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Chapter 1

THE TAXONOMIC CHALLENGE TO GENERAL THEORIES OF DELINQUENCY: LINKING TAXONOMY DEVELOPMENT TO DELINQUENCY THEORY

Tim Brennan [*] ***and Markus Breitenbach***
Northpointe Institute, 101 Pat Mell Drive,
Peachtree City, Ga 30269

ABSTRACT

Theoretical approaches in delinquency have prioritized the search for a "general" global theory with the assumption that a single unified theory underlies all delinquency (e.g. strain theory, social control, social learning, low self-control, etc).

Recent theorists have also attempted to integrate various elements of these diverse theories into a unified general model (e.g. Farrington 2003, Elliot et al 1985, Sampson and Laub 2005). In contrast, the taxonomic approach adopts a theoretical pluralism that denies the existence of a single unified explanation. It aims to unravel delinquency populations into multiple categories or sub-types that may represent diverse causal processes. Moffitt (1993), Lykken (1995) and others, offer such proposals.

The theoretical stakes are high with advocates on both sides. We will address several issues central to this debate including: Can diverse types of delinquents be reliably identified? Are the boundaries between types distinct? What kind of taxonomic structure exists in this population? We then report on a large scale (N = 3070) replication and refinement of a previously published delinquent taxonomy using the Youth COMPAS assessment system (Brennan, Breitenbach and Dieterich 2008).

Multiple validation methods were used. Substantially the same results emerged, with evidence of stable taxonomic structure in which six out of seven replicated types emerged; these were again nested within five more super-ordinate clusters. These types had multiple matches in the prior literature on explanatory delinquent typologies. We finally explore the implications of our findings for the debate over the general theory paradigm.

[*] E-mail: tbrennan@npipm.com

INTRODUCTION

This chapter addresses the unresolved and contentious issue of different explanatory "types" or "etiological patterns" among delinquents and the conflict this creates for advocates of "general theory" in delinquency. We also explore the on-going development and validation of a previously published taxonomy of delinquent youth (Brennan, Breitenbach and Dieterich et al 2008). This taxonomy is subjected to several new tests of replication and we examine the degree to which it generalizes on a large new sample. In this paper we focus on a male only sample. An analogous taxonomy for female delinquents has been separately presented (Brennan 2008). The examination of males only was motivated by the possibility that different pathways may exist for boys and girls driven by the differential importance of certain factors (e.g. sexual abuse, relationship issues, parental supervision etc) and the possibility of heterogeneous interactions leading to different patterns of explanatory factors by gender. Thus, this paper aims to achieve more precise, homogeneous and explanatory profiles for boys. Finally, an overall theme of this chapter is to explore some of the theoretical implications of typological analysis for delinquency research.

The chapter is structured as follows. First, several contentious but critical issues are examined regarding whether "types" exist, given the anti-typological views of many prominent delinquency theorists. Second, we briefly review the prior literature on explanatory typologies of male delinquents and we identify several recurring types in this body of research. We then conduct a replication of our earlier taxonomic analysis on delinquents (Brennan, Breitenbach and Dieterich 2008). This examines the degree to which the types generalize on a new sample (N = 3070) and the similarity between original and replicated types. We incorporate the McIntyre-Blashfield (1980) replication test to examine both cross sample and within-sample robustness of this typology. All seven types from the earlier taxonomy re-appear in the validation sample, however one small cluster from the original taxonomy was unstable and did not recur in the new taxonomic analysis of the validation sample. We then assess whether the present types replicate or match any of the type profiles identified in prior published research on delinquent types (Warren 1971, Rubenfeld 1976, Harris and Jones 1999 and others). To conclude we discuss some theoretical implications of our taxonomic findings. In the debate on the "existence" of delinquent types the present findings offer additional evidence of the reality of these types. In this spirit we invoke Salmon's (1984) well known maxim that it is a "damn strange coincidence" when highly similar empirical data structures re-emerge across diverse mathematical approaches, different falsification tests and different samples (Meehl 1992).

GOALS

The goals of this chapter are as follows.

1. In the first section we discuss several issues pertaining to the theoretical debate between advocates of a "general theory" of delinquency as opposed to the typological approaches and theoretical pluralism.

2. In the main empirical section we replicate and further develop a previously published taxonomy of delinquent youth.
3. We will examine the structural evidence that may support or detract from the conjecture that taxonomic or categorical structure exists in the explanatory causal domain of delinquency.
4. We contextualize our typological findings by examining the congruency of the new type patterns against prior published explanatory typologies of delinquency in the social-psychological explanatory domain. Since the classic integrative studies of Rubenfeld (1967) and Warren (1971) an increasing number of studies have aimed to build taxonomies on a broad range of social and psychological domains (e.g. Stefurak and Calhoun 2004, Harris and Jones 1999). This literature remains scattered and poorly integrated.

THEORETICAL ISSUES AND TAXONOMIC RESEARCH

The theoretical importance of the present study would best be explicated by examining the reciprocal links between taxonomy and theory development. However, this topic is large and complex so that a full presentation is beyond the scope of this chapter (see Enc 1972, Thagard 1992, Murphy 2006). However, we comment on several issues that seem particularly pertinent to the current situation in criminological theory:

1. The dominance of the General Theory Paradigm: The dominant paradigm in delinquency theory denies the existence of types both in regard to criminal specialization and in terms of differentiated explanatory patterns. Instead, many prominent criminologists prioritize the development of a unified or global explanatory theory of delinquent behavior (e.g. Gottfredson and Hirschi 1990; Jessor et al. 1991; Sampson and Laub 2005, Thornberry 2005, and others). This paradigm assumes that a single causal explanatory process underlies all forms of delinquency and that distinct etiological types do not exist. Such omnibus general explanations include the General Theory of Crime of Gottfredson and Hirschi (1990), Sampson and Laub's General Age-Graded Theory of social-control (1993), Agnew's General Strain Theory (1997), Cohen and Felson's (1979), Routine Activities Theory, and several "integrated" unified theories (Catalano and Hawkins, 1996; Farrington, 2003; Thornberry 1987; Elliott, Ageton and Cantor, 1984, and others).

The "anti-typological" stance among criminologists is shown in several ways. It is reflected in a tendency to deny or ignore the existence of types. Hirschi and Gottfredson (1994) starkly dismiss taxonomic heterogeneity ascribing most criminal behavior to a single "persistent underlying trait." Sampson and Laub (1993, 2004) reject the typological approach partly for it's methodological difficulties and the belief that the fundamental causes of delinquency are the same for everyone. They also claim that typological results are unreliable and that the groups often discussed in this literature are "tenuous". David Farrington (2003) underlined the on-going dominance of the global theory paradigm in a presidential address to the American Society of Criminology, noting that most recent theoretical developments, with the exception of Moffitt's (1993) taxonomic theory, do not support the idea of types. Osgood (2005) explicitly states his preference for general theories and the "dimensional'' data structures assumed to underlie the causal reality of general theories of delinquency.

However, it is worth noting that in spite of decades of research to test, refine and compare such omnibus theories none of them has achieved general acceptance among criminologists. Additionally, most remain only partially supported, and numerous studies show only modest empirical support for any of these theories (e.g. Mak, 1990, LaGrange and Silverman 1999; Longshore et al 2004; Longshore and Turner 1998; Hay and Forrest 2008, and others). The contents of any recent annual meeting of the American Society of Criminology (ASC) will show that most of the general theories remain in contention.

2. The lack of analytical categories in delinquency as a basis for theoretical development: However, from the perspective of theory development a key role of taxonomic research in any science including criminology is to produce analytical categories and causally homogeneous types that can identify and demarcate some natural classes or coherent process. These categories - often known as scientific objects (Daston 2000) – can then become starting points for more focused explanatory or theoretical questions to clarify, define and progressively explicate the causal structures underlying the identified category or process (Bryant 2000, Thagard 1992). In this regard, Belnap (2006) has argued that we have not yet established appropriate analytical categories for delinquency explanations of either boys or girls. Belnap also argues that much theorizing in delinquency is premature since the preliminary taxonomic work of establishing basic categories of delinquency has been neglected. More than two decades ago Cernkovich and Giordano (1979) complained about criminological theorists rushing into print with causal models of delinquency before knowing what it is they are explaining.

This typical scientific sequence appears to have been ignored in the field of delinquency research as theory development was quickly prioritized leading to a tendency to leapfrog or ignore basic taxonomic tasks. Sadly, this lack of clear coherent categories of delinquents continues to the present and remains widespread. Tremblay (2003), for example, in a broad review of the current status of causal analysis and delinquency taxonomies - whether of behavioral phenotypes, criminal careers or explanatory taxonomies – asserted that this field still does not yet have clear, agreed upon or consensus categories to support effective causal and theoretical research. Thus, a consistent hazard for delinquency research and theory development is that even the dependent variable (e.g. delinquency, variously defined) or the delinquent population or target group being studied, is often a hodge-podge of diverse latent classes that does not represent any clear category or pattern (Richters 1997). This is reflected in Tremblay's conclusions following his review of behavioral and explanatory taxonomies in delinquency:

> "Considering its prevalence….its social relevance….one would expect a well established taxonomy. Unfortunately, this is not the case" (p.186).

Thus, the substantial failure in criminology and delinquency to address the critical task of descriptive taxonomy is still largely unaddressed. It appears that we still need to discover or demarcate suitable "scientific objects" for further study (Daston 2000). Such taxonomic progressions can then reciprocally interact with on-going theory development to refine and clarify the causal mechanisms that may produce and underlie the taxonomic patterns. In this way there is a complex interaction between refinements of both the initial taxonomy and evolving theory related to the relevant taxonomic categories (Enc 1972; Hey 2001).

The damage to criminology and delinquency research of ignoring basic taxonomic work is perhaps enormous. In the absence of identification such scientific objects or categories cannot be accurately described, experimentally manipulated, and compared with appropriate contrast categories to build new knowledge and theories. The fields of psychopathology and personality theory are aware of this typical scientific sequence of tasks. For example, Cattell (1940) emphatically stated that: "nosology precedes etiology". Biologists are also emphatic of the need to carefully establish basic pre-theoretical descriptive classifications and patterns prior to theoretical and explanatory work (Brady 1994). (added linebreak)

In delinquency this disinterest in basic taxonomic research and the prioritization of general theory continues, paralleled by a fairly strong anti-taxonomic attitude among several major theorists. The present study thus runs counter to this tendency by tackling two early tasks of taxonomic research i.e. discovery (identification) of patterns/homogeneous categories and their empirical description.

TAXONOMIES AND THEORETICAL PLURALISM

Taxonomic research has a different set of assumptions from the general theory paradigm. It rejects the idea of a unified global theory and the assumed causal homogeneity that purports to explain all forms crime and delinquency. It embraces an explanatory model that assumes theoretical pluralism and the existence of heterogeneous or differentiated offender categories (types) representing multiple causal processes or pathways to criminal behavior. It asserts that the dominant paradigm mistakenly tries to "force" all forms of delinquency and delinquents into a single promethean structure. Several difficult and unresolved theoretical and empirical issues are involved in this controversy:

Causal homogeneity vs. Heterogeneity: Does theoretical pluralism occur in criminology? Theoretical pluralism is usually understood as describing a situation where no single explanation or theory is sufficient for a given domain. In this approach several different theories or explanatory processes may apply within diverse categories and/or different phases or processes within a given domain. Such pluralism is compatible with the taxonomic approach and is prevalent in most scientific fields e.g. biology, ecology, genetics, medical diseases, psychopathology, and so on (Beatty 1994, Richters 2001).

The explanatory taxonomy that has emerged for medical diseases (Thagard 1999) may be instructive to criminology in its delineation of several broad "generic" explanatory categories with several disease sub-types nested within each broad causal category. This explanatory schema has four broad disease "genera" or causal categories. The clarification of these different explanatory categories was instrumental in the development of different treatment approaches to each category. These explanatory categories of medical diseases are as follows:

1. Nutritional diseases – These diseases result from the body being deprived of some critical nutrients (e.g. scurvy, beriberi). Explanatory analogues in delinquency causation may include theories emphasizing social deprivation, strain and low human and social capital (Lykken 1995; Walsh 2002).
2. Infectious diseases – This category has several subtypes based on different sub-classes of infectious agent e.g. bacteria, viruses, fungi and the recently discovered

infectious agent named prions (Creutzfeldt-Jakob disease). Theoretical analogues in delinquency may include models that emphasize social learning theory and the learning of anti-social attitudes, excuses and neutralizations, skills, motives, etc.

3. Molecular-Genetic diseases – This more recently recognized category has two broad sub-categories. Mendelian diseases, (e.g. cystic fibrosis) are caused by an inherited mutation in a single gene. Its sub-categories emerge from mutations arising from any of the five Mendelian inheritance processes. The second broad molecular-genetic category includes Multi-factorial diseases (e.g. hypertension, cancer, atherosclerosis, diabetes) that may involve complex interactions of multiple genes (polygenic processes) and various environmental factors. The discovery of this explanatory category introduced advances in molecular medicine and new families of treatments. In criminological research the theoretical biosocial taxonomies of Lykken (1995), Mealey (1995) and Moffitt et al (2001) all include multi-factorial pathways in which biological factors are involved in complex interactions with environmental factors that unfold in several complex developmental pathways (Walsh 2002).
4. Autoimmune Diseases – This category includes several diseases that emerge when the person's immune system becomes overactive and attacks rather than defends the body (e.g. Lupus). While it may be a stretch, analogues of this category may include various psychological and neurotic conflicts leading to anti-social behavior. For example, Lykken (1995) describes a broad "genera" of neurotic/internally conflicted criminal types (paranoid personalities, limit-testing punishment seekers, and so on).

The above illustrates the broad links between theoretical pluralism and taxonomy and the more precise targeting of different intervention and treatment approaches based on improved understanding of the diverse causal categories within a domain. Medical interventions have clearly advanced in parallel with the clarification of the taxonomic diversity of disease categories and their underlying causes. We clearly do not claim an exact analogy between the criminological and medical domains and offer the above framework only as illustrative of the manner in which basic taxonomic research may facilitate new directions in determining the causes of crime, for designing more precise target populations and guiding more focused differentiated treatment and interventions in response to particular types of offenders and their crimes.

Theoretical pluralism also characterizes the emerging meta-discipline of dynamic or open systems theory that has recently entered developmental delinquency and child development studies (Richters 1997; LeBlanc 2005, 2006; Wachs 2000). Open-system concepts such as equifinality (multiple pathways to the same end) and multifinality (diverse end states emerging from the same initial state) imply a diversity of developmental pathways. Richters (1997) argues that equifinality as used in developmental psychopathology explicitly signifies that different structural/causal processes can underlie similar overt patterns of child problem behavior and that these processes jointly involve interactions between genetic influences, cognition, emotion, behavior and psychopathology (Cicchetti and Richters, 1993). Richters concludes that equifinality (or causal pluralism) is a ubiquitous characteristic of human functioning and development.

The Categorical vs. Dimensional controversy: A further pivotal empirical issue is the debate over general theory versus typological approaches. This focuses on the specific form of statistical distributions that underlie delinquent populations across theoretically relevant

factors. This debate contrasts dimensional versus categorical representations of the underlying statistical data distributions of delinquency populations (Beutler and Malik 2002). Are such distributions relatively continuous and perhaps multivariate normal, or do they contain substantial density variations, high-density clusters and thus are clumpy or multimodal? Distributional concerns can be critical in multivariate situations with multiple explanatory or causal factors where latent high-density clusters may be suspected but are difficult to detect. If the underlying inter-point distribution of cases contains substantial density variation or multimodality then categorical and typological/categorical methods are arguably more appropriate and perhaps essential (e.g. latent class models, clustering methods, etc). Conversely, if the distribution is multivariate normal, or relatively continuous with minimal multimodality then dimensional methods (e.g. regression and path analysis, survival models, factor analysis, structural equation modeling, etc.) are more appropriate (Fielding 2007, Richters 1997, Meehl 1992).

This debate on dimensional versus categorical approaches pervades the behavioral and psychological sciences and is not fully resolved (Beutler and Malik 2002: Lykken 1991). In discussions of criminological theory and taxonomic models for delinquency Osgood (2005) acknowledged the critical relevance of this issue, and on balance, preferred the dimensional approach – which aligns well with the dominant general theory paradigm. However, he also acknowledged - and we agree - that the ultimate resolution of this controversy will emerge from careful empirical examinations of our data distributions in delinquency studies, across specific sets of factors, to assess the degree of multi-modality and the presence of reliable clustering structure. Several resolutions to this debate have been proposed in which these two general approaches are seen as complementary rather than mutually exclusive (Beutler and Malik 2002). For example, it is possible to conduct data analysis in a both/and approach that simply embeds categorical results within a broader dimensional framework. However, this debate is not yet resolved in the area of delinquency studies.

WHAT STRUCTURAL FEATURES SIGNIFY THE PRESENCE OF TYPES?

The above disagreements over the reality of delinquent "types" have often proceeded with little attention to what structural features can be taken to signify the strength or weakness of typological structure in data. Such structural features are generally not revealed, and remain larely invisible to standard correlational or variable-centered methods (Ragin 2000, Bergman 2000). These data structures include, for example: 1) the stability of cluster centers, 2) the boundary conditions of clusters and 3) the proportion of "unclassifiable" cases.

The stability of cluster centers: Stable cluster centers are a first indicator of the presence of type structures. The patterns identified by cluster centers (typically cluster centroids) are the basis of the narrative interpretations of each type. Cross-sample and cross method comparisons are conventionally used as tests of cluster stability. Such stability in turn hinges on the presence of sufficiently high-density regions within a multivariate distribution that can be reliably detected by pattern recognition procedures. Our later empirical taxonomic research pays particular attention to such multiple tests of stability as the basis for judging the reality of delinquent types.

Cluster Boundaries - Fuzzy/Probabilistic versus Crisp: A second issue concerns the common assumption that for type structures to be "real" the identified clusters must be "distinct" and have well-separated boundaries. However, this idea of well-separated clusters with distinct boundaries and empty regions between them, is a fairly extreme data structure that rarely appears in the behavioral and biological sciences. These sciences mostly exhibit clusters with considerable fuzziness at their boundaries and a straggling of outlier and hybrid cases in the spaces between major social or biological categories (Hey 2001; Lykken 1995). Lykken, in fact has noted that even an ideal taxonomy of antisocial offenders may include substantial outlier and hybrid cases. Additionally, several mathematically alternative "density-search" clustering procedures have been developed to detect varying kinds of cluster structures according to boundary conditions i.e. overlapping clusters, straggly cloud-like data clusters, compact spherical clusters, and so on. Specific algorithms also exist to detect cluster structures that vary in the strength of internal density: e.g. complete-link clusters, family-resemblance clusters, average-link clusters, single-link "natural" clusters, boundary based partitions, and so on.

In reviewing delinquency studies - where appropriate taxometric methods have been used - our conclusion is that type structures in delinquent populations do not offer distinct well-separated clusters. A degree of multi-modality or cluster structure does appear to exist in many relevant domains given the consistency with which central core dense regions of delinquent type patterns are repeatedly identified across different samples and clustering methods (Harris and Jones 1999; Frick 2004; Brennan, Breitenbach and Dieterich 2008). Such studies that incorporate cross validation tests that demonstrate stable recurrent data clusters suggest that a degree of typological structure cannot be rejected in this area.

However, we also acknowledge that cluster boundaries are often fuzzy and probabilistic in the domain of explanatory delinquency taxonomies and that any inappropriate or naïve use of clustering methods might easily fail to detect reliable clusters. Full details of the diverse forms of cluster-seeking methods and cluster structural forms, and appropriate validation tests, are given in several expository texts (Arabie, Hubert and deSoete 1996, Fielding 2007, Han and Kamber 2000).

What proportion of a sample is unclassifiable? Another sign of weaker typological structure is the percentage of cases that remain unclassified and outside the boundaries of any cluster. Such cases are not part of any clustering structure and larger percentage of such cases implies a weaker typological structure. Such outliers or hybrids are generally relegated to a "residue" non-classifiable class. In previous work we found that the number of outliers and hybrid cases in the residue class amounted to 15% - 47%, depending on clustering method, types of cluster definitions and sample. It also depends critically on whether irrelevant variables were included among the classification features. These will blur the boundaries between clusters since they have no discriminatory power and simply add noise to the data. Our prior results have shown that a majority of youth in most samples consistently enter the same clusters and thus support the conclusion that, a replicable multimodal structure containing a majority of delinquent youth is repeatedly found. This typological structure conforms closely to the "family resemblance" category structure described by Rosch (1978) that also appears to be widespread in nature (Hey 2001; Bryant 2000). Thus, on balance we concluded that a reliable and consistent categorical structure does exist in the explanatory domain of delinquency, but that it does not consist of highly distinct well-separated types.

Thus, boundaries are fuzzy and a substantial percentage of youth will not belong to any type-profile.

SCOPE CONDITIONS AND THEORETICAL PLURALISM

Any shift in delinquency research from general nomothetic theories and general laws to theoretical pluralism and multiple contingent etiologies will heighten the need to establish scope conditions (SC) for each specific theory or etiological pathway. In most social and biological sciences, scope conditions are widely accepted as critical in various research designs (Goertz 2006; Richters 1997). They are used to select appropriate study samples and to restrict the range of generalizations and applicability of any theory e.g. to specific cultural contexts, specific population categories, disease categories, specific processes, stages in a developmental process, and so on. Cases falling under the SC of a theory are used to form homogeneous samples that can safely represent a particular causal category or mechanism (e.g. lupus, measles, Moffitt's LCP, neurotic offenders). The demarcated categories can then be tested, manipulated and measured to further refine and evaluate the proposed theory. Cases outside the SC may represent a totally different causal process, or may be used as explicit contrast categories. If such cases are included in any theory-testing sample or evaluation design, this may introduce unknown or latent heterogeneity to contaminate or distort research findings (Richters 1997; Meehl 1990; Lykken 1991).

The topic of SC is poorly developed in delinquency research since the dominant theoretical paradigm asserts, logically, that a "general" theory should apply to all youth and all forms delinquency. Thus, there is little need for any further specification of scope conditions. However, by ignoring scope conditions the resulting sample may unwittingly co-mingle a range of causally heterogeneous categories. Such "mixing" may change the sample wide correlations between predictors and outcomes and distort results depending on the mixing proportions of the underlying categories. This may preclude any valid substantive understandings stemming from any of the methods based on sample-wide correlation or covariance matrices e.g. path analysis, factor analysis, regression models, and so on (Richters 1997, Goertz 2006, Meehl 1992). In this regard Jack Block (2000) in examining the search for general theory in the context of child development research, wrote as follows:

> "Too often, it seems to me, psychologists assume unthinkingly a grand universality of the lawfulness of behavior. They do not inquire whether the covariance pattern of a set of variables within one group of individuals is reliably difference from the covariance pattern in another group of individuals. If there is such a reliable difference the possibility comes into play that we psychologists are dealing with importantly different kinds of individuals……If there indeed is, in the sample or population being studied, a mixture of two or more kinds of latent classes of individuals, it would advance conceptual understanding and predictability if we identify and keep analytically separate these commingled categories of persons" (Block 2000, p160).

Procedures to establish SC typically require guidance from a putative theory or some other means to define relatively homogeneous study samples. In disciplines with strong theory this is usually some conjunction of core factors of the theory. In disciplines like criminology with relatively weak theories, such conjunctions may be less useful and only an approximate atheoretical extensional definition may offer scope conditions to denote a relevant category e.g. a denotative definition may select one or several surface features as scope conditions, or may seek empirical clusters to give relatively homogeneous categories. A full discussion of SC methods is beyond the scope of this chapter and we refer readers to discussions of SC in typological and theoretical research (Goertz 2006, Richters 1997, George and Bennett 2005).

CURRENT STATUS AND TRENDS IN TAXONOMIC RESEARCH IN DELINQUENCY

Turning away from general theoretical and philosophical issues we now examine the current status and several trends related to these as a prelude to our empirical research. The following appear relevant:

1. Emergence of Theoretical Pluralism and Typological Pathways in Delinquency

Given the above context across several behavioral, social and biological sciences, it seems paradoxical that many criminological theorists deny theoretical pluralism while most other biological and social sciences embrace pluralism [Beatty 1994, Richters 1997, Lykken 1991, Goertz 2006]. We grant, that from one perspective the multiple theory paradigm will violate the norm of scientific simplicity and parsimony.

We agree with Sampson and Laub (2005) that maximum simplicity and parsimony would be provided by a single unified theory encompassing all offenders and crimes. However, we are more inclined to agree with a statement (attributed to Einstein) that everything should be as simple as possible, but not simpler (cited in Thagard p. 34). For example, Thagard (1999) and others, argue that a uniform understanding does not only come from a general overarching theory but also from the availability of clearer and more coherent explanatory schemas.

However, several voices are now embracing an explicit theoretical pluralism as well as the taxonomic approach in criminology (Moffitt 1993, Huizinga, Esbenson and Weiher 1991, Lykken 1991, 1995; Brennan, Huizinga and Elliott 1978; Harris and Jones 1999, and others). Lykken (1991, 1995) has forcefully argued that the complexity of delinquency – with its multiple interactions between socialization factors, environmental factors, personality, genetic influences, gender, cultural and learning processes – is much more likely to produce structural heterogeneity and diverse types than a single global unified process.

To demonstrate this he delineated four broad explanatory categories of criminal offenders: normal offenders, sociopathic offenders, psychopathic offenders and neurotic or internally conflicted offenders. Each involved a distinct etiology and had several sub-categories. In proposing his theoretical taxonomy he rejected a single general theory and commented on the dominant approaches of delinquency theorists by commenting on:

> "The almost irresistible tendency for criminological theorists to oversimplify the causes of crime, to underestimate the variety of psychological peculiarities that can contribute to the underlying dispositions for criminal behavior" (1995, p 17).

McVie (2004, p 22), similarly, in the context of a large national longitudinal study of delinquency in Scotland comments on current theory development as follows:

> "The complex nature of the patterns in prevalence and frequency of offending for different offence types implies that a 'general' theory of offending is unwise, as it takes no account of offence classification or attempts to understand the differential groupings of offence or offender. Contra Sampson and Laub, it appears essential that a typology is developed, at least to understand juvenile offending which is diverse and multifarious in nature."

2. Recent Advances in Taxonomic Research in Delinquency

While the taxonomic approach to delinquency is still at an early stage of development the last decade has seen several advances that may lead to stronger and more cumulative findings. These are as follows:

Theoretical Advances indicating multiple types: First, advances in theoretical taxonomies from several related disciplines have offered compelling descriptions of diverse types of antisocial offenders (Lykken 1995; Mealey 1995; Moffitt 1993). Each of these taxonomies was offered as a theoretical integrative statement based on a broad range of psychological, social and biological evidence. The specific types proposed in these taxonomies show surprising overlap in the central causal mechanisms underlying the types – although Lykken's taxonomy addresses a broader range of sub-types. Moffitt's adolescent limited (AL) and life course persistent (LCP) taxonomy, in particular, have inspired a substantial number of empirical studies to clarify and validate her types (Moffitt 2003, Piquero and Moffitt 2005).

A further theoretical advance is the entry of the open systems and complexity paradigm into child developmental research and delinquency (LeBlanc 2005, 2006; Wachs 2000). This approach is friendly to taxonomic heterogeneity with its concepts of diverse "attractor" regions and bifurcations between states of youth adaptations within a multi-dimensional phase-space map with each state defined by a specific pattern of theory-relevant variables.

Methodological advances in taxonomy development: Paralleling these theoretical advances, the last decade has also seen continuing developments in methods of taxonomy development and validation (Fielding 2007, Lenzenweger 2004). Studies that use a single clustering method on a single sample are now obsolete and have largely disappeared from the literature. More sophisticated validation designs involving cross-method and cross-sample replication are now being routinely integrated into the development of taxonomies (e.g. McIntyre and Blashfield 1980; Milligan 1996). Multiple methods designs and two-stage clustering are also now routine (i.e. where a preliminary hierarchical clustering, e.g. Ward's minimum-variance, establish provisional classifications that are then refined by subsequent

methods such as K-means partitioning). Advances have also been made in basic clustering methods e.g. mixture-models (Nagin and Paternoster 2000), semi-supervised clustering and bootstrapped aggregation methods (Brennan, Breitenbach and Dieterich 2008). New techniques from machine-learning (e.g. Support Vector Machines, Random Forests, etc) have given us efficient techniques to classify unidentified youth into pre-existing taxonomies and to address the need to establish theoretically homogeneous categories for theory testing studies and to establish scope conditions for diverse theories.

New empirical studies supporting heterogeneous delinquent types: An encouraging body of recent empirical taxonomic studies on diverse youth samples is steadily building support for the existence of causally heterogeneous delinquent types (Aalsma and Lapsley 2001; Harris and Jones 1999; Huizinga et al. 1991; Jefferson and Johnson 1991; Jones and Harris 1999; Mezzich et al. 1991; Potter and Jenson 2003; Skilling et al. 2001; Sorensen and Johnson 1996; Brennan, Breitenbach and Dieterich 2008, Brennan 2008). Additionally, the related field of child psychopathology has identified several developmental pathways leading to problem behaviors. Frick (2004) in reviewing this related discipline concluded there was sufficient evidence to indicate distinct developmental pathways leading to conduct disorder and that each pathway involves unique causal processes (see also Loeber 1996; Loeber et al. 1997).

3. Weaknesses in Prior Research on Explanatory Typologies on Delinquency

When Sampson and Laub (2005), and others, criticize the typological approach for unreliability we must agree that several methodological and design weaknesses have tended to undermine the impact, reliability and quality of taxonomic research. Thus, while the above advances are placing typological studies of delinquency on a more secure footing, we acknowledge several weaknesses that have hindered prior research – and which hopefully are now being avoided as this taxonomic effort moves forward. These weaknesses may explain why findings to date remain tentative and have lacked the cumulative development to support a more forceful challenge to the general theory paradigm.

1. *Small or inadequate samples:* Many prior studies of delinquent taxonomies used very small inadequate sample sizes – often under 200 cases. Small samples will produce very small clusters that often cannot be reliably identified. Taxonomic studies require much larger samples to ensure adequate reliability and stability of the various types (Milligan 1996).
2. *Inadequate coverage of explanatory factors:* An absence of key differentiating factors can undermine the ability to identify, differentiate or fully describe the structure of key type patterns. A comprehensive coverage of risk and need factors is needed when identifying or describing explanatory patterns (Lenzenweger 2004; Brennan 2008).
3. *Inadequate taxonomic methods and study designs*: Several prior studies of delinquency typologies used deficient taxonomic methods - e.g. clinical descriptions, inverse factor analysis, or a single cluster analysis applied to a single sample without cross-validation. However, recently more reliable research designs and appropriate validation techniques are now being incorporated into taxonomic studies (Harris and Jones 1999; Aalsma and Lapsley, 2001; Stefurak and Calhoun, 2006).

4. *Imposition of artificial cross-classifications that disguise the presence of latent classes*: Another hazard, particularly in tests of Moffitt's taxonomy, has been the use of simple cross-classifications of age of onset against selected measures of criminal offending to identify types and operationalize her taxonomy. This approach has almost no chance of discovering natural patterns and may actually mask the natural diversity among offenders. Francis et al. (2004) discuss the hazards of this approach.
5. *Inadequate knowledge of key differentiating factors between offender types:* As noted elsewhere the initial selection of classification factors for a taxonomic study is often hazardous given our limited knowledge of latent types and weak guidance from extant delinquency theories. The basic problems at this stage are the inclusion of irrelevant factors or the exclusion of critical differentiating factors. Irrelevant variables introduce the danger of blurring the boundaries between clusters and thus lowering reliability. This selection of classification factors is of equal importance to any subsequent step (Milligan 1996; Lenzenweger 2004). It governs explanatory power, interpretative coherence, completeness of type description and the ability to discriminate between types and recognize latent types. A safe approach is to utilize a comprehensive coverage of theory-relevant factors. Recent integrated omnibus theories such as Farrington's (2003) are useful guides in the factor selection task by suggesting a broad coverage of key explanatory factors.
6. *Category contamination if latent undiscovered types exist*: In classification studies, where the number of types (K) is not sufficiently large, the presence of undiscovered latent types can introduce considerable distortion of the recovered clusters. Any unrecognized classes will be falsely merged into the recovered clusters to distort the type descriptions. This has been a particular danger, for example, in verification studies of Moffitt's categories (AL and LCP) where the researchers have not sufficiently identified other latent subtypes, thus producing contaminated descriptions of the two main categories.
7. *Absence of operational "matching" procedures*: Prior studies mostly fail to provide operational methods to identify "matches" to their types or rules for type recognition and matching. This omission has seriously crippled other researchers from conducting replication studies. Thus, matching could only proceed by "eyeballing" the specific feature matches of type profiles across studies. The recent introduction of powerful case matching procedures from the Machine Learning/Artificial Intelligence field largely resolves this weakness (Berk 2008, Brennan, Breitenbach and Dieterich 2008).

Given these weaknesses it is no surprise that many prior studies of delinquent taxonomies present their findings tentatively with pleas for replication (Harris and Jones 1999, Stefurak, Calhoun and Glaser 2004).

4. Integrating Recurring Types from the Prior Literature into Our Previous Taxonomy

To contextualize the present taxonomic study we briefly review the most likely matches between those delinquent types from the prior literature that appear fairly reliably across these

prior studies with our taxonomic findings. In our prior study (Brennan, Dieterich and Breitenbach 2008) we developed a broad based explanatory taxonomy of seven delinquent types using two large samples of delinquent and problem youth (Development sample N = 1572; Replication sample N = 1453). We used multiple taxonomic methods and multiple cross-validation procedures to identify seven replicated delinquent types. The descriptions below link these seven types to the most likely matches from previously published delinquency taxonomies. For each of our seven types we found several likely or close replications. However, we note that these "matches" were based only on examining feature matches across types – and were not based on a quantitative pattern matching procedures such as Support Vector Machines (SVM) or K-Nearest Neighbor methods (for expositions of these methods see Han and Kamber 2000; Fielding 2007).

We concluded that these seven types may offer sufficient stability to begin the process of forming a consensus explanatory taxonomy of delinquent youth. The advances of this recent approach over prior delinquency typologies include: tested reliability across multiple methods and samples, internal coherence, external validity, precision of empirical profiles across a range of explanatory factors; and a broad matching to several recurring types from the past literature. These types, from our prior study, are as follows (Note: In the following description we use the numbering system from our previous study).

Type 1. Internalizing - A: Withdrawn, Abused and Rejected

Our cluster 1 had an extreme pattern of internalizing features - social withdrawal, hostility and suspicion – together with extremely violent parental abuse and neglect. The prior literature offered several similar internalizing abused neurotic types (Lykken 1995; Miller et al. 2004; Aalsma and Lapsley 2001; Harris and Jones 1999).

Type 2. Socially Deprived: Sub-culturally Socialized Delinquents

This appears to replicate the socially deprived ''lower class'' or sub-culturally ''socialized'' delinquent often mentioned in the sociological literature (Jesness 1988; Miller 1958; Van Voorhis 1994; Warren 1971). Its multiple features include: poverty and lower socio-economic class, criminal/drug-using parents, family disorganization, poor discipline, neglect and school failure. Lykken (1995) similarly described a ''common sociopath,'' as poorly socialized, often within an oppositional sub-culture, but also as psychologically ''normal''. Our cluster matched all the above features and also offered little evidence of low self control or serious internalizing psychological issues thus appearing psychologically normal and supporting Lykken's finding.

Type 3. Low-Control A: Versatile Offenders

Our taxonomy - contra Moffitt but consistent with Lykken - produced two highly impulsive low control/high delinquency clusters (3 and 6). These partly overlap Lykken's primary and secondary psychopaths. The present Cluster 3 largely matches the features of Lykken's (1995) primary psychopath in the following ways: impulsivity, low empathy, hostility, manipulative-dominance, low remorse, attention problems, disruptive school behaviors, criminal peers, high-risk lifestyle, drug abuse and serious criminal history. Other fairly close type replications with similar features are found in Moffitt's LCP, Alterman et al.'s (1998) ''Psychopathic'' and Vincent et al.'s (2003) ''Impulsive'' cluster.

Type 4. Normal ''Accidental/Situational'' Delinquents

Our type 4 category has very few risk factors, mostly minor delinquency and a relatively late age-at-first-adjudication. It partly matches Moffitt's AL type in its positive social resources, later onset and low delinquency. Lykken (1995) similarly describes a "normal" type with reasonably good socialization and competent parents. Other ''normal'' types - that are named as such - are found in Simourd et al. (1994), Aalsma and Lapsley (2001), Harris and Jones (1999) and Huizinga et al. (1991). Delinquency in this category is often explained by situational-accidental factors or peer influences (Warren 1971; Van Voorhis 1994).

Type 5. Internalizing Youth B: with Positive Parenting

Our Clusters 5 and 1 both exhibit an internalizing pattern of social withdrawal, isolation and mistrust. Both avoid delinquent peers, drugs and sex and have low adjudication rates. However, in stark contrast to the violent abusive parents of cluster 1, the parents of cluster 5 appear mostly non-abusive, competent and caring. Cluster 5 has several replicates e.g. Lykken's (1995) broad ''neurotic'' category contains a sub-type he describes as having positive parenting and normal socialization, but who are engulfed by some unconscious or emotional complexity (see also Harris and Jones's 1999 ''internally conflicted'' cluster).

Type 6. Low-Control B: Early Onset, Chronic Versatile Offenders with Multiple Risk Factors

Cluster 6 is very rare as well as unreliably identified. It is a more extreme version of Cluster 3 and perhaps simply forms a more extreme "variant" of a general low self-control category. It has multiple antisocial personality factors, high drug use, promiscuity, criminal peers, school attention problems and the highest parental crime and parental abuse. It had the earliest age-at-first-adjudication and the highest total adjudications. Similar descriptions in the literature and likely replications include: Lykken's secondary psychopath (1995), Mealey's (1995) primary sociopath, Moffitt's LCP category; as well as Sorenson and Johnson 1996; Blackburn's 1995 ''Secondary Psychopath;'' Aalsma and Lapsley's (2001) ''psychopath'' and Alterman et al.'s (1998) ''Psychopathic.'' However, this cluster was unstable in our cross-sample validation test – although we attribute this to sample differences since our second sample did not contain a sufficient number of the most serious delinquents.

Type 7. Normative Delinquency: Drugs, Sex and Peers

This cluster, like cluster 4, again reflects more ''normal'' youth with substantial school and family strengths. However, unlike Cluster 4, these youth exhibit a strong vulnerabilty to drugs, sex and peers. They show a later age-at-first-adjudication and had mostly non-violent offenses. Likely prior replicates include Moffitt's (1993) AL category; Lykken's (1995) ''dissocial sociopath'' that he describes as psychologically ''normal'' but engaged in a search for meaning and excitement that may involve drugs and sex; Harris and Jones' (1999) ''average normal'' and Alterman et al.'s (1998) ''drug-only clusters''.

We now shift to examine the degree to which this above taxonomy re-emerges on a new sample from a different locale. We use similar methods to identify, validate and cross-replicate the new taxonomic results.

METHODS

Sample

The current validation sample (n=3070) consists of adjudicated and non-adjudicated youth assessed in three statewide juvenile justice departments and two large juvenile justice county jurisdictions. This sample contains only males since the taxonomic structure of female delinquents is examined elsewhere (Brennan 2008a). The ethnic/racial breakdown of this validation sample is: 28% Caucasian, 57% African American, 0.4% Asian Americans, and 11% Hispanic. The ages range from 9 to18 with a mean of 15.58 years (Standard Deviation = 1.33). The ages at first adjudication range from 7 to17 with a mean of 13.38 (S.D. = 1.7). The number of total adjudications ranged from 0 to 19 with a mean of 3.06 (S.D. = 1.93). The number of felony adjudications ranged from 0 to 10 with a mean of 0.29 (S.D. = 0.77). These numbers reflect the fact that some non-adjudicated youth enter the sample by being referred to Juvenile Assessment Centers (JAC's) in their respective jurisdictions. Finally, this validation sample is independent of the original construction sample in our previous study (Brennan, Breitenbach and Dieterich 2008).

Other than gender this validation sample differs from the previous construction sample in two main ways. First, it has more African American youth (57%) than the original construction sample (27.4%). One of our main sampling sources was a statewide juvenile justice system from a southern state with a high proportion of African-American youth. Second, the new sample contains more minor delinquents than the original construction sample which had a mean = 1.2 and S.D. = 1.1 for felony adjudications. The range of agencies in the two samples was similar, except that the newer sample had more youth initially referred to JAC's many of whom were not adjudicated but had been referred for truancy, family problems, being incorrigible, and so on.

Measures

We designed this classification space to be comprehensive and theory-guided. Explanatory coherence is more likely in the presence of a set of theoretically relevant factors in the classification domain. We aimed at a broad coverage of features guided by the prior taxonomic literature and relevant theory. The conceptual platforms most closely guiding feature selection were Bronfenbrenner's (1979) ecological perspective and Farrington's (2003) Integrated Cognitive Antisocial Potential Theory. These identify well established theoretical domains of risk factors e.g. youth lifestyle and behaviors, youth attitudes and personality, school, leisure activities, peer relations, family, neighborhood characteristics and demographics. Each of these domains is included in the main instrument i.e. Youth COMPAS (Brennan and Dieterich 2003). This is a 171-item semi-structured assessment instrument with 32 scales. Each scale contains a set of ordinal level items with four or five response categories. For example, the response categories on the five-point items range from ''definitely no'' (1) at one pole to ''definitely yes'' (5) at the other. Example items from each of the scales are in Appendix A.

Table 1 (below) lists all of the Youth COMPAS scales, their respective numbers of items, mean scores, standard deviation and Cronbach's alpha in this sample. Most of these scales show alpha coefficients greater that 0.70 and thus fall into an acceptable range. These scores largely repeat those from our prior study. Full details of the Youth COMPAS scales, item content and measurement properties are available on request from the first author.

Table 1. Scale means and standard deviations and Alpha reliability coefficients

Input	Mean	SD	Min	Max	Alpha (Constr.)	Alpha (Validation)
Age at Assessment	15.62	1.31	9.2	18		
Felony Adjudications	0.29	0.81	0	14		
Total detentions	1.82	2.15	0	21		
Criminal Associates	1.97	0.76	1	4	0.82	0.86
Criminal Opportunity	2.16	0.62	1	4	0.82	0.77
Low Pro-social	3.12	0.64	1	4	0.66	0.78
Impulsivity	3.56	1.04	1	5	0.83	0.79
Low Empathy	2.48	1.13	1	5	0.79	0.60
No Remorse	2.34	1.00	1	5	0.78	0.76
Manipulative	3.10	0.99	1	5	0.82	0.73
Aggression	3.39	1.02	1	5	0.81	0.76
Violence Tolerance	2.79	1.18	1	5	0.88	0.84

Input	Mean	SD	Min	Max	Alpha (Constr.)	Alpha (Validation)
Social Isolation	2.14	1.03	1	5	0.87	0.84
Negative Cognition	2.75	1.08	1	5	0.83	0.77
Soft Drug Use	2.25	1.01	1	5	0.72	0.69
Hard Drug Use	1.10	0.28	1	4	0.63	0.70
Substance Trouble	2.15	1.27	1	5	0.89	0.89
Promiscuity	2.48	0.81	1	5	0.66	0.66
Academic Failure	3.00	1.07	1	5	0.39	0.66
Low Goals	1.88	1.07	1	5	0.77	0.83
Attention Problems	3.11	1.19	1	5	0.85	0.81
School Behavior	3.23	0.97	1	5	0.60	0.56
Fam. Discontinuity	3.12	1.17	1	5	0.69	0.62
Socioeconomic	2.70	1.27	1	5	0.88	0.88
Fam. Crime	2.31	0.92	1	5	0.85	0.82
Low Bonding	1.88	0.60	1	4	0.58	0.73
Inconsistent Discipline	2.27	1.09	1	5	0.89	0.91
Low Supervision	2.20	1.02	1	5	0.80	0.87
Neglect	2.10	1.02	1	5	0.86	0.80
Physical Abuse	1.87	1.06	1	5	0.81	0.83

Sexual Abuse	1.53	0.90	1	5	0.87	0.91
Parental Conflict	2.35	1.25	1	5	0.93	0.92
Neighborhood	2.46	1.28	1	5	0.88	0.89
Low Emotional Support	2.19	0.94	1	5	0.73	0.74
Youth Rebellion	2.70	1.03	1	5	0.79	0.76

Analytical Methods

1) Preliminary Data Transformations: We followed the generally accepted practice of initially transforming all raw scale scores into normalized Z-scores with zero mean and unit standard deviation (Milligan 1996).

2) Pattern Discovery: To identify type patterns in the new validation sample we used a bootstrapped aggregation (bagging) variant of K-Means clustering. The combination of bagging with K-Means was introduced by Dolnicar and Leisch (2000) to reduce problems related to initial starting points in K-Means clustering and the instability of clustering results due to outliers, hybrids, fuzzy boundaries and noisy data – all of which are typical in social science data. Bagging produces multiple classification models using each bootstrap sample of the data. These replication models are then integrated into a final aggregated classification model that typically is a more stable classification and is more robust to noise and outliers (Breiman 1996).

In the present analysis we used the bagging K-means implementation in R (R Development Core Team 2006) using all Y-COMPAS factors as input factors. We generated 1000 random samples (bags) from the validation sample with no outliers removed to create separate cluster solutions for each bag. In each replication we used two-thirds of the full training set to create each model, giving classification models that should be fairly independent so that the final aggregated model should be more robust to noise or outliers inherent in the training set. The 1000 cluster centers from these bags were then treated as data points and re-clustered with K-means. These stable cluster centers were then used as starting seed point centers for an overall K-means on the total sample to create a final taxonomic model.

3. Pattern Verification and Replication

(*a*) *Replications between Construction and Validation Sample:* To assess replication of the original typology from Brennan et al 2008 and the new typology from the present validation sample we use the McIntyre and Blashfield (1980) cross validation method.

This method can be applied to any two datasets A and B where similar clustering structure is expected. First, clustering methods are applied to A and B independently to give models M1 and M2. Second, a pattern-matching procedure, previously trained on the original clusters (Sample A), is then used to quantitatively match any cases in B that fit the original clusters of A to give model M3. This identifies and labels any cases in B that meet quantitative criteria to match M1. Third, (M3) is cross-tabulated against the independent clustering of B (M2) and an agreement coefficient is computed between the two partitions of B (e.g. Cohen's Kappa, Contingency Coefficient, etc).

We used a Support Vector Machine (SVM; Vapnik, 1998) for the pattern-matching step that was previously trained on the original typology from Brennan et al. (2008). SVM's have

demonstrated impressive pattern matching performance for many practical applications (Caruana, 2006).

(b) *Replications of the overall typology in the Validation sample*: The Macintyre-Blashfield cross validation was also incorporated into the pattern discovery bagging analysis on the validation sample using a split-sample approach. Cohen's Kappa is again used to assess convergence of the two typological models arising from this method.

(c) *Replications of specific clusters from original and validation samples:* To assess replication of matching cluster centers from the original and validation samples we computed Pearson's correlation coefficient (r) between the relevant pairs of cluster center vectors i.e. from the SVM defined 7 clusters from Brennan et al 2008 (M3) and the 7 clusters from the independent clustering of the validation sample (M2). In a second approach we demonstrate the matching of cluster pairs from the two independent solutions by clustering the joint set of 14 centroids using Ward's method and computed the resulting dendrogram. The fusion of cluster pairs at the base of the dendrogram directly illustrates the close matching between the seven pairs of cluster centers. Thirdly, we provide a graphical representation of this matching by mapping the M2 and M3 cluster centers into a 2D-Scatter Plot computed using Principal Component Analysis (PCA).

RESULTS

Generalizability and Internal Validation

Do the original seven clusters appear in the validation samples: The SVM when applied to the validation sample found that almost all cases in the validation sample could be matched to one of the seven clusters from the original study. Only 1% of the cases in the validation sample were not matched to one of the original seven clusters by the SVM procedure. Specifically, it found the following percentages of cases matching the original seven clusters (using the original numerical labels): cluster 1 (7.4%), cluster 2 (18.5%), cluster 3 (14%), cluster 4 (20%), cluster 5 (23.4%), cluster 6 (5%), cluster 7 (11%). The distributions of clusters were also similar, with the most infrequent cluster in the validation sample again being the extremely low self control/high delinquency cluster 6 with 5% while the more frequent clusters again included the socially deprived lower class youth (cluster 2), the normal situational (cluster 4) and the internalizing positive parent (cluster 5). While these percentages are not exactly the same as in the previous study, the general similarity is shown in the identification of the largest and smallest clusters. However, the more important point is that all of the original types re-emerged using the SVM in the validation sample.

Overall partition agreement between original and cross-validation typologies: The Macintyre-Blashfield (1980) method to examine the stability of clustering between the original and validation studies also found a strong matching between the original model (M3) and independent validation cluster model (M2). Cohen's Kappa was 0.64 for the overall match, with a contingency coefficient of 0.84 ($p < .000$), both indicating strong but not identical partition agreement. When the small original cluster 6 and its analogue in the validation sample were removed, kappa rose to 0.69 for the remaining six clusters, with the contingency coefficient remaining at 0.84. In the validation cluster model we found that 20%

of the cases fell in the unclassifiable category. Thus, a large majority of youth in the independent sample (about 80%) was assigned to the new independent typology model (M2).

Replication of Specific Cluster Types

(a) *Cross classification analysis*: To examine the matching of specific cluster pairs we first examined the full contingency table of original clusters (M3) cross-classified against validation clusters (M2). This confirmed that 6 of the 7 original clusters re-emerged with strong overlapping memberships across the two classifications. However, the small unstable and highly delinquent original cluster 6 failed to replicate in the M2 partition and an alternative cluster 6 was formed (in M2). Our original paper speculated that the small unstable original cluster 6 was perhaps a fragment of the larger highly delinquent low self-control cluster 3. This was confirmed by the contingency table showing that a segment of original cluster 3 cases were re-assigned to the new cluster 6 in M2.

(b) *Pair-wise Correlations between original and validated clusters*: To more precisely examine the specific stability of profile pairs between original and validation partitions we computed Pearson's r between the vectors for the matched cluster pairs from both typologies (M3 and M2). The correlations between these matching pairs indicated very high profile similarities. These correlations in Table (2) range from 0.87 to .99 for the six matched pairs. This confirms the extreme stability and replication of these cluster prototypes from the original and validation analyses. The exception obviously was cluster 6:

Thus, the Cluster 6* profile in the M2 validation model clearly differs from the original model as indicated by it's very low correlation (0.01) with the earlier cluster 6. In all other cases the pair-wise correlations ranging from .87 to .99 indicate that essentially similar stable centroids emerge across the two typologies from original and replication samples.

Table 2. Correlations between original and validation cluster centers*

M3 Original Cluster Centers	1	2	3	4	5	6	7
M2 Validation Cluster Centers	2	1	3	7	5	6*	4
Pearson R for matched pairs	0.90	0.87	0.96	0.99	0.97	0.01	0.93

* Note: the numerical labels assigned to the clusters differ between the original study model (M3) and validation study model (M2). These numerical labels were purely arbitrary. The matching pairs are seen in each column of the above table.

Another approach to illustrate the close replications of the matched clusters from original and validation studies is shown in the dendrogram below. The Ward clustering of these 14 centroid vectors shows the six matched pairs almost immediately are grouped together at very high similarity levels at the base (left side) of the dendrogram. The six pairs can be seen being amalgamated into six small clusters at the earliest fusion steps of this Ward analysis, beginning with the pair (4, M7). The M designation in this figure refers to the validation sample clusters. The six paired matches (4-M7, 5-M5, etc) all occur close to the base of the dendrogram showing that their mutual similarity is very high. The one mismatched case (M6)

in the dendrogram joins the other high delinquency, low self-control clusters (3, 6, and M3) but at a lower level of similarity. As expected these three vectors form a category of highly delinquent low-control clusters (see cluster descriptions below).

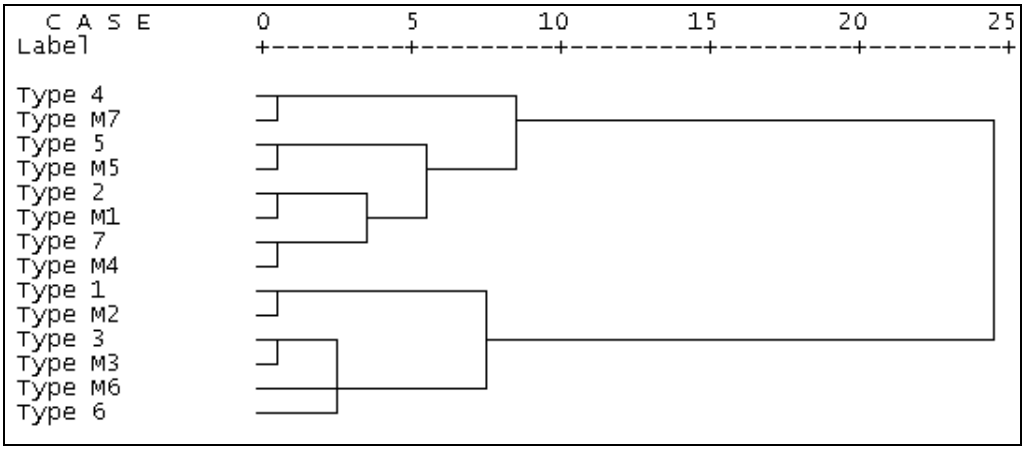

Figure 1. Dendrogram showing fusions of matched cluster pairs from original and validation sample (M).

In our third approach to illustrate the similarity of matching cluster profiles between original and validation clusters we a used Principal Component Analysis (PCA) to project the centers for fourteen clusters into a 2D space of the first two principal components. In the scatter plot the (+) markers indicate the seven cluster centers found in our replication data set (M2). The centers of the original construction sample are marked only with their number. This scatter plot shows that with the exception of cluster 6 the respective centers from the validation and original sample form six tight pairs indicating their high mutual similarity.

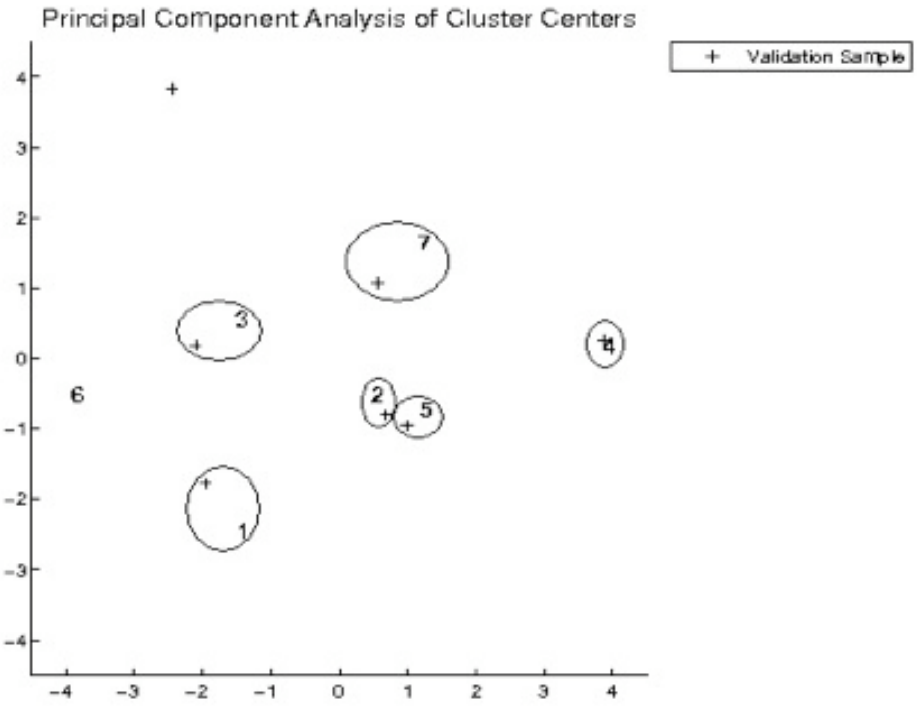

Figure 2. PCA scatter plot from the cluster centers of the original and validation sample (M).

External Validation

To examine external validation series of one-way ANOVAS with a Scheffe post-test procedure were applied to examine the associations between the new typology (M2) and five external delinquency history and demographic criterion variables that were not used in cluster development. Significant differences in such variables across types are conventionally viewed as supporting the external validation of a typology. Please note that the cluster number labels in these analyses now refer to the validation cluster model (M2). The results include many significant differences as follows:

1. *Age of each cluster*: Age differed significantly across the seven types (F = 39.1, p<.000). The Scheffe test indicated that clusters 2 and 5 were significantly younger at 15.1 and 15.3 respectively than other types, while clusters 4 (16.1) and 6 (16.2) fell into a significantly higher subset than other clusters.
2. *Age at first adjudication*: This age significantly differed between types (F = 21.7, p <.000). Clusters 2 (12.9) and 5 (12.8) were significantly younger at first adjudication than most clusters. Clusters 4 (13.8) and 6 (14.1) were significantly older.
3. *Total adjudications*: This differed significantly between types (F = 6.7, p<.000). The Scheffe test indicated that types 3 (3.4) and 4 (3.2) had significantly higher adjudications than other types, while type 7(2.8) had significantly fewer.

4. *Total Felony adjudications*: The types differed significantly on this variable (F = 8.1, p<.000). The small cluster 6 had a significantly higher average (.58) than other clusters, while clusters 1 and 2 fell in a significantly lower subset on the Scheffe test.
5. *Total detentions:* This differed significantly between types (F = 6.8, p<.000). The post hoc test indicated that type 7(1.4) fell in a subset significantly lower than other clusters, while types 2 and 3 were in a significantly highest subset.

These differences are largely consistent with the prior study. For example, the large "normal situational" type 7 again falls below the others in seriousness, extent of adjudications and detentions and is older at first adjudication. Similarly, the low self-control cluster 3 again has more adjudications and detentions than most other clusters. These differences are also consistent with the theoretical expectations for these types. The internalizing types (2 and 5) again have an early age of first adjudication that had previously characterized these two types in the original study.

Cluster Descriptions

In these descriptions we use the z-scores (Table 3) to build the narrative of each cluster. We use z scores of +/- 0.30 as indicators of relevant type characteristics following Costa et al (2002). These are highlighted in the table and are given in parenthesis in the narratives. We occasionally deviate from this rule if z scores are close to .30 and also form a coherent pattern with other key features of the profile. Please note that in the following descriptions we do not discuss matches to the prior literature – and also the number labels are now those that came with the validation analysis. The links to the prior literature are given in the final discussion section.

Table 3. Z scores for the eight male types (validation sample)

Input	1 (n=428)	2 (n=328)	3 (n=456)	4 (n=525)	5 (n=607)	6 (n=79)	7 (n=647)
Age at Assessment	–0.16	–0.26	0.12	0.38	–0.38	0.46	0.03
Felony Adjudications	–0.10	–0.11	0.00	0.04	–0.07	0.35	0.06
Total Number of Detentions	0.02	0.12	0.16	0.09	–0.01	–0.17	–0.18
Criminal Associates	–0.36	–0.06	1.02	0.51	–0.52	0.80	–0.66
Criminal Opportunity	–0.27	–0.16	0.73	0.43	–0.54	0.75	–0.36
Low Pro-social	0.30	0.12	0.55	–0.01	–0.18	0.21	–0.46
Impulsivity	–0.50	0.29	0.56	–0.01	0.44	0.47	–0.84
Low empathy	–0.20	0.08	0.96	–0.10	0.30	–0.07	–0.37
No remorse	0.09	0.24	0.80	–0.20	–0.14	–0.08	–0.54
Manipulative	–0.40	0.21	0.69	0.00	0.31	0.42	–0.78
Aggression	–0.47	0.42	0.57	–0.07	0.46	0.15	–0.87
Violence Tolerance	–0.54	0.40	0.68	–0.04	0.51	0.30	–0.79
Soc. Isolation	–0.25	0.70	–0.10	–0.38	0.38	–0.05	–0.53
Neg. Cognition	–0.37	0.59	–0.00	–0.30	0.41	–0.07	–0.75

Input	1 (n=428)	2 (n=328)	3 (n=456)	4 (n=525)	5 (n=607)	6 (n=79)	7 (n=647)
Soft drugs	–0.39	–0.10	0.48	0.65	–0.66	1.12	–0.56
Hard drugs	–0.28	–0.19	–0.15	–0.09	–0.32	3.51	–0.28
Substance Trouble	–0.38	–0.06	0.70	0.55	–0.56	1.25	–0.60
Promiscuity	–0.20	–0.13	0.45	0.43	–0.42	0.59	–0.50
Academic Failure	0.25	0.08	0.56	0.24	–0.18	0.20	–0.37
Low Goals	0.16	0.01	0.87	–0.01	–0.25	0.19	–0.35
School attendance	–0.10	0.44	0.45	0.06	0.21	0.34	–0.73
School behavior	–0.14	0.26	0.80	0.38	0.05	0.39	–0.81
Fam. discontinuity	0.22	0.81	0.02	–0.28	–0.10	–0.18	–0.57
Low Socioeconomic	0.30	0.71	0.42	–0.26	–0.11	–0.13	–0.59
Fam. Criminality	0.08	0.79	0.12	–0.18	–0.33	0.24	–0.51
Low bonds	0.26	0.55	0.45	–0.39	–0.32	0.01	–0.59
Discipline	0.49	0.81	0.56	–0.45	–0.43	0.15	–0.66
Low supervision	0.38	0.62	0.79	–0.33	–0.42	0.31	–0.61
Neglect	0.33	1.03	0.19	–0.40	–0.35	0.16	–0.64
Phys. abuse	–0.22	1.05	–0.11	–0.44	0.02	–0.06	–0.58
Sexual abuse	–0.34	0.34	–0.20	–0.39	0.01	–0.19	–0.45
Parental Conflict	0.11	0.82	0.09	–0.21	–0.44	0.42	–0.60
Bad Neighborhood	–0.16	0.35	0.55	0.11	0.36	0.03	–0.47
Low emotional support	0.21	1.00	0.23	–0.33	–0.36	0.29	–0.74
Youth rebellion	–0.41	0.57	0.41	–0.25	0.04	0.63	–0.90

Type 1 (N =428, 11%). Lower Socioeconomic Youth with Poor Family Socialization

The correlation between the original and present cluster is r = .90. This cluster - like its original counterpart – exhibits social deprivation and inadequate socialization. The youth are from lower socio-economic families (.30) with above average family disorganization (.22), inadequate discipline (.49), poor supervision (.38), neglect (.33), poor emotional support (.21) and weak family bonds (.26). School performance is relatively poor (.25) and the youth have few pro-social activities after school (.30). As in the original study, this type has little evidence of sexual (-.22) or physical abuse (-.34) and is not in rebellion against the parents (-.41). They do not show social withdrawal (-.25) or hostile negative social attributions (-.35) or aggression to others (-.47) and display no marked low-control personality features. They have lower than average involvement in drugs or promiscuity.

This cluster is a little younger than average (15.4). Its juvenile criminal history scores are about average. However, its age at first adjudication (13.2) is significantly younger than clusters 3, 4, 6 and 7.

Type 2 (N= 328, 8.5%) Internalizing Youth A: Withdrawn, Abused and Rejected

This pattern correlates at r = .87 with it original counterpart. This cluster has the same pattern of extreme abuse/neglect and an internalizing personality e.g. extreme physical abuse (1.1), sexual abuse (.34), emotional rejection (1.00), neglect (1.03), weak discipline (.81) and poor supervision (.62). This is accompanied by serious social isolation/withdrawal (.70), negative social cognitions/mistrust (.59), a hostile attitude to others (.42), above average tolerance of violence (.40) and some impulsivity (.29). The lifestyle features (drugs, promiscuity, peer associates and pro-social leisure activities) of this cluster all tend towards

average – and thus are not quite as low as in the original matched cluster. These youth come from very poor (.71) and disorganized families (.81) with high rates of crime/drugs (.79) and reside in dangerous areas (.34).

External validation tests show that this cluster has significantly earlier mean age-at-first-adjudication (12.9) than several other clusters (4, 6, and 7).

Type 3 (N = 456, 11.8%) Low-Control A: Versatile Offenders

This cluster correlates very highly with its original counterpart at r = .96. It shares the same pattern of extremely low self-control, i.e., impulsivity (.56), low empathy (.96), manipulative-dominance (.69), aggression (.57), low remorse (.80) and a reckless high-risk lifestyle. Their lifestyle again involves criminal peers (1.02), high antisocial opportunity (.73), promiscuity (.45), common drugs (.48), getting into trouble as a result of drugs (.70) and few pro-social leisure activities (.55). These activities are conducted mostly in unsafe neighborhoods (.55). Their school experience is very negative: school failure (.56), attention problems (.45) and disruptive school behavior (.80). Family factors show low socio-economic status (.42) and residence in a higher crime neighborhood (.55). Parenting factors include very little supervision (.79), poor discipline (.56) and low bonding with the youth (.45). These youth, in turn, are highly rebellious against parents (.41).

This cluster's official criminal history coheres with the above extreme profile. It has the highest mean number for both adjudications (3.4) and detentions (2.2) compared the other clusters.

Type 4 (N =525, 13.6%) Normative Delinquents: Drugs, Sex and Peers

This is one of the larger clusters. It correlates at r = .99 with its original counterpart.

It has the same pattern of risks (drugs, sex, and peers) as in the original study. These youth are slightly older than average (.38) and have several family and personal strengths. Their families are not in the lowest socioeconomic strata (-.26), are not disorganized (-.28) and do not reside in dangerous areas. Sexual (-.39) and physical abuse (-.44) are far lower than average and there is no evidence of neglect (-.40), poor discipline (-.40) or weak supervision (-. 33). Family bonds are stronger than average (-.39). However, these youth exhibit a very risky lifestyle e.g. antisocial associates (.51), few pro-social leisure activities (.43), promiscuity (.43), conventional drugs (.65), trouble from drug use (.55) but a relative avoidance of hard drugs (-.09). At school they show above average failure (.24) and negative behaviors (.38), but no loss of future goals. Personality shows no extreme low self-control factors and there are no signs of social isolation (-.38) or negative cognitive mistrust (-.30).

This type is significantly older (Ave. = 16.2) than clusters 1,2,3,5 and 7. The ANOVA analyses indicate a significantly later mean age-at-first adjudication than clusters 1, 2, 3, and 5. Otherwise, its official history scores are average.

Type 5 (N = 607, 15.7 %) Internalizing Youth B: With Positive Parenting

This cluster profile correlates very highly with its original counterpart at r = .97. It is again an internalizing type (like Cluster 2) with substantial negative social attributions (.41), hostile aggression (.46) and social withdrawal (.38). Their social isolation perhaps explains a relatively low-risk lifestyle (-.54) and an avoidance of delinquent peers (-.52) common drugs (-.66), hard drugs (-.32) and promiscuity (-.42). This cluster differs profoundly from Cluster 2

by the presence of caring, competent and non-abusive parents, who are not emotionally rejecting (-.32) or neglectful (-.35) and who do not shirk their supervision (-.42) and discipline (-.39) duties. These families give little evidence of serious disorganization (-.10) and have lower than average family crime/drugs (-.33) and low parental conflict (-.44).

This type is younger (Ave = 15.1) than average, with the post hoc test showing that it is significantly younger than clusters 3, 4, 6 and 7 (subset alpha = .05). It also has a significantly earlier mean age-at-first-adjudication than 4, 6 and 7; and significantly fewer felony adjudications than 6.

Type 6 (N = 79, 2%) Low Control B: High risk offenders

This small cluster does not have a high association with its original counterpart (r = .01). This cluster like cluster 3 has many serious criminogenic features. These youth follow a high risk lifestyle (.75), associate with anti-social peers (.80) and have the highest scores for soft drugs (1.12), hard drugs (3.51), drug related trouble (1.25) and promiscuity (.59). Their personality shows above average impulsivity (.47), manipulative-dominance (.42) and tolerance of violence (.30). At school they show disruptive behavior (.39 and attention problems (.34) but only slightly above average failure (.20). Surprisingly, their families are about average on most parenting and stability issues. However, these parents do not provide clear supervision (.31), are in serious conflict with each other (.42) while these youth show extreme rebellion against the parents (.63).

The profile of Cluster 6 has several similarities to the high risk cluster 3 but differs dramatically from 3 in it's greater drug involvement, especially hard drugs, in more positive parenting, family stability, less poverty and residence in safer neighborhoods.

Although the original counterpart was also highly delinquent, extremely rare, and had little self-control, these two type patterns, as note above, do not have a high association with each other. Thus, we again encounter the instability of this potential high risk, low self-control and rare cluster.

Type 7 (N = 647, 16.7 %) Normal ''Accidental/Situational'' Delinquents

This cluster correlates at r = 0.93 with its original counterpart. Relative to other clusters it has the lowest risk and need levels and appears virtually normal in comparison to all other clusters. These youth have higher socio-economic families (-.59), less family instability (-.57), live in safer areas (-.47), have better supervision (-.61), more consistent discipline (-.66), less physical (-.58) and sexual (.45) abuse. Their families show less parental crime/drugs (-.51) and less parental conflict (-.60) than other clusters. These youth have less risky lifestyles (-.36), fewer high crime peers (-.66), less drugs (-.56) and less promiscuity (-.50). There are no obvious school problems. They are less socially isolated (-.70). Their personality pattern shows no clear tendency towards low self control. Bonding to parents shows less erosion (-.59) and the youth show less rebellion (-.90) than most of this sample.

The official criminal history of this cluster coheres with the above benign profile showing relatively low official delinquency. Their criminal record shows significantly lower mean adjudications compared with clusters 3 and 6.

Figure (3) below shows an alternative graphical representation of the z-scores of these seven clusters. All scales are scored with a directionality such that higher scores always represent more problems or higher risks. A bar extending to the left indicates a cluster has a

lower mean score (less problems) than the grand mean. If the bar extends to the right the cluster has a higher mean score (more problems) than the grand mean. The scale inputs in the bar chart are sorted by domains that represent peers, substance abuse, attitudes, cognitions, school, neighborhood and family for easier comprehension.

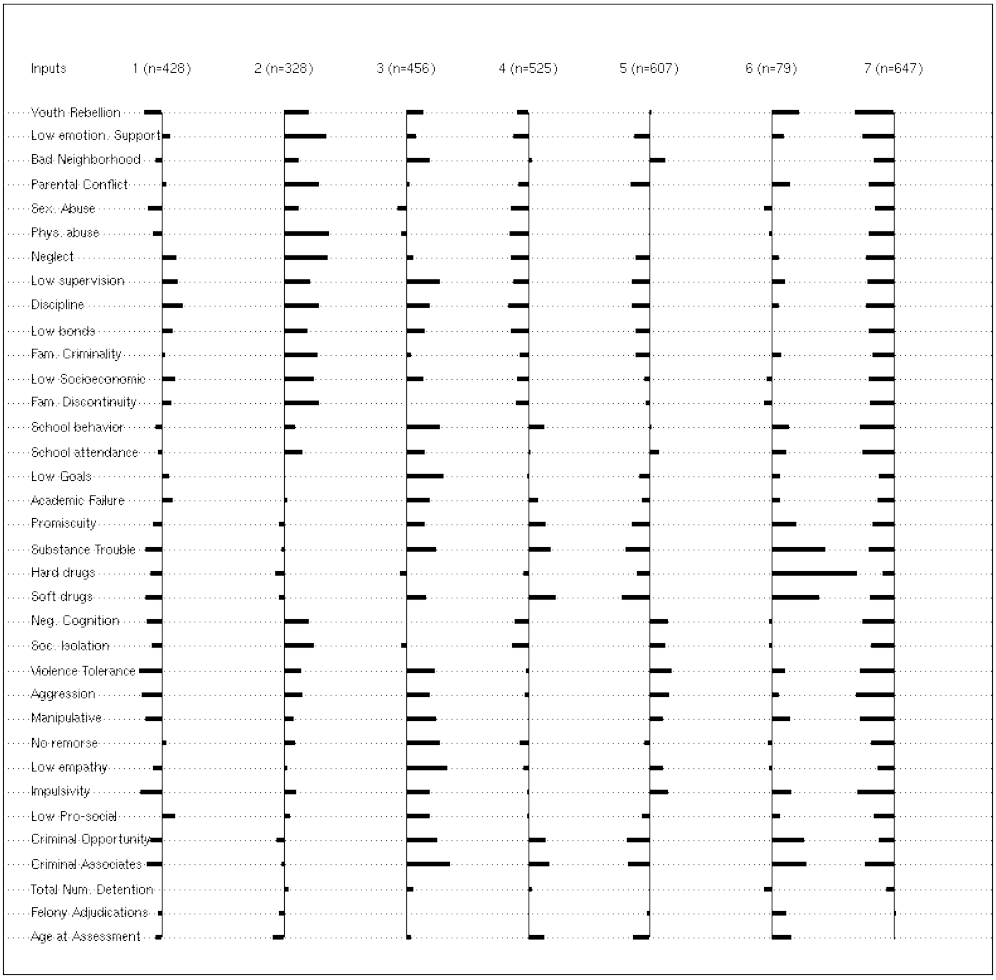

Figure 3. Z scores profiles for males only validation sample.

DISCUSSION

In this discussion we first examine conclusions regarding the structural aspects of this taxonomy of delinquents. Second, we address the congruency, continuities and likely matches between our present taxonomy and the prior literature on explanatory delinquency typologies. This leads to some conclusions regarding the most reliable taxonomic structure and major explanatory types in this domain. We then comment on the relationship between taxonomic research and delinquency theory. This involves the transformation from raw empirical

clusters towards progressively more scientific analytical categories. Finally, we note some limitations of this study.

Structural Features of This Taxonomy

What do our results imply regarding the structural aspects of a taxonomy of delinquents in the social-psychological explanatory domain? Basically, we found that the structural features of this updated delinquent taxonomy largely replicates our previous model. As noted previously most prior studies rarely discuss the structure of their taxonomies – leading to confusion over the data structures that constitute the taxonomic organization of delinquency samples. The following structural issues are critical:

Does the youth taxonomy generalize across regions? The present data shows that our original taxonomy is strongly replicated in the validation study and thus across a different locale and sample. The SVM procedure demonstrated that all seven of the original types re-emerged in the validation sample – including the small unstable cluster 6. The overall partition agreement between original and validation taxonomies was highly significant (Cohen's Kappa = 0.64; Contingency coefficient = 0.84 , $p < .000$). However, while showing strong overall agreement these coefficients also show that the two taxonomies are not identical and that the boundaries of clusters appeared unstable. This replicated our findings regarding boundaries in the first study.

Replication of specific types: In examining the replication of specific delinquent types we again found substantial stability. The data show that 6 out of the 7 original types had impressive replications in the validation sample with pair-wise correlations as follows: .90, .87, .96, .99, .97 and .93. These were the same six clusters that had high replication in the first study. Only the small low-control delinquent cluster 6 from the original study failed to replicate. However, we note that the two low-control clusters had several high delinquency features that overap and thus some similarity in their interpretations, despite the fact that they differ overall in their profile pattern.

Internal structure of clusters - Stable cores, graded membership and unstable boundaries: Our data suggest the following conclusions about the taxonomic structure.

1. Stable Central Prototypes: As shown above the replicated six cluster centers were very stable. Pairwise correlations in the range of 0.90 show the almost perfect stability of these six cluster centers across original and validation studies.
2. Unstable boundaries: We conclude that the type boundaries are somewhat unstable. This was shown by the kappa coefficients from the McIntyre-Blashfield split-half validation studies. Ranging from 0.64 to 0.69 these confirm strong but not perfect agreement between the overall partitions. Since the cluster centers were clearly stable the disagreements likely relate to unstable boundary conditions. This underscores a point made by Brewer (1993) that natural classes are primarily defined not by boundaries but by their central cases; not by what is excluded, but by what they most strongly include.
3. Probabilistic membership levels within clusters: We also conclude that the internal structure of our delinquency types – denser stable cores, fuzzy boundaries and a gradation of membership - is consistent with a "family resemblance" definition of category structure (Rosch 1978; Bryant 2000). The membership probabilities of

> cases within each cluster also confirmed this gradation ranging from high probability central core members to boundary members with progressively lower probabilities.

Outliers and Unclassifiable cases: In the typology for the validation sample about 20% of cases fell in an Outlier/Hybrid class. This is lower than in the original study and is likely due to the fact that the present typology included only boys. Since this validation model is optimally adjusted to fit boys, this would reduce the proportion of non-classifiable cases. A separate study of a girls-only sample has provided profiles specifically orientated towards girls (Brennan 2008).

Hierarchical Structure: Seven or Five Clusters? We conclude that a hierarchical arrangement defines this taxonomy – with seven basic clusters nested within a broad 5-cluster solution. As in our original study, both 7 and 5-cluster taxonomies seemed viable each giving evidence of reliability, interpretative coherence and clear matches to the prior literature. The 5-cluster solution simply merges the two "internalizing socially withdrawn clusters" (2 and 5), and the two low self-control clusters (3 and 6) merge into one larger super-ordinate low self-control cluster. One represents the internalizing pattern, and the other, the low self-control pattern.

Conclusions regarding Multimodality: When multiple methods (K-Means, Bagged methods, Semi-supervised clustering) across multiple samples and separate studies converge on highly similar core clusters this suggest that some stable structure is present. Additionally, the apparent matching to clusters in the prior literature also supports the reliability of these findings. These multiple convergences suggest that the dense clusters and their core prototypes are stable reference points reflecting several dominant patterns among delinquent youth. Our results thus support a conclusion that these data distributions have sufficient multimodal structure that leads to the reliable identification of stable latent classes. This may address Osgood's (2005) and Sampson and Laub's (2005) challenge regarding the "existence" of differential types - although given fairly entrenched positions this may clearly require further replications. In this regard we note a recent comment by Skilling, Quinsey and Craig (2001)

> "If several taxometric methods indicated the presence of a taxon, and parameter estimates arrived at in different ways (derived within and across taxometric procedures) were numerically consistent, then there would be strong grounds for believing the taxon exists"

We note that such natural categories (taxons) would almost by definition create a high-density cluster in a measurement space of theory-relevant attributes.

Are These Taxonomic Findings Congruent with the Prior Theoretical and Taxonomic Literature?

We now examine the degree to which our present taxonomy identifies delinquent types that are potentially congruent with, and may represent replications of types from previous explanatory typologies in delinquency. The prior taxonomies of Lykken (1995) and Moffitt (1993) were theoretical statements. Lykken referred to his taxonomy as an "armchair"

taxonomy, and Moffitt (2003) has indicated the need to clarify the number of types (K) in her taxonomy and add empirical precision to her theoretical prototypes. Additionally, the growing literature on explanatory delinquent typologies now offers several empirically defined taxonomies across a variety of social and psychological factors. Unfortunately, this literature is fragmented with diverse samples, diverse methods and mostly different measurement factors so that it is not easy to establish clear comparative or matching criteria. However, we attempted to examine continuities, corroborations and extensions to the most common prior theoretical and empirical taxonomies:

Type 1. Socially Deprived Delinquents – sub-culturally socialized: Our type 1 appears to replicate a socialized or sub-cultural delinquent type recurrently identified as emerging from social deprivation, poverty and sub-cultural socialization (Jesness 1988; Miller 1958; Van Voorhis 1994; Warren 1971). Our type 1 has the same conjunctive pattern of poverty, criminal/drug-using parents, low socio-economic status, family disorganization, poor discipline, neglect, and school failure; but little evidence of serious low social control or internalizing psychological issues. This also supports Lykken's (1995) contention that such ''common sociopaths'' (his term) although poorly socialized are, in fact, psychologically ''normal''. The theoretical process driving these "socialized delinquents" is that they have simply adapted to their sub-cultural environment (Miller 1985, Warren 1971).

Type 2. Internalizing and Abused: Isolated and Rejected: Several prior studies describe an internalizing delinquent type characterized by social withdrawal, hostility and neurotic behavior and a family background of serious violent abuse (Lykken 1995; Miller et al. 2004; Aalsma and Lapsley 2001; Harris and Jones 1999). Cluster 2 largely matches this type with its conjunction of internalizing features, social withdrawal, hostility, suspicion and extreme parental abuse, violence and neglect.

Type 3. Moffitt's LCP type and Low Self-Control Theory: Our cluster 3 appears to corroborate Moffitt's LCP as well as Lykken's (1995) "primary psychopath" concept. The key pattern of these types includes: impulsivity, low empathy, hostility, manipulative-dominance, low remorse, attention problems and disruptive school behaviors. Related behavioral features in our present cluster are: criminal peers, high-risk lifestyle, drug abuse and serious criminal history. Other potential replicates include Alterman et al.'s (1998) ''Psychopathic'' and Vincent et al.'s (2003) ''Impulsive'' cluster. Several theoretical models appear currently in contention to explain this type: Moffitt (1993), Lykken (1995), Gottfredson and Hirschi (1990), Hare (1996) and others.

An unresolved question is whether there are sub-types within this low-self control category. Both of our studies produced two sub-types (3 and 6). However, the instability of cluster 6 in both studies casts doubt on this finding and we acknowledge that it may be reasonable to simply offer a single super-ordinate category by combining these two clusters. Further work in this issue is required.

A second theoretical point concerns the scope conditions of the low self-control theory. Clearly, Cluster 3 largely exemplifies Gottfredson and Hirschi's General Theory of Crime in virtually every respect e.g. poor parental discipline and supervision, low-self control personality, higher opportunity and serious chronic delinquency. However, this pattern occurs only in a small percentage of the sample and does not apply to several other types. This challenges the claim that this is a "general" theory that applies to all youth and all delinquency. Thus, it would seem that the G/H theory requires a more constrained set of scope conditions.

Type 4. Normative Delinquency: Drugs, Sex and Peers: This basic pattern consists of apparently ‘‘normal’’ youth with some school and family strengths who exhibit high vulnerability and presumably interest in drugs, promiscuity and antisocial peers. They also show a later age-at-first-adjudication and commit mainly non-violent offenses. This type represents potential matches to Moffitt’s (1993) AL category; Lykken’s (1995) ‘‘dissocial sociopath’’ type he describes as psychologically ‘‘normal’’ but who seek meaning and excitement; see also Harris and Jones’ 1999; Alterman et al (1998). Such youth may be simply exhibiting the well known concept of “normative delinquency” that reflects common adolescent risk-taking and autonomy-seeking behavior.

Type 5. Internalizing Youth B – Not abused and have Positive Parenting: Clusters 5 and 2 share a similar internalizing pattern of social withdrawal and isolation, mistrust and avoidance of delinquent peers, drugs and sex. However, in contrast to cluster 2, the parents of cluster 5 appear non-abusive, competent and caring. Matches to Cluster 5 in the prior literature include Harris and Jones’s 1999 ‘‘internally conflicted’’ cluster; and a sub-type in Lykken’s (1995) broad ‘‘neurotic’’ category he describes as having positive parenting and normal socialization, but who are engulfed by some unconscious or emotional complexity. The recurrence of two internalizing clusters in both of our taxonomic studies raises the possibility that at least two different causal processes may underlie this broad internalizing pattern.

Type 6. Low-Control B: Early Onset, Chronic Versatile Offenders with Multiple Risk Factors: This second, and quite rare, low self-control cluster remains tentative due to unstable boundaries and weak replication. However, in both studies it fell in the high delinquency low self control region, implying a variant of cluster 3. In fact, it has a similar profile to cluster 3 with extreme antisocial personality, high-risk lifestyle, drug use, promiscuity and criminal peers, as well as school attention problems, high parental crime and abuse. We will not attempt to link this cluster to matches in the literature due to this instability. More “discovery” work is required before any confidence could be placed on such matches.

Type 7. Normal ‘‘Accidental/Situational’’ Delinquents: Cluster 7 identifies a commonly recurring category with apparently few risk or need factors and a relatively late age-at-first-adjudication. Similar “normal” clusters are described in Simourd et al. 1994; Aalsma and Lapsley 2001; Lykken 1995; Harris and Jones 1999; Huizinga et al. 1991 and others. Theories for the delinquency of this type are often attributed to external situational-accidental factors or peer influences (Warren 1971; Van Voorhis 1994). This cluster partially matches Moffitt’s AL type, although it does not have the strong affiliation to delinquent peers expected in Moffitt’s type.

Traversing the Path From Empirical Clusters to Scientific/Theoretical Categories

We suggest that the clusters of delinquent types emerging from this study - although surviving various validation and reliability tests – cannot yet be viewed as theoretical or analytical categories. Some may never reach that status and may be replaced by more coherent and refined categories. In their present status they provide only an ostensive or denotative definition of a category – based on an overall empirical similarity across the classification factors. At this stage these clusters successfully reflect relatively homogeneous empirical categories of delinquent youth connected by a strong mutual similarity over a broad

set of theory-relevant factors. Although we can reliably identify their membership using techniques such as SVM, these clusters are pre-theoretical in the sense that they do not yet clearly identify the underlying causal or theoretical "process" that may be producing each cluster.

These categories are not without some scientific progress as we attempt to develop them into an more precise set of analytical scientific categories. They have exhibited substantial internal homogeneity and stability. Each cluster has an explicit and fairly coherent central pattern around which most members coalesce and they appear to generalize across localities. We also have developed an explicit objective SVM-based procedure for reliable identification. These cluster patterns are also, to a degree, theory-guided, in the sense that they each reflect a specific pattern built on factors of known theoretical and predictive importance. Each pattern suggests it's own potential causal mechanism and may suggest how several current delinquency theories can be linked to a taxonomic analysis. This occurs to the degree that our taxonomic study used an input classification space was permeated by theory-relevant factors. Our input classification space specifically included over 30 factors drawn from several extant delinquency theories (opportunity, strain, social learning, low self-control, etc). Thus, a potential strength of this analysis is that the central "patterns" of each cluster may offer a starting point for the further delineation of the causal processes that may underlie each cluster (Brady 1994, Goertz 2006). Clearly, future challenges are to learn more about the causal processes that may underly these types. Additionally, the availability of quantitative identification procedures for each type may facilitate research on the developmental course of each type, specific risk prediction procedures for each; and more precision regarding differential treatment and interventions to address the specific needs of each type.

In summary, we view identifying raw empirical clusters as only a starting point in developing an acceptable taxonomy of delinquent youth. Much of our continuing analyses will aim to bolster this transformation from raw empirical clusters towards acceptable scientific categories. Daston (2000) has noted that the work of establishing scientific objects or categories is difficult and time-consuming and that these are often "elusive and hard-won" (p. 2). This is particularly the case for elusive latent classes or complex multidimensional categories (Quarks, genes, Moffitt's LCP, psychopaths, etc) and is particularly difficult in the high dimensional behavioral sciences. This shift from raw empirical clusters - based on surface similarities (phenotypes) – towards theoretically defined classes will ultimately shift the definition of these classes towards deeper theoretical criteria, and a transformation from poorly understood vague categories to more precisely measured analytical categories, with known defining features, ostensive definitions and ultimately connotative definitions based upon clearer theoretical processes. We view the present work as an early step on this journey towards a more powerful explanatory taxonomy of delinquent.

LIMITATIONS

A first limitation pertains to the often vague and diverse cluster descriptions given in the prior literature. Many prior studies fail to provide clear matching or identification rules for their types. Some prior types are described only theoretically. Thus, the matching process we

used to identify the central features of prior types and match them to our seven types was sometimes difficult. Procedures such as SVM or K-Nearest Neighbor matching now offer useful tools for this challenge (Han and Kamber 2000). An important contribution of this study is that other researchers can have the ability to reliably identify our categories by following our outlined methodology using Youth COMPAS or similar instruments of their choice and the SVM tools. The study of new "scientific objects" or analytical categories will only cumulatively progress when we can ensure that across different studies or research teams we are talking about the same things (Daston 2000; Ragin 1992). However, unfortunately, the current status in delinquency typology is such that any integrative study of delinquent explanatory types will encounter this difficulty of poor identification and matching (Tremblay 2003).

The current overlapping nomenclature in delinquency and criminology is also problematic and disorganized and creates problems of matching. For example, Moffitt's LCP, Hare's psychopath, Lykken's Primary Psychopath, and Mealey's Primary Sociopath ALL have feature lists that substantially overlap. This compounds the difficulty of matching these theoretical categories and determining whether these different terms are referring to the same or different offender categories.

A second limitation is the lack of clear tests for the degree of multimodality or "clusterability" in any high dimensional multivariate data distribution. Thus, our conclusion of multimodality is based mainly on the consistent replication of highly similar clusters. Two factors cause us to be cautious regarding any final conclusion on multimodality: 1) the unreliability and fuzziness of boundaries, and 2) the relatively large number (20%) of outliers. Both of these features serve to weaken any taxonomic or multimodal data structure by blurring the boundaries between clusters, introducing unreliable cluster matches, and ruling out the possibility of "distinct" well-separated types. Another unresolved factor contributing to fuzzy boundaries is the difficulty of clearly identifying irrelevant variables. This has been a perennial challenge in pattern recognition work and no clear solution as yet has emerged (Han and Kamber 2000).

A third limitation is that the present study does not yet attempt to address the issue of "process". Our research so far has been primarily concerned to establish the robustness, stability and descriptive content of these delinquency type patterns. A shift from pattern to process explanation clearly will involve analysis of the sequencing, course and developmental processes within each of the delinquent types. Fortunately, the extreme multi-dimensionality and breadth of our data on each of these types, and the fact that many of our variables have "time markers" may support procedures such as "process-tracing" (George and Bennett 2005) that are designed to unravel the sequential processes that may underlie complex cases such as these complex holistic types. Current studies are underway to examine how different treatments affect the types we have identified.

APPENDIX A. YOUTH COMPAS

The following briefly describes the Youth COMPAS scales used in this study. Scale name abbreviations and factor loadings (in parenthesis) for selected key items in each scale are indicated. Full psychometric characteristics and theoretical justifications for each scale are available from the first author.

Antisocial Opportunity (CrimOpp): Hang around with friends (.66), parties w/o adults (.69).
Absence of prosocial engagement (LowProsoc): Church activities (.66), sports, music/ hobbies (.66), school activities (.70).
Anti-social peers (CrimAssoc): Friends use drugs (.75), friends arrested (.70), friends dropped out (.65).
Social isolation (SocIsolate): Has trouble making friends (.77), no close friends (.62)
Common drugs (ComDrug): Alcohol use (.81), marijuana use (.78).
Hard drugs (HardDrug): Used cocaine (.72), used heroin (.62), has injected (.48).
Substance abuse trouble (SubTrbl): Poor judgment when high (.87), violent feelings when high (.83)
Sexual promiscuity (Promiscty): Frequency of intercourse (.78), number of partners (.68).
Impulsivity (Impulsiv): Takes risks (.64), makes quick decisions (.76), seen as reckless (.73).
Manipulative-dominance (Manipulate): Good at talking one's way out of trouble (.67), easily lies and gets away with things (.73), can dominate/threaten others (.55).
Empathy (LowEmpath): Feels sad when seeing other people cry (.81), guilt feelings when breaking a promise (.84).
Aggression/anger (Agress): Quick temper (.79), History of fights (.66), stays calm in arguments (.53).
Tolerance of violence (ViolTol): How wrong it is to hit someone to win an argument (.50), hit someone to teach them a lesson (.76).
Lack of remorse (LowRemor): Blames others/situation (.72), doesn't express regret (.63).
Negative social cognitions (NegCognit): Kids put you down (.78), few kids can be trusted (.63).
Academic failure/success (AcadFail): Usual grades (.79), number of classes failed (.80), times grade repeated (.57).
Attention problems (AttProbs): Trouble paying attention (.85), easily bored (.71).
Educational aspirations (LowGoals): Intends to graduate (.72), education is important (.81).
School behavior (SchoolBeh): Suspended (.72), argues/fights with students (.67), conflict w. teachers (.74).
Family discontinuity (FamDisc): Multiple caretakers (.64), separated from natural parent (.61), out-of-home placements (.72).
Social class and poverty (LowSES): Family receives social assistance/subsidized housing (.68), parent has unstable/low wage employment (.81), difficulty paying bills (.87).
Family criminality (FamCrime): Mother arrested (.62), father jailed (.60), sibling drug use (.51).
High crime neighborhood (Nhood): Friends or family assaulted (.73), drug sales (.84), witnessed fights/gunfire (.87).
Parental conflict/domestic violence (ParentConf): Parents threaten each other (.84), parents yell/fight (.78), parents attack each other (.82).
Inconsistent discipline (InconDiscp): parents have clear rules (.72), perceived fairness (.72), clear reasons for punishments (.75).

Inadequate supervision (PoorSuper): Parents check when youth returns home (.84), parents check on youth's friends (.65), parents monitor youth's activities (.85).

Emotional bonding with parents (EmotBonds): Feels close to mother (.73), close to father (.51), feels close to sibling (.70).

Parental neglect (Neglect): Youth feels neglected (.80), parents show no interest (.71), parents rarely talk to youth (.79).

Physical abuse (PhysAbuse): Youth is scared of being hurt (.86), parents violent when high/drunk (.78), youth removed from home because of abuse (.73).

Emotional support (EmotSupp): Mother is hostile (.64), kicked out of the house (.50). *Sexual abuse* (SexAbuse): Sexually abused by family member (.81), removed from home because of sexual abuse (.74).

Youth rebellion (YouthRebel): Youth intimidates parent/caretakers (.65), youth openly defies parents/caretakers (.82).

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