curve of factor model" (McArdle 1988) in order to explicitly assess whether these factorial invariance

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[48] The most common approach to creating composites of the multiple items to model the growth of latent constructs is taking mean or sum of the scale's items (Leite 2007: 581).

assumptions are met[49], and the results from conventional HLM continue to hold when different (and more sophisticated) method is applied. In particular, this is a direct effort to address the concerns from Gottfredson and Hirschi (1990: 108) who assert that any changes in the relative rankings of self-control over time should be minimal which is accounted for in large part by "*misidentification* or *measurement errors*" (emphasis added).

In second-order LGM, two-level growth models incorporate the measurement model of SEM and structural model of SEM. Therefore, it is comprised of two types of latent factors: First, the second-order latent factors are equivalent to the individual growth parameters of HLM (e.g., intercept, slope). As in HLM, these growth factors allow for specific functional forms to be tested over time. Second, the first-order latent factors are part of longitudinal CFA model where repeated latent construct of interest is measured by multiple indicators. An advantage of the reformulation proposed by Willett and Sayer (1994) is that, once the model is translated into the framework of SEM, the full range of covariance structures associated with software for SEM become available[50]. In second-order LGM, LGM of latent constructs can be performed preserving multiple items instead

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[49] An alternative approach to HLM using composites of multiple items – especially in order to account for the different amount of measurement error in a set of items – is estimating and fixing error variances of the composites using the reliability estimates (e.g., Cronbach's alpha: Bollen, 1989; Jöreskog and Sorbom 1996). While the factors represent the estimated true scores at each time points after removing the estimated error variances, Leite (2007: 586-587), through Monte Carlo simulation, found that both approaches produce the same parameter estimates, standard errors, chi-square statistics, and fit indexes. Most of all, this approach also has inherent limitation in testing factorial invariance assumptions because factor loadings and intercepts of indicators are not estimated, and therefore does not allow us to distinguish between true change in the latent factor and method effects.

[50] These include autocorrelated level-1 random effects and heterogeneous level-1 random effects (Raudenbush and Bryk 2002: 186)

of creating composite scales by taking the mean or sum of each item[51]. In other words, second-order LGM is a combination of a common factor model and a latent growth model where the first part of model examines how well the multiple items assess the latent variable at each occasion of measurement and the second part of model determines the patterns of initial level and growth of latent variable over time. More than anything else, second-order LGM has the advantage of creating a theoretically error-free construct, which provides more accurate estimate of growth parameters because they are estimated within SEM framework which estimates the relationships among observed variables after adjusting for measurement error. Therefore, the relationship estimated among factors, as opposed to the observed relationships among the indicators or even composite scales of multiple indicators is a better estimate of the population value of this relationship.[52] In particular, the incorporation of a longitudinal CFA model allows for the evaluation of the measurement structure of the indicators over time. This is a unique advantage of second-order LGM when attempting to estimate the 'true' change of latent factors over time, which cannot be achieved by other sophisticated alternatives to simple mean score approaches proposed by recent literature (e.g., fixing error variances of composite scales:

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[51] An alternative approach to creating composite scales by taking the mean or sum of each item is creating factor scores. Factor scores take both measurement errors and the differentially weighted items into account, which provide a more accurate parameter estimates and variability within and over time compared to mean/sum scores (Curran et al. 2007). When the longitudinal CFA model is not properly specified, especially when factorial invariance assumptions are not met, however, latent factors might be defined in substantively different ways over time which leads to the biased estimates of growth factors.

[52] Specifically, Ferrer et al. (2008: 24) argue that, because measurement error is removed from the construct over time, the regression coefficients representing relations among the growth parameters and other covariates should be disattenuated and the standard errors smaller, which allows for more precise estimates of the relations between change and its correlates.

Leite 2007; creating factor scores: Curran et al. 2007). For example, Wirth (2008) using Monte-Carlo simulation found that the use of both mean and factor scores lead to biased fit statistics and estimates of almost all parameters regardless of which scoring method was used when factorial invariance is not maintained and measurement structure changes systemically over time.

In second-order LGM, factor loadings, measurement error/uniqueness, and intercept of items can be estimated as well as the fitted variance and covariances associated with seven time points. Consequently, statistical tests of factorial invariance can be performed to assess whether indicators' factor loadings, intercept, and error variances are constant over time. HLM or typical LGM using composite scales may result in poor model fit if there is significant factor variance across time points. This is because the process of creating composites of equally weighted items assumes that the items measuring a construct at a single measurement time are essentially "tau-equivalent"[53] (Lord and Novick 1968), which is very unlikely to be met with real data. In addition, LGM using composite scores not only assumes a degree of item equivalence *within* time, but also *over* time. If these assumptions are not met, individuals' score on the composite will differ from their scores on the latent variable, which in turn leads to the biased growth parameter estimates[54]. In addition, second-order LGM has an advantage over HLM because distinct pattern of estimated variance and covariance structures (after simplifying

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[53] Tau-equivalent items have equal factor loadings, but different error variances and intercepts, whereas congeneric items measuring a construct have different factor loadings, error variances, and intercepts.
[54] Using Monte Carlo simulation, Leite (2007) compared the LGM of means of multiple items with the second-order LGM model and found that two models only yield adequate results when items are essentially "tau-equivalent" and there is "strict" factorial invariance.

them to known patterns by comparing model fit indices between two models – e.g., unrestricted vs. simpler models) can also provide substantive and meaningful findings of interest. For example, by determining the variability across individuals in both initial levels and growth rates, second-order LGM provides a means for testing some hypotheses of substantive interest such as whether variance of self-control increases/decreases with age (e.g., cumulative advantage/disadvantage) or correlations between adjacent time points remains same or differ (e.g., crystallization of criminal propensity). In sum, second-order LGM provides more accurate parameter estimates and a better picture of longitudinal changes in means, variance, and covariance of variables.

Although one of the disadvantages of LGM is that it requires balanced data where each individual is required to have the same spacing of time points, current data enable to replicate the same estimation process of HLM within the framework of second-order LGM because primary measures of interest in this study have been taken at the end of grade for all participants. In addition, as in HLM, "complete data" can be reasonably assumed by treating different number of time points per individual results from missing at random. That is, while the aim of the study was to collect complete observations of seven time points for each individual, it is almost impossible to do so in reality and only the subset of values that were originally aimed to collect are available. If the data are missing at random, however, the data structure can still be conceived as complete data and multivariate analysis for repeated measures can be conducted assuming a common covariance matrix for all individuals in a given subpopulation (Raudenbush and Bryk 2002: 189). Unlike conventional methods (e.g., ANOVA), therefore, both HLM and second-order LGM can incorporate all participants who have been observed at least once

and results of the analysis can be interpreted as if no missing data were present under the assumption that the data are missing at random.

The following section fully describes the second-order LGM procedures in general and the discuss a number of related methodological issues to replicate HLM approach beginning with exploratory and confirmatory factor analyses, which are necessary steps before proceeding to the second-order LGM with mean structure, time invariant, and time variant covariates. In doing so, a series of factorial invariance tests are conducted and the results from both the unconstrained and the constrained models with different level of factorial invariance constraints[55] are presented.

4.2.1 EFA/CFA

Exploratory factor analysis (EFA) is a data-driven approach to discovering unknown factorial structures, whereas confirmatory factor analysis (CFA) is a theory-driven approach to confirming or failing to disconfirm a hypothesized factorial structure. Given the data limitation in this study where only the subscales are available which appear to measure some combination of the defining elements of either self- or social control construct (not the actual items used to create those subscales), both EFA and CFA approaches are employed in order to build a theoretically and empirically optimal measurement model.

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[55] In practice, a researcher should take a step-by-step approach starting from the least constrained model to progressively more constrained model after considering the results from the invariance of model parameters across time. If more restricted model produce a significantly poorer fit to the data, one should not proceed to add restrictions to an already unsatisfactory model. As discussed in the next section, however, the equality constraints were added even if fit indexes get significantly worse and all the results from different model specifications with varying constraints are presented.

To ascertain if the potential indicators of 'interest/desire to exercise self-control' (e.g., social control/bonds) are empirically distinguishable from the conventional 'ability/capacity for self-control' items (e.g., trait-like self-control), a principal components analysis (PCA) was performed with an oblique rotation[56] and a forced two-factor solution for the entire set of subscales (10 items in total: 5 items for self-control and 5 items for social control/bond). In doing so, the same procedure was repeated for each time point in order to confirm that the same pattern persists across different time points. This is an important initial step because Hirschi (2004) and Gottfredson (2006) recently posit that, although self-control and social control are two different theories rather than two interpretations of the control mechanism, it is almost impossible to measure their central constructs in different ways largely because social control is the primary source of self-control. The results from the PCA appear in Table 5 and Figure 11. Self-control items and social control/bond items generally load on two distinct latent constructs and the same pattern appears to persist across different time points.

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[56] Although orthogonal rotation often produces simple solutions assuming that the factors are uncorrelated with each other, oblique rotation is more reasonable approach in the current study considering that self- and social controls are conceptually different but nevertheless presumed to be correlated to some extent.

Table 5. Factor Structure Matrix Generated using PCA Rotated Oblique Solution[57]

| | Components | | | | | | | | | | | |
| | Grade 6 | | Grade 7 | | Grade 8 | | Grade 9 | | Grade 10 | | Grade 11 | |
	1	2	1	2	1	2	1	2	1	2	1	2
Impulsivity	**.854**	.090	**.853**	-.015	**.834**	.154	**.799**	.141	**.759**	.005	**.783**	-.150
Hyperactivity	**.845**	.124	**.826**	.024	**.827**	.132	**.825**	.157	**.757**	.053	**.766**	-.056
Concentration	**.856**	.209	**.840**	.223	**.866**	.184	**.840**	.223	**.818**	.243	**.848**	.342
Oppositional	**.906**	.121	**.888**	.181	**.862**	.190	**.877**	.276	**.883**	.132	**.887**	.019
Helpless	**.846**	.170	**.838**	.237	**.839**	.151	**.821**	.202	**.810**	.194	**.808**	.285
Monitoring	.074	**.594**	.107	**.644**	.058	**.648**	.191	**.745**	.141	**.764**	.074	**.687**
Punishment	.082	**.490**	.081	**.514**	.151	**.619**	.161	**.473**	.226	**.299**	.069	**.516**
Attachment	.299	**.601**	.155	**.509**	.187	**.568**	.267	**.661**	.127	**.559**	**.117**	.115
Involvement	.154	**.721**	.038	**.701**	.182	**.658**	.206	**.669**	.081	**.774**	.099	**.599**
Supervision	-.025	**.562**	.051	**.652**	.030	**.610**	-.053	**.561**	-.048	**.694**	-.065	**.681**
Factor Correlation	.164		.144		.189		.224		.158		.113	

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[57] When undertaking an oblique rotation, three factor matrices are generated: (1) a factor pattern matrix, (2) a factor structure matrix, and (3) a factor correlation matrix. Because the resulting factors are correlated, the regression-like beta weights that estimate the unique contribution that each factor contributes to the explained variance in a given items (a factor pattern matrix) are no longer equal to the simple correlations between the items and the factors (a factor structure matrix) as in the orthogonal solution (Pett, Lackey, and Sullivan 2003: 150). In this table, only the factor structure matrix is presented because factor identification and interpretation is of primary interest. Factor score matrix is useful in determining factor scores and for reproducing the correlation matrix.
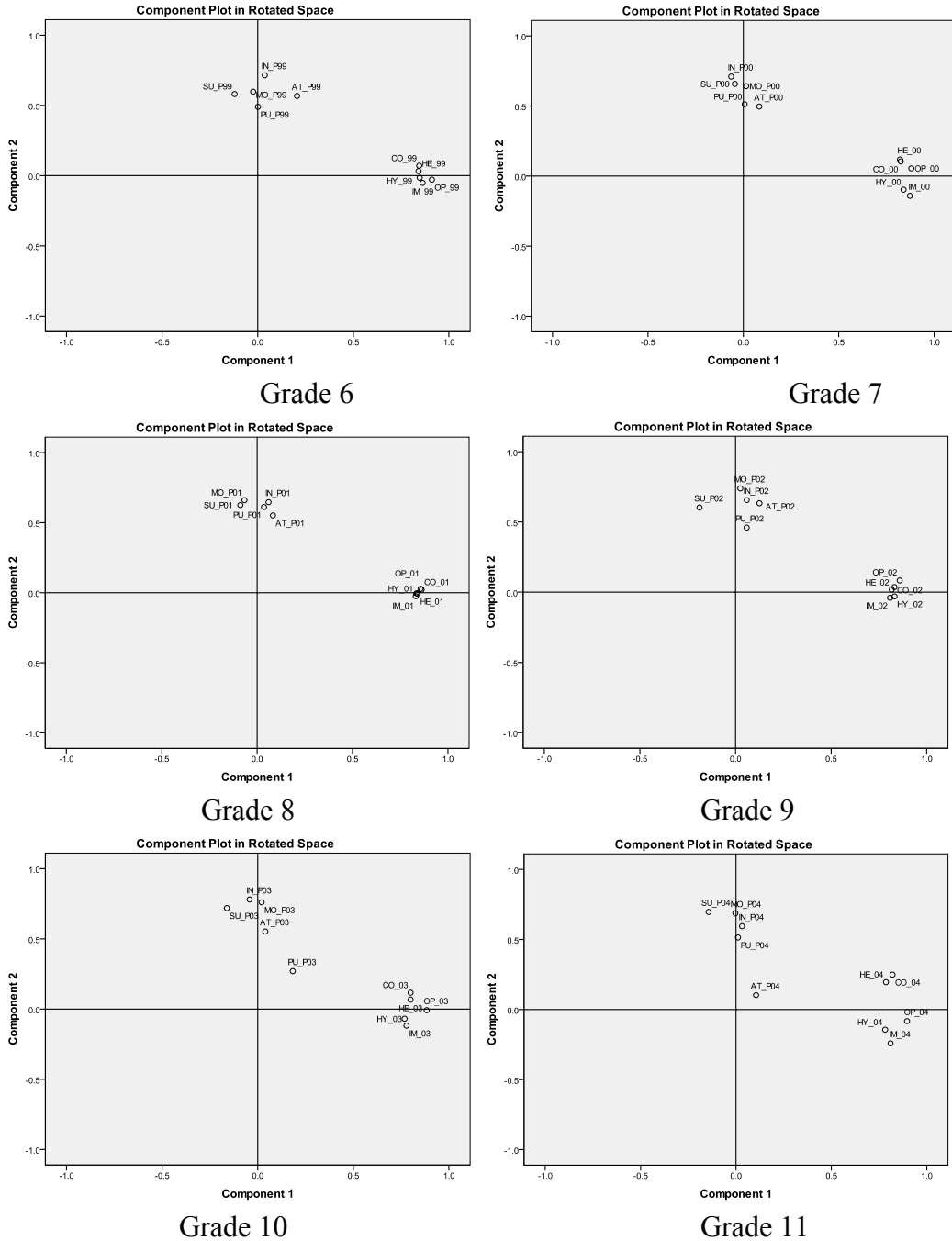
Figure 11. Plots of the PCA with a Rotated Oblique Solution

In addition, given the fact that the measurement model should first be assessed and optimally specified prior to more complex analyses such as the investigation of growth

patterns in second-order LGM or the specification of directionality of relationship in

longitudinal SEM, this was followed by a longitudinal CFA to assess whether the

observed covariance of multiple subscales is consistent with the pre-specified

measurement model hypothesized based on the theory and exploratory work (e.g., the

pattern of indicator-factor loadings, convergent and discriminant validity). Figure 12

presents the measurement model of self- and social control, respectively. While not

specified in the Figure 12 for the interest of simplicity, error variances (indicator

uniqueness) for the corresponding items measuring the same constructs were allowed to

covary across time points[58]. The specification of error covariance is justified on the basis

of method effects that result from the application of common assessment methods across

time points[59]. Measurement error is composed of two primary sources: indicator specific

and random errors. It is based on the premise that indicator-specific variances other than

random error are temporarily stable. Table 6 suggests that the model with error

covariances fits observed covariance matrix reasonably well and substantially better than

the model without error covariances for both self- and social control constructs.

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[58] For self-control construct, two other error/uniqueness covariances were added within
the same time points (1) between concentration and helpless, and (2) between impulsivity
and hyperactivity based on the substantive (they are measuring similar elements of self-
control – see appendix 1 for more detail) and empirical rationales (modification indexes
indicate substantial improvement of model fit, exclusion of which may lead to biased
parameter estimates of interest. Fit indices without additional error covariance: $\chi^2 =$
2,453.197, $p = .000$ ($df = 434$), SRMR = .136, RMSEA = .108 ($CI_{90} = .104\ .112$), CFI =
.813; with additional error covariance: $\chi^2 = 1,114.791$, $p = .000$ ($df = 420$), SRMR =
.072, RMSEA = .064 ($CI_{90} = .060\ .069$), CFI = .936). In particular, this is justified given
the exploratory nature of the analyses where five subscales already created by JHU PIRC
are used which appear to measure some combination of the defining elements of self-
control (Gottfredson and Hirschi 1990; Grasmick et al. 1993) instead of collecting or
creating them originally to build theoretically optimal measurement model.
[59] Alternatively, we could specify a 'systematic unique measurement factor' that allows
each indicators to freely load onto method factor in addition to the latent factors of
substantive interest

Table 6. Data-Model Fit Indexes for Longitudinal CFA

	Self-Control		Social Control/bond	
	With error covariance	Without error covariance	**With error covariance**	Without error covariance
X^2	**1,114.791** **$p = .000$ ($df = 420$)**	3,969.093 $p = .000$ ($df = 539$)	**449.678** **$p = .000$ ($df = 315$)**	2,150.160 $p = .000$ ($df = 390$)
SRMR	**.072**	.139	**.056**	.112
RMSEA	**.064** **($CI_{90} = .060\ .069$)**	.126 ($CI_{90} = .123\ .130$)	**.033** **($CI_{90} = .026\ .040$)**	.108 ($CI_{90} = .103\ .112$)
CFI	**.936**	.683	**.962**	.502

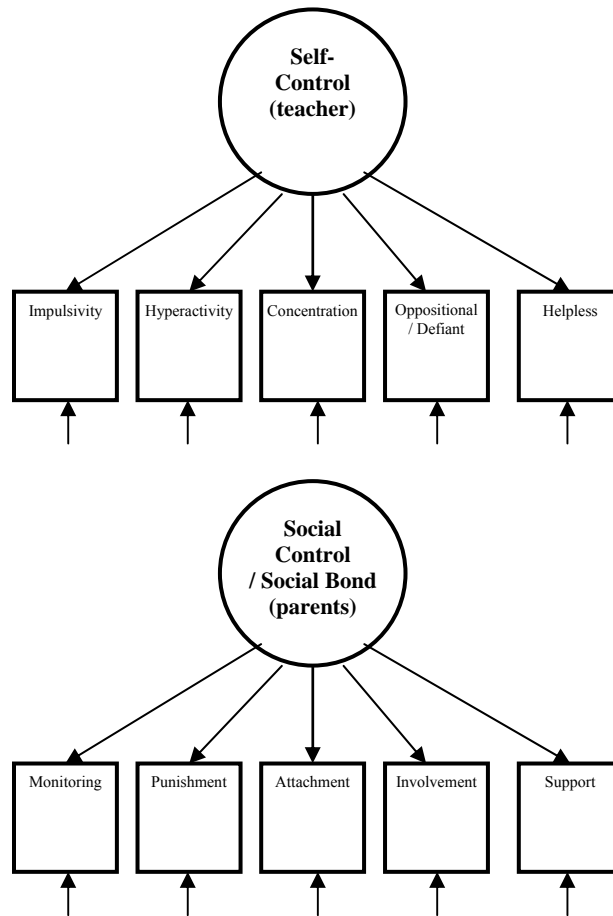Figure 12. Measurement Model using Longitudinal CFA

Note: 1. Each of factors has multiple time points, as follows:
  - Self-control (teacher): 7 time points (grades 6, 7, 8, 9, 10, 11, and 12)
  - Social control/bond: (parents): 6 time points (grades 6, 7, 8, 9, 10, and 11)
2. The covariances between (1) factors and (2) corresponding error terms across time points are not shown for simplicity.

4.2.2 LGM with Mean Structure

After fixing a measurement model that fits the data reasonably well, the second-order

LGM was fitted to the data using maximum likelihood (ML) estimation in Mplus version

6.1 (Muthén and Muthén 1998-2010)[60]. If η_t is denoted as a latent construct indicated at

time t by J measured variables Y_{tj}, The level 1 measurement model could be represented

as:

$$y = \tau + \Lambda\eta + \varepsilon \quad \text{[Equation 7]}$$

where
y is a vector that contains T sets of values across time for J measured variables Y
τ is a vector of intercepts of measured variables
Λ is a matrix of factor loadings relating each η_t construct to its measured variables
ε is a vector of random normal errors.

The level 2 structural model could be represented as:

$$\eta = \Gamma\xi + \zeta \quad \text{[Equation 8]}$$

where
Γ is a matrix of second-order factor loadings reflecting hypothesized growth patterns underlying η_t constructs (e.g., for linear function, [1 1 1 … 1] in the first column and [0 1 2 ... 6] in the second column)
ξ is a vector of growth factors (e.g., intercept, slope)
ζ is a vector of random normal disturbances in the first-order η_t constructs

Unstandardized parameter estimates are presented in the Figure 13. Given that the

primary goal of this study is to estimate the mean change in self-control construct over

time, a mean structure must be estimated simultaneously along with covariance structure.

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[60] Mplus code appears in Appendix 4.

In doing so, the first order self-control factors were not regressed on unit vector 1 because the expected values of latent self-control are perfectly reproducible from the intercept and slope factors alone (see [Equation 8]). While not shown in the Figure 13 for the interest of simplicity, however, regression of observed items on the unit vector 1 is necessary to estimate the vector of intercept terms (τ) because the expected value of observed items is not only a function of the factor loading but also depends on intercept (see Equation 7). However, unit vector 1 was not regressed on the variables used as the scale indicators for the first-order factors because, with factor loadings fixed to 1, the structural equations for these indicators (impulsivity) alone effectively constitute a first-order growth model and therefore no intercepts are necessary (see Hancock, Kuo, and Lawrence 2001: 474 for more detail). As was the case with HLM, the paths from slope factor (Γ) were fixed to 0, 1, 2, 3, 4, 5, and 6 without including a quadratic or logarithmic factor in the model because primary goal of this study to describe and explain the variability of individuals' growth rates that follow the linear functional form, which reflects a rough approximation of the more complex growth pattern observed at the individual trajectories. In addition, intercept and slope factors are allowed to covary to examine whether those start at the higher initial level of self-control at grade 6 have either faster or slower rate of change over time.

Without factorial invariance constraints

The unconstrained second-order LGM with mean structure fits the data reasonably well: $\chi^2 = 1155.252$, $p = .000$ ($df = 443$), SRMR = .078, RMSEA = .063 (CI$_{90}$ = .059 .068), CFI = .934. This allows for the interpretation of the parameter estimates that are

related to the latent growth structure. Figure 13 shows that, even after accounting for the

measurement error, the level of self-control increases on average by about .09 point over

time ($p < .01$), which is similar to the HLM results that used composite scales ($\beta_{11} = .04$,

$p < .01$). The growth factor variance indicates that both the intercept and the slope (linear

growth) significantly vary between individuals ($p < .01$), which is also consistent with

HLM results ($r_0 = 1.43$, $r_1 = .01$, both at $p < .01$).
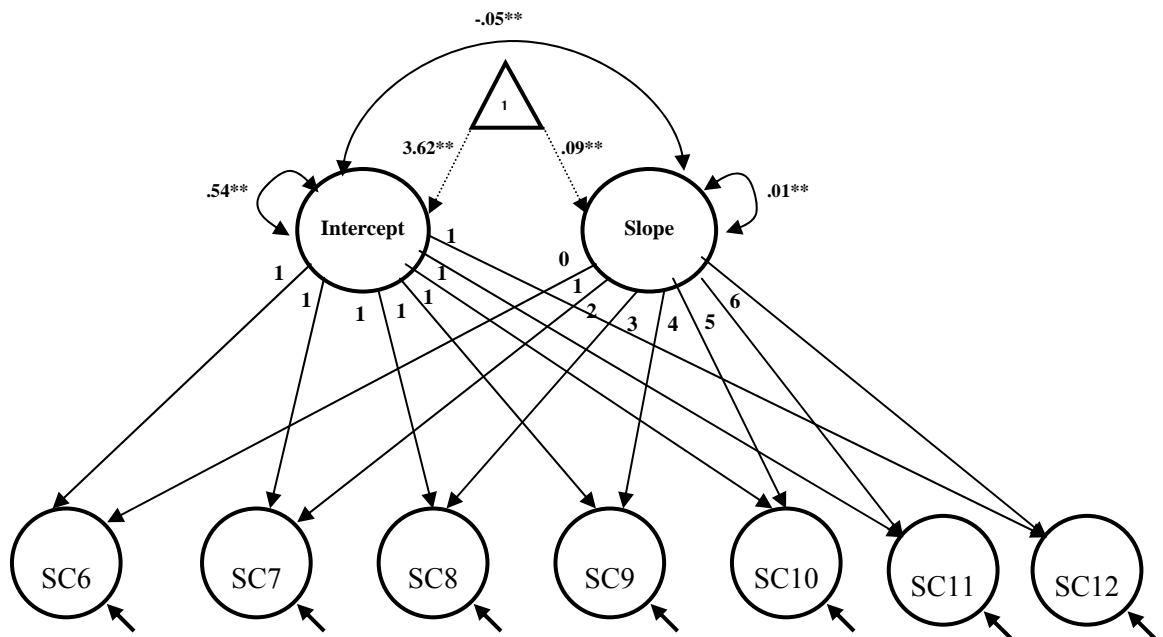
Figure 13. LGM with Mean Structure
Note: Measurement model using longitudinal CFA (Figure 12) is not shown for the
interest of simplicity.** $p < .01$; * $p < .05$ (two-tailed).

With factorial invariance constraint

To test the factorial invariance assumptions for the corresponding indicators

measuring the same latent factor repeatedly over time, a series of likelihood ratio tests

were conducted with increasingly more restricted models. The likelihood ratio test

statistically compares the fit indices of the more restricted solution with those of a

comparable solution without constraints. This is a fundamental aspect of evaluating temporal change in a latent construct because it is very difficult to determine whether temporal change observed is due to true change in the factor score or artifact of method effects in the absence of such evaluation (Brown 2006; 252-53).

An implicit assumption in the study of developmental trajectory of latent construct is that observed change in the manifest variables is due to real changes in the theoretical construct, not due to changes in the relation between indicators and latent construct of interest. Equation 7 shows that there are three potential paths that account for the changes in the latent variables, mostly related to the measurement properties of latent construct: factor loading, intercepts, and error variances of the indicators. In contrast to the HLM approach that assumes these measurement properties are the same over time, the LGM solution can freely estimate these parameters and allows for a set of equivalence tests. Different degrees of factorial invariance are traditionally specified and tested by sequentially placing equality constraints on sets of model parameters related to the measurement structure. In the following, a brief introduction to factorial invariance is provided.

Factorial Invariance

Although extensive work has been published on factorial invariance, most efforts to test invariance have been made within the framework of multiple-group CFA in order to validate the factor structure invariance across different samples when comparing group means on a construct, not within the context of longitudinal invariance over time for the same group. Nonetheless, the fundamental issues raised by multi-group CFA are similar

in nature and are applicable to analyzing longitudinal panel data. The type and degree of

invariance depend on the parameters of measurement structure that are constrained over

time (Meredith 1993).

Table 7. Description of Analytic Models[61]

Model	Description
HLM	HLM with composite scales (cannot test factorial invariance)
1LGM	LGM with composite scales (cannot test factorial invariance)
2LGM-0	Second-order LGM without factorial invariance constraints
2LGM-1	Second-order LGM with factor loading invariance constraint
2LGM-2	Second-order LGM with factor loading and intercept invariance constraints
2LGM-2-1	2LGM-2 with item 1 ("impulsivity") as a reference indicator
2LGM-2-2	2LGM-2 with item 2 ("hyperactivity") as a reference indicator
2LGM-2-3	2LGM-2 with item 3 ("concentration") as a reference indicator
2LGM-2-4	2LGM-2 with item 4 ("oppositional") as a reference indicator
2LGM-2-5	2LGM-2 with item 5 ("helpless") as a reference indicator

* Same descriptions are applied to the longitudinal SEM analyses

First, the factor loadings of corresponding indicators can be constrained to be equal

across all time points in order to ensure a comparable definition of self-control. This is

referred to as "weak" or "factor pattern" invariance (Millsap 1995), and it is generally

accepted that, at minimum, factor loading invariance should be maintained to ensure that

the same latent constructs are being measured at each time of assessment. If the restricted

model does not fit the data significantly worse than the original model, it can be assumed

that indicators of a given factor over time have equivalent relations with the underlying

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[61] As Manski (2003: 13) asserts, the prevalent approach to empirical research in the social sciences begins by maintaining assumptions that are strong enough to identify quantities of interest and to yield statistically precise point estimates of these quantities. Concerns about the credibility of assumptions are commonly addressed through the performance of specification tests and/or sensitivity analysis. In a similar vein, this study conducts a set of factorial invariance tests with different level of constraints and sensitivity analysis using different reference indicators in order to explore whether parameter estimates and statistical precisions of primary interest change under different model specifications.

construct they measure. In other words, a one-unit change in the latent construct is associated with the same amount of change in each indicator that loads on the same factor over time. However, even higher levels of invariance are recommended for unbiased estimates of growth parameters in LGM. Second, the intercepts of corresponding variables can also be constrained to be equal, reflecting the fact that change over time in a given variable should start at the same initial point. Even if a factor loading can be interpreted as the amount of predicted change in an indicator given a unit change in the latent factor, these coefficient do not reflect the exact predicted score of the indicator. Therefore, the intercept invariance test reveals whether shifts in the mean of an indicator reflect substantive changes in the latent construct or simply changes in the intercept of the indicators. Therefore, if the goal is to examine the trajectory of change in the level of a given construct, the comparison of means is meaningful only if the factor loadings and intercepts of indicators are found to be invariant. That is, if this constraint is not met, the observed scores of the indicators will vary over time even when the true score of latent factor remains unchanged, and vice versa[62]. While the latent variable means are assumed to be zero in covariance structure analysis, in mean structure analyses, latent variables may take on mean values other than zero. In other words, by fixing the intercept of a reference indicator to zero, the factor mean can be assigned to take on the mean as its reference indicator ("impulsivity" in this study). Third, error variances of the same indicator over time could also be constrained to be equal to check whether the indicators

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[62] Non-invariant indicator intercepts would suggest inequality of the indicator's location parameters over time, which leads to a spurious shift from using one portion of the indicator's response scale at time 1 to another portion of the response scale at time 2, as might occur in various forms of rater drift such as "leniency bias" (e.g., different teachers at different time points may have different level of leniency when they evaluate student's level of self-control).

are measuring the latent construct with varying precision over time, although many researchers doubt this constraint actually holds in practice due to the occurrence of increasing variance over time which is commonly found in many social and behavioral science phenomena.

The most restrictive solution treats indicators as paralleled, in which the observed measures are posited to have equal factor loadings, intercepts, and equal error variances[63]. If these assumptions are met, it can be assumed that the same indicators loading on self-control factor over time are 'interchangeable.' Meredith (1993) suggests that "strict" invariance is preferred when modeling a latent construct. However, heterogeneity of variance is a common outcome in repeated measures designs and observing strict invariance in practice may often be unrealistic (Hancock et al., 2005). Indeed, the test of equal residual variances usually fails in actual data because of the temporal fanspread of indicator variances (Brown 2006). This could be reflective of individual differences in response to the intervention to improve self-control. That is, at time 1 the variances are more homogeneous because individuals are more similar with regard to their level of self-control. By time 2, individual differences could be more pronounced because some participants responded favorably to the intervention whereas others did not (or vice versa[64]). Considering that factor loadings and intercepts invariances are of particular interest when investigating stability and change of construct,

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[63] Meredith (1993) denotes a condition in which all loadings, intercepts, and unique factor variances are invariant as "strict invariance" whereas "strong invariance" is defined as a condition in which both the factor loadings and measurement intercepts are invariant.

[64] In this study, the variance of self-control gets smaller over time reflecting the negative interaction between intercept and slope factors ($p < .01$).

I decided to conduct only "strong" invariance test (Meredith 1993) allowing the error/uniqueness of items to vary freely.

Since ML estimation allows researcher to find optimal parameters that minimize the differences between the observed (**S**) and the model-predicted (Σ) variance-covariance matrices (and mean structures in this study), the constrained model find a single estimate applied to all time points instead of allowing them to freely take on any set of values but still maximizes the fit of the model. A direct statistical comparison of the alternative solution through χ^2 difference testing is possible because of the nested nature of the constrained and the unconstrained models. If the constrained model does not produce a significant reduction in fit relative to the corresponding solution, equivalent assumption is sustained. It is usually preferred to employ an incremental strategy which will allow us to more readily detect the sources of non-invariance if significant degradations in the model fit are encountered. Thus, it begins with the congeneric measurement model where factor loadings, intercepts, and error variances are free to vary but indicators loads on the same factor. Then, the appropriate restrictions on the solution are placed and evaluated by comparing the resulting change in model χ^2 using the less restricted model as the baseline solution.

Table 8. Goodness-of-Fit Indices of the Models (I)[65]

Model	χ^2(*df*)	$\Delta\chi^2$(*df*)	SRMR	RMSEA (90% CI)	CFI
HLM					
1LGM	42.588 (23)		.076	.046 (.023 .068)	.980
2LGM-0	1,155.252 (443)		.078	.063 (.059 .068)	.934
2LGM-1	1,204.798 (467)	49.546 (24)**	.085	.063 (.059 .067)	.932
2LGM-2-1	1,335.127 (491)	130.329 (24)**	.092	.066 (.061 .070)	.922
2LGM-2-2	1,335.127 (491)		.092	.066 (.061 .070)	.922
2LGM-2-3	1,335.127 (491)		.092	.066 (.061 .070)	.922
2LGM-2-4	1,335.127 (491)		.092	.066 (.061 .070)	.922
2LGM-2-5	1,335.127 (491)		.092	.066 (.061 .070)	.922

** $p < .01$; * $p < .05$

Table 9. Parameter Estimates of the Models (I)

Model	Fixed Effects		Random Effects	
	Intercept	Slope	Intercept	Slope
HLM	3.16**	.04**	1.43**	.01**
1LGM	3.40**	.04**	.59**	.01**
2LGM-0	3.62**	.09**	.54**	.01**
2LGM-1	3.63**	.09**	.46**	.01**
2LGM-2-1	3.76**	.05**	.48**	.01**
2LGM-2-2	3.76**	.04**	.46**	.01**
2LGM-2-3	2.84**	.05**	.46**	.01**
2LGM-2-4	3.61**	.06**	.46**	.01**
2LGM-2-5	2.97**	.04**	.46**	.01**

** $p < .01$; * $p < .05$ (two-tailed)

Tests of the factor loading and intercept invariance of the indicators suggest that these restrictions result in an increase in χ^2 to 49.546 and to 130.329 with $df = 24$ ($p < .01$),

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[65] One thing we need to note is that these fit indexes do not indicate whether the results are theoretically meaningful or 'confirm' theory. Although model evaluation usually begins with the examination of these fit indexes, it is equally important to examine a solution in terms of potential areas of localized strain and the interpretability of the parameter estimates (e.g., whether they are consistent with the theoretically-driven prediction with respect to direction and strength). In addition, we should not confuse the notions of goodness of model fit and the meaningfulness of the model's parameter estimates. Even if a model is very successful at reproducing the observed covariance matrix, this does not ensure that the latent variables are substantively interrelated or account for meaningful variance in the indicators. Thus, it is just as important to assess the magnitude and significance of parameter estimates as it is to evaluate the goodness of fit when determining the acceptability of the solution.

respectively. Because these differences are above the critical value of the χ^2 distribution at $df = 24$ ($\chi^2 = 42.980$, $p < .01$), the hypothesis of an invariant pattern of factor loadings is untenable and further restrictions should not be added to an already unsatisfactory model with a poorer fit to the data. While it is common convention to use χ^2 difference scores to empirically test factorial invariance, however, relying solely on this statistic could be too conservative in this study considering that it is an omnibus test of invariance over multiple time points and the invariance assumption is more likely to be rejected in second-order LGM with multiple time points (seven in this study) than in multi-group analysis that involves the comparison between only two or three groups. In addition, I am very skeptical on the feasibility of strong invariance in the second-order LGM framework because the source of invariance can be traced not only to the intrinsic properties of an assessment instrument per se but also to the characteristics of the interviewers and respondents from each time points. In this study, for example, self-control measures were taken by different teachers at each time point, who might have different definition and leniency when they assess the level of student's self-control. Moreover, there continues to be some confusion and little consensus concerning the most appropriate criterion to use in determining evidence of invariance, and some researchers advocate a practical approach to such judgment, whereas others support a more conservative statistical perspective (Byrne and Stewart 2006). For example, Byrne and Stewart (2006: 304) suggest that, although by convention the χ^2 statistic and its related degrees of freedom are used in the model evaluation, its use as a viable indicator of model fit is precluded by its extreme sensitivity to sample size as well as small to moderate discrepancies of the data from normality. In both instances, it tends to reject a model on the basis of very small

discrepancies from the model that may be of no *theoretical* or *practical* substance

(Bentler and Bonett 1980, emphasis added). As a consequence, other goodness of fit

statistics that take a more pragmatic approach to the model evaluation process have been

recommended such as CFI (Bentler 1990), RMSEA (Steiger 1990), and SRMR (Steiger

1990). In particular, Byrne and Stewart (2006) recommend CFI change in determining

evidence of measurement invariance although the use of this criterion has been purely

heuristic nature[66].

In a similar vein, some researchers recently propose that a less stringent level of

invariance is sufficient for modeling growth. For example, Byrne, Shavelson, and

Muthén (1989) have suggested that constraining only a subset of the factor loadings or

item intercepts (that are found to be invariant) to remain equal over time may provide a

more realistic criterion. By doing so, the scale of the latent construct remains constant,

measurement error is taken into account, and potential model misspecification is

minimized because only time variant factor loadings or item intercepts are freely

estimated. The primary concern is the ongoing debate on the level of "partial" invariance

required for modeling change and comparing factor means.

Milsap and Kwok (2004: 94) discuss the implications of partial invariance for

measurement interpretation[67]. They note that the investigations of factorial invariance are

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[66] While Little (1997) suggested that CFI difference should not exceed a value of .05,
other researchers have been less specific and based evidence for invariance merely on the
fact that change in the CFI values between nested models is "minimal." However, after
pointing out that .05 criterion suggested by Little (1997) has neither strong theoretical nor
empirical support, Cheung and Rensvold (2002) arbitrarily suggest that its difference
should not exceed .01 (see Byrne and Stewart (2006) for more detail).
[67] They discuss the issue of partial factorial invariance in the context of examining
whether the factor structures are equivalent across *multiple populations* with identical
indicators. However, the same idea extends logically to the study where the primary

typically limited to documenting the violations of invariance and assessing the size of any violation, and the next step of deciding what to do about these violations is left to users of the measures. In the face of the evidence for factorial non-invariance, therefore, investigators are left with three options: First, use only subset of indicators that are found to be invariant after diagnosing the sources of non-invariance. Second, retain all indicators in the belief that the population differences in factor structure are small and that these differences will not obscure the substantive inferences from the parameter estimates of primary interest. Third, abandon the use of the indicators altogether for the study of longitudinal change in the latent factor. Milsap and Kwok (2004) acknowledge that because current literature on factorial invariance offers little guidance in choosing among these three options, researchers either (1) decide not to further test other invariance or research hypotheses without engaging in follow-up procedure to pinpoint and deal with the source of inequality, or (2) simply proceed without any efforts to deal with this problem. Importantly, they clearly argue that the decision should be made in relation to the specific purpose of the measure, not solely based on the empirical test. In a similar vein, Byrne, Shavelson, and Muthén (1989) also asserted that the meaning and importance of any violations of factorial invariance should be judged based on multiple criteria including "substantive, theoretical and conceptual considerations."

Even if χ^2 difference tests suggest worse fit in the constrained model, therefore, I decided to force them to be equal as a sensitivity analysis in order to verify whether there are meaningful changes in the estimates of important parameters under alternative specifications. Although the other formal model fit indices are not optimal in both

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interest is to verify whether factor structures are equivalent across *multiple time points* for the same population.

constrained and unconstrained models, I believe they still suggest a theoretically and substantively reasonable representation of the data. In addtion, according to the "practical" perspective based a CFI criterion cutpoint of .01 (Byrne and Stewart 2006), yielded results support reasonable factorial invariance. After all, since hypothesized models in social science must be considered only as approximation to reality rather than as exact statements of truth, direct attention is paid to the practical meaning and significance of parameter estimates when *subjective* criteria indicate a substantively reasonable approximation to the data, instead of completely removing a set of second-order LGM analyses from this study in the face of factorial non-invariance based on the stringent statistical criterion (e.g., χ^2 difference criterion cutpoint of .05 or .01). For example, if the estimates of major parameters undergo no appreciable change when equality constraints are imposed and there is not substantial change in the model fit, this could indicate that the initially hypothesized constrained model is empirically robust. If, on the other hand, the major parameters undergo substantial alteration, the constrained model may lead to biased estimates (see e.g., Byrne, Shavelson, and Muthén 1989: 461 for more detail). Table 8 suggests that the sacrifice of goodness of fit is minimal considering the substantive gain of interpretability of parameter estimates[68] and the

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[68] At this point, further models could be examined to better understand the source of invariance in the context of "partial invariance" model (Byrne, Shavelson, and Muthén 1989), followed by a set of additional sensitivity checks in order to verify whether there are meaningful changes in the estimates of important parameters under different versions of partial invariance specifications (e.g., using only some combination of a subset of constrained factor loadings and item intercepts found to be invariant over time). Given the consistent patterns of parameter estimates across different level of factorial invariance, however, I decided not to further investigate the partial non-invariance patterns within each level.

parameters of growth factor (both fixed and random effects of slope) are close to identical across different model specifications under different level of invariance constraint.

In addition, Ferrer et al. (2008: 22) recently demonstrated that, if factorial invariance fails to hold, choice of indicator used to identify the latent variable can have substantial influences on the characterization of patterns of growth, strong enough to alter conclusions about growth. Table 8 also shows that fit indices and parameter estimates are consistent even when different items are specified as reference indicators, suggesting that marginally non-invariant factor structure observed in the current data does not affect substantive meaning of the findings of primary interest.

Figure 14 presents the hypothesized path model in which the construct of self-control is posited to be structurally the same at each time point by placing both factor loading and intercept invariance constraints (using "impulsivity" as a reference indicator) even if χ^2 difference tests suggest that model fit of data significantly degraded.
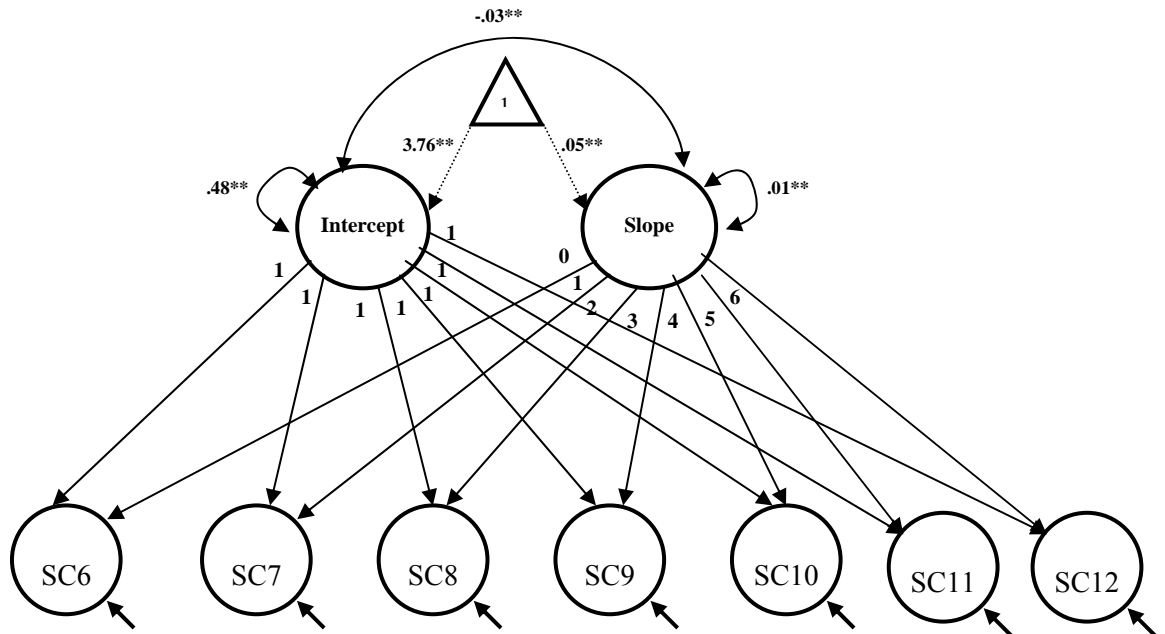
Figure 14. LGM with Mean Structure (with Strong Factorial Invariance Constraints)
Note: Measurement model using longitudinal CFA (Figure 12) is not shown for the interest of simplicity. ** $p < .01$; * $p < .05$ (two-tailed)

Considering that it is very restrictive solution with strong factorial invariance constrains (equal factor loadings and intercepts) imposed, this model fits the data reasonably well: $\chi^2 = 1,335$, $p = .000$ ($df = 491$), SRMR = .092, RMSEA = .066 (CI$_{90}$ = .061 .070), CFI = .922. The establishment of reasonable data-model fit allows for the interpretation of the parameters of interest such as intercept and slope factor means, variances, and covariance. As in HLM results, the parameters associated with intercept are not of primary interest in this study and therefore not discussed here. The mean structure portion contains information about growth at the aggregate level. The factor means can be estimated through the introduction of a pseudo-variable that assumes a

constant value of 1 for all subjects[69]. Consistent with HLM results, the slope factor

estimate in the second-order LGM is still positive $(.05)$[70] and significantly different from

zero ($p < .01$), which suggests that the more accurate growth pattern of self-control in

the population manifests overall increase with age, even after accounting for the

measurement error and methods effects arising from instrument or rater unreliability.

This, however, merely represents an average tendency that students have a positive rate

of growth in self-control at the aggregate level and therefore is not necessarily indicative

of the trend for all individuals. The covariance structure of the second-order LGM

contains information about individual differences in the growth trajectories, which shows

that there still is evidence of substantial variability across individual growth rate as

indicated by a significant variance in the slope factor ($.01, p < .01$). In contrast to what is

often assumed in more traditional methods, therefore, there is strong evidence that

individuals do not develop at the same rates. All individuals also differ in their initial

levels of self-control in addition to their rates of growth from that initial level and there is

a significant relationship between initial level and rates of change ($-.03, p < .01$). In sum,

diversity exists in both initial levels and rates of change in self-control development.

Individuals that start with lower levels of self-control tend to grow at a faster rate than

those that start with higher level of self-control. This provides us with more direct

evidence that individuals' relative positions in their level of self-control might shift over

time.

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[69] It has no variance and therefore cannot covary with any measured variable or factor. Nonetheless, its inclusion in LGM allows for intercept and slope factor means to be estimated (see Kline 2005; Hancock and Lawrence 2006 for more detail).

[70] The numerical value of .05 is not comparable to .04 in HLM results because it is tied to the units of the self-control scale indicators ("impulsivity") instead of mean scores of multiple items.

As in HLM, relatively large and significant slope factor variance (.01, $p < .01$) indicates students' self-control levels change at greatly varied rates. An estimate of standard deviation of slope factor (.084) can also be calculated by taking square root of slope factor variance. If we assume the normal distribution of slope factor among individuals, the estimated latent mean and standard deviation could be used to create the distributional representation for the growth in latent self-control. Figure 15 indicates that approximately 95% of youths grow annually between -.119 and .209 points along the latent self-control continuum, which has the same metric as the reference indicator ("impulsivity"). More accurate estimates of mean growth rate and variance among individuals still suggest that almost 30% of individuals manifest decreasing level of self-control over time, which is consistent with HLM results.
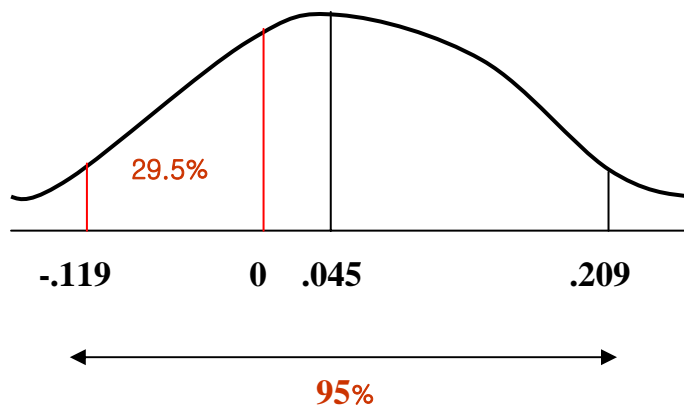

Figure 15. Distribution of Slope Parameter from Second-Order LGM (with Strong Factorial Invariance Constraints)

4.2.3 LGM with Time-Invariant and Time-Variant covariates

As in HLM, one of the advantages of LGM approach over traditional methods is its ability to explain the variability in the latent growth factors by explicitly incorporating both time-invariant and time-variant predictors into the model. In this study, one of the research hypotheses of primary interest is the long-term effect of treatment on the youths' self-control growth trajectory over time. The path from group membership (0=control, 1=treatment) to slope factor describes the sign and magnitude of the effect of group membership on the rate of change in self-control. Table 11 and Figure 16 show that, while there is no difference in the initial level, there is a meaningful difference in the average linear growth rates between two groups. Individuals who received treatment during grade 1 have faster increasing rates than those who did not by .02 each year. This slope parameter has the same metric as the first reference indicator ("impulsivity") and Table 11 suggests that the same pattern persists when other indicators are used as a reference indicator. After accounting for the measurement errors and method effects using second-order LGM, however, the fixed effect of slope factor is no longer significant at $p < .1$ level ($p = .123$). This could be interpreted as either (1) the evidence that supports the assertion from Gottfredson and Hirschi (1990: 108) who claimed that any changes in the relative rankings of self-control over time should be minimal which is accounted for in large part by "*misidentification* or *measurement errors* or (2) simply the lack of statistical power to detect meaningful difference in the population. Given the consistency in the magnitude and significance of growth parameters across different model specifications, however, I conclude that both study group members follow distinct patterns of growth trajectory in their self-control development.

Table 10. Goodness-of-Fit Indices of the Model (II)

Model	$\chi^2(df)$	$\Delta\chi^2(df)$	SRMR	RMSEA (90% CI)	CFI
HLM					
1LGM	47.629 (28)		.067	.042 (.020 .062)	.980
2LGM-0	1,194.401 (476)		.076	.062 (.057 .066)	.934
2LGM-1	1,243.916 (500)	49.515 (24)**	.083	.061 (.057 .065)	.931
2LGM-2-1	1,374.043 (524)	130.127 (24)**	.089	.064 (.060 .068)	.921
2LGM-2-2	1,374.043 (524)		.089	.064 (.060 .068)	.921
2LGM-2-3	1,374.043 (524)		.089	.064 (.060 .068)	.921
2LGM-2-4	1,374.043 (524)		.089	.064 (.060 .068)	.921
2LGM-2-5	1,374.043 (524)		.089	.064 (.060 .068)	.921

** $p < .01$; * $p < .05$

Table 11. Parameter Estimates of the Models (II)

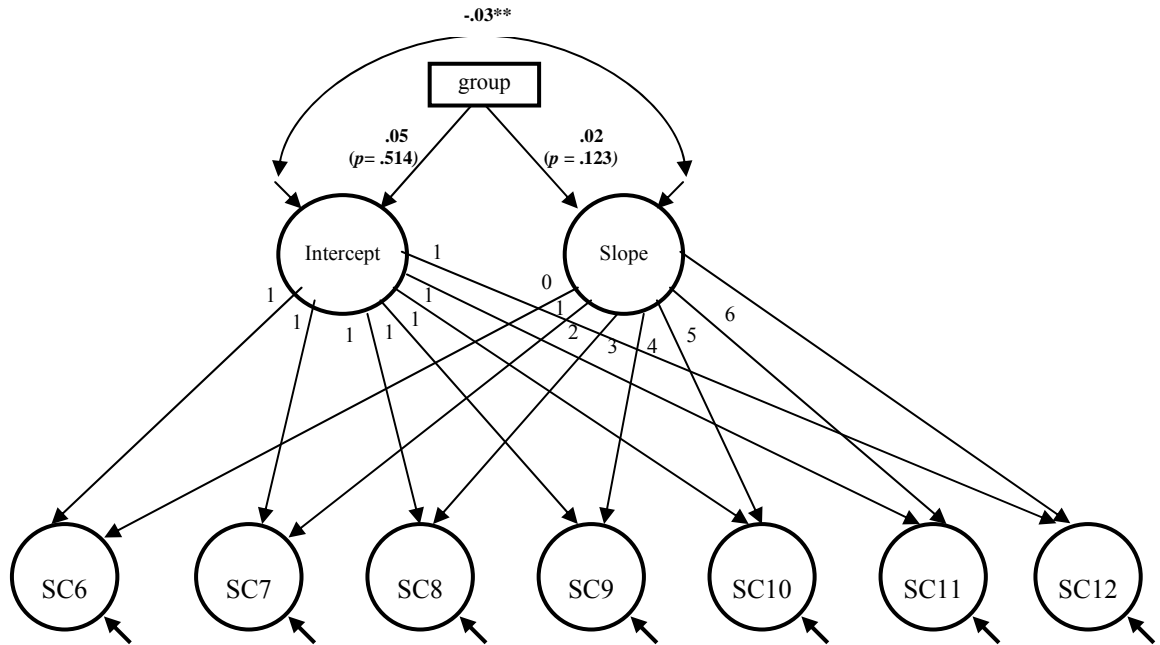| Model	The Effects of Treatment on	
	Intercept	**Slope**
HLM	-.13(p=.452)	**.03 (p=.087)**
1LGM	.03(p=.713)	**.03 (p=.066)**
2LGM-0	.06(p=.520)	**.02 (p=.231)**
2LGM-1	.05(p=.531)	**.02 (p=.126)**
2LGM-2-1	.05(p=.514)	**.02 (p=.123)**
2LGM-2-2	.05(p=.568)	**.02 (p=.163)**
2LGM-2-3	.05(p=.560)	**.03 (p=.097)**
2LGM-2-4	.07(p=.510)	**.03 (p=.130)**
2LGM-2-5	.05(p=.541)	**.02 (p=.110)**

Figure 16. LGM with Time-Invariant Covariates(with Strong Factorial Invariance Constraints)
Note: Measurement model using longitudinal CFA (Figure 12) is not shown for the interest of simplicity. ** $p < .01$; * $p < .05$ (two-tailed)

After incorporating the time-varying covariates at each time point, the model still fits the data reasonably well: $\chi^2 = 3,053.248$, $p = .000$ ($df = 1,668$), SRMR = .094, RMSEA = .046 ($CI_{90} = .043$ .048), CFI = $.895^{71}$. Figure 17 shows that the different rate of change for both study groups becomes less significant ($p = .231$) when changing levels of social control/bond are accounted for, which is consistent with HLM result. Moreover, the paths from social bond to self-control are relatively strong and significant across all time points. The consistency of the findings across different approaches gives me the rationale to more fully investigate the dynamic relation between two latent constructs over time.

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[71] While I present the results only from 2LGM-2-1 with time-variant covariate, the same pattern persists under different model specifications as in Table 8.
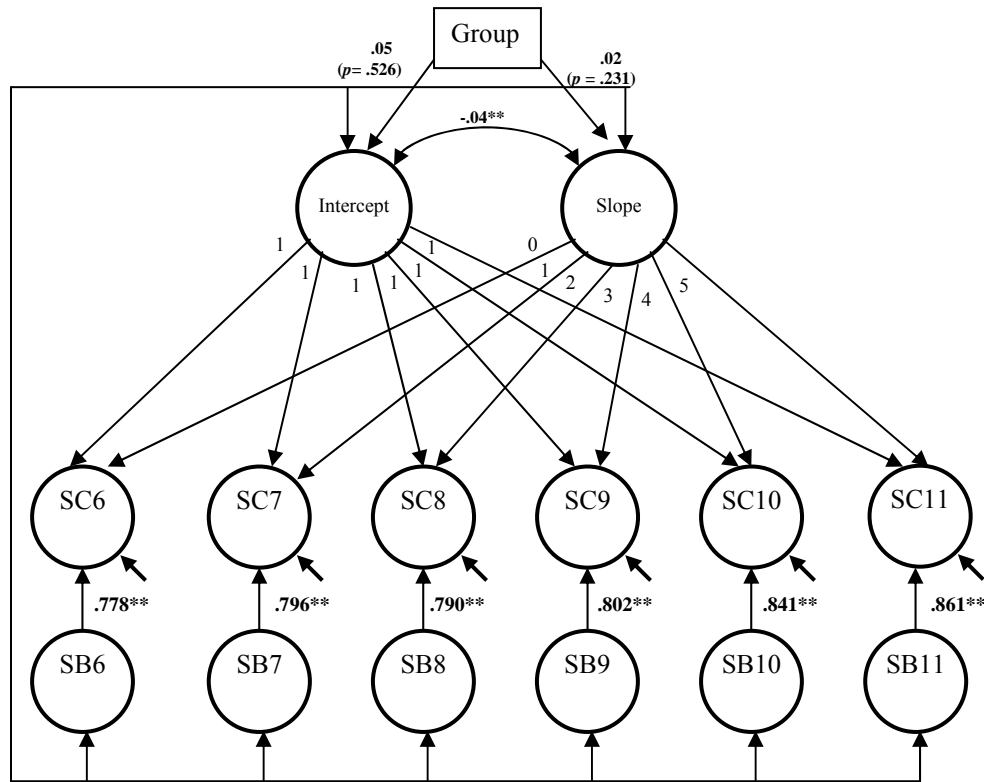
Figure 17. LGM with Time-Invariant and Time-Variant Covariates (with Strong Factorial Invariant Constraints)

Note: Measurement model using longitudinal CFA is not shown for the interest of simplicity

** $p < .01$; * $p < .05$ (two-tailed)

4.3 SEM results

Both HLM and second-order LGM results suggest that there is a substantial variability in the changing level of self-control across individuals that belong to the two study groups and such variability is somehow accounted for by the changing level of social control/bond triggered by treatment condition. To better disentangle the causal mechanism underlying stability and change of self- and social control constructs and their relation to the pattern of offending trajectories over time, a more rigorous methods is

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employed to explicitly specify the dynamic relationship between two key mediating

factors that are known to be the primary predictors of offending behaviors in the field. In

particular, in an effort to test Gottfredson and Hirschi's pure population heterogeneity

hypothesis or social-selection postulate, a direct comparison is made between

bidirectional and unidirectional causation models using SEM with longitudinal panel

design. Contrary to the traditional methods that focus on the longitudinal influences

between two measured variables or composite scales over time, this study employs recent

advances in general applications of SEM that incorporates longitudinal CFA and latent

SEM with panel design. Just as second-order LGM has greater advantage over traditional

LGM or HLM approaches, latent SEM with panel design is considered to be more

sophisticated method than traditional path analysis in several ways. Most of all, it allows

for (1) the creation of measurement error-free latent constructs to ensure the robustness of

the findings and (2) the test of factorial invariance to assess whether the constructs are

measured equivalently across time. Because it begins with longitudinal CFA to assess the

adequacy of measurement model and the tenability of measurement invariance

assumption, the hypotheses of primary interest pertaining to the structural relations

among the constructs can be better addressed within SEM framework.

     As in second-order LGM, Table 12 shows that the more constrained models fit the

data significantly worse than the less constrained models. In particular, the intercept

invariance constraint worsens data-model fit more seriously than factor loading

invariance constraint does, which makes the parameter estimates in the Figure 18c less

interpretable[72]. Nonetheless, there is a distinct pattern across different model

specifications with different level of factorial invariance constraints and with different

reference indicators that supports bidirectional model over unidirectional model. The

deletion of five directional paths from social control/bond to time lagged self-control lead

to the significant amount of change in model fit relative to the changes in degrees of

freedom. Table 12 suggest that, for SEM-2-1 model, $\Delta\chi^2 = 284.846$ ($df = 5$, $p<.01$) and

ΔCFI = .015. This is not surprising considering the magnitude and significance of

parameter estimates of paths that included in the bidirectional model but omitted in the

unidirectional model, all of which are consistently strong and significant across different

model specifications. Interestingly, no meaningful pattern is observed in the directional

paths from self-control to time-lagged social control/bond. In sum, contrary to

Gottfredson and Hirschi's assertion, current data suggest that there is strong evidence that

social causation process continues to occur during adolescence period whereas the

magnitude and significance of social selection process is negligible during the same

period.

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[72] Modification indexes suggest that the establishing strong factorial invariance for the social control/bond construct is the primary source of ill-fit, which means that the fundamental meaning of the social control/bond construct has changed substantially across the different developmental periods.

Table 12. Goodness-of-Fit Indices of the Models (III)

Model	χ²(*df*)	Δχ²(*df*)	SRMR	RMSEA (90% CI)	CFI
Unidirectional					
SEM-0	2,870.634 (1,541)		.181	.047 (.044 .049)	.899
SEM-1	3,044.728 (1,581)	174.094 (40)**	.232	.048 (.046 .051)	.889
SEM-2-1	3,415.921 (1,621)	371.193 (40)**	.111	.052 (.049 .054)	.870
SEM-2-2	3,415.921 (1,621)		.111	.052 (.049 .054)	.870
SEM-2-3	3,415.921 (1,621)		.111	.052 (.049 .054)	.870
SEM-2-4	3,415.921 (1,621)		.111	.052 (.049 .054)	.870
SEM-2-5	3,415.921 (1,621)		.111	.052 (.049 .054)	.870
Bidirectional					
SEM-0	2,588.777 (1,536)		.084	.042 (.039 .044)	.920
SEM-1	2,738.723 (1,576)	149.946 (40)**	.094	.043 (.041 .046)	.911
SEM-2-1	3,131.075 (1,616)	392.352 (40)**	.108	.049 (.046 .051)	.885
SEM-2-2	3,131.075 (1,616)		.108	.049 (.046 .051)	.885
SEM-2-3	3,131.075 (1,616)		.108	.049 (.046 .051)	.885
SEM-2-4	3,131.075 (1,616)		.108	.049 (.046 .051)	.885
SEM-2-5	3,131.075 (1,616)		.108	.049 (.046 .051)	.885

** *p* < .01; * *p* < .05
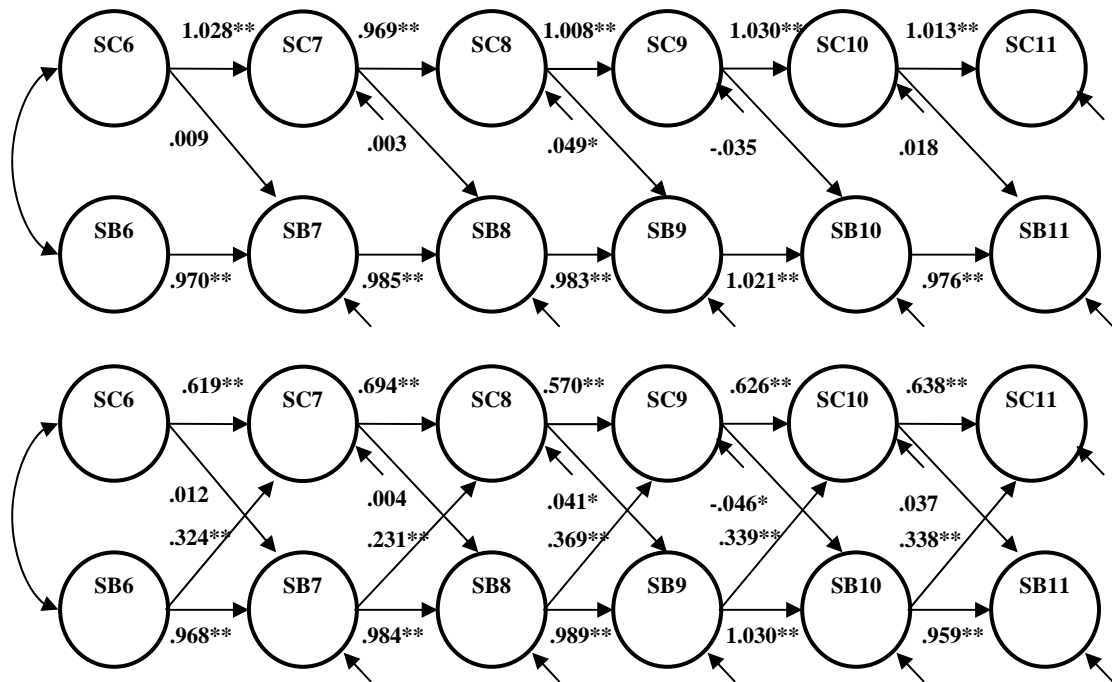
Figure 18a. SEM with Longitudinal Latent Variables – Unconstrained model
(Unidirectional – upper panel; Bidirectional – lower panel)
** *p* < .01; * *p* < .05 (two-tailed)
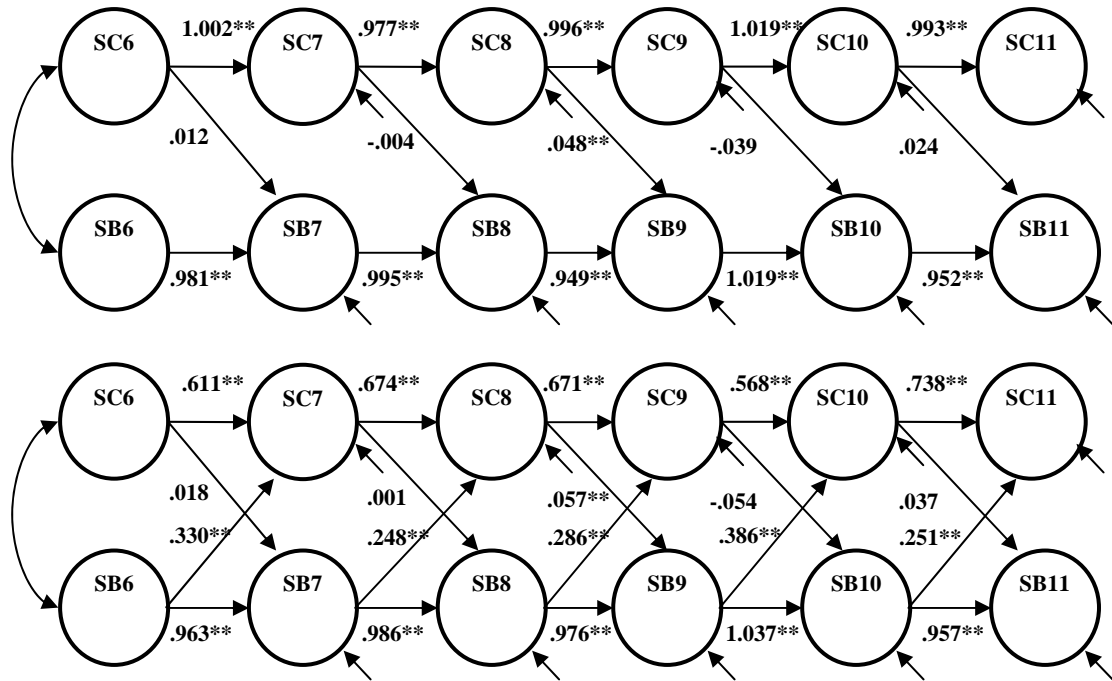
Figure 18b. SEM with Longitudinal Latent Variables – with Factor Loading constraint (Unidirectional – upper panel; Bidirectional – lower panel)
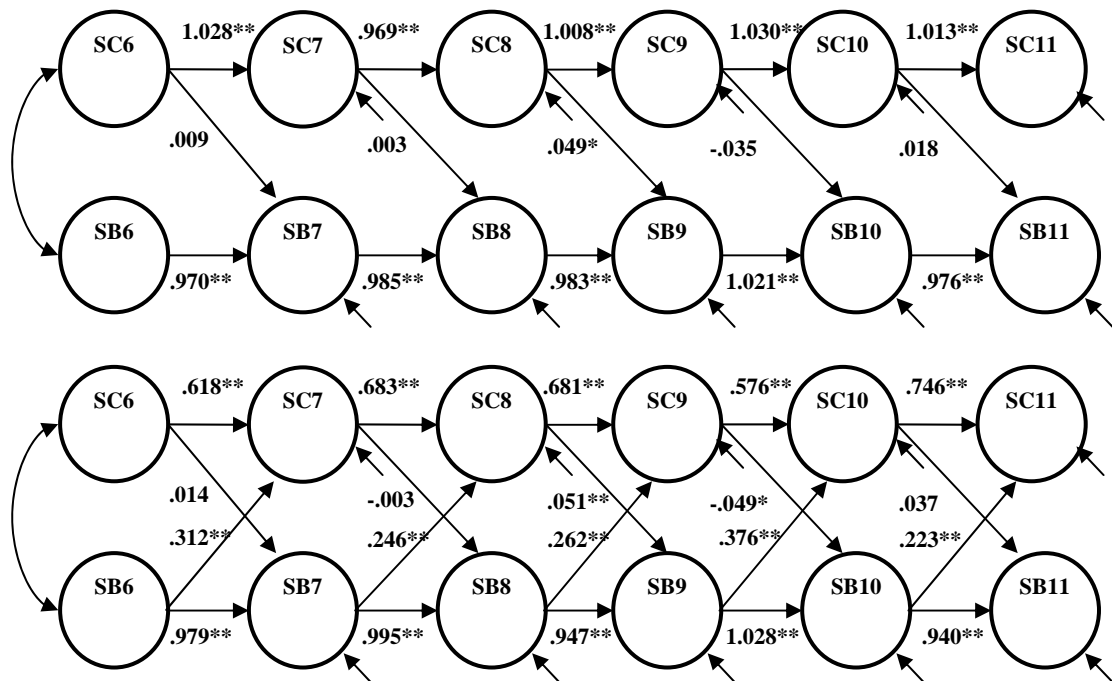** *p* < .01; * *p* < .05 (two-tailed)

Figure 18c. SEM with Longitudinal Latent Variables – with Factor Loading and Intercept constraints (Unidirectional – upper panel; Bidirectional – lower panel)
** *p* < .01; * *p* < .05 (two-tailed)

In order to further verify whether this process of bidirectional causation or pure social causation explains both stability and change of behavior within a unified theoretical framework (Sampson and Laub 2003; Caspi, Robert, and Shiner 2005), multiple-group analyses are conducted within SEM framework. The main question addressed in this multiple-group SEM is: "Do the primary parameters of interest in the bidirectional model differ across groups?" or "Does group membership moderate the relationship specified in the bidirectional model?"[73] The simplest way to address these questions is to estimate the same model within each of control and treatment groups and then compare the unstandardized parameter estimates.[74] However, more sophisticated analytic skills are available within SEM framework that performs a multiple-sample analysis and simultaneously estimates a model across two study groups using all samples. That is, the systems of equations are solved for all groups together yielding: (1) separate parameter estimates with the same values as when estimated separately but (2) data-model fit indices are calculated across both groups. Through cross-group equality tests of parameters or set of parameters, the fit of the constrained model can be compared with that of the unconstrained model with the chi-square difference statistics and corresponding degrees of freedom. Table 13 shows that, even after releasing invariance constraints of parameters of interest in the structural model, the same directional pattern

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[73] In the latent variable SEM, there are two questions that can be addressed using multi-group analyses: (1) Do the relations between factors and indicators differ across groups? (in the measurement phase) (2) Do the theoretically interesting paths among factors differ across populations? (in the structural phase). Only the results from the latter phase are presented in the following.

[74] Unstandardized instead of standardized estimates should generally be compared when the groups differ in their variabilities (Klein 2005: 289).

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of effect persists across both control and treatment groups, which supports bidirectional or even social causation model over unidirectional model. Especially, the pattern of parameter estimates observed in the all groups combined becomes more pronounced in the treatment group.[75]

Table 13. The Comparison of Unstandardized Parameter Estimates

Path	All	Control Group	Treatment Group
Self Selection			
SC6 → SB7	.014	-.006	.046
SC7 → SB8	-.003	-.011	.013
SC8 → SB9	.051**	.048	.066*
SC9 → SB10	-.049*	.012	-.183**
SC10 → SB11	.037	-.002	.130*
Social Causation			
SB6 → SC7	.312**	.266**	.365**
SB7 → SC8	.246**	.245**	.265**
SB8 → SC9	.262**	.203**	.335**
SB9 → SC10	.376**	.306**	.482**
SB10 → SC11	.223**	.220**	.249**

** $p < .01$; * $p < .05$ (two-tailed)

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[75] In the multi-group analyses, more commonly utilized strategy is to take the following sequential steps: (1) constrain all parameters of interest to be equal across groups, (2) use the modification indices or LM tests to estimate the benefit of releasing each individual equality constraint, (3) release constraints *sequentially,* each time assessing the statistical significance of the largest change in the data-model fit, and (4) when complete, parameters whose constraints where released are inferred to differ across populations whereas parameters with constraints remaining have tenable equality. In table 12, however, the unstandardized parameter estimates are presented before and after releasing equality constraint for all the directional paths of theoretical interest in order to focus mainly on the comparison of the overall pattern of relation among latent constructs across study groups.

5. Conclusion

In contrast to the Gottfredson and Hirschi's prediction that the relative ranking or observed differences of self-control between individuals or groups over different time points should remain stable over the life course (Hirschi and Gottfredson 2001: p.90), this study found evidence that suggests meaningful differences in the growth pattern of self-control among individuals in the population and especially those within different study groups. The same pattern persisted regardless of the analytic techniques applied to test the same research hypotheses, which suggests that the differences observed are not the artifact of measurement error, model specification, or statistical methods. Most of all, in sharp contrast to Gottfredson and Hirschi's stability postulate that emphasizes the population heterogeneity explanation to better account for the stability in offending, these findings are harmonious with the possibility that self-control is malleable and continues to develop being influenced by changing level of social control/bond even during the period of adolescence. Given the condition of the study design that individuals were randomly assigned to one of two study groups and only one group received treatment, which is exogenous to the initial level of self-control, such different rates of change can best be explained by the changing level of social control/bonds within-individuals triggered by treatment conditions. In addition, this study was able to better disentangle the 'long-term' relation between self- and social control variables, which is found to be more dynamic and bidirectional than previously hypothesized (e.g., distinct, independent, unidirectional) and theoretically predicted.

Practically, this study provides convincing evidence of why early prevention/intervention efforts might be cost-effective by tracking and highlighting the long-term effects of such programs, instead of merely comparing before-and-after mean scores of the outcome variable. While Sampson and Laub (1993) originally developed the concept of the "turning point," focusing primarily on the life events and experiences during the later stages of life course, this study explores whether and how some good prevention/intervention programs within the family and school settings during relatively early stages of life might also function as a "turning point" of an individual's life trajectory. At the same time, such evidence could also serve as an alternative or even more precise explanation of the causal mechanism underlying the effects of "turning points" during adulthood (e.g., marriage, job) than those proposed by Laub and Sampson (2003).

Theoretically, the observed malleable nature of self-control and the dynamic relation between internal and external inhibiting factors over time provide evidence for the "mixed" model of population heterogeneity and state dependence. While pure population heterogeneity theories assert that any change observed in the offending pattern does not result from criminal or conventional events and experiences that are exogenous to the individual propensity to offend, state dependence theories emphasize circumstances and situations that are external and temporally proximate to individuals in explaining the change. That is, the state dependence process assumes that establishing conventional relationships and commitments still has a direct impact on the probability of offending independent of the existing level of offending propensity.

This study found evidence that partially supports for the bidirectional model – the observed positive correlation between past and current delinquency might reflect a mixture of the two models. While the propensity to offend such as self-control is found to remain relatively stable over time, there still is evidence of substantial variability in its development, which is somehow explained away by the influence of the social contexts in which individuals are situated.

In particular, contrary to the pure population heterogeneity explanation that claims such time-stable propensities exert their influence (independent of settings or) by making individuals self-select into criminogenic settings that facilitate them to act in a predetermined manner, this study found weak evidence of a pure self-selection hypothesis. At the same time, contrary to the pure state dependence postulate that emphasizes the predominant roles played by life events and experiences in explaining both stability and change *without* any clear reference to the changing nature of offending propensity, this study found some strong and significant evidence that the improvement of social relationships – triggered by experimental condition and therefore independent of existing level of self-control – continues to have a direct impact on the changing level of offending propensity.

Evidence of the malleable nature of both self- and social controls that continuously develop over time by mutually reinforcing each other allows us to question the current thinking of the nature and role of control mechanisms. While scholars (including Gotffredson and Hirschi themselves) are consistent in believing that both dimensions of control are important in predicting the probability of offending behaviors, they still

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remain silent on the possible link between the two control mechanisms over a longer period of time. Drawing on the extant literature and based on the findings in this study, efforts should be made to further investigate the possibility of theoretical elaboration and modification – and eventually theoretical integration – of both control perspectives in order to better specify the control mechanism in general and in particular to better account for the stability and change of offending over time within the control perspective.

Specifically, if we assume that two distinct inhibiting factors exist inside and outside of individuals and both mechanisms play great roles in the individual's rational reasoning and decision making process, there is a strong need for the reconceptualization of both inhibiting factors as two key elements of the same control mechanism instead of setting them apart as two theoretical concepts under fundamentally different assumptions. That is, as the perceived costs and benefits of committing (negative reinforcement) and avoiding (positive reinforcement) crime and deviance become pronounced by the changing level of situational and structural factors (e.g., improvement in the relational attachment and commitment to the conventional others), individuals would become more sensitive to the costs and benefits associated with offending, which ultimately influences the more general ability to measure and calculate the costs and benefits within individuals – *slowly* but *steadily*. For example, drawing on Wikström and Treiber's (2007) notion of "executive capability" and the description of how it functions interacting with immediate and long-term contingencies, we can conceive that this process is driven by: 1) as attachment and commitment to social institutions increase, they become more salient to the individual and carry greater weight during the processes of choice. In particular, as such past experiences accumulate over time, the capacity for self-control which governs

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purposeful behaviors influenced by executive functions may also adjust to such structural and situational changes by constructing and applying different representations of environmental factors. Therefore, the general ability of self-control to govern cognitive function of incorporating information (both internal – past experiences and external – contemporary experiences) into internal representation should become more *efficient*. Therefore, differences in the executive capabilities as an individual's ability to construct and apply such representations should continue to develop because internal representations remain flexible and adaptable to changing circumstances. In particular, if we pay close attention to the original conceptualization of both control theories, the changing level of commitments and attachments as key elements of Hirschi's social bond should be logically related to changing levels of present-orientation and self-centeredness, which are key defining elements of Gottfredson and Hirschi's self-control concept[76]. That is, just like present-oriented and self-centered individuals who have a higher discount rate for future consequences are less likely to invest in the accumulation of "personal capital" such as conventional commitments (e.g., educational and occupational goals) and social relationships (e.g., emotional relationships among family, friends, teacher, and co-workers), accumulation of social capital as an exogenous factor (e.g., by chance, by receiving intervention) should also shift the individual's willingness to trade-off current versus future gratification (which is commonly referred to as the discount rate), which in turn should influence the level of present-orientation and self-

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[76] In this vein, Brownfield and Sorenson (1993) also suggested that some elements of self-control such as "the tendency to engage in long-term pursuits or relationships" or "the tendency to be indifferent or insensitive to the feeling of other people" are essentially identical to or direct carry-over from Hirschi's (1969) earlier concept of commitment or attachment.

centeredness because they are more willing to: 1) endure delayed gratification and 2)

value others more than themselves (see Nagin and Paternoster 1994: pp. 585-89 for more

details). In particular, given the relatively stable nature of both self-control and social

bonds, this process would take place continuously over time reinforcing each other in a

cumulative fashion[77]. This would present a more accurate picture of the link between two

theoretical concepts based on a dynamic interaction model than simply placing them

under a larger theoretical umbrella and focusing on the additive or conditioning effects of

one over the other. Interestingly, while Gottfredson and Hirschi are explicit in their belief

that self-control is a time-stable individual characteristic established early in life, *they do*

not argue that individuals with low self-control also lack the capacity to reason and

therefore are unresponsive to incentives. This opens the possibility that similar causal

mechanisms during the formative period of self-control may also continue to operate

during adolescence and early adulthood especially when other sources of reinforcement

are taken into account (e.g., support dimension of parenting practices, positive

reinforcement for appropriate behaviors, risk of damaging social bonds) – that become

more important during the later stages of life. This is also a plausible hypothesis

considering that Gottfredson and Hirschi's concept of self-control is the tendency to

attend principally to immediate and easy incentives and greatly discount difficult,

uncertain, and delayed consequences. In other words, as individuals come to accumulate

a greater social bond, their tendency to weigh the incentives of the moment should also

be readjusted because previously difficult, uncertain, and delayed consequences become

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[77] This is consistent with Bushway and his colleagues' (2001) notion that onset,
persistence, and desistence of offending should be viewed as "process" that triggers,
maintains, and terminates state of offending/non-offending rather than an "event" (see
also Laub and Sampson 2003).

more concrete and pronounced when they engage in reasoning process. Accordingly, they can better defer immediate and easy gratification, become less self-centered, less risk taking, and more interested in long-term planning, all of which are core elements of self-control according to Gottfredson and Hirschi's original conceptualization. In the language of behavioral economics, as individuals come to have more to lose by committing crime, they are less likely to have a high "discount rate." Since they place more value on future consequences, present-oriented individuals come to invest in a line of activity that sacrifices immediate for future gratification (especially, as their school performance improves, they are more likely to invest in human capital such as education, job training, or other activities that provide for future rather than place a greater value on the current gratification). As Laub and Sampson (2003: p.37) suggest ("although at first it may seem counterintuitive, our fundamental beginning argument is that persistence and desistance can be meaningfully understood within the same theoretical framework…"), this cumulative process can explain both stability and change of behavior within a unified theoretical framework. More convincingly, this is also consistent with current thinking within the field of psychology where it is commonly agreed that the effect of life experience on personality development is to deepen the characteristics that lead people to those experiences in the first place (Roberts et al. 2003; Roberts and Robins 2004). This process is "corresponsive" in a sense that traits that selected people into specific experiences were the same traits that changed in response to those same experiences (Caspi, Roberts, and Shiner 2005).

Contrary to pure self-selection and social-causation explanations, therefore, a re-conceptualization of the nature and role of self-control and the re-specification of its relation to the social control based on the "mixed model" would better explain the underlying mechanism of *both* direct and indirect effects of self-control and social control on offending behaviors. Under this unified theoretical constructs and propositions, the level of self-control has not only an independent impact (controlling for social control) but also has an indirect influence on the probability of crime by determining the strength of the social bond, which in turn has a direct effect on crime. Similarly, the strength of the social bond has not only an independent impact (controlling for self-control) but also has an indirect influence on crime by readjusting the level of self-control, which in turn has a direct effect on crime. Most importantly, such a dynamic relationship over time contradicts the strict notion that weak social bonds are just another manifestation of low self-control that Hirschi (2004) and Gottfredson (2006) still believe. Further efforts for theoretical sophistication and empirical assessment of the "mixed" model approach are strongly encouraged to be made in order to create a more comprehensive theoretical perspective that recognizes crime as a product not just of individual characteristics or social factors, but as a consequence of the dynamic interaction of both. Criminological theories have so far emphasized only one of these causal mechanisms at the expense of the other (Wright et al. 2001). More recent theories that attempt to incorporate both explanations have not been fully tested using rigorous data and methods.

In sum, by explicitly specifying the dynamic interaction of between population heterogeneity and state dependence variables that are based on the same control tradition

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to better explain the continuity and change in offending over time, this study adds to the current research in the field that attempts to reconcile two conflicting control perspectives under more comprehensive and dynamic model.

Limitations

This study uses a sample of high-risk youth with a relatively low level of self-control and the findings cannot be generalized to a general population. Because those with low self-control have more 'room to change' through an intervention program, a high-risk sample provides more robust findings by increasing the observed effect size. Practically, limited resources should target selective individuals and areas where crime is most like to be committed. The biggest limitation, however, is the lack of the external validity when applied to a general population. Considering that statistical power is a function of not only the effect size but also sample size, a large sample drawn from a more representative population could also produce robust findings retaining the external validity at the same time. The availability of such a more 'general' sample with relatively large sample size would also allow for the cross-validation of the findings using alternative analytical techniques such as GBTM (Nagin 2005) and GMM (Muthén 2001). In this vein, while HLM and LGM approaches aim to identify the factors that account for individual variability about the population's mean developmental trajectory, a group-based approach could be more appropriate than standard growth curve modeling considering that it makes little sense to assume that everyone within the treatment group would respond to the experimental conditions in a similar way. In other words, treatment programs may have a greater impact on some individuals (e.g., those with lower initial level of self-control) but

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have no meaningful impact on most individuals within the same treatment group. In this scenario, it makes little sense to frame a statistical analysis of population differences in the developmental pattern of self-control in terms of variation about the mean trajectory because this might mask or underestimate the meaningful effect of treatment programs that alter the developmental trajectories of specific subgroups within the same treatment group. In sum, while this study uses a relatively homogeneous sample and assumes that the average causal effect of the intervention program is the same for all members within the treatment group, this constant effects assumption might not hold with a possibility of treatment effect heterogeneity.

This study does not provide any evidence that the same results could be replicated in a more general population. Theoretically, Gottfredson and Hirschi's prediction might actually be true when tested based on a well-representative population because such interventions could have negligible impact on the rest of the population (e.g., lower risk youths) and accordingly the average changes in the relative ranking or distance in the level of self-control observed from the general population might be minimal. Indeed, Gottfredson and Hirschi's theory was developed based on the empirical regularities observed from a general population across different time and places. It is therefore claimed to be a "general theory" and key theoretical concepts and propositions should be tested against general population, not on the specific segment of the population.

The base measurement model (longitudinal CFA) could not be optimally specified prior to more complex analyses (second-order LGM, longitudinal SEM) because the five subscales of self-control used in this study had already been created by JHU PIRC and actual items that comprise those subscales were not available. That is, because key

measures were not collected or created originally to fulfill the goals of this study, a substantial amount of exploratory work was required to build a theoretically and empirically relevant measurement model. Most of all, such five subscales of self-control do not seem to measure each of defining elements of trait-like self-control. Accordingly, while the final longitudinal CFA model suggests a reasonable data-model fit, it still failed to reach the conventional cutoff criteria and accordingly there still is a possibility of model misspecification. In other words, CFA for construct validation could not provide compelling evidence of the convergent and discriminant validity of the theoretical construct of self-control. While strong convergent validity was indicated by the evidence that different subscales of self-control (level-1 factor) are strongly interrelated and load on the same factor (level-2 factor), either convergent or (especially) discriminant validity could not be assessed at the indicator level (e.g., discriminant validity – whether the actual indicators that constitute theoretically distinct subscales of self-control (level 1 factor) are not highly intercorrelated and load solely on the subscales they purport to measure[78]). In addition, because the subscales of self-control were created using a different number and type of indicators between the period of 1-3 and 6-12, the self-control scores across two time periods are not comparable. While it is possible to employ second-order LGM even when the same indicators are not available for all time points (see Hancock and Buehl 2008 for detail), there should at least exist a common set of indicators across different time points with the evidence of strong factorial invariance to give construct s a common identity and thus be able to model growth therein.

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[78] In fact, "concentration and helpless" and "impulsivity and hyperactivity" are measuring some combination of almost same defining elements of self-control (see appendix 1.1), and therefore are highly correlated to each other (see appendix 3).

The original sample size of 448 was reduced to 399 after removing 49 cases with missing on all variables from grade 6 to 12. In addition, while maximum likelihood techniques for missing data in both HLM and second-order LGM can incorporate all participants who have been observed at least once and the results can be interpreted as if no missing data were present, the tenability of such assumption cannot be verified in the current data. While it is almost impossible to collect complete observations of multiple time points within the longitudinal panel design, "complete data" can be reasonably assumed only when different number of time points per individual results from 'missing at random.'

Appendix 1: Subscale Items

1.1 Self-Control (measured by teacher)

Impulsivity (measuring "impulsivity," "self-centered")
  1. waits for turn
  2. interrupts or intrude on others*
  3. blurted out answer before question was complete*

Hyperactivity (measuring "physical," "risk seeking")
  1. can't sit still*
  2. fidgeted and/or squirmed a lot*
  3. always on the go/driven by a motor*

Concentration Problems (measuring "impulsivity," "simple task")
  1. completed assignment
  2. concentrates
  3. stayed on task
  4. easily distracted*
  5. had difficulty organizing tasks and activities*

Oppositional-Defiant Behavior (measuring "self-centered," "temper")
  1. accepted responsibility for actions
  2. disobey teachers and other adults*
  3. talked back to teachers and other adults*
  4. broke rules*

Helpless Achievement Behaviors (measuring "impulsivity," "simple task")
  1. tried to finish assignments, even when they were difficult
  2. worked to overcome obstacles in his/her schoolwork
  3. became discouraged after encountering an obstacle in his/her schoolwork*
  4. said things like I can not do it when she/he had trouble with school work*

Note: The subscales are created by taking the means of corresponding items. The scores are recoded (* = reverse coded) so that higher values reflect more self-control.

* Chronbach-alpha (teacher scales)

	G6	G7	G8	G9	G10	G11	G12
Impulsivity	.81	.78	.78	.73	.78	.65	.70
Hyperactivity	.86	.88	.83	.83	.85	.78	.76
Concentration	.93	.93	.92	.92	.91	.91	.90
Oppositional	.93	.93	.90	.90	.89	.87	.87
Helpless	.83	.85	.86	.86	.85	.85	.84

1.2 Social Control/Bonds (measured by parent)

Monitoring
  1. talk with child about what child did in day
  2. talk with child about next day
  3. how often can child get in touch with parent
  4. child out after dark without adult*

Punishment
  1. how often child talk out of discipline*
  2. how often punish child for misbehaving
  3. child get out of punishment by whining*
  4. how often child get away with things*
  5. child get out of things by whining*

Attachment
  1. child goes out of way to please
  2. difficulty being patient with child*
  3. how pleasant raising child
  4. how well do you get along with child

Involvement
  1. how often take child to fun activity
  2. how often - fun activity at home with child
  3. how often attend child's activity

Support
  1. go over child's homework
  2. discuss child's schoolwork

Note: The subscales are created by taking the mean of corresponding items. The scores are recoded (* = reverse coded) so that higher values reflect more social control/bond.

* Chronbach-alpha (parent scale)

	G6	G7	G8	G9	G10	G11
Monitoring	.37	.25	.33	.49	.58	.58
Punishment	.77	.77	.79	.78	.78	.78
Attachment	.69	.70	.73	.78	.78	.85
Involvement	.51	.52	.49	.56	.59	.38
Support	.50	.53	.54	.56	.62	.71

Appendix 2: Descriptive Statistics

2.1 Self-Control (teacher)

	N	Minimum	Maximum	Mean	Std. Deviation	Factor Loading
Impulsivity_6	339	.25	5.00	3.6490	1.05279	.852
Hyperactivity_6	339	.17	5.00	3.7878	1.07355	.843
Concentration_6	339	.00	5.00	2.9704	1.15467	.862
Oppositional_6	339	.00	5.00	3.6622	1.12621	.906
Helpless_6	339	.50	5.00	3.0610	1.03355	.853
Impulsivity_7	340	.50	5.00	3.8050	1.00590	.846
Hyperactivity_7	340	.33	5.00	3.8733	.98101	.821
Concentration_7	340	.40	5.00	3.0169	1.08259	.849
Oppositional_7	340	.50	5.00	3.7213	1.07652	.889
Helpless_7	340	.25	5.00	3.1218	.99986	.848
Impulsivityl_8	348	.00	5.00	3.7340	1.05955	.829
Hyperactivity_8	348	.00	5.00	3.8356	1.01419	.831
Concentration_8	348	.20	5.00	3.0243	1.12702	.871
Oppositional_8	348	.33	5.00	3.7021	1.05978	.865
Helpless_8	348	.50	5.00	3.1136	1.02635	.843
Impulsivity_9	329	.00	5.00	3.8343	.99627	.796
Hyperactivity_9	329	.33	5.00	3.9316	.98197	.828
Concentration_9	329	.00	5.00	2.9501	1.12749	.853
Oppositional_9	329	.00	5.00	3.7439	1.10678	.886
Helpless_9	329	.00	5.00	3.0210	1.06325	.828
Impulsivity_10	308	.50	5.00	4.0140	.97287	.787
Hyperactivity_10	308	.00	5.00	3.9905	.95015	.780
Concentration_10	308	.60	5.00	2.9501	1.02814	.832
Oppositional_10	308	.67	5.00	3.9624	.94766	.878
Helpless_10	308	.00	5.00	3.1078	.96032	.791
Impulsivity_11	259	1.25	5.00	4.1745	.82857	.764
Hyperactivity_11	258	1.00	5.00	4.0846	.84389	.759
Concentration_11	260	.40	5.00	3.0663	1.04929	.848
Oppositional_11	259	.50	5.00	3.9748	.95550	.882
Helpless_11	260	.25	5.00	3.1391	1.02034	.802
Impulsivity_12	289	1.25	5.00	4.2422	.80412	.789
Hyperactivity_12	289	.00	5.00	4.1012	.84649	.786
Concentration_12	289	.00	5.00	3.1961	1.07707	.850
Oppositional_12	289	.00	5.00	4.1203	.88108	.892
Helpless_12	289	.00	5.00	3.3636	1.00063	.830

2.2 Social control/bond (parent)

	N	Minimum	Maximum	Mean	Std. Deviation	Factor Loading
Monitoring_6	342	2.50	5.00	4.7429	.45250	.574
Punishment_6	342	1.20	5.00	3.9096	.73853	.503
Attachment_6	342	2.00	5.00	3.9639	.60218	.644
Involvement_6	342	1.00	5.00	3.3582	.90676	.734
Support_6	342	1.00	5.00	4.6681	.69998	.499
Monitoring_7	354	2.50	5.00	4.6412	.45572	.657
Punishment_7	354	1.20	5.00	3.9270	.71242	.523
Attachment_7	354	2.00	4.75	3.6900	.41898	.569
Involvement_7	354	1.00	5.00	3.4256	.86341	.675
Support_7	353	1.00	5.00	4.5368	.85284	.626
Monitoring_8	356	2.00	5.00	4.5829	.48660	.652
Punishment_8	356	1.80	5.00	3.8572	.76701	.635
Attachment_8	356	2.00	4.75	3.6566	.42362	.592
Involvement_8	356	1.00	5.00	3.4059	.86469	.666
Support_8	356	1.00	5.00	4.4438	.89581	.583
Monitoring_9	349	2.25	5.00	4.6870	.48353	.730
Punishment_9	348	1.00	5.00	3.8866	.79438	.541
Attachment_9	349	2.00	5.00	3.6160	.47886	.713
Involvement_9	349	1.00	5.00	3.2221	.91886	.643
Support_9	346	1.00	5.00	4.2110	1.05170	.533
Monitoring_10	320	2.00	5.00	4.6534	.53445	.772
Punishment_10	319	1.40	5.00	3.9292	.75665	.328
Attachment_10	318	2.25	4.75	3.6305	.38997	.572
Involvement_10	319	1.00	5.00	3.1317	.92489	.764
Support_10	315	1.00	5.00	3.7825	1.30207	.685
Monitoring_11	319	2.00	5.00	4.6204	.55708	.708
Punishment_11	319	1.60	5.00	3.8596	.74792	.489
Attachment_11	319	1.00	4.75	3.1520	.79454	.069
Involvement_11	319	1.00	5.00	2.9326	.83578	.532
Support_11	316	1.00	5.00	3.4873	1.41416	.692

2.3 Self-Control (composite scale)

	N	Minimum	Maximum	Mean	Std. Deviation
self-control_6	339	.53	4.97	3.4261	.93981
self-control_7	340	.83	5.00	3.5077	.87617
self-control_8	348	.82	5.00	3.4819	.89670
self-control_9	329	.63	4.97	3.4962	.88585
self-control_10	308	1.01	5.00	3.6049	.79090
self-control_11	260	1.45	5.00	3.6806	.77691
self-control_12	289	.50	5.00	3.8047	.76703

2.4 Social Control/Bond (composite scale)

	N	Minimum	Maximum	Mean	Std. Deviation
social control_6	342	2.76	4.88	4.1286	.41046
social control_7	354	2.77	4.90	4.0436	.41154
social control_8	356	2.22	4.85	3.9893	.43856
social control_9	349	2.21	4.96	3.9225	.47536
social control_10	320	2.17	4.70	3.8280	.51412
social control_11	319	2.29	4.83	3.6098	.48178

2.5 Delinquency (composite scale)

	N	Minimum	Maximum	Mean	Std. Deviation
Delinquency6	339	1.00	5.00	1.5860	.67384
Delinquency7	340	1.00	4.21	1.5133	.56182
Delinquency8	348	1.00	4.07	1.5666	.60129
Delinquency9	329	1.00	4.71	1.5155	.60049
Delinquency10	308	1.00	4.00	1.4604	.53096
Delinquency11	260	1.00	4.21	1.4506	.51233
Delinquency12	289	1.00	4.36	1.4182	.46590

Appendix 3: Correlation Matrix

3.1 Grade 6

Correlation	1	2	3	4	5	6	7	8	9	10
1. Impulsivity	1									
2. Hyperactivity	.799**	1								
3. Concentration	.534**	.593**	1							
4. Oppositional	.785**	.719**	.699**	1						
5. Helpless	.561**	.534**	.892**	.697**	1					
6. Monitoring	.037	.037	.126*	.065	.115*	1				
7. Punishment	.053	-.004	.114*	.053	.123*	.152**	1			
8. Attachment	.243**	.257**	.217**	.222**	.182**	.149**	.237**	1		
9. Involvement	.089	.143**	.162**	.134*	.121*	.233**	.199**	.333**	1	
10. Support	-.011	.039	.020	-.013	-.006	.216**	.017	.112*	.255**	1

Note: Pairwise deletion of missing cases. Number of cases for correlations ranges from 329 to 354. ** $p < .01$; * $p < .05$ (two-tailed)

3.2 Grade 7

Correlation	1	2	3	4	5	6	7	8	9	10
1. Impulsivity	1									
2. Hyperactivity	.815**	1								
3. Concentration	.512**	.532**	1							
4. Oppositional	.762**	.663**	.657**	1						
5. Helpless	.513**	.497**	.907**	.688**	1					
6. Monitoring	.039	.112*	.105	.122*	.070	1				
7. Punishment	-.044	.021	.110*	.086	.163**	.227**	1			
8. Attachment	.100	.122*	.103	.148**	.108	.168**	.242**	1		
9. Involvement	-.051	-.050	.125*	.090	.127*	.291**	.177**	.199**	1	
10. Support	.036	.007	.065	.084	.081	.267**	.086	.207**	.312**	1

Note: Pairwise deletion of missing cases. Number of cases for correlations ranges from 329 to 354. ** $p < .01$; * $p < .05$ (two-tailed)

3.3 Grade 8

Correlation	1	2	3	4	5	6	7	8	9	10
1. Impulsivity	1									
2. Hyperactivity	.777**	1								
3. Concentration	.520**	.587**	1							
4. Oppositional	.734**	.646**	.654**	1						
5. Helpless	.493**	.525**	.918**	.626**	1					
6. Monitoring	.064	.064	.064	.099	.030	1				
7. Punishment	.122*	.093	.117*	.164**	.106	.317**	1			
8. Attachment	.175**	.117*	.115*	.194**	.111*	.249**	.327**	1		
9. Involvement	.114*	.116*	.205**	.129*	.180**	.205**	.219**	.219**	1	
10. Support	.033	.053	.074	.015	.050	.246**	.113*	.095	.411**	1

Note: Pairwise deletion of missing cases. Number of cases for correlations ranges from 337 to 356. ** $p < .01$; * $p < .05$ (two-tailed)

3.4 Grade 9

Correlation	1	2	3	4	5	6	7	8	9	10
1. Impulsivity	1									
2. Hyperactivity	.780**	1								
3. Concentration	.449**	.524**	1							
4. Oppositional	.703**	.685**	.680**	1						
5. Helpless	.427**	.495**	.910**	.630**	1					
6. Monitoring	.118*	.149**	.186**	.240**	.175**	1				
7. Punishment	.104	.063	.144*	.182**	.156**	.244**	1			
8. Attachment	.232**	.256**	.159**	.249**	.150**	.347**	.340**	1		
9. Involvement	.093	.089	.227**	.222**	.232**	.354**	.158**	.327**	1	
10. Support	-.012	.017	.029	.028	-.037	.311**	.124*	.178**	.198**	1

Note: Pairwise deletion of missing cases. Number of cases for correlations ranges from 311 to 346. ** $p < .01$; * $p < .05$ (two-tailed)

3.5 Grade 10

Correlation	1	2	3	4	5	6	7	8	9	10
1. Impulsivity	1									
2. Hyperactivity	.756**	1								
3. Concentration	.424**	.445**	1							
4. Oppositional	.677**	.640**	.623**	1						
5. Helpless	.362**	.353**	.883**	.613**	1					
6. Monitoring	.053	.057	.144*	.119*	.123*	1				
7. Punishment	.079	.091	.176**	.162**	.178**	.179**	1			
8. Attachment	.048	.079	.127*	.118	.080	.268**	.122*	1		
9. Involvement	-.022	.034	.149*	.047	.110	.453**	.165**	.307**	1	
10. Support	-.025	-.009	.004	-.019	-.028	.417**	.045	.209**	.378**	1

Note: Pairwise deletion of missing cases. Number of cases for correlations ranges from 274 to 319. ** $p < .01$; * $p < .05$ (two-tailed)

3.6 Grade 11

Correlation	1	2	3	4	5	6	7	8	9	10
1. Impulsivity	1									
2. Hyperactivity	.675**	1								
3. Concentration	.424**	.465**	1							
4. Oppositional	.666**	.622**	.654**	1						
5. Helpless	.385**	.356**	.874**	.619**	1					
6. Monitoring	-.100	.035	.217**	-.008	.150*	1				
7. Punishment	-.004	-.006	.134*	.002	.123	.137*	1			
8. Attachment	.022	.106	.081	.069	.084	.000	-.031	1		
9. Involvement	.020	.004	.178**	.082	.089	.154**	.157**	.092	1	
10. Support	-.096	-.051	.030	-.063	.020	.321**	.116*	.007	.127*	1

Note: Pairwise deletion of missing cases. Number of cases for correlations ranges from 232 to 319. ** $p < .01$; * $p < .05$ (two-tailed)

Appendix 4: Missing Data

4.1 Self-Control (composite scale)

	N	Intervention Condition		Race		Gender	
		n1 control (%)	n2 treatment (%)	n1 black (%)	n2 white (%)	n1 male (%)	n2 female (%)
Self-control_1	448	219 (48.9)	229 (51.1)	389 (86.8)	59 (13.2)	237 (53.0)	211 (47.0)
Self-control_6	339	161 (47.5)	178 (52.5)	294 (86.7)	45 (13.3)	180 (53.1)	159 (46.9)
Self-control_7	340	160 (47.1)	180 (52.9)	297 (87.4)	43 (12.6)	182 (53.5)	153 (46.5)
Self-control_8	348	165 (47.4)	183 (52.6)	303 (87.1)	45 (12.9)	185 (53.2)	163 (46.8)
Self-control_9	329	159 (48.3)	170 (51.7)	287 (87.2)	42 (12.8)	174 (52.9)	155 (47.1)
Self-control_10	308	148 (48.1)	160 (51.9)	267 (86.7)	41 (13.3)	165 (53.6)	143 (46.4)
Self-control_11	260	128 (49.6)	130 (50.4)	229 (88.1)	45 (11.9)	131 (50.4)	129 (49.6)
Self-control_12	289	140 (48.4)	149 (51.6)	254 (87.9)	35 (12.1)	146 (50.5)	143 (49.5)

4.2 Social Control/Bond (composite scale)

	N	Intervention Condition		Race		Gender	
		n1 control (%)	n2 treatment (%)	n1 black (%)	n2 white (%)	n1 male (%)	n2 female (%)
Social control_1	448	219 (48.9)	229 (51.1)	389 (86.8)	59 (13.2)	237 (53.0)	211 (47.0)
Social control_6	342	164 (48.0)	178 (52.0)	295 (86.3)	47 (13.7)	181 (52.9)	161 (47.1)
Social control_7	354	169 (48.0)	184 (52.0)	305 (86.2)	49 (13.8)	188 (53.1)	166 (46.9)
Social control_8	356	174 (48.9)	182 (51.1)	307 (86.2)	49 (13.8)	193 (54.2)	163 (45.8)
Social control_9	349	168 (49.3)	177 (50.7)	300 (86.0)	49 (14.0)	190 (54.4)	159 (45.6)
Social control_10	320	155 (49.8)	158 (50.2)	271 (84.7)	49 (15.3)	175 (54.7)	145 (45.3)
Social control_11	319	153 (48.9)	163 (51.1)	274 (85.9)	45 (14.1)	174 (54.5)	145 (45.5)

4.3 Delinquency (composite scale)

	N	Intervention Condition		Race		Gender	
		n1 control (%)	n2 treatment (%)	n1 black (%)	n2 white (%)	n1 male (%)	n2 female (%)
Delinquency6	339	161 (47.5)	178 (52.5)	294 (86.7)	45 (13.3)	180 (53.1)	159 (46.9)
Delinquency7	340	160 (47.1)	180 (52.9)	297 (87.4)	43 (12.6)	182 (53.5)	153 (46.5)
Delinquency8	348	165 (47.4)	183 (52.6)	303 (87.1)	45 (12.9)	185 (53.2)	163 (46.8)
Delinquency9	329	159 (48.3)	170 (51.7)	287 (87.2)	42 (12.8)	174 (52.9)	155 (47.1)
Delinquency10	308	148 (48.1)	160 (51.9)	267 (86.7)	41 (13.3)	165 (53.6)	143 (46.4)
Delinquency11	260	128 (49.6)	130 (50.4)	229 (88.1)	45 (11.9)	131 (50.4)	129 (49.6)
Delinquency12	289	140 (48.4)	149 (51.6)	254 (87.9)	35 (12.1)	146 (50.5)	143 (49.5)

Appendix 5: Mplus Code

5.1 Second-order LGM with mean structure

DATA: FILE IS SC-1.dat;

VARIABLE: NAMES ARE
    im1 hy1 co1 op1 he1 im2 hy2 co2 op2 he2 im3 hy3 co3 op3 he3
    im4 hy4 co4 op4 he4 im5 hy5 co5 op5 he5 im6 hy6 co6 op6 he6
    im7 hy7 co7 op7 he7 trt;
USEVARIABLES ARE
    im1 hy1 co1 op1 he1 im2 hy2 co2 op2 he2 im3 hy3 co3 op3 he3
    im4 hy4 co4 op4 he4 im5 hy5 co5 op5 he5 im6 hy6 co6 op6 he6
    im7 hy7 co7 op7 he7;
MISSING ARE ALL (-99);

ANALYSIS: ESTIMATOR = ML;
        ITERATIONS = 10000;
        SDITERATIONS = 500;
        H1ITERATIONS = 10000;
        CONVERGENCE = .001;
        H1CONVERGENCE = .001;

MODEL:
t1 BY im1@1
    hy1*(1)
    co1*(2)
    op1*(3)
    he1*(4);
t2 BY im2@1
    hy2*(1)
    co2*(2)
    op2*(3)
    he2*(4);
t3 BY im3@1
    hy3*(1)
    co3*(2)
    op3*(3)
    he3*(4);
t4 BY im4@1
    hy4*(1)
    co4*(2)
    op4*(3)
    he4*(4);
t5 BY im5@1

```
        hy5*(1)
        co5*(2)
        op5*(3)
        he5*(4);
t6 BY im6@1
        hy6*(1)
        co6*(2)
        op6*(3)
        he6*(4);
t7 BY im7@1
        hy7*(1)
        co7*(2)
        op7*(3)
        he7*(4);
im1-he7*;

 im1 WITH im2;
 im1 WITH im3;
 im1 WITH im4;
 im1 WITH im5;
 im1 WITH im6;
 im1 WITH im7;
 im2 WITH im3;
 im2 WITH im4;
 im2 WITH im5;
 im2 WITH im6;
 im2 WITH im7;
 im3 WITH im4;
 im3 WITH im5;
 im3 WITH im6;
 im3 WITH im7;
 im4 WITH im5;
 im4 WITH im6;
 im4 WITH im7;
 im5 WITH im6;
 im5 WITH im7;
 im6 WITH im7;

 hy1 WITH hy2;
 hy1 WITH hy3;
 hy1 WITH hy4;
 hy1 WITH hy5;
 hy1 WITH hy6;
 hy1 WITH hy7;
 hy2 WITH hy3;
 hy2 WITH hy4;
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hy2 WITH hy5;
hy2 WITH hy6;
hy2 WITH hy7;
hy3 WITH hy4;
hy3 WITH hy5;
hy3 WITH hy6;
hy3 WITH hy7;
hy4 WITH hy5;
hy4 WITH hy6;
hy4 WITH hy7;
hy5 WITH hy6;
hy5 WITH hy7;
hy6 WITH hy7;

co1 WITH co2;
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co5 WITH co7;
co6 WITH co7;

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op1 WITH op4;
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op1 WITH op6;
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op2 WITH op3;
op2 WITH op4;
op2 WITH op5;
op2 WITH op6;

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op3 WITH op7;
op4 WITH op5;
op4 WITH op6;
op4 WITH op7;
op5 WITH op6;
op5 WITH op7;
op6 WITH op7;

he1 WITH he2;
he1 WITH he3;
he1 WITH he4;
he1 WITH he5;
he1 WITH he6;
he1 WITH he7;
he2 WITH he3;
he2 WITH he4;
he2 WITH he5;
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he2 WITH he7;
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he3 WITH he6;
he3 WITH he7;
he4 WITH he5;
he4 WITH he6;
he4 WITH he7;
he5 WITH he6;
he5 WITH he7;
he6 WITH he7;

co1 WITH he1;
co2 WITH he2;
co3 WITH he3;
co4 WITH he4;
co5 WITH he5;
co6 WITH he6;
co7 WITH he7;

im1 WITH hy1;
im2 WITH hy2;
im3 WITH hy3;
im4 WITH hy4;

im5 WITH hy5;
im6 WITH hy6;
im7 WITH hy7;

[im1@0, im2@0, im3@0, im4@0, im5@0, im6@0, im7@0];
[hy1* hy2* hy3* hy4* hy5* hy6* hy7*] (5);
[co1* co2* co3* co4* co5* co6* co7*] (6);
[op1* op2* op3* op4* op5* op6* op7*] (7);
[he1* he2* he3* he4* he5* he6* he7*] (8);

b0 BY t1-t7@1;
b1 BY t1@0 t2@1 t3@2 t4@3 t5@4 t6@5 t7@6;
t1-t7*;
[b0*];
[b1*];
[t1-t7@0];

OUTPUT: SAMPSTAT;
MODINDICES (ALL);

5.2 Second-order LGM with time-invariant covariate

(For the measurement model, the same Mplus codes as in 4.1 are used)

b0 BY t1-t7@1;
b1 BY t1@0 t2@1 t3@2 t4@3 t5@4 t6@5 t7@6;
b0 ON trt;
b1 ON trt;
t1-t7*;
[b0*];
[b1*];
[t1-t7@0];

OUTPUT: SAMPSTAT;
MODINDICES (ALL);

5.3 Second-order LGM with time-invariant and time-variant covariates

DATA: FILE IS ALL.dat;

VARIABLE: NAMES ARE
    im1 hy1 co1 op1 he1 im2 hy2 co2 op2 he2 im3 hy3 co3 op3 he3
    im4 hy4 co4 op4 he4 im5 hy5 co5 op5 he5 im6 hy6 co6 op6 he6
    im7 hy7 co7 op7 he7
    m1 p1 a1 i1 s1 m2 p2 a2 i2 s2 m3 p3 a3 i3 s3
    m4 p4 a4 i4 s4 m5 p5 a5 i5 s5 m6 p6 a6 i6 s6
    trt;
USEVARIABLES ARE
    im1 hy1 co1 op1 he1 im2 hy2 co2 op2 he2 im3 hy3 co3 op3 he3
    im4 hy4 co4 op4 he4 im5 hy5 co5 op5 he5 im6 hy6 co6 op6 he6
    m1 p1 a1 i1 s1 m2 p2 a2 i2 s2 m3 p3 a3 i3 s3
    m4 p4 a4 i4 s4 m5 p5 a5 i5 s5 m6 p6 a6 i6 s6
    trt;
MISSING ARE ALL (-99);

ANALYSIS: ESTIMATOR = ML;
        ITERATIONS = 10000;
        SDITERATIONS = 500;
        H1ITERATIONS = 10000;
        CONVERGENCE = .001;
        H1CONVERGENCE = .001;

MODEL:

sc1 BY im1@1
    hy1*(1)
    co1*(2)
    op1*(3)
    he1*(4);
sc2 BY im2@1
    hy2*(1)
    co2*(2)
    op2*(3)
    he2*(4);
sc3 BY im3@1
    hy3*(1)
    co3*(2)
    op3*(3)
    he3*(4);
sc4 BY im4@1
    hy4*(1)
    co4*(2)

```
        op4*(3)
        he4*(4);
    sc5 BY im5@1
        hy5*(1)
        co5*(2)
        op5*(3)
        he5*(4);
    sc6 BY im6@1
        hy6*(1)
        co6*(2)
        op6*(3)
        he6*(4);

im1-he6*;

  im1 WITH im2;
  im1 WITH im3;
  im1 WITH im4;
  im1 WITH im5;
  im1 WITH im6;
  im2 WITH im3;
  im2 WITH im4;
  im2 WITH im5;
  im2 WITH im6;
  im3 WITH im4;
  im3 WITH im5;
  im3 WITH im6;
  im4 WITH im5;
  im4 WITH im6;
  im5 WITH im6;

  hy1 WITH hy2;
  hy1 WITH hy3;
  hy1 WITH hy4;
  hy1 WITH hy5;
  hy1 WITH hy6;
  hy2 WITH hy3;
  hy2 WITH hy4;
  hy2 WITH hy5;
  hy2 WITH hy6;
  hy3 WITH hy4;
  hy3 WITH hy5;
  hy3 WITH hy6;
  hy4 WITH hy5;
  hy4 WITH hy6;
  hy5 WITH hy6;
```

co1 WITH co2;
co1 WITH co3;
co1 WITH co4;
co1 WITH co5;
co1 WITH co6;
co2 WITH co3;
co2 WITH co4;
co2 WITH co5;
co2 WITH co6;
co3 WITH co4;
co3 WITH co5;
co3 WITH co6;
co4 WITH co5;
co4 WITH co6;
co5 WITH co6;

op1 WITH op2;
op1 WITH op3;
op1 WITH op4;
op1 WITH op5;
op1 WITH op6;
op2 WITH op3;
op2 WITH op4;
op2 WITH op5;
op2 WITH op6;
op3 WITH op4;
op3 WITH op5;
op3 WITH op6;
op4 WITH op5;
op4 WITH op6;
op5 WITH op6;

he1 WITH he2;
he1 WITH he3;
he1 WITH he4;
he1 WITH he5;
he1 WITH he6;
he2 WITH he3;
he2 WITH he4;
he2 WITH he5;
he2 WITH he6;
he3 WITH he4;
he3 WITH he5;
he3 WITH he6;
he4 WITH he5;

he4 WITH he6;
he5 WITH he6;

co1 WITH he1;
co2 WITH he2;
co3 WITH he3;
co4 WITH he4;
co5 WITH he5;
co6 WITH he6;

im1 WITH hy1;
im2 WITH hy2;
im3 WITH hy3;
im4 WITH hy4;
im5 WITH hy5;
im6 WITH hy6;

[im1@0, im2@0, im3@0, im4@0, im5@0, im6@0];
[hy1* hy2* hy3* hy4* hy5* hy6*] (5);
[co1* co2* co3* co4* co5* co6*] (6);
[op1* op2* op3* op4* op5* op6*] (7);
[he1* he2* he3* he4* he5* he6*] (8);

sb1 BY m1@1
    p1*(9)
    a1*(10)
    i1*(11)
    s1*(12);
sb2 BY m2@1
    p2*(9)
    a2*(10)
    i2*(11)
    s2*(12);
sb3 BY m3@1
    p3*(9)
    a3*(10)
    i3*(11)
    s3*(12);
sb4 BY m4@1
    p4*(9)
    a4*(10)
    i4*(11)
    s4*(12);
sb5 BY m5@1
    p5*(9)
    a5*(10)

```
    i5*(11)
    s5*(12);
sb6 BY m6@1
    p6*(9)
    a6*(10)
    i6*(11)
    s6*(12);
m1-s6*;

m1 WITH m2;
m1 WITH m3;
m1 WITH m4;
m1 WITH m5;
m1 WITH m6;
m2 WITH m3;
m2 WITH m4;
m2 WITH m5;
m2 WITH m6;
m3 WITH m4;
m3 WITH m5;
m3 WITH m6;
m4 WITH m5;
m4 WITH m6;
m5 WITH m6;

p1 WITH p2;
p1 WITH p3;
p1 WITH p4;
p1 WITH p5;
p1 WITH p6;
p2 WITH p3;
p2 WITH p4;
p2 WITH p5;
p2 WITH p6;
p3 WITH p4;
p3 WITH p5;
p3 WITH p6;
p4 WITH p5;
p4 WITH p6;
p5 WITH p6;

a1 WITH a2;
a1 WITH a3;
a1 WITH a4;
a1 WITH a5;
a1 WITH a6;
```

a2 WITH a3;
a2 WITH a4;
a2 WITH a5;
a2 WITH a6;
a3 WITH a4;
a3 WITH a5;
a3 WITH a6;
a4 WITH a5;
a4 WITH a6;
a5 WITH a6;

i1 WITH i2;
i1 WITH i3;
i1 WITH i4;
i1 WITH i5;
i1 WITH i6;
i2 WITH i3;
i2 WITH i4;
i2 WITH i5;
i2 WITH i6;
i3 WITH i4;
i3 WITH i5;
i3 WITH i6;
i4 WITH i5;
i4 WITH i6;
i5 WITH i6;

s1 WITH s2;
s1 WITH s3;
s1 WITH s4;
s1 WITH s5;
s1 WITH s6;
s2 WITH s3;
s2 WITH s4;
s2 WITH s5;
s2 WITH s6;
s3 WITH s4;
s3 WITH s5;
s3 WITH s6;
s4 WITH s5;
s4 WITH s6;
s5 WITH s6;

[m1* m2* m3* m4* m5* m6*] (13);
[p1* p2* p3* p4* p5* p6*] (14);
[a1* a2* a3* a4* a5* a6*] (15);

[i1* i2* i3* i4* i5* i6*] (16);
[s1* s2* s3* s4* s5* s6*] (17);

b0 BY sc1-sc6@1;
b1 BY sc1@0 sc2@1 sc3@2 sc4@3 sc5@4 sc6@5;
b0 ON trt;
b1 ON trt;
sc1-sb6*;
[b0*];
[b1*];
[sc1-sb6@0];

sc1 ON sb1;
sc2 ON sb2;
sc3 ON sb3;
sc4 ON sb4;
sc5 ON sb5;
sc6 ON sb6;

OUTPUT: SAMPSTAT;
MODINDICES (ALL);

5.4 SEM with longitudinal latent variables

(For the measurement model, the same Mplus codes as in 4.3 are used)

 sc1-sb6*;
[sc1*];
[sc2-sc6@0];
[sb1*];
[sb2-sb6@0];

sc2 ON sc1 sb1;
sb2 ON sc1 sb1;
sc3 ON sc2 sb2;
sb3 ON sc2 sb2;
sc4 ON sc3 sb3;
sb4 ON sc3 sb3;
sc5 ON sc4 sb4;
sb5 ON sc4 sb4;
sc6 ON sc5 sb5;
sb6 ON sc5 sb5;

OUTPUT: SAMPSTAT;
MODINDICES (ALL);

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