



## Identification of neuropsychological subtypes in a sample of delinquent adolescents

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Received 14 May 1999; received in revised form 20 August 1999; accepted 8 December 1999

### Abstract

Although research has long recognized a relationship between neurological dysfunction and delinquency, the nature of this relationship is unclear. Based on the theory that there may be clusters of delinquents with different types of neurological dysfunction which contribute to the delinquency in different ways, the present research attempted to identify these subtypes using neuropsychological testing. Seventy-seven such adolescents were administered the full Luria–Nebraska Neuropsychological Battery-III (LNNB-III) and a battery of assessments measuring behavioral functioning and substance use. A Hierarchical Cluster Analysis yielded four identifiable neuropsychological clusters: Verbal/Left-Hemispheric Deficits, Subcortical-Frontal Deficits, Mild-Verbal Deficits, and Normals. The distinctiveness of these subtypes was confirmed by univariate analyses. Results further indicated that the number of LNNB scales that were in the abnormal range differed per subtype, with each subtype differing significantly from one another. These neuropsychological subtypes were found to be associated with specific psychological and behavioral problems. © 2000 Elsevier Science Ltd. All rights reserved.

**Keywords:** Delinquency; Adolescents; Neuropsychology; Brain damage; Conduct disorder; Luria–Nebraska Neuropsychological Battery

### 1. Introduction

The literature clearly indicates that neuropsychological and neurological variables are integral in the etiology of many forms of violence and aggression in adults (Elliott, 1976, 1982, 1992; Golden et al., 1996; Jones, 1992). However, the role of these variables in adolescents is less clear. A higher than expected incidence of neuropsychological impairment has been demonstrated in several delinquent samples (e.g., Denno, 1990; Moffitt, 1988; Otnow-Lewis et al., 1985; Skoff and Libon, 1987; Yeudall et al., 1982) and reviews of this literature (e.g., Golden et al., 1996; Moffitt, 1990, 1993; Teichner and Golden, 2000). The

pattern of these findings strongly suggest that there is extensive neuropsychological heterogeneity within the population.

Based on this conclusion, the purpose of this study was to examine differential patterns of neuropsychological functioning within a sample of adolescent delinquents. The identification of specific subtypes of neuropsychological dysfunction may assist in better explaining the pattern of cognitive deficits that are particular to this population. This study also assessed behavioral functioning specific to identifiable neuropsychological clusters, specifically in relation to aggression, delinquency, and other problem behaviors.

### 2. Method

Subjects were 77 adolescents consecutively referred

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by community resources to an outpatient community clinic established as part of a grant project for the assessment and subsequent treatment of drug and behavior problems (all who were involved had indications of both problems). Basic demographic data is reported in Table 1. On the basis of the SCID-IV, the majority of subjects (68%) had a DSM-IV diagnosis of Cannabis Dependence, and only 8% were identified to have abused other drugs. On the basis of the Child Assessment Schedule, almost all subjects had a DSM-IV diagnosis of either Conduct Disorder (75.3%) or Oppositional Defiant Disorder (17.1%). A substantial number exhibited other co-morbid Axis I diagnoses including: Dysthymic Disorder (34.7%), Attention Deficit Hyperactivity Disorder (30.3%), and Generalized Anxiety Disorder (11.8%). The majority of subjects (63.9%) were referred to the clinic by their parents, while 32.5% were referred by the juvenile justice system, and 3.9% by schools. A total of 63 subjects were queried regarding prescribed psychotropic medications; 17% were prescribed such agents, with Ritalin being the drug of choice in almost every case.

### 2.1. Procedure

A structured telephone screen was performed with the youth's legal guardian prior to participation at the clinic to determine if the youth met the following inclusionary criteria which were required for treatment at the clinic: (1) diagnosis of substance abuse and conduct disorder consistent with the DSM-IV (American Psychiatric Association, 1994); (2) between 13 and 17 years of age; (3) not currently receiving psychological

intervention; (4) living with the legal guardian (usually a parent); and (5) not diagnosed with mental retardation or a psychotic disorder. The following measures were employed:

1. The Child Assessment Schedule (CAS), a structured clinical interview developed by Kay Hodges and her associates (Hodges et al., 1982) which was revised and employed to assess DSM-III-R Axis I categories of psychopathology in adolescents (Kashani et al., 1989).
2. Neuropsychological functioning was determined on the basis of performance on the Luria-Nebraska Neuropsychological Battery-III. The LNNB-III is a comprehensive neuropsychological testing battery which consists of 31 clinical subscales, yielding 35 scores (for a description of these scales see Teichner et al., 1999).
3. The Eyeberg Child Behavior Inventory (Eyeberg and Ross, 1978) is a parent-reported rating scale of problem behaviors for children and youth between the ages of 2 and 17.
4. The Child Behavior Checklist (Achenbach, 1991) is a parent self-report of their child's social competence and behavior.

### 3. Results

The 35 scores of the LNNB were entered as independent variables for a hierarchical cluster procedure. The four resultant clusters had 23, 12, 19, and 23 subjects respectively. Neuropsychological differences

Table 1  
Demographic differences between clusters

Variable	Group										F or $\chi^2$ <sup>a</sup>
	All Subjects (N = 77)		Verbal/Left (N = 23)		Sub/Frontal (N = 12)		Mild-Verbal (N = 19)		Normals (N = 23)		
	M	SD	M	SD	M	SD	M	SD	M	SD	
Age	15.3	1.2	14.61	1.31	15.42	1.16	15.42	1.07	15.26	1.21	3.78*
No. years education	9.1	1.3	8.65	1.34	8.75	0.62	9.26	1.24	9.70	1.55	2.89*
Income (1000s)	40.9	23.9	34.6	23.7	35.5	22.3	46.1	28.2	45.1	20.3	1.24
Special education (%)	32.5		40.9		58.3		21.1		17.4		7.92*
Prior head injury (%)	9.1		17.4		0.0		10.5		13.0		6.25
Seizure (%)	3.9		4.3		0.0		0.0		13.0		5.40
Birth difficulties (%)	9.1		17.4		8.3		5.3		4.3		2.80
Male (%)	77.9		87.0		91.7		78.9		61.0		6.25
Caucasian (%)	61.0		47.8		33.3		73.7		78.3		
African-American (%)	3.9		8.7		8.3		0.0		0.0		
Hispanic (%)	26.0		39.1		41.7		21.1		8.7		
Other (%)	9.1		4.3		16.7		5.3		13.0		16.8 <sup>b</sup>

<sup>a</sup> df = (3,72) for all F-tests. Chi-squares are across the four clusters (df = 3). \*p < 0.05.

<sup>b</sup> Across all ethnic groups (4 x 4 chi-square); non-significant

between the clusters were evaluated by performing a series of one-way analyses of variance (ANOVAs), followed by post-hoc pair-wise comparisons using the Tukey procedure. Specific patterns of neuropsychological functioning emerged per subtype, showing that 27 of the 35 scores significantly differentiated between subtypes. The first cluster was characterized by impaired scores on Speeded Repetition, Expressive Speech, Spelling, Reading Comprehension, Arithmetic, Serial Auditory Memory (Immediate and Delayed), and Intelligence. This cluster appeared to represent the traditional deficits seen in the verbally impaired delinquent seen frequently in the literature. As a consequence, this cluster was named "Verbal/Left Hemisphere" (VLH).

The second cluster consisted of a more general set of deficits. This included Purposeful Movement, Visual Spatial Analysis, Drawing, Expressive Speech, Reading Comprehension, Arithmetic, Figural Memory (Immediate and Delayed), Verbal List Memory (Recall, Recognition, and Delayed), Color Naming, Trail Making, General Intelligence, and Intellectual Analysis. The deficits in this group were not as severe and appeared to involve memory and higher level analysis problems, most consistent with a frontal/subcortical type of etiology. This group was labeled "Subcortical/Frontal" (SF).

The third cluster showed only mild deficits in relatively fewer areas. This included Reading Comprehension and Verbal List Learning (Recall and Delayed, but not Recognition). Overall this seemed to represent a mild verbal deficit centered in verbal learning. This group was named "Mild-verbal" (MV). The final cluster showed no deficits at all. This cluster was named "Normal" (N).

One-way ANOVAs or chi-square analyses were conducted across all demographic variables to assess the demographic similarity between subtypes. Table 1 presents differences between the clusters for major variables. Differences included a younger age for the VLH cluster, while subjects in the VLH and SF clusters were less educated than the Normals. Subjects in the VLH and SF clusters were more likely to be enrolled in special education ( $\chi^2=7.92, p < 0.05$ ). No between-cluster differences were observed for other Axis I DSM-IV diagnoses (all  $ps > 0.05$ ).

The number of LNNB scales in the abnormal range differed by subtype ( $M_s=9.87$  (VLH), 13.0 (SF), 5.11 (MV), 2.48 (Normals),  $F = 31.71, p < 0.0001$ ), with each subtype differing significantly from one another (all  $ps < 0.01$ ). Subtypes did not differ for the social competence measures of the Child Behavior Checklist, or for measures of problem intensity or number of problem behaviors as measured by the ECBI. The CBCL yielded significant between-group differences for Thought Problems and Delinquent Behavior, with the

highest scores in the SF group. The Thought Problems scales assesses the severity of thought problems such as having unusual ideas and behaviors, repeating activities, and psychotic symptomatology. The Delinquency subscale assesses the severity of delinquent behaviors such as truancy, lying, stealing, vandalizing, and alcohol and drug use.

#### 4. Discussion

This study was the first to use a cluster analysis approach which provides a unique description of the neuropsychological functioning of this sample of delinquents. This approach allows for the broad group of delinquents to be treated as a heterogeneous rather than homogeneous group, allowing us to recognize the presence of subtypes within this population. The current findings help to explain the heterogeneous and sometimes discrepant results characterizing this literature. The present investigation identified four distinct clusters of neuropsychological functioning. The overall data does not suggest substantial behavioral differences among the groups but suggests differences in the origins of their problems.

The findings have implications for treatment and understanding of these subtypes. In the VLH group, there was substantial impairment at all levels of verbal skills. It has been suggested that verbal ability is the necessary mediator of self-control mechanisms (Luria, 1980), which develop and internalize over time through social interactions. Lesions that affect these verbal mediating processes may result in impulsive acting out behaviors as self-regulation has not been adequately achieved. The severity of this group may also be reflected in their younger age, perhaps suggesting that they are recognized earlier on as having problems by referral sources.

The cognitive processes of subjects in the SF subtype were the most impaired as compared to the other subtypes. This subtype exhibited behaviors that may, in part, be a reflection of their neuropsychological status. They showed a higher rate of thought problems and delinquent behaviors as compared to subjects in the MV and Normal groups. These individuals may tend to exhibit the most impulsive forms of aggression and delinquency as they are unable to internally control their emotional reactions. These individuals are unpredictable and difficult to manage.

In contrast to the two grossly impaired subtypes, the MV cluster exhibited a profile characteristic of mild impairment. The mild deficits of these individuals may largely go unnoticed by others. As a result, they may be perceived as 'normal' rather than having their difficulties recognized at school and home.

The current findings must be considered preliminary

until a replication of these results is completed with other delinquent samples. It is recognized that the current study was exploratory, and selective in its sampling method. Ideally, future research should involve a larger number of subjects to ensure stability of any cluster or discriminant analysis approaches. Such research should also include a non-delinquent comparison group so that neuropsychological functioning, behaviors, and drug usage can be compared between neuropsychological subtypes emerging from these populations.

### Acknowledgements

The authors would like to acknowledge the invaluable support of the entire staff at the Nova Southeastern University Youth Center. Special gratitude is extended to Leah DeCato, James D.D. Bradley, Sue Warshall, Jennifer Howell, Elissa Miller, Nicole Friedman, Jesse Burguard, Dayami Rodriguez, Jeff Rindsberg, Heather Lawson, and Adrienne Manno, for their endless hours of dedication. Ed Simco, PhD provided valuable feedback regarding the data analyses. We would also like to thank the youths and their families who participated in this investigation. This research was supported by a grant from the National Institute of Mental Health (MH53455) awarded to Nathan H. Azrin, PhD.

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