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Linking Specialization and Seriousness in Criminal Careers

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Abstract

Some research suggests that recidivistic criminal offending patterns typically progress in a stepping-stone manner from less to more serious forms of offending from childhood to adolescence to adulthood. Whether the progression into more serious types of offending reflects patterns of crime specialization is a matter of debate. Using data from 449 adolescent offenders who were interviewed at six time points between adolescence and adulthood, we present a new method for measuring crime specialization and apply it to an assessment of the link between specialization and offense seriousness. We measure specialization by constructing an empirical measure of how similar crimes are from each other based on the rate at which crimes co-occur within individual crime pathways over a given offender population. We then use these empirically-based population-specific offense similarities to assign a specialization score to each subject at each time period based on the set of crimes they self-report at that time. Finally, we examine how changes over time in specialization, within individuals, is correlated with changes in the seriousness of the offenses they report committing. Results suggest that the progression of crime into increasingly serious forms of offending does not reflect a general pattern of offense specialization. Implications for life course research are noted.

Keywords

criminal specialization; crime seriousness; criminal careers; longitudinal

Introduction

The life-course paradigm represents a way of thinking about the inter-related issues of development, timing, social context, human agency, and continuity and change in human behavior (Elder, 1994). Historically, it has been applied to many substantive problems in the fields of sociology and psychology (Mayer, 2009). In the past quarter of a century, the life course paradigm has made headway into the field of criminology (Sampson and Laub, 1993). Application of the life-course paradigm to the study of antisocial behavior represents a particularly useful and important way of thinking about the problem of crime—especially in how researchers assess the correlates of crime throughout the life-course and the impact

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that criminal involvement has across and into different life domains. In this regard, the types of crimes that an individual commits may reveal important insight into the etiology of criminal behavior. Prior research has resulted in general agreement that offending patterns often progress over time into more serious forms of criminal offenses (Le Blanc and Frechette, 1989; Loeber et al., 1998). This insight has important consequences for explaining criminal careers and crafting social policy responses (Wolfgang et al., 1972; Blumstein et al., 1986; Piquero et al., 2003). While the majority of those who engage in criminal behavior in adolescence desist from crime in adulthood (Laub and Sampson, 2001), those who persist typically engage in more frequent and oftentimes more serious offenses over the life course (LeBlanc and Loeber, 1998; Moffitt, 1993).

Whether patterns toward the escalation into more serious forms of offending also reflect the development of offense preferences and resulting criminal specialization remains unclear. Alternatively, the pathway to serious offending may reflect a general propensity for crime that reflects a diverse array of offending behaviors, as several prominent life course and developmental perspectives on crime suggest (Moffitt, 1993; Sampson and Laub, 1993). While research on specialization is extensive, empirical investigations into its relationship with the longitudinal patterning of escalation in seriousness of offending have been less common (Blumstein et al., 1988; Piquero et al., 2003).

Attempts to disentangle the relationship between the seriousness of offending and crime specialization date back forty years (Wolfgang et al., 1972; Rossi et al., 1974). Studies of crime specialization, alone or in relationship with crime seriousness, have encountered several methodological challenges. Primary among these is the difficulty inherent in both defining and measuring offense specialization (Nieuwbeerta et al., 2011; Piquero et al., 2003; Sullivan et al., 2009). While the seriousness of a crime may be a function of the calculated economic harms it poses to victims or society (Cohen, 1988; Cohen and Piquero, 2009) or the public's opinion on relative severity of offenses (Blumstein and Cohen, 1980; Wolfgang et al., 1985; Rossi et al., 1974), criminal specialization is less tractable. Criminal specialization has been defined by preferences for a specific offense (e.g., burglary, robbery) (Blumstein et al., 1988; Lattimore et al., 1994; Tracy and Kempf-Leonard, 1996; DeLisi et al., 2010) or specific categories of offenses grouped by researchers a priori, or what Cohen (1986) referred to as 'offense clusters' (e.g., property, violent, and drug crime) (Wolfgang et al., 1972; Farrington, 1986; Kempf, 1987; Piquero et al., 1999; Raudenbush et al., 2003; Deane et al., 2005; Osgood and Schreck, 2007). In addition to this fundamental definitional challenge, more serious offenses (especially violent) are most typically committed by chronic offenders (Wolfgang et al., 1972; Blumstein et al., 1986; Farrington, 1998; Piquero, 2000a), which means that measuring crime specialization is typically confounded with the rate of offending.

A recent generation of studies relying on new analytic approaches including: marginal logit models (Deane et al., 2005), item-response theory measurement (Osgood and Schreck, 2007), and random-effects regression (McGloin et al., 2007) suggest that criminal specialization may occur for those who engage in more serious forms of offending. This line of research suggests that there are meaningful differences in the tendency for criminally active persons to repeat *violent* offenses compared to other offense types (Deane et al., 2005;

Lynam et al., 2004; Osgood and Schreck, 2007), and that the diversity of offenses is structured (at least partially) as a function of short-time spans and changes in local life circumstances (Sullivan et al., 2006; McGloin et al., 2007, 2011). These newer approaches help improve upon earlier efforts to assess specialization because they enable one to reconcile the low base rate of more serious offenses (e.g., violent offenses) (Deane et al., 2005; Osgood and Schreck, 2007) and allow one to assess within-individual change in offending (Osgood and Schreck, 2007; Sullivan et al., 2006; McGloin et al., 2007). In sum, these recent efforts suggest that criminal behavior is not simply a function of an individual's criminal propensity and that other considerations may be necessary.

These improvements notwithstanding, there still remain several under-researched and unanswered questions that emerged out of the National Academy of Sciences report on criminal careers (see Blumstein et al., 1986), such as whether the progression of more serious offenses reflects a pattern of criminal specialization. This is also an important question for the purpose of developing and evaluating theories that inform behavioral models of crime over the life course (see Sampson and Laub, 1993; Moffitt, 1993). However, answering this question requires addressing several remaining challenges to traditional and newer approaches to measuring criminal specialization and assessing its link to the development of serious offending behavior. In fact, only a few studies have sought to simultaneously and directly link different dimensions of offending over the course of the criminal career (Brame et al., 2001; Monahan and Piquero, 2009; Lammers, Bernasco, and Elffers, 2012).

Our objective in this study is to illustrate an alternative methodology for assessing crime specialization among self-reported offenses and its association with offense seriousness. We measure specialization in two steps. First, we design an algorithm for calculating how 'similar' crimes are to each other based on the rate at which crimes co-occur within individual crime pathways over a given offender population. This algorithm maps each pair of crimes to a 'similarity' value. We then use these empirical and population-specific offense similarities to assign a specialization score to each subject at each time period based on how similar or dissimilar the set of crimes they self-report at that time are. Finally, we examine how changes over time in this specialization measure, within individuals, is correlated with changes in the seriousness of the offenses they report committing. By relying on an empirically derived measure of crime specialization, we demonstrate that in the population studied here, the average progression toward more serious forms of offending is associated with a greater diversity of offending, a result consistent with expectations from Moffitt's (1994) hypothesis of a life-course-persistent style of offending.

In the next section, we provide some background motivation for this work and suggest that our approach for measuring crime specialization addresses a number of the noted limitations with prior methods, particularly when a range of criminal behaviors are present and the rates of offending are highly skewed as is often the case in offender-based samples. We then describe our data, analytic assumptions, and method for estimating crime specialization and its correlation with the development of serious offending patterns. Finally, we discuss the implications of our results for understanding the measurement of specialization and advancing future work in this area, how our methods and findings relate to key

developmental/life-course criminological debates, and how the methods presented could be useful in other non-criminological life course research.

Background

Participation in criminal offending tends to rise in early adolescence, peak in mid-to-late adolescence, and decline as adulthood approaches (Blumstein et al., 1986; Piquero et al., 2003). The end of adolescence marks the time when most individuals desist from offending (Hirschi and Gottfredson, 1983; Farrington, 1986). Natural maturation, entrance into and conformity to adult life routines of work, marriage, military experience, and family are among the factors cited as reasons for the age-graded discontinuation in offending (Horney et al., 1995; Laub and Sampson, 2001). And while most persons exhibit general desistance in late adolescence or early adulthood (Sweeten et al., 2013), new methodological techniques have permitted investigating the extent to which the aggregate age-crime relationship holds within longitudinal studies (Nagin and Land, 1993). This line of research has revealed important heterogeneity in offending patterns within various samples of criminal offenders, suggesting that there may be unique age-crime curve trajectories for different offending groups (see Piquero, 2008; Jennings and Reingle, 2012). Importantly, the majority of these investigations report evidence of a small subgroup of individuals who offend at high rates and continue to offend after adolescence and into adulthood (Moffitt, 1993). The offense preferences of persistent offenders has received much attention, as research has examined how offense preferences among this group changes over time with respect to offense severity, whether there is evidence of crime specialization, and the interplay between the two.

Offense seriousness or severity can be considered a multi-dimensional construct that encompasses among its dimensions the economic costs, the public's perception of offense severity, and the punitive consequences to the offender (see Ramchand et al., 2009). The most common method used to measure crime severity has been public perception surveys, where individuals are asked to rank the severity of crime scenarios relative to a reference offense (Sellin and Wolfgang, 1964; Warr, 1989; Wolfgang et al., 1985).¹ Two other approaches for measuring crime severity are based on approaches from environmental economics that calculate the costs of crime by jury awards (Bureau of Justice Statistics, 1984; Cohen, 1988; Miller et al., 1986) or the public's willingness to pay for reductions in specific offense types in their communities (Cohen et al., 2004; Nagin et al., 2006). Studies also have measured crime severity based on the maximum penalty imposed for a given crime (Lammers, Bernasco, and Elffers, 2012). A recent approach for measuring the severity of crimes is based on estimating crime severity using a Bradley-Terry model of multiple paired comparisons to discern the likelihood that specific crimes will occur before or after other specific crimes in the course of individuals' criminal careers (Ramchand et al., 2009). In the current study, we examine offending severity using multiple metrics.

¹Although alternative strategies have been proposed, including “deconstructing” criminal events to their components (Gottfredson et al., 1980) or asking victims themselves to rate the severity of their crime victimization (Lynch and Danner, 1993), using normative judgments as a method for ranking the severity of criminal offenses has been the mainstay in criminology.

Offense Specialization

Generally, specialization can be described as the tendency to repeat the same offense type(s) in successive crimes. Theoretically, there are two sets of views on whether offenders' criminal participation is marked by concentration in certain crime types or marked by versatility in offending. The latter view is held most strongly by Gottfredson and Hirschi (1990) who argue that active offenders will commit a wide range of acts throughout the course of their offending careers, all of which are attributable to the same individual characteristic of self-control. Other theorists claim that there may be some degree of specialization in specific crime types or among certain types of offenders and that the factors related to one type of crime may be different from the factors that relate to another type of crime (see Shover, 1996; Moffitt, 1993; Loeber et al., 1998).

Prior empirical research on specialization has tended to find the weakest evidence in samples of juveniles (see Bursik, 1980; Kempf, 1987; Cohen, 1988), with some evidence of offense specialization among adult offenders (Blumstein et al., 1986). Early research on the 1945 Philadelphia Birth Cohort found little evidence of specialization; as Wolfgang and colleagues (1972, p.172) noted the “increment in offense probability per rank number is nil.”² Some contemporary studies report some evidence of specialized offending patterns—especially with offender-based samples (Farrington et al., 1988; Lattimore et al., 1994; DeLisi et al., 2010). By and large, however, most studies support the notion that offenders—especially chronic offenders—engage in a diverse array of offending behaviors.

While the majority of findings suggest that chronic offenders do not tend to specialize, the lack of evidence for specialization may be due, in part, to how offense specialization has been conceptualized and measured. Investigators generally examined offense transition matrices to assess the relative change in the aggregate probability of officially-recorded offense types across prescribed categories like violence, property, or drug crimes (Wolfgang et al., 1972; Farrington et al., 1988; Blumstein et al., 1988; Piquero et al., 1999).³ While transition matrices may be useful ways to classify and analyze the aggregate probability of offense switching over time, they cannot comment on within-individual change in offending patterns, and have been criticized for a lack of clear interpretation in their distributional properties as well as the ambiguity of what reported values actually mean (Britt, 1996).⁴

More recently, individual-level assessments of specialization have been advanced (Nieuwbeerta et al., 2011). Diversity indices based on the work of Agresti and Agresti (1978) have been used to construct measures of offense dispersion (or heterogeneity) among individuals as a way to characterize offense specialization (Piquero et al., 1999; Mazerolle et al., 2000). For instance, McGloin and colleagues (2007) used random effects regression within a panel design and showed that changes in opportunity structures intermittently were correlated with statistically significant changes in a diversity index. Work by Deane and

²Wolfgang et al. (1972) also noted that the knowledge of the immediate prior offense in the 1st order Markov model had some prediction on the subsequent offense, but that with the exception of the crime of theft, the prediction was “not very strong” (p. 206).

³Markov models or forward specialization coefficients are used commonly to test for significant differences in the probability transition between successive offenses.

⁴Verifying claims made by Farrington et al. (1988), Paternoster et al. (1998) found that the distributional properties of the forward specialization coefficients are close to normally distributed and sufficient for z-test statistic.

colleagues (2005) applied a marginal logistic regression model (Agresti and Liu, 2001), which allows one to account for differences in the lower base rate of violence compared to other offense categories, and found that violent offenses were more associated with each other than with nonviolent offenses, providing some evidence for specialization in violence. Osgood and Schreck (2007) used a multilevel model to estimate specialization in violence compared to general offending patterns among adolescents. The model uses an item response theory approach that estimates the additive properties of the response vectors (crime endorsements) to assess whether the level of endorsement of violence items are more closely correlated than the overall tendency for offending. According to their construction of this measurement model, individuals who report committing more violence than nonviolent offenses will rank higher on the violence specialization construct, all else held constant. Osgood and Schreck found substantively important differences in the tendency to commit general offending from that of violent offending, suggesting that there is evidence for specialization in violent crimes (see also Lynam et al., 2004). Finally, DeLisi et al. (2010) advanced an offense specialization coefficient, defined as the sum of a specific offense divided by the total number of offenses, as an individual-level measure that considered specialization within an offense. This study found that there was some evidence of offense specialization, and those that began offending later tended to show less versatility in offending patterns. In sum, these newer methods allow respondents to more fully represent their offense history and better capture change over time among individuals. Thus, while early specialization studies report little evidence in favor of specialization, more recent individual-level-based methods provide some evidence for the presence of specialization, particularly in violent offending in short-term periods.

These studies offer compelling measurement approaches to estimating offense specialization and they all possess some desirable features, but they do have some limitations. Measurement models, for example, attempt to model crime classifications according to the notion that there is an underlying set of distinguishable dimensions that constitute similar crime types. It is unclear, however, whether latent constructs of criminal behaviors represent important distinctions the way they do in psychometric scaling of maladaptive behaviors (e.g., depression and anxiety). Diversity indices, on the other hand, are affected by the overall base rate of offenses making it difficult to compare the diversity of offenses that are rare in a sample (e.g., homicide or sexual assault). Other individual-level specialization measures, such as the offense specialization coefficient, are limited because (a) they may be biased upward toward offenses that are more commonly reported and (b) they cannot be compared across offenses. Thus, there is room for additional methods that can provide unique insight into offending and provide commentary for theoretical debates about the nature and patterning of offending over the life course.

Offense Severity and Chronic Offending

For some theorists, there may be an intuitive appeal to the notion that the development of serious offending follows a progression of crime specialization. Some chronic offenders may exhibit patterns signifying offense specialization only as they progress into more serious forms of offending, especially as they acquire skills at committing certain crimes types for which they have had a successful history of evading detection (cf. Spelman, 1994).

Successive crime preferences based on success would comport with development theories of crime that focus on offender typologies (Le Blanc and Loeber, 1998; Nagin and Tremblay, 1999).⁵ Research in this area, however, generally has been limited to examinations of patterns of specialization and offense seriousness independent of each another, or evidence for specialization among only the most serious offenders (Lattimore et al., 1994; DeLisi et al., 2010). For instance, using the records of Michigan offenders, Blumstein et al. (1988) found specialization for some crime types and, independently, in the escalation in crime severity. Piquero et al. (1999) found that offense specialization increased somewhat (though not very strongly) as a function of age in the 1958 Philadelphia Birth Cohort, supporting the notion that among persistent offenders their criminal activity becomes more specialized over time. Yet, Piquero et al.'s (2007) analysis of data from working-class South London males in the Cambridge Study in Delinquent Development found little specialization in violence into mid-adulthood even among the more serious offenders. Research has not yet tied these two constructs together to identify whether evidence of specialization in offending is associated with an escalating severity of offending.

Current Study

Research on specialization has relied on diverse methods, measures, samples, and reporting time frames, and has produced a wide range of findings. Yet, common throughout these studies have been a consistent set of ideas regarding some minimum requirements for an adequate measurement approach to assessing specialization. In particular, such an approach should: focus on the variety of offenses committed rather than their precise sequence; employ self-report records in addition to official records of offending; address the confounding between specialization and the frequency of offending; and define specialization at the individual level (Piquero et al., 2007; Osgood and Schreck, 2007). Transition matrices, for example, only capture patterns of specialization and escalation for pairs of crimes adjacent to one another in a temporal sequence, thus limiting the dimensionality of specialization or escalation to patterns that occur between two sequential crimes. The use of official records is *potentially problematic* because of the offenses that do not get detected or processed by the criminal justice system (Lynam et al., 2004), and because of the well documented state-dependence effect whereby the probability of arrest increases as a function of prior arrests – even when one conditions on self-reported offenses (Nagin and Paternoster, 1991). Specialization may also reflect the byproduct of more frequent offending, and the highly skewed distribution of offending frequency in some samples may mask the relative progression into more serious forms of offending that occurs by way of specialized offense preferences. Since more frequent offenders, on average, have committed more serious offenses (Farrington, 1986; Piquero, 2000b), it becomes difficult to distinguish between the escalation into serious forms of criminal behavior and the level of specialization over time. Few studies have high-risk samples containing adequate self-

⁵Not all developmental/life-course theories ascribe to this view. Moffitt's (1994) taxonomy expects that life-course-persistent offenders will evince varied and not specialized offending repertoires. She (1994, pp. 45–46, emphasis in original) suggests that life-course persistent offending will be characterized by: (1) earliness of onset; (2) individual stability across developmental stages; (3) stability across settings or agreement among reporting sources; (4) frequency or rate of offending; (5) variety of heterotypic activities in the antisocial spectrum; (6) severity of offenses, as represented by violence or confrontations with victims; and (7) willingness to offend alone or with relatively few accomplices.

reports of serious forms of offending to differentiate patterns of offense specialization and seriousness over time (Piquero et al., 2003).

In this study, we develop a new method for measuring specialization and its relationship to serious offending over time that addresses a number of the limitations of past research. We use this method to examine whether crime specialization is associated with progression toward more serious types of offending. Such a finding would highlight the utility of crime specialization explanations for the development of serious offending patterns, as in Loeber and colleagues (1997) progression-based three-pathway model. In contrast, evidence suggesting a general progression of increasingly serious offenses that follows a diverse range of criminal behaviors would provide greater weight to the argument that offending develops in a unorganized fashion and is a reflection of a general criminal propensity, as in Gottfredson and Hirschi's (1990) general theory. We examine this issue by relying on an approach that measures specialization based on the co-occurrence of offenses within individuals. This method provides a new lens for measuring specialization and addresses many of the basic requirements needed for assessing the link between crime specialization and offense seriousness.

Data and Methods

Data used in this study come from the RAND Adolescent Outcomes Project (AOP). The AOP was designed to examine the effectiveness of a substance abuse treatment program for a representative sample of criminally adjudicated youth sent to large residential treatment programs by the Los Angeles Probation Department, the largest juvenile court system in the country (Morrall et al., 2003). The original purpose of the AOP study was to examine the outcomes of youth on probation attending one long-term residential substance abuse program (Phoenix Academy) versus youth placed in other traditional community settings (e.g., group homes) and as such there is some oversampling of youth sent to Phoenix Academy. All participants were recruited in February 1999 and for 15 months thereafter from the three juvenile detention facilities in Los Angeles County while they awaited their community probation disposition. On average, participants were 16 years of age (range 13-17) and provided written informed consent and parental notification of enrollment in the study. Eighty-seven percent of the participants (n=392) were male and 55% (n=248) were Hispanic/Latino (see Ramchand et al., 2009). Youth were excluded from the study if they were admitted to a residential program before they could be interviewed, could not participate in an English-language interview, or had parent/guardian request that the youth be excluded. Twenty-two percent (n=125) of those recruited were excluded for these reasons, with the majority (80%) excluded because they were moved from the detention facilities before a research interview could be scheduled.⁶ This procedure resulted in 449 youth at the intake interview (baseline). Respondents were re-interviewed at 3-months (n=406), 6-months (n=410), 12-months (n=408), 72-months (n=365), and 87-months (n=383) after baseline. Twelve respondents died between intake and the 87-month follow-up (Ramchand et al., 2009). Thus, excluding those deceased as being eligible to participate,

⁶Approximately 6% could not participate because of language barriers. Only 2% of eligible youths refused to participate in the study, leaving 12% not interviewed for unaccounted reasons, such as being removed too quickly to schedule an interview.

retention was over 90% for the first 3 waves of follow-up, and 83% at the sixth wave (87-month) assessment. Study participants were asked at each interview wave about the number of times they had engaged in each of 15 offenses during the previous 90 days (see Table 1). Our analytic strategy does not include offending that occurred earlier than 90-days prior to the baseline assessment of the AOP sample.

As noted earlier, crime severity can be thought of as a multidimensional construct that includes among its dimensions harms done to society, harms experienced by victims, the punitive consequences faced by the offender, and even by the sequence of crimes committed by offenders throughout their careers. Thus, we approach the measurement of crime severity by relying on seriousness scores derived from multiple sources including: the National Survey of Crime Severity developed by Wolfgang et al. (1985); a categorical scale of severity adapted from Gottfredson and Barton (1993); a simple ordinal scale derived from Blumstein and Cohen (1980); and a scale based on the temporal sequencing of offending behaviors from a Bradley-Terry model (Ramchand et al., 2009). Table 2 displays how crimes are ranked according to each of these severity metrics. We define individual and time period specific crime severity as the maximum severity of any crime reported by the individual in that time period. In our data, the average maximum crime severity consistently increases between the 3 and 87-month assessment applying any of the four crime severity scales.

A New Measure of Crime Specialization - Concept

In our approach to measuring crime specialization, person and time specific specialization measures are arrived at through two steps. We first define crime similarity (CS) for each pair of crimes using a statistic based on the co-occurrence of crimes observed at any point in individual's crime pathways summarized over the entire AOP sample. Two crimes, A and B, are defined as either co-occurring or not based on whether an individual ever reports committing crime A *and* ever reports committing crime B. We then assess whether the degree of co-occurrence between crimes A and B that appears across all AOP subjects is higher, lower, or about what would be expected if crimes were selected independently. Under independence, the frequency of crimes co-occurring is only a function of the relative frequency of each crime considered separately. Our measure of CS is a statistic summarizing the degree to which each pair of crimes co-occurs more (or less) than would be expected if they were selected independently. This definition of CS relies on the assumption that on average, crimes that co-occur more frequently within individual pathways, regardless of whether they occur at different time points, are more similar to each other than crimes that co-occur less frequently within individuals.⁷

With this empirical AOP level measure of the similarity of every pair of crimes, we then define person and time specific specialization as the minimum of the CS seen among the set of crimes reported by an individual study participant in an observation period. For instance, consider a person reporting two crimes in period one, crimes A and B, and three crimes in

⁷The co-occurrences of particular types of offending behaviors have been demonstrated across several studies (Reiss and Roth, 1993; Tolan and Gorman-Smith, 1998). It remains unclear, however, whether the co-occurrence is a function of frequency of offending and occurs by chance.

period two, crimes A, B, and C. Also assume that CS(A, B) is high, i.e., that the two crimes co-occur frequently and thus are considered similar while CS(A, C) and CS(B, C) are low, i.e., that crime C does not co-occur very often with either crimes A or B and thus is considered dissimilar from both. In period 1, this individual would be assigned a high level of crime similarity and thus be considered fairly specialized. In period 2, this individual would be assigned a low level of crime similarity and thus be considered considerably less specialized. Thus, our proposed specialization measure can be interpreted as a measure of how similar the two *least* similar crimes are among all crimes that a person commits in a specific time period. Because our measure of CS relies on co-occurrences of pairs of offenses, individuals with only one offense type in a time period drop out of the analysis.

An important departure from previous specialization measures is that our proposed CS measure is entirely empirical and thus is agnostic on how crimes are related to one another. No a-priori decision is made that violent crimes are more related to each other than they are to property crimes. This measure also has the advantage of discounting the potential influence of frequency when studying specialization. Specifically, we measure whether or not each listed crime was endorsed by a given offender in a given time period and not the relative frequency with which each endorsed offense was committed. In addition, the co-occurrence calculations adjust for the rate at which each component crime is ever endorsed across all AOP individuals. As a result, our measure of CS is not influenced by low (or high) counts which could, for example, suggest that someone who committed 3 burglaries and 1 car theft specializes in burglary. This approach, therefore, addresses a number of the requirements noted in earlier investigations of specialization.⁸

Calculation of Crime Similarity (CS)

To calculate the CS measure, responses are pooled over time within subject to create an $n \times x$ matrix where each row represents a respondent (n) and each column represents a specific crime (x). Dichotomous (1/0) values were placed in cells indicating whether a respondent endorsed committing the specific behavior *at any period in time*. Pearson correlation coefficients between each pair of crimes were then calculated over individuals. For dichotomous variables, the Pearson correlation is also called the Phi Correlation and can be rewritten as a function of the observed and expected counts for each pair of crimes. That is, the Phi Correlation for two items, i and j , is equivalent to:

$$\varphi = \sqrt{\frac{\chi_p^2}{n}} \text{ where } \chi_p^2 = \sum_i \sum_j \frac{(e_{ij} - o_{ij})^2}{e_{ij}} \quad (1)$$

$$e_{ij} = \frac{(c_i) * (c_j)}{n}$$

In equation 1, n represents the sample size, c_i and c_j represent counts of the number of subjects who ever report committing crime i and j respectively, e_{ij} represents the expected

⁸It is important to note that this approach is population specific. If there is something unique about the AOP population, the CS measure may be idiosyncratic. However, it is unlikely that the behavior of the AOP population will be unique given participants were selected because they were placed on probation as adolescents and are typical of studies of high risk youth in other urban settings. Such a sample has several advantages, including being a policy-relevant group given their volume, varied, and seriousness of offending (Laub and Sampson, 2001; Mulvey et al., 2004).

count of subjects who report committing both crimes during their crime pathway, and o_{ij} represents the observed counts of subjects reporting having committed both crimes during their crime pathway.

The resulting pair-wise crime similarities are simply a correlation ranging between -1 and 1, where 1 corresponds to the maximum similarity where the crimes always co-occur; -1 corresponds to minimum similarity where the crimes never co-occur; and 0 corresponds to co-occurrence by chance only – the crimes co-occur as expected based on frequency of each crime considered alone.

The CS is subsequently determined at the person and time period specific level based upon the mix of crimes reported by the individual in that period. The CS of each pair of crimes among those reported is calculated and the minimum of these values is assigned as the degree of specialization for the person at that time. By using the minimum, we are thus identifying the two particular crimes that are most surprising to occur together among all those committed, and assigning the similarity of those two crimes as the person/time specific specialization measure.

Analytic Approach

We approach our analysis of the relationship between specialization and seriousness in two stages. First, the person and time specific CS and offense seriousness measures described above are differenced between consecutive survey waves to obtain measures of increases or decreases in specialization or seriousness. Increases in CS over time would provide evidence in support of specialization, whereas decreases in CS or constant values would both be evidence against specialization. As an example of the change in offense severity, for all four offense severity metrics, homicide is considered the most serious offense. For an individual whose most serious offense at baseline is a motor vehicle theft who then reports participating in a homicide during a subsequent survey wave, this would provide evidence of escalation in severity across all four metrics.

The second stage of our analysis entails testing the relationship between changes in the degree of specialization of each individual against changes in their offense severity across consecutive survey waves. We calculate the correlations between changes in CS and changes in each of the four metrics of crime seriousness across all individuals in the study that report criminal behavior in consecutive observation periods. We calculate Spearman Rank, Pearson, and Kendall's Tau correlation statistics reporting the Spearman Rank in the paper and all three in the Appendix to demonstrate robustness of results. We test these correlation statistics against a null of zero by creating 95% confidence intervals accomplished by 9,999 non-parametric bootstrap samples. All analyses are carried out in R (version 2.13.0). If individuals who exhibit patterns of escalation in offense seriousness are more likely to exhibit increased specialization in offense preferences, we should see positive correlations between the maximum crime severity score and our CS measure.

Results

Table 3 shows the results for the population level crime similarities (CS). This table displays the specific similarity between each offense pair (above the diagonal), the average similarity between an offense and all other offenses (left-most column), as well as the relative rank in offense pair similarities (below the diagonal). According to this measure of CS, arson and murder are the most different from all other offenses. Robbery and drug sales are the two offenses that most often co-occur with other offenses and are hence, on average, the most similar to all other offenses in the sample's crime histories. In terms of crime pairings, it can be seen that robbery involving a weapon is most closely paired with robbery ($\phi = .70$), aggravated assault is most closely paired to simple assault ($\phi = .46$), and selling drugs is most closely linked to larceny/theft ($\phi = .38$). Aside from the numerical utility of defining similarities in offenses by their relative co-occurrence, these similarities appear to have some face validity in showing that offenses that are the most similar in instrumentation are the most closely linked, such as aggravated assault and simple assault.

Table 4 provides an example of an individual AOP member's responses to self-reported crime questions at two specific survey waves and summarized over all waves. The crimes this individual ever reported committing contributes to the higher population level similarity of those crimes such as drug sales and DUI, or fraud/theft and simple assault. The crimes this individual never reported committing contributes to the lower population level similarity of those crimes. At baseline, this member of the AOP sample reported having committed only two types of crime: larceny/theft and simple assault. Of these two crimes the one with the greater seriousness (on the BT scale) is larceny/theft and thus the seriousness of that crime is assigned as the individual's seriousness at baseline (indicated by underlining in Table 4). As this member of the AOP sample reported only two crimes, the similarity between those two crimes is assigned as the individual's specialization at baseline (indicated by italics in the Table). At 6 months, this individual reported having committed 6 different types of crime. Of these crimes, the most serious (on the BT scale) is robbery with a weapon and thus the seriousness of that crime is assigned as the individual's seriousness at 6 months. Of all possible pairs of the crimes reported at 6 months, the two that are most surprising to occur together, the two estimated to be the least similar, are stealing and simple assault. Thus, the similarity between these two crimes is assigned as the individual's specialization at 6 months. Using the BT seriousness scale and the CS results based on our analysis, this individual increased in seriousness between baseline and 6 months (from .31 to 2.51) and decreased slightly in CS (from .25 to .20).

Relationship Between Crime Specialization and Crime Severity

Table 5 displays the results for the analysis of the correlation between change in crime specialization and change in maximum crime severity scores between each consecutive pair of survey waves, using each of the four severity metrics. Point estimates and confidence intervals for Spearman Rank correlations are shown in table. Pearson and Kendall's Tau correlations with confidence intervals are displayed in the Appendix. Results are substantively similar across the three correlation measures demonstrating that the choice of parametric form does not change the findings. Using any of the four metrics for assigning

the maximum severity of an offense we find a strong, statistically significant, and negative correlation between CS and offense severity. Thus, on average, those who report committing more serious crimes over time are also more likely to have increasingly diverse offense profiles.

For the most part, the empirically derived measure of CS has the lowest shared correlation with the offense severity metric derived from the Wolfgang et al. (1985) National Crime Severity Survey. This lower but still statistically significant correlation is the result of the large and irregular separations between values on this scale such as that caused by murder receiving a severity score of 38.2 which is substantially higher than any other offense. Because the other severity metrics are ordinal or close to ordinal in the way they categorize crime severity they provide smaller and more uniform separation in the severity of offenses which results in a higher correlation.

The results hold across each of the life course transitions covered by the consecutive waves of the data as average seriousness is increasing among offenders in this population. In fact, regardless of severity metric or correlation measure choice, the estimates indicate a consistent theme in the offense profile changes during adolescence (0-12 month change), the transition between adolescence and adulthood (12-72 month change), and during early adulthood (72-87 month change). Specifically, we find that those whose offense severities increase at any of these incremental stages are more likely to become less specialized (or equivalently, more diverse) in their crimes committed. While only suggestive, the point estimates have a pattern of stronger negative correlations in later adolescence (6-12 month change) and early adulthood (72-87 month change) relative to during earlier adolescence or the transition between adolescence and adulthood. A graphic depiction of Spearman rank correlations between changes in offending specialization and changes in maximum crime severity (using the Bradley-Terry metric) between each of the consecutive waves of data is displayed in Figure 1. Overall, results suggest that crime specialization is less common for those who escalate to more serious types of offending.

Discussion

Following prior research on measuring criminal careers and offense specialization and attempting to overcome several measurement limitations, we developed a new measurement approach for assessing crime specialization that was agnostic on the substantive relationship between offenses. Given the inherent complexity in the underlying mechanisms for different criminal offenses, we chose an approach that did not prescribe specific crime types as related to each other based on instrumentation, motivation, or harm. Instead, our method permits crimes that co-occur the most frequently within individuals to represent the underlying mechanism of crime similarity. While there are some limitations to this CS approach, it offers a useful descriptive tool for assessing relative specialization in offending that can be used to inform current theoretical debates about the nature and longitudinal patterning of criminal behavior.

Results from this study lend support to theories that predict general criminal offending patterns as opposed to specialized offending patterns, as suggested by Gottfredson and

Hirschi (1990) and Laub and Sampson (2003). We also find no evidence that criminal behavior develops in any type of orderly progression, as suggested by developmental theorists like Loeber et al. (1997). We do not observe evidence of an organized profile of more similar types of offenses being mapped onto more serious forms of offenses. Importantly, because we chose only the most serious crime in any given survey wave and co-occurrence relationships between pairs of offenses, our analysis removes the potential confounding effects whereby more frequent offenses drive the dissimilarity metric. The results suggest that among those who continue to engage in more serious forms of crime, offense preferences are increasingly diverse and do not reflect specialization. It appears that those who persist in crime into adulthood are not developing their offending mix in a fashion that reflects a pattern of criminal specialization. Our findings suggest that a general criminal propensity of seriousness is associated with a diverse variation in offense behaviors.

To be sure, our investigation is the first application of the empirical CS measure of specialization and as such limitations should be noted and some directions for future research should be highlighted. For example, our data were from a sample of processed juvenile delinquents, and although the nature of the participants was such that they had an accumulated offending history, the conclusions drawn from our investigation about seriousness and specialization may have been idiosyncratic to a serious juvenile offender sample. At the same time, we found evidence that increasingly serious forms of offending did not reflect a general pattern of offense specialization, which is important because some of the studies finding evidence for specialization have used justice-processed offender samples. Nevertheless, future studies should expand the range of samples considered to include general population samples as well.

An additional limitation of our sample was the age range examined. Although there were strengths of our study, i.e., longitudinal, bridging the gap between adolescence and adulthood, we did not follow the offenders into later portions of their criminal careers. Evidence shows that tracking offending careers into middle and late adulthood tends to highlight some unique offense type patterning and we encourage subsequent investigation using our methodology for linking specialization and seriousness of offending over different periods of the life course. Researchers should also be mindful that self-report data can suffer from both under- and over-reporting. The potential for these sorts of recall biases may become more pronounced as the gaps between survey assessments lengthen and/or become imbalanced. Thus, our results should be read with these limitations in mind.

Further, because our aim in this study was more modest—developing and estimating a new methodological approach to studying the linkage between specialization and seriousness—we did not investigate the correlates associated with the new specialization measure. It would be good to examine how various risk/protective factors influence this measure within and between offenders over time. Given recent findings linking short-term changes in local life circumstances to short-term changes in offense diversity (McGloin et al., 2007, 2009, 2011), it would be interesting to examine whether similar substantive findings emerge using our proposed approach.

Lastly, there has been little research examining shifts in the mix of offenses over the course of individual criminal careers. Such changes (perhaps from more to less serious) may be a marker of the onset of desistance (cf. Fagan, 1989). In one of the few studies examining this issue, Massoglia (2006) used data from the National Youth Survey to examine the mix of offenses from adolescence into early adulthood and found evidence in support of within-individual displacement of various crime types. Continued investigation on this issue is also relevant.

We do see the potential application of our modeling approach to other areas of life-course research more generally. For example, many life-course trajectories, such as employment, education, substance abuse, health, and inter-personal relationships evolve in related ways over time. Specific involvement within one of these trajectories, say substance abuse, may be considered within the context of specialization and seriousness where some individuals only imbibe in one specific substance, say alcohol—and even within that substance perhaps some specialize further in only one type of alcohol, say vodka, and perhaps even further by drinking only certain brands of vodka. It is also possible that the particular patterning of behavior may also relate to the frequency or seriousness of drinking. And, it is possible that the co-occurrences of multiple alcohol drinks may map onto particular forms of seriousness in alcohol addiction, such as measured by visits to emergency rooms for alcohol poisoning or liver failure. Other areas of life course scholarship, such as employment could also benefit as well. For example, patterns of employment may develop in particular forms of jobs that co-occur and correlate with specific increases in wages. To the extent that most life course research measures co-occurring behavioral and emotional phenomenon, our modeling approach offers an avenue for examining patterns of specialization that link to accumulated life course outcomes.

Appendix Table: Correlation Between Change In Specialization And Change In Severity

Data Waves	Crime Seriousness Scale				Correlation Statistic
	Bradley-Terry	Wolfgang	GB	Ordinal	
0-6 Months (n=89)	-0.32 (-0.15, -0.47)	-0.35 (-0.22, -0.48)	-0.57 (-0.35, -0.71)	-0.59 (-0.39, -0.73)	Pearson
	-0.57 (-0.38, -0.70)	-0.58 (-0.40, -0.71)	-0.55 (-0.34, -0.71)	-0.62 (-0.42, -0.75)	Spearman Rank
	-0.41 (-0.27, -0.52)	-0.42 (-0.28, -0.53)	-0.44 (-0.26, -0.57)	-0.48 (-0.32, -0.59)	Kendall's Tau
6-12 Months (n=47)	-0.41 (-0.26, -0.58)	-0.39 (-0.22, -0.51)	-0.69 (-0.53, -0.82)	-0.72 (-0.58, -0.82)	Pearson
	-0.74 (-0.60, -0.85)	-0.71 (-0.54, -0.81)	-0.79 (-0.63, -0.89)	-0.82 (-0.68, -0.90)	Spearman Rank
	-0.55 (-0.41, -0.69)	-0.53 (-0.38, -0.63)	-0.66 (-0.50, -0.78)	-0.66 (-0.52, -0.76)	Kendall's Tau
12-72 Months (n=62)	-0.35 (-0.12, -0.54)	-0.35 (-0.19, -0.52)	-0.68 (-0.49, -0.82)	-0.77 (-0.64, -0.86)	Pearson

Data Waves	Crime Seriousness Scale				Correlation Statistic
	Bradley-Terry	Wolfgang	GB	Ordinal	
72-87 Months (n=93)	-0.64 (-0.42, -0.77)	-0.53 (-0.28, -0.71)	-0.69 (-0.48, -0.8)	-0.79 (-0.64, -0.88)	Spearman Rank
	-0.48 (-0.31, -0.60)	-0.39 (-0.20, -0.54)	-0.57 (-0.38, -0.70)	-0.63 (-0.49, -0.74)	Kendall's Tau
	-0.43 (-0.28, -0.58)	-0.64 (-0.43, -0.75)	-0.72 (-0.57, -0.82)	-0.75 (-0.64, -0.83)	Pearson
	-0.70 (-0.59, -0.79)	-0.68 (-0.52, -0.79)	-0.66 (-0.48, -0.78)	-0.69 (-0.54, -0.79)	Spearman Rank
	-0.54 (-0.44, -0.63)	-0.53 (-0.39, -0.63)	-0.53 (-0.37, -0.65)	-0.54 (-0.41, -0.64)	Kendall's Tau

Table Notes: 95% confidence intervals are derived from 9,999 non-parametric bootstrap samples.

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Figure 1.

Table 1

Measures and Prevalence of Self-Reported Offending

SURVEY QUESTION # Times In Past 90 Days You Have:	CRIME	MONTHS					
		Baseline	6	9	12	72	87
Hurt Someone Badly Enough They Needed Bandages Or A Doctor?	Aggravated Assault	16.5	6.7	7.3	8.6	13.2	6.2
Used A Knife Or Gun Or Some Other Thing (Like A Club) To Get Something From A Person?	Armed Robbery	4.5	3.7	3.4	3.4	2.5	1.0
Intentionally Set A Building, Car Or Other Property On Fire?	Arson	3.6	0.5	0.7	1.5	1.4	0.5
Broken Into A House Or Building To Steal Something Or Just To Look Around?	Burglary	10.9	4.2	2.9	4.2	2.5	2.4
Taken A Car That Didn't Belong To You?	Car Theft	13.4	3.2	4.6	5.9	3.6	2.2
Driven A Vehicle While Under The Influence Of Alcohol Or Illegal Drugs?	DUI	10.2	4.7	4.9	8.8	21.9	21.6
Sold, Distributed Or Helped To Make Illegal Drugs?	Drug Sales	25.2	6.9	8.3	9.6	13.7	11.5
Passed Bad Checks, Forged (Or Altered) A Prescription Or Took Money From An Employer?	Fraud/Theft	3.3	0.5	1.0	1.7	2.2	1.0
Taken Something From A Store Without Paying For It?	Larceny/Theft	34.1	7.9	10.2	11.5	7.1	7.9
Been Involved In The Death Or Murder Of Another Person (Including Accidents)?	Murder	2.2	1.0	2.0	1.5	0.5	0.02
Hit Someone Or Got Into A Physical Fight?	Simple Assault	45.2	17.2	16.8	20.3	29.6	23.6
Other Than From A Store, Taken Money Or Property That Didn't Belong To You	Stealing	20.0	8.4	10.0	9.1	7.7	7.9
Purposely Damaged Or Destroyed Property That Did Not Belong To You?	Vandalism	25.6	11.1	11.5	14.0	12.9	7.9
Used A Weapon, Force, Or Strong-Arm Methods To Get Money	Weapon (Robbery)	6.2	3.2	3.7	3.7	1.9	2.4

Table 2

Offense Severity Weights

	Bradley-Terry	Wolfgang Et Al.	Gottfredson and Barton	Blunstein and Cohen
Simple Assault	0.06	6.2	1	3
Vandalism	0.17	1.5	1	1
Stealing	0.17	2.2	1	2
Drug Sales	0.21	8.5	5	9
Larceny/Theft	0.31	5.4	1	4
Aggravated Assault	0.42	11.4	6	10
DUI	0.43	NA	1	6
Car Theft	0.68	6.3	3	8
Burglary	1	3.1	4	7
Armed Robbery	1.93	12.2	6	13
Weapon (Robbery)	2.51	9.6	6	11
Fraud/Theft	4.18	8.7	2	5
Arson	4.31	12.7	7	12
Murder	5.76	38.2	7	14

Note: NA- Not Available In Wolfgang et al. (1985)

Table 3

Crime Similarities (CS) for All Pairs of Crimes

Offense Type	Arson	Murder	Stealing	Fraud/ Theft	Simple Assault	Car Theft	DUI	Burglary	Aggr. Assault	Vandal	Robbery	Larceny/ Theft	Drugs	Robbery (Weapon)
Average Similarity	14.4	27.6	36.5	37.5	38.2	42.6	43.4	47.1	54.9	57.1	58.5	58.8	60.1	67.3
Arson	--	0.17	0.18	0.09	0.09	0.11	0.1	0.17	0.22	0.21	0.18	0.15	0.12	0.17
Murder	16	--	0.12	0.11	0.16	0.22	0.17	0.19	0.22	0.19	0.29	0.16	0.21	0.36
Stealing	21	7	--	0.2	0.2	0.14	0.21	0.27	0.2	0.29	0.18	0.34	0.33	0.26
Fraud/Theft	2	4	27	--	0.11	0.25	0.27	0.19	0.2	0.22	0.29	0.32	0.29	0.36
Simple Assault	1	13	26	6	--	0.14	0.27	0.18	0.46	0.37	0.21	0.25	0.35	0.24
Car Theft	5	35	10	44	9	--	0.32	0.29	0.16	0.31	0.37	0.28	0.22	0.34
DUI	3	18	31	53	50	68	--	0.23	0.25	0.26	0.26	0.23	0.35	0.24
Burglary	15	24	52	25	19	58	41	--	0.29	0.3	0.36	0.31	0.23	0.33
Aggr. Assault	36	34	29	28	90	12	45	61	--	0.32	0.35	0.31	0.37	0.41
Vandalism	30	23	59	37	85	65	49	62	67	--	0.27	0.33	0.34	0.32
Robbery	22	57	20	60	32	83	47	79	77	51	--	0.38	0.28	0.7
Larceny/Theft	11	14	75	66	46	54	39	64	63	71	86	--	0.38	0.42
Drug Sales	8	33	70	56	76	38	78	40	84	74	55	87	--	0.36
Robbery w/Weapon	17	81	48	80	43	73	42	72	88	69	91	89	82	--

Note: Crime similarity values are above the diagonal and ranks of these values are below.

Table 4

Offense Similarities for Individual AOP Member

Interview	Ever Endorsed	Baseline	6-Months
Simple Assault	Yes	<i>1</i>	<i>1</i>
Vandalism	Yes	0	1
Stealing	Yes	0	<i>1</i>
Drug Sales	Yes	0	1
Larceny/Theft	Yes	<i>1</i>	1
Aggravated Assault	No	0	0
DUI	No	0	0
Burglary	No	0	0
Armed Robbery	No	0	0
Weapon (Robbery)	Yes	0	<i>1</i>
Fraud/Theft	No	0	0
Arson	No	0	0
Murder	No	0	0
Seriousness	--	<i>0.31</i>	<i>2.51</i>
Specialization	--	<i>0.25</i>	<i>0.20</i>

Table Notes: Underlining is used to indicate the crimes that determine the Seriousness and that Seriousness value. Italics are used to indicate the crime pair that determines the Specialization and that Specialization value.

Table 5
Correlation between Change in Specialization and Change in Severity

Data Waves	Crime Seriousness Scale		
	Bradley-Terry	Wolfgang	GB Ordinal
0-6 Months (n=89)	-0.57 (-0.38, -0.70)	-0.58 (-0.40, -0.71)	-0.55 (-0.34, -0.71)
6-12 Months (n=47)	-0.74 (-0.60, -0.85)	-0.71 (-0.54, -0.81)	-0.79 (-0.63, -0.89)
12-72 Months (n=62)	-0.64 (-0.42, -0.77)	-0.53 (-0.28, -0.71)	-0.69 (-0.48, -0.8)
72-87 Months (n=93)	-0.70 (-0.59, -0.79)	-0.68 (-0.52, -0.79)	-0.66 (-0.48, -0.78)

Table Notes: Estimates are Spearman Rank correlations and 95% confidence intervals from 9,999 non-parametric bootstrap samples.