

April 2021

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Recommended Citation

Kenneth J. Burke, The XYY Syndrome: Genetics, Behavior and the Law, 46 Denv. L.J. 261 (1969).

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THE "XYY SYNDROME": GENETICS, BEHAVIOR AND THE LAW

BY KENNETH J. BURKE*†

Certain persons have been discovered who possess more or less than the normal complement of two sex chromosomes. The probable incidence of males possessing an XYY complement (XY being normal) of sex chromosomes has been estimated at 1:1000 by most authorities. However, a much larger incidence of this complement has been found in institutionalized individuals and studies have suggested a strong correlation between anti-social behavior and the XYY individual. Furthermore, the relationship of genetics and biochemistry to behavior may suggest that the presence of an extra Y chromosome could be a cause of the anti-social behavior observed in XYY males.‡ The question thus arises: is the male, possessing the extra Y chromosome, criminally responsible for his anti-social acts? The present tests for legal insanity stress cognitive and/or volitional elements. Perhaps under a test such as M'Naghten, which recognizes only cognitive behavior, the XYY individual may be able to successfully argue for the inclusion of a volitional element on the constitutional ground of due process.

PROLOGUE

ON April 21, 1968, The New York Times carried a front page article beginning with the words: "The murder of a prostitute by a stable hand in a cheap Paris hotel has opened a twilight zone of criminology for unsuspecting jurists and scientists."¹

The article described the murderer as possessing an extra Y chromosome which, it was thought, might predispose him to commit violent acts. The story thus exhumed the age-old question of whether criminals are born rather than made, and if born, to what extent one's genetic nature might diminish his criminal responsibility in a traditionally nurture-oriented legal system. The report quoted Berkeley geneticist Dr. Curt Stern's interesting speculation that woman's gentility is attributable to the absence of a

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† The author is indebted to W. R. Matoush, Ph.D., staff member, Denver Law Journal, for his contribution to the discussion on genetic and biochemical topics contained in Section III, PHYSIOLOGICAL RELATIONSHIP OF XYY TO BEHAVIORAL ABNORMALITY as well as the probability figure contained in table 2.

‡ For a recent survey article concerning the XYY male, incorporating published and unpublished data, see Brown, *Males with an XYY Sex Chromosome Complement*, 5 J. MED. GENETICS 341 (1968).

¹N.Y. Times, Apr. 21, 1968, at 1, col. 3.

Y chromosome, while a double complement of the male-determining Y may perhaps explain overly-aggressive behavior.²

The next day, it was reported that Richard F. Speck, convicted of the 1966 Chicago murder of eight nurses, also possesses an extra Y chromosome, and that his lawyers were considering raising the issue on appeal.³ This article painted a picture of the XYY offender as being a tall, mentally dull, aggressive, sometimes violent individual likely to be afflicted with facial acne. These reports set off a wave of speculation in the practicing as well as in academic circles of the legal profession, heightened by the announcement that an Australian XYY defendant was acquitted in a case involving genetic structure as an indication of insanity.⁴

In view of the spate of concern generated by such news articles, the purpose of this inquiry is to analyze available scientific data to determine *first* whether there is a positive correlation between the extra Y chromosome and antisocial behavior, and *second* whether the correlation is significant enough to present an adequate defense to a criminal charge.

I. THE SEX CHROMOSOMES⁵

Of the 46 chromosomes found in each human cell, two are termed the sex chromosomes, of which the normal female possesses two X-type, or an XX complement, and the normal male possesses one X and one Y-type, or an XY structure. Occasionally, however, individuals are discovered with more or less than the normal complement of two sex chromosomes, and within the past seven years, individuals as varied as XO (only one X), XXX, XXXX, XXY, XYY, XXYY, and XXXXY have been described and confirmed. Furthermore, it is also possible that not all of an individual's cells will carry the same sex chromosome complement, and such an individual is referred to as a "mosaic" because of his uniquely varied genetic structure.⁶

The chromosomal structure is analysed by a process known

² *Id.* at 72, col. 6.

³ N.Y. Times, Apr. 22, 1968, at 43, col. 3. This report has never been confirmed in any of the scientific journals. Ironically, Speck is reported to carry a chest tattoo bearing the legend "Born to Raise Hell."

⁴ TIME, Oct. 25, 1968, at 76. This report also informed us that the above-described Parisian murderer was convicted and sentenced to seven years, notwithstanding his abnormal genetic structure.

⁵ Unless otherwise indicated, the source of the material presented in this section is M. BARTALOS & T. BARAMKI, MEDICAL CYTOGENETICS (1967).

⁶ For examples of genetic mosaics, see Court Brown *et al.*, *Fertility in an XY/XXY Male Married to a Translocation Heterozygote*, 1 J. MED. GENETICS 35 (1964); Cox & Berry, *A Patient with 45XO/48XYYY Mosaicism*, 4 J. MED. GENETICS 132 (1967); Kajii *et al.*, *XY/XYY Mosaicism in a Pre-Pubertal Boy with Tall Stature, Prognathism, and Malformation of the Hands*, 41-2 PEDIATRICS 985 (1968).

as karyotyping, which is accomplished through the following steps:

- (1) culturing⁷ the skin or blood cells of the subject to be studied,
- (2) photographing the stained chromosomes, and
- (3) rearranging the photographed chromosomes to fit a standard, international pattern.

Although the link between chromosomal defects and *physical* abnormalities is well known for many conditions such as albinism⁸ or acondroplastic dwarfism,⁹ direct evidence linking genetics with mental and *behavioral* problems is relatively new. Exemplifying a genetic condition which combines severe physical and mental defects in mongolism (Down's Syndrome), which has been found to be associated with an extra chromosome (number 21 in the karyotype).¹⁰

Regarding the sex chromosomes in particular, since only those individuals whose X structure was altered were found to be acutely abnormal or troublesome, it was generally felt that the Y chromosome carried relatively little genetic information.¹¹ In studies of multiple sex chromosome conditions, geneticists had devoted the greater proportion of their time to the X chromosome, much effort having been expended in the study of "chromatin-positive" males (those with two or more X chromosomes) in an effort to discover a link between the extra X chromosome and mental deficiency,¹² especially since there appeared to be no notable differences between patients with either XXY or XXYY structure.¹³

II. THE XYY COMPLEMENT

The first XYY individual noted in the medical literature¹⁴ appears to have come to light in 1961 after his chromosomal con-

⁷ It is during the division process known as mitosis in which two identical cells are produced from a parent cell, the primary genetic material being distributed equally to each daughter cell. During the metaphase of the mitotic process, the chromosomes align themselves in an equatorial plane of the cell, and are most easily distinguished. The chromosomes are then stained to facilitate examination, and to highlight the differences between each type.

⁸ A. MONTAGU, *HUMAN HEREDITY* 235-36 (1963).

⁹ *Id.* at 269.

¹⁰ "All patients with this characteristic phenotype . . . have all or most of chromosome 21 triply represented rather than doubly . . ." V. MCKUSICK, *HUMAN GENETICS* 18 (1964).

¹¹ Telephone interview with Dr. Arthur Robinson, geneticist, at the University of Colorado Medical Center, Denver, Colo., Oct. 16, 1968. Cf. G. VALENTINE, *THE CHROMOSOME DISORDERS* 91 (1966).

¹² Maclean *et al.*, *A Survey of Sex-Chromosome Abnormalities Among 4514 Mental Defectives*, *LANCET*, Feb. 10, 1962, at 293.

¹³ Either of these double-X male structures produces what is known as "Klinefelter's Syndrome," characterized by some mental retardation, development of breasts, high-pitched voice, and increased social problems with advancing age.

¹⁴ Sanberg *et al.*, *An XYY Human Male*, *LANCET*, Aug. 26, 1961, at 488; See also Haushka *et al.*, *An XYY Man with Progeny Indicating Familial Tendency to Non-Disjunction*, 14 *AMER. J. HUMAN GENETICS* 22 (1962).

stitution was examined because he fathered at least one defective or abnormal child during each of his two marriages. The subject, a 45-year-old white male, was described as being of average intelligence, and aside from his difficulty in satisfying employers, he appears to have been normal in all respects. Aside from confirming the existence of the XYY karyotype, this case appears to have passed relatively unnoticed by the medical community, and was probably considered to be further evidence of the absence of congenital defects and small gene content associated with the Y chromosome.

In 1965, investigators discovered a high incidence of XXYY individuals in an institution for violent or aggressive subjects who were also mentally subnormal.¹⁵ This study prompted an inquiry by Dr. Patricia Jacobs and her colleagues who discovered seven of the 197 inmates of a maximum security hospital to have XYY karyotypes.¹⁶ Since then, numerous studies have been completed in various countries.

A. Statistical Evidence of XYY Relationship to Behavioral Abnormality

Out of a total of 967 institutional and other subjects surveyed by karyotyping, 50 postpubescent individuals were found whose chromosomal structure was either totally XYY or, in the case of mosaics, was dominated by 80 percent or more XYY cells. The survey data are collected in Tables 3, 4, and 5 of the appendix. Since many of the studies reported different information concerning the same subjects, great care was taken not to duplicate individuals in the tables, and where doubt has arisen concerning an overlapping area, those individuals were eliminated from consideration.

Before considering the data further, it would be well to discuss briefly the incidence of this defect. Estimates of the incidence of the XYY complement in the general population run from as low as 1:2000¹⁷ or 1:1500¹⁸ to an unofficial high of 1:300.¹⁹ Geneticists are reluctant to accept this latter figure since it does not correspond to the known incidence of similar chromosomal disorders, and it appears that chromosomal defects come in un-

¹⁵ Casey *et al.*, *Sex Chromosome Abnormalities in Two State Hospitals for Patients Requiring Special Security*, 209 NATURE 641 (1966). The authors noted that the extra Y chromosome might also be responsible for the height difference noted between XXY and XXYY individuals.

¹⁶ Jacobs *et al.*, *Aggressive Behavior, Mental Sub-normality, and the XYY Male*, 208 NATURE 1351, 1352 (1965).

¹⁷ Slater, 2 WORLD MEDICINE 44 (1967).

¹⁸ Jacobs *et al.*, *supra* note 16, at 1352.

¹⁹ N.Y. Times, Aug. 7, 1968, at 34, col. 1.

predictable clusters.²⁰ Most authorities agree upon an incidence of 1:1000 as most probable, a figure which equals 0.10 percent of the male population.

A statistical analysis was conducted of the data in Tables 3 and 4, and from the results of that analysis, set out in full in the appendix, a summary of the more important conclusions are presented below and are illustrated in Tables 1 and 2:

Table 1
XYY's In Selected Populations

Institutional	No. XYY's	% XYY's	
Ordinary Criminals (C)	108	6	5.56
Ordinary Mentally Ill (M)	24	2	8.33
Both Mentally Ill and Antisocial (MI)	679	22	3.18
Mentally Subnormal and Antisocial (MS)	115	13	11.3
Total Institutional	926	43	4.32
Total Non-Institutional	36	0	0
Total Population	962	43	4.16
Other XYY's (Table 5)	7	7	
Total Subjects	969	50	

1. Heights of XYY Individuals

The statistics indicate a marked positive correlation of height with incidence of XYY. The average height of XYY's ranged from 71.1 inches to 75.6 inches, depending on whether height was a factor in the sampling process. This is in contrast to the normal average male height (British subjects) of approximately 67 inches.²²

2. Incidence of the XYY Syndrome

Summarized in Table 1 are the incidence rates for XYY among various samples of the surveyed population. Based on an estimated incidence of 1:1000 for this condition in the normal population, the probabilities of the indicated rates of incidence are also shown.

3. Behavioral Characteristics of XYY Individuals

Of the 50 XYY's discovered in the surveyed population, only one can be classed as behaviorally normal. A large majority (45) are given the general designation, "antisocial," but in reality, the remaining five, with such varied problems as obsessive-compulsive overaggressiveness, impulsiveness coupled with mental retardation or merely difficulties in holding employment, might also be classed

²⁰ Robinson interview, *supra* note 11.

²¹ P. HOEL, INTRODUCTION TO MATHEMATICAL STATISTICS 37-39 (1947).

²² H. KALMUS, GENETICS 41 (1964).

TABLE 2
 XYY Syndrome — Summary of Statistical Analysis

Population Surveyed	No Height Limitation in Sampling			Some Height Limitation in Sampling			Minimum Height Used in Sampling	
	Fraction XYY's	Percent XYY's	*Probability of This Incidence by Chance Alone	Fraction XYY's	XYY's Percent	Fraction XYY's	Fraction XYY's	
All Individuals	43/962	4.16	4.9 x 10 ⁻⁵⁵	30/383	7.83	11/177	10.7 (72")	
Institutional	43/926	4.32	9.4 x 10 ⁻⁵⁶					
Non-Institutional	0/36	0	0.96					
Criminal	6/108	5.56	1.7 x 10 ⁻⁹					
Mentally Ill	2/24	8.33	2.7 x 10 ⁻⁴					
Mentally Ill and Antisocial	22/679	3.18	6.6 x 10 ⁻²⁶	11/160	6.88	6/62	9.68 (72")	
Mentally Subnormal and Antisocial	13/115	11.3	4.4 x 10 ⁻²³			13/115	11.3 (71")	

*Based on estimated XYY incidence of 1:1000 in the general population, computed by use of $P(x) = \frac{n!}{x!(n-x)!} p^x q^{n-x}$, where $P(x)$ = probability of exactly x successes when drawing a sample of n persons from the population, where p is the probability of success and q, of failure on each draw.²¹

in that general category. As thus viewed, 49 of 50, or 98%, were found to be in some way behaviorally abnormal to a significant degree.

The data on the incidence of XYY among institutionalized individuals suggests a strong positive correlation between antisocial behavior and the XYY individual, a correlation which increases significantly with increased stature. Furthermore, although it appears that there is a controlling source bias in attempting to formulate any relationship with intelligence, the evidence is strong that the extra Y chromosome does have some effect on one's behavior. Indeed, the opinions of the active investigators ranged from firm, yet cautious confidence in the relationship²³ to scientific reticence concerning the term "YY Syndrome."²⁴ Most authorities would agree that the XYY is more likely than not to be significantly taller than his parents,²⁵ at best disinvolved, but probably aggressive and reacting more often against property than against the person. They would further agree that the XYY's antisocial behavior is likely to exhibit itself at a relatively early age²⁶ which, coupled with the conspicuous absence of crime among the siblings of the XYY's,²⁷ lends credence to the proposition that their deviant behavior is more influenced by genetic rather than environmental factors.

Other findings which may prove of future value in describing or treating the XYY individual, but which have not yet been studied widely enough to be reliable, are a significantly different reading in some parts of the electrocardiogram,²⁸ and abnormal electroencephalograms.²⁹ One of the most intriguing preliminary findings is an apparently direct relationship between sex chromosomes and

²³ "Therefore we believe the XYY karyotype can be correlated with height and unusual behavioural problems . . ." Borgaonkar *et al.*, *The YY Syndrome*, LANCET, Aug. 24, 1968, at 461,462; "The frequency . . . indicates that an extra Y chromosome has a part to play in antisocial behaviour . . ." Casey *et al.*, *YY Chromosomes and Antisocial Behaviour*, LANCET, Oct. 15, 1966, at 859, 860; "We have no doubt, nevertheless, that there is some form of link between an extra Y chromosome and antisocial conduct . . ." Forssman *et al.*, *The YY Syndrome*, LANCET, Oct. 5, 1968, at 779; "[c]onfirms Court Brown's proposal that . . . the XYY complement perhaps influences behaviour rather than intelligence." Leff & Scott, *XYY and Intelligence*, LANCET, Mar. 23, 1968, at 645; "[I]t seems reasonable to suggest that their antisocial behaviour is due to the extra Y chromosome." Price & Whatmore, *Criminal Behavior and the XYY Male*, 213 NATURE 815 (1967).

²⁴ Kelly *et al.*, *Another XYY Phenotype*, 215 NATURE 405 (1967).

²⁵ See Borgaonkar *et al.*, *supra* note 23, at 462.

²⁶ See Price & Whatmore, *supra* note 23.

²⁷ *Id.*

²⁸ See Borgaonkar *et al.*, *supra* note 23; Price, *The Electrocardiogram in Males with Extra Y Chromosomes*, LANCET, May 25, 1968, at 1106.

²⁹ See Cowie & Kahn, *XYY Constitution in Prepubertal Child*, 1 BRITISH MED. J. 748 (1968); Mintzer & Sato, *The XYY Syndrome*, J. PEDIATRICS, Apr., 1968, at 572; Welch *et al.*, *Psychopathy, Mental Deficiency, Aggressiveness and the XYY Syndrome*, 214 NATURE 500 (1967).

fingerprints,³⁰ which led at least one observer to comment wryly: "A fascinating thought is that, since it is known now that an extra Y chromosome may predispose its possessor to commit crimes, finger-print clues could be used simultaneously for detection and diagnosis of the thief — at least in science fiction."³¹

While it is well known that certain chromosomal defects are closely and intimately associated with the regular production of detectable effects upon the organism as a whole,³² the *biochemical* cause (as opposed to the *descriptive* cause associated with any one-to-one correspondence) appears to be shrouded in mystery, although more knowledge is continually being accumulated.³³ It is known, however, that chromosomes carry the genetic information which determines the structure and duplication of body chemicals,³⁴ and it is also known that the presence or absence of certain chemicals in the human brain is intimately associated with behavioral changes, although this field of inquiry requires far more investigation in order to be conclusive.³⁵ It is interesting to speculate that, if and when discovered, the biochemical cause of overly aggressive behavior might possibly be controlled through the administration of proper drug therapy.

Using the aforementioned figure of 1:1000 as an expected incidence to interpret the survey results, the overall rate for XYY's of 4.32 percent (Table 2) of all anti-social (institutional) types surveyed is 43.2 times higher than would be expected in the general population. Similarly, this figure rises to 78.3 times the expected incidence when we include some minimum height restriction, and to 107 times the expected incidence when the minimum height is restricted to 6 feet. Estimates of the probability of drawing the identified XYY's from a normal population solely by chance indicate an extremely small probability that the results are merely fortuitous. Moreover, if there were no difference between the

³⁰ See Alter, *Is Hyperploidy of Sex Chromosomes Associated with Reduced Total Finger Ridge Count?*, 17 AMER. J. HUMAN GENETICS 473 (1965); Hunter, *Finger and Palm Prints in Chromatin Positive Males*, 5 J. MED. GENETICS 112 (1968); Penrose, *Medical Significance of Finger-prints and Related Phenomena*, 2 BRITISH MED. J. 321 (1968).

³¹ Penrose, *supra* note 30, at 324.

³² See McKUSICK, *supra* note 10. See generally, BARTALOS & BARAMKI, *supra* note 5.

³³ The biochemical cause of the genetically-linked disease phenylketonuria, for example, is attributed to untoward changes in brain chemistry; see McKUSICK, *supra* note 10, at 69. Testing of the newborn for this disease, required by COLO. REV. STAT. ANN. §§ 66-27-1 *et seq.* (Supp. 1965), can result in the elimination of the severe mental retardation produced by the malady, through the use of proper diet therapy, involving reduced intake levels of the amino acid phenylalanine.

³⁴ See McKUSICK, *supra* note 10, at 61.

³⁵ See Mandell *et al.*, *Psychochemical Research in Man*, 162 SCIENCE 1442 (1968).

observed incidence and the incidence in the general male population, the figure 4.32 percent indicates a tremendous societal problem, particularly since psychiatric treatment does not appear to help many of these individuals.³⁶

III. PHYSIOLOGICAL RELATIONSHIP OF XYY TO BEHAVIORAL ABNORMALITY

While the statistical evidence that has been collected shows a strong correlation between the XYY condition and antisocial behavior, a more satisfying demonstration of a cause and effect relationship would rest upon the demonstration of an actual biochemical mechanism for behavioral aberrations traceable to the presence of the XYY chromosomal complement. Clear evidence of such a mechanism is not yet available, however; hence any discussion of the available data in this area is necessarily quite speculative.

A. *The Relationship of Genetics and Biochemistry to Behavior*

Although many workers in the field would ascribe considerable importance to environmental factors,³⁷ a genetic origin has been suggested for many aspects of general behavior. Such specific psychological illnesses as amaurotic family idiocy and Huntington's chorea³⁸ have been shown to follow classic hereditary patterns, while other illnesses with mental or behavioral implications, such as phenylketonuria (PKU)³⁹ and galactosemia⁴⁰ have been traced to metabolic disturbances which very likely have a genetic origin.

Perhaps of greater significance, however, are the studies which indicate possible genetic or biochemical bases for schizophrenia and manic-depressive psychosis. Extensive statistical analysis of studies involving identical and fraternal twins has indicated that a strong "genetic factor" is indicated in schizophrenia,⁴¹ although this factor does not follow classical Mendelian patterns but is explicable on the hypothesis that genetically predisposed individuals will develop schizophrenia if subjected to sufficient environmental stress. Less

³⁶ Nielsen, *The XYY Syndrome in a Mental Hospital*, BRITISH J. CRIM., Apr., 1968, at 186; see Price & Whatmore, *Behaviour Disorders and Pattern of Crime Among XYY Males Identified at a Maximum Security Hospital*, 1 BRITISH MED. J. 533 (1967).

³⁷ See e.g., J. COLEMAN, *ABNORMAL PSYCHOLOGY AND MODERN LIFE* (1956).

³⁸ See A. MASLOW & B. MITTELMANN, *PRINCIPLES OF ABNORMAL PSYCHOLOGY* 117 (1951).

³⁹ See MONTAGU, *supra* note 8, at 174-76, 365.

⁴⁰ *Id.* at 363.

⁴¹ See Kallman, *The Genetic Theory of Schizophrenia*, in READINGS IN LAW AND PSYCHIATRY (R. Allen, E. Ferster & J. Rubin, eds. 1968) 56-60; MASLOW & MITTELMANN, *supra* note 38, at 119.

extensive twin studies have suggested a similar genetic factor in manic-depressive psychosis.⁴²

From a physiological point of view, schizophrenia has been related to a disturbance in adrenal gland function in which there is a lack of sufficient corticoid hormone secretion to meet stressful conditions.⁴³ The ability to induce schizophrenic symptomology with such drugs as mescaline and lysergic acid has suggested to some that schizophrenia may result from the presence of certain brain chemicals with properties similar to these drugs.⁴⁴ Heath obtained the most impressive physiological results by injecting volunteers with a substance (taraxein) obtained from the blood of schizophrenic patients which induced such schizophrenic symptoms as catatonic reactions, paranoia, disorganization and depersonalization.⁴⁵ The onset of symptoms was gradual, reaching a peak between 15 and 40 minutes following the injection and then subsiding. Heath considers the symptoms resulting from taraxein to be more specifically schizophrenic in nature than those resulting from mescaline or lysergic acid, the effects of which he considers more characteristic of toxic psychoses.

The significance to a genogenic argument of these biochemically based explanations of schizophrenia may not become clear until it is pointed out that physiology and body chemistry are fundamentally reflections of one's genetic endowment. That is, genes and chromosomes are the ultimate sources of those biochemical substances (enzymes) which regulate all biochemical processes,⁴⁶ which in turn are known to have an effect upon behavior.

Turning again to the XYY syndrome, a strong statistical correlation between the genetic condition and antisocial behavior has been shown. Confirmation of the causal link through the demonstration of a physiological mechanism is not yet possible, although the presumption of a genetic-biochemical relationship is perhaps stronger than with other psychopathologies, since in XYY individuals there is an *observable* chromosomal abnormality with the result that microbial and traumatic pathologies are essentially eliminated.

⁴² See MASLOW & MITTELMANN, *supra* note 38, at 121.

⁴³ See COLEMAN, *supra* note 37, at 275; C. MORGAN & E. STELLAR, *PHYSIOLOGICAL PSYCHOLOGY* 541-42 (1950); *but see* C. MORGAN, *PHYSIOLOGICAL PSYCHOLOGY* 564 (3d ed. 1965).

⁴⁴ See COLEMAN, *supra* note 37, at 275.

⁴⁵ *Id.* at 276.

⁴⁶ See E. GARDNER, *PRINCIPLES OF GENETICS* 259-80 (3d ed. 1968).

B. *Interrelationship of the Sex Chromosomes*

It would be tempting to ascribe the antisocial behavior of XYY's to a masculinizing or more aggressive behavioral influence traceable to an excess of male hormones (androgens), an increase in which would be suggested by the extra Y chromosome. However, since both male and female hormones (estrogens) are present in both sexes,⁴⁷ a genetic link for androgens would not be indicated for the Y chromosome. It is nevertheless possible for the Y chromosome to have the function of activating or regulating other gene sites, particularly on the X chromosome. Present scientific theory suggests that unlike the "euchromatin" of gene-bearing chromosomes, which govern specific, Mendelian traits, the so-called "heterochromatin" of the Y chromosome appears to act as a genetic regulator and therefore exerts a quantitative effect which may be the real basis for observable sex differences.⁴⁸ Consequently, the presence of the extra Y chromosome may alter a delicately balanced regulatory function, with possibly far-reaching consequences.

Certain genes govern the production of specific physiological intermediates which in turn direct ultimate physiological results. When such genes are "nonfunctional" in whole or in part, as appears to be the case with such diseases as phenylketonuria (PKU) and *diabetes mellitus*, it is presumably the absence or scarcity of gene sites that brings on the symptoms and determines their severity.⁴⁹ Conversely, where an *excess* capacity is available for the production of physiological intermediates, it appears plausible that an *overproduction* of gene products will ensue, with or without detectable physiological effects. Returning to the XYY syndrome and assuming that the Y chromosome produces an intermediate activator substance, the presence of two chromosomes in the XYY male presumably makes available *twice* the genetic capacity for the Y-related product, with consequent disruption in the *quantitative* function which has been postulated.

It should be noted that where multiple X chromosomes are concerned (including the case of the normal XX female), only one of the X chromosomes is "euchromatic" and is therefore functioning via Mendelian genes (i.e., conferring specific, qualitative traits).

⁴⁷ See U. MITTWOCH, SEX CHROMOSOMES 243-44 (1967).

⁴⁸ See *id.* at 238-45, for a discussion of the possible mode of action of sex chromosomes.

⁴⁹ See Sinsheimer, *The Prospect for Designed Genetic Change*, 57 AM. SCIENTIST 134 (1969).

One well-known theory (Lyon hypothesis)⁵⁰ holds that only this *one* X chromosome (whether in the normal XX female or such multiple X complements as XXY and XXX) is genetically active, while the others are not, although the possibility remains that the "inactive" chromosomes may yet retain a *quantitative* function. While multi-X individuals are able to *survive*, the lack of totally normal physiology supports the notion of a secondary quantitative function.

In summary, it may be said that the presence of an extra Y chromosome provides a potential excess capacity for synthesis of genetic products, which *could* be a cause of the type of behavior observed in XYY males. Perhaps it is unnecessary to attempt to define the specific role of the extra Y chromosome, and it may be sufficient to note that chromosomal abnormalities can be expected to cause some degree of disturbance in biochemical-physiological balance, as evidenced by widespread physical and mental abnormalities observable in the individuals affected by other multiple-chromosomal defects, such as mongolism.

The foregoing speculations, while not in the least establishing a physiological cause-and-effect relationship between XYY individuals and antisocial behavior, do suggest a strong probability of such a relationship, especially when the physiological-genetic hypothesis is reinforced by the rather convincing statistics observed earlier. Based upon a consideration of the foregoing presentation, we shall next inquire into the possibility of modifying the present outlook on criminal responsibility, through an analysis of the various tests of insanity and the various constitutional issues involved therein.

IV. THE XYY MALE AND CRIMINAL RESPONSIBILITY

A. *Mens Rea*

One writer has summarized *mens rea* by stating that it is inefficacious and unjust to punish conduct without reference to the actor's mental state. The author noted that the primary problem lies not with the actor's *mens rea*, but with his ability to cope with it.⁵¹ In an exhaustive study of the *mens rea* concept, another writer, recalling the slogan expressed by R.M. Hare that "ought"

⁵⁰ MITTWOCH, *supra* note 47, at 242.

⁵¹ Packer, *Mens Rea and the Supreme Court*, 1962 SUPREME COURT REVIEW 107, 148-52. For three conflicting Supreme Court decisions concerning *mens rea*, see Lambert v. California, 355 U.S. 225 (1957); Morissette v. United States, 342 U.S. 246 (1942); United States v. Balint, 258 U.S. 250 (1922).

implies "can,"⁵² traced the development of the notion of a "capacity to conform" in terms of the constitutional principles of due process as applied to the concept of insanity.⁵³ Furthermore, when considered in conjunction with the widening communication gulf between psychiatrists and lawyers,⁵⁴ the chaotic results which have obtained with an intent-oriented concept of diminished capacity,⁵⁵ and the presumption that courts will continue to embrace some notion of a free will in human affairs,⁵⁶ it appears that future developments in the field of criminal responsibility will emerge as modifications of the insanity defense. The remainder of this article will therefore be devoted to an analysis of this defense as applied to the XYY male.

B. Insanity

It is evident that an insane person cannot constitutionally be tried for a crime,⁵⁷ although the constitutional limitation really prescribes that any test is sufficient if it has some basis in fact which is consonant with state policy.⁵⁸ The chief tests of insanity in the

⁵² R. HARE, FREEDOM AND REASONS 51 (1963).

⁵³ Dubin, *Mens Rea Reconsidered: A Plea for a Due Process Concept of Criminal Responsibility*, 18 STAN. L. REV. 322 (1966).

⁵⁴ See J. MACDONALD, PSYCHIATRY AND THE CRIMINAL (1958).

⁵⁵ *People v. Conley*, 64 Cal. 2d 310, 411 P.2d 911, 916-17, 49 Cal. Rptr. 815, 820-21 (1966) affirmed the principle stated in *People v. Henderson*, 60 Cal. 2d 482, 386 P.2d 677, 682, 35 Cal. Rptr. 77, 82 (1963) which recognized the significance of a defense not amounting to legal insanity, yet resulting in an amelioration of the M'Naghten approach to criminal responsibility. The *Conley* court approved the rule that the doctrine of "diminished capacity" dealt with the defendant's ability to form the requisite specific intent, specifically when some mental defect (e.g., drunkenness) reduces his ability to comprehend the law's proscription and to understand the obligation to conform his conduct thereto. The doctrine would thus present a defense to a crime if the evidence established such diminished capacity that the defendant could not form the required specific intent. However, in *People v. Talbot*, 64 Cal.2d 691, 414 P.2d 633, 646, 51 Cal. Rptr. 417, 430 (1966) cert. denied, 385 U.S. 1015 (1967) and 388 U.S. 923 (1967), the California Supreme Court held that no prejudice resulted from a failure to read to the jury instruction on manslaughter as set forth in the *Conley* case which would have allowed the jury to consider the doctrine of diminished capacity in a felony-murder conviction; *Talbot v. Nelson*, 390 F.2d 801, 803 (9th Cir. 1968) upheld this position in a federal habeas corpus proceeding. In an intervening California appellate court decision, *People v. Aubrey*, 61 Cal. Rptr. 772, 777 (Ct. App., 2d Dist. 1967), it was held that the trial court has committed error "in failing to advise the jury that a deliberate and unprovoked homicide may be manslaughter" due to the diminished capacity of the defendant. Finally, *People v. Muszalski*, 260 Cal. App. 2d 764, 67 Cal. Rptr. 378, 384-86 (Ct. App., 1st Dist. 1968) added more support to the *Conley* decision by indicating that the doctrine of diminished capacity does apply to felony-murder situations, thus leaving California with two somewhat different, yet overlapping, standards of criminal responsibility.

⁵⁶ See e.g., *United States v. Chandler*, 393 F.2d 920, 929 (4th Cir. 1968); see also *Powell v. Texas*, 392 U.S. 514 (1968).

⁵⁷ See *Bishop v. United States*, 350 U.S. 961 (1956); *Leland v. Oregon*, 343 U.S. 790 (1952); *People v. McClain*, 37 Ill. 2d 173, 226 N.E.2d 21, 24 (1967).

⁵⁸ *Leland v. Oregon*, 343 U.S. 790 (1952).

United States are the M'Naghten, Durham, and "substantial capacity" tests, each of which is explored below.⁵⁹

1. M'Naghten.

In those jurisdictions which rely on the old M'Naghten test⁶⁰ or its numerous variants, the essence of the defense requires the accused to prove that, due to a defect of reason, from disease of the mind, he was totally unable either to understand what he was doing or to comprehend the wrongfulness of his act.⁶¹ At least one state has embellished the test with instructions that "care should be taken not to confuse such mental disease with moral obliquity, mental depravity or passion growing out of anger, revenge, hatred, or other motives, and kindred evil conditions, for when the act is induced by any of these causes the person is accountable to the law,"⁶² thus confusing the already vague situation with even more nebulous normative judgments. Major critics of this test mention as primary liabilities its overemphasis of the cognitive element⁶³ and its "all or nothing" approach.⁶⁴

Since the XYY individual apparently has difficulty *controlling* his behavior, it is hard to see the relevance of genetically affected conduct to a cognition test in the first instance, or the weight it would be accorded in the second.⁶⁵ Under such circumstances, it is highly unlikely that a successful defense can be predicted upon one's genetic makeup where the test of criminal responsibility is determined under the M'Naghten rules.

2. Durham⁶⁶

In 1954, the District of Columbia Circuit broke with tradition and introduced a test which relieved the defendant of criminal responsibility if the act in question was the product of mental disease or defect. Soon plagued by problems of construction,⁶⁷ the

⁵⁹ Although many states include "Irresistible Impulse" with their law regarding the insanity plea, this defense was not considered relevant to the discussion at hand due to the disfavor attending the concept; see R. PERKINS, CRIMINAL LAW 756-63 (1957). A further reason for its dismissal is the lack of evidence propounded by the cited medical authorities regarding compulsive behavior as being attributable to the extra Y chromosome and the resultant unwillingness of geneticists to mechanistically attribute compulsive or aggressive behavior to any single genetic defect.

⁶⁰ Daniel M'Naghten's Case, 8 Eng. Rep. 718 (H.L. 1843).

⁶¹ PERKINS, *supra* note 59, at 746-51.

⁶² COLO. REV. STAT. ANN. § 38-8-1(2) (Supp. 1965).

⁶³ See MACDONALD, *supra* note 54, at 26-38.

⁶⁴ See T. SZASZ, LAW, LIBERTY AND PSYCHIATRY 127-37 (1963).

⁶⁵ The issue concerning a defendant's genetic constitution as an XYY was reportedly raised in a recent American proceeding concerned with a rape-homicide charge. TIME, Oct. 25, 1968, at 76.

⁶⁶ Durham v. United States, 214 F.2d 862 (D.C. Cir. 1954) (adopted similar 1870 New Hampshire test, *id.* at 874); see PERKINS, *supra* note 59, at 763-65.

⁶⁷ See Blocker v. United States, 288 F.2d 853, 857-73 (D.C. Cir. 1961) (concurring opinion).

court was forced to redefine the terms "mental disease or defect" to include any abnormal condition of the mind which "substantially affects mental or emotional processes and substantially impairs behavior controls."⁶⁸

The admissibility and evidentiary weight of an XYY genetic structure are evident in the *Durham-McDonald* test and the likelihood that one's genetic composition might present a valid defense to a criminal charge is thus correspondingly increased over that afforded by the M'Naghten rules, although the limitation of this test to "conditions of the mind" may operate to lessen the impact of the modification in the case of an XYY individual.

3. American Law Institute or "Substantial Capacity"

One year before *Durham* was announced, the American Law Institute (A.L.I.) proposed a model standard of criminal responsibility worded as follows:

(1) A person is not responsible for criminal conduct if at the time of such conduct as a result of mental disease or defect he lacks substantial capacity either to appreciate the criminality [wrongfulness] of his conduct or to conform his conduct to the requirements of law.

(2) As used in this Article, the terms "mental disease or defect" do not include an abnormality manifested only by repeated criminal or otherwise anti-social conduct.⁶⁹

Of those states rejecting the opportunity to adopt the new test, some courts maintain that they are bound by statute and that change is for the legislature,⁷⁰ while others contend that there was no error in refusing instructions based upon this test.⁷¹

⁶⁸ *McDonald v. United States*, 312 F.2d 847, 851 (D.C. Cir. 1962); *accord*, *Washington v. United States*, 390 F.2d 444 (D.C. Cir. 1967). An interesting dictum appears at 446 wherein the court states that a defendant's "genetic structure," *inter alia* may impair his ability to control behavior.

⁶⁹ MODEL PENAL CODE § 4.01 (Proposed Official Draft, 1962). Alternative (b) to paragraph (1) of MODEL PENAL CODE § 4.01 (Tent. Draft 41 No. 4, 1955) provided the interesting variation either: "to appreciate the criminality of his conduct or is in such state that the prospect of conviction and punishment cannot constitute a significant restraining influence upon him."

⁷⁰ *State v. Dhaemers*, 276 Minn. 332, 150 N.W.2d 61, 66 (1967) (husband convicted of murder of wife and mother-in-law after receiving additional papers concerning divorce proceeding commenced by wife); *accord*, *State v. Eubanks*, 277 Minn. 257, 152 N.W.2d 453, 457 (1967), *cert. denied*, 390 U.S. 964 (1968). This case interpreted the failure of the legislature to modify *Minn. Stat.* § 611.026 (1965) after *Dhaemers* as indicating adherence to the old rule (sociopath convicted of first degree murder arising out of attempted rape).

⁷¹ See *e.g.*, *State v. Lucas*, 30 N.J. 37, 152 A.2d 50, 68-69 (1959) (mentally deficient defendant convicted of felony-murder arising out of rectory arson). The court stated: "Until such time as we are convinced by a firm foundation in scientific fact that a test for criminal responsibility other than M'Naghten will serve the basic end of our criminal jurisprudence . . . we shall adhere to it." *Id.* at 68. Note: The M'Naghten test had been adopted in *State v. Spencer*, 21 N.J.L. 196, 200-13 (O.&T. 1846); *accord*, *State v. Poulson*, 14 Utah 2d 213, 381 P.2d 93, 94-95, *cert. denied*, 375 U.S. 898 (1963) (former inmate of mental institution convicted of first degree murder arising out of rape-homicide of eleven-year-old girl); *State v. White*, 60 Wash. 2d 551, 374 P.2d 942, 959-66 (1962), *cert. denied*, 375 U.S. 883 (1963) (sociopath convicted of unprovoked murder of woman arising out of rape-homicide).

Adoption of this test, either by statute⁷² or by court decision,⁷³ has been exceedingly slow in the several states but it is hoped that recent advances in the science of psychiatry will drastically accelerate the required changes.

In contradistinction to the states, however, the federal circuits have not been unwilling to include a volitional element in tests other than that proposed by the A.L.I.,⁷⁴ and in fact have adopted the A.L.I. test almost verbatim in at least five other circuits.⁷⁵

It is clear that any test substantially incorporating the A.L.I. approach will grant a distinct advantage to the XYY individual, an advantage not shared by defendants in the state courts. It is with the constitutional implications of this relationship that this article will conclude.

V. THE XYY MALE AND THE CONSTITUTION

In 1952, the Supreme Court in *Leland v. Oregon*⁷⁶ noted the prevalence of M'Naghten in the majority of American jurisdictions and indicated reluctance to eliminate it, reasoning that the science of psychiatry had not yet reached the point where its knowledge would require such abandonment as being "implicit in the concept of ordered liberty."⁷⁷

If, however, it is a federally cognizable denial of due process to try an insane person,⁷⁸ the question of what constitutes a proper

⁷² ILLINOIS ANN. STAT. ch. 38, § 6-2 (Smith-Hurd 1964); MD. ANN. CODE art. 59, § 9(a) (as amended ch. 709 § 1, 1967); MO. ANN. STAT. §§ 552.010, 552.030 (1949 Rev.) (includes volitional element but eliminates "substantial capacity" qualification); VT. STAT. ANN. tit. 13, ch. 157, § 4801 (1959) (substitutes word "adequate" for "substantial"); but cf. N.Y. PENAL LAW, ch. 39, § 30.05 (McKinney 1967) (adopting "substantial capacity" test of cognition but rejecting inclusion of words "to conform conduct"; see Practice Commentary, *id.* at 48).

⁷³ *Terry v. Commonwealth*, 371 S.W.2d 862, 864-65 (Ky. 1963). (Actually this case adopts a rule comprised of "substantial capacity" as applied to M'Naghten and Irresistible Impulse, although the court stated that § 4.01 of the *Model Penal Code* correctly reflected the law.); *Commonwealth v. McHoul*, 352 Mass. 544, 266 N.E.2d 556, 563 (1967); *State v. Shoffner*, 31 Wis. 2d 412, 143 N.W.2d 458, 465 (1966). This case gives the defendant a choice between M'Naghten and A.L.I. wherein the state must establish his sanity beyond a reasonable doubt if the former is chosen; upon giving a written waiver, however, the defendant may request the A.L.I. test be given whereupon he then assumes the burden of establishing lack of criminal responsibility "to a reasonable certainty, by the greater weight of the credible evidence." *Id.*

⁷⁴ See *McDonald v. United States*, 312 F.2d 847, 851-52 (D.C. Cir. 1962); *Feguer v. United States*, 302 F.2d 214 (8th Cir.), *cert. denied*, 371 U.S. 872 (1962); *Dusky v. United States*, 295 F.2d 743, 759 (8th Cir.), *cert. denied*, 368 U.S. 998 (1961).

⁷⁵ *United States v. Chandler*, 393 F.2d 920, 926-28 (4th Cir. 1968); *United States v. Shapiro*, 383 F.2d 680, 688 (7th Cir. 1967); *United States v. Freeman*, 357 F.2d 606, 625 (2d Cir. 1966); *Wion v. United States*, 325 F.2d 420, 430 (10th Cir.), *cert. denied*, 377 U.S. 946 (1963); *United States v. Currens*, 290 F.2d 751, 774 (3d Cir. 1961) (cognitive element omitted).

⁷⁶ 343 U.S. 790, 800-01 (1952).

⁷⁷ *Palko v. Connecticut*, 302 U.S. 319, 325 (1937).

⁷⁸ *Pate v. Robinson*, 383 U.S. 375, 378 (1966); see also *Bishop v. United States*, 350 U.S. 961 (1956).

test of insanity should be federally answerable, at least to the extent of prescribing minimum standards in the light of modern knowledge.

The most recent constitutional pronouncement in this area is found in *Powell v. Texas*,⁷⁹ an unfortunate 4-1-4 decision affirming the public drunkenness conviction of a defendant who had been similarly convicted approximately 100 times since 1949. For affirmance, four justices⁸⁰ distinguished *Robinson v. California*⁸¹ from the case at hand on the primary ground that *Robinson* dealt with a status or condition, while the present case involved potentially dangerous public conduct. The justices also refused to expand the *Robinson* doctrine for the additional reason that it would involve the issuance of a constitutional doctrine of criminal responsibility which, it was felt, would reduce the "fruitful experimentation" of the various jurisdictions regarding insanity, and "freeze the developing productive dialogue between law and psychiatry into a rigid constitutional mold."⁸² The justices implied that a constitutional defense would probably be presented only if one could establish both an inability to abstain from drinking in the first place and a loss of control over such conduct once begun.⁸³

The dissenting justices⁸⁴ recognized the need for more knowledge regarding the disease of chronic alcoholism, but argued that it is folly to ignore what is already known. Noting agreement concerning the alcoholic's decreased moral fault, they recognized the futility of solving psychiatric problems with criminal sanctions, and parenthetically point out that a number of things may affect the likelihood of one's becoming an alcoholic, including "hereditary proclivity."⁸⁵ Finally, they felt that the protection of *Robinson* ought to preclude punishment of an individual if the condition essential to constitute the defined crime is part of the pattern of his disease and is occasioned by a compulsion symptomatic thereof.

Apart from the dicta noted above, *Powell* appears to limit the XYY's eighth amendment argument until such time as more causally linked statistical data become available, unless another

⁷⁹ 392 U.S. 514 (1968).

⁸⁰ Warren, C.J., and Marshall, Black, and Harlan, JJ.

⁸¹ 370 U.S. 660 (1962). This case invalidated a statute making it a crime to be addicted to the use of narcotics. The Court based its decision on the cruel and unusual punishment clause of the eighth amendment as applied to the states through the 14th amendment.

⁸² *Powell v. Texas*, 392 U.S. 514, 536-37 (1968). Other factors considered by the Justices, but not made an express basis for their holding were: the lack of agreement concerning the definition of "disease," the lack of treatment facilities, and the need for proper treatment in the event that such a defense is recognized. It should also be noted that the Justices somewhat caustically denounced the unpreparedness of both adversaries. *Id.* at 522.

⁸³ *Id.* at 522-26.

⁸⁴ Fortas, Douglas, Brennan, and Stewart, JJ.

⁸⁵ *Powell v. Texas*, 392 U.S. 514, 561 (1968).

abnormal genetic structure may first be shown to fit the dissent's extension of *Robinson*.⁸⁶ If we assume that a true "compulsion" is required in order to present a defense under the *Powell* rationale, however, it is evident that our XYY individual will not fit that test, although forensic psychiatrists may force the facts to meet the test in order to satisfy their sense of justice. On the other hand, *Powell* leaves the due process argument intact, and if we assume that the "fruitful experimentation" of the various jurisdictions has yielded the conclusion that volition is equally as important as cognition in determining behavior, then perhaps we can state that the A.L.I. test prescribes minimum standards of criminal responsibility which are now "implicit in the concept of ordered liberty."

CONCLUSION

The XYY male is more likely than not to be taller than his parents, displaying both nonsocial and anti-social behavior patterns, and tending to react more often against property than against the person. His genetic structure will most likely not present a valid defense in those jurisdictions utilizing the M'Naghten or cognition test, although his chances appear better in the minority of jurisdictions requiring a volitional element, particularly the model test proposed by the A.L.I. In those jurisdictions whose test is based solely upon cognition, it appears that current developments in psychiatry and genetics may enable the XYY individual to successfully argue for the inclusion of a volitional element on the constitutional ground of due process.

It is the author's opinion that substantial changes will eventually be brought about in the area of criminal responsibility based upon current inquiries into behavior control. The author also feels that this enlightened and more humane approach to criminal law will result in a system so different from the one we presently employ, that in retrospect, our present system shall appear as inequitable and antiquated as *trial by ordeal*.

APPENDIX

I. SURVEY OF POPULATIONS FOR XYY

Tables 3 and 4 contain the data collected from surveys of various populations for the XYY anomaly. The surveys were primarily of institutionalized persons, the only noninstitutional population consisting of 36 basketball players all of whom were found to be normal.

⁸⁶ Such a possibility might be presented by linkage of sex-chromosome anomalies with homosexuality.

TABLE 3
XYY's in Selected Populations

Footnote Numbers	Institution and How Surveyed	Subjects' Country	Avg. Ht.	Total No.	Type Class	YY's	%	Property	Conduct Against Person	Murder	I.Q. Avg.	+
87	Prison for Psychiatric Treatment for Criminals — no ht. limitation	England	71.0"	204	MI	2	1.0	2	2	0	1	1
88	Maximum Security Hospital for Mentally III — no ht. limitation	Scotland	71.4"	315	MI	9	2.9	81	(Total Convictions)	1	8	1
89	Institution for Psychologically Abnormal Criminals — over 180 cm. (71.1") — over 184 cm. (72.5")	Denmark		37 (12)*	MI	2	5.4 16.7	2	2			
92	Reform School — taller than 90th Percentile	England		29	C	3	10.3	3	n/r		3	
93	Forensic Psychiatric Ward — over 180 cm. (71.1")	Denmark	75.4"	23	MI	3	13.0	2	1	0	1	2
94	Mentally Subn. and Anti-Soc. Mentally III and Anti-Soc. Mentally III Criminal — Intermediate Terms	England		50 50 24 30	MS MI M C	12 4 2 0	24.0 8.0 8.3 0.0			12		

C = Ordinary Criminal
M = Ordinary Mentally III
MI = Mentally III and Anti-Social
MS = Mentally Subnormal and Anti-Social

*Figures in parenthesis contain one or more repetitive entries and should be disregarded in computing total number of subjects surveyed.

TABLE 4
 XYY's in Selected Populations (Cont'd)

Footnote Numbers	Institution and How Surveyed	Subjects' Country	Avg. Ht.	Total No.	Type Class	YY's	%	Property	Conduct Against Person	Murder	-	I.Q. Avg.	+
95	Detention Center for Juv. Dels. — over 71"	U.S.A.	.74.5"	14	C	1	7.15						
96									1	0	1		
97	Prison for Mentally Defective Prison Hospital for Criminally Insane — all over 71"	U.S.A.		30 35 50	MS C MI	0 2 2	0.00 5.72 4.00						
98	Inst. for Defective Delinquents — over 72", less than 75 IQ — the ten "most aggressive" — over 74" (95th percentile) Total	U.S.A.		(10)* (10)* (20)* 35	MS MS MS MS	0 0 1 1	0.00 0.00 5.00 2.86						
99	Basketball Players (Normal)	U.S.A.		36	N	0	0.00						
100	Mentally Subnormal — possibility of overlap, therefore only used in ht. and offense studies Highly Variable Populations	England & Scotland	74.0"	-		-		2	0	2	0		
			73.6"	-		-		3	0	1	0	2	1

*Figures in parenthesis contain one or more repetitive entries and should be disregarded in computing total number of subjects surveyed.

C = Ordinary Criminal
 N = Ordinary Mentally III
 MI = Mentally III and Anti-Social
 MS = Mentally Subnormal and Anti-Social

TABLE 5
Additional XYX's Detected

Footnote Numbers	Institution and How Surveyed	Subjects' Country	Height	XYX's	Remarks	Property	Conduct, Against Person	Murder	-	+ I.Q. Avg.
101	Inst. for Mental Defectives — examined due to "webbed neck"	U.S.A.		1		1	1 ^a	0	1	
102	Psychiatric Hospital Class for the Backward	U.S.A.	80.0" 77.5"	1 1	unstable, deviate impulsive	0	0	1	0	1 ^b 1
103	Referred Due to Aggressive Fantasies	Ireland	78.0"	1	depressed, immature	1	0	0	0	1 ^c
104	Examined Because of Unusual Height	Sweden	80.8"	1	overly aggressive	0	0	1	0	1 ^d
105	Examined Because of Tall Daughters	Mexico	76.8"	1	aggressive, often changes jobs					1
106	Examined Because of Defective Offspring	U.S.A.	72.0"	1	job trouble					1

a—suspected arson

b—I.Q. 125

c—I.Q. 118

d—I.Q. 116

Also shown in Tables 3 and 4 are data on the types of criminal conduct exhibited and the intelligence quotient (I.Q.) possessed by the XYY's identified in the surveys. Similar data appear in Table 5 for additional isolated cases of XYY's who have come to light for various reasons.

II. STATISTICAL ANALYSIS OF XYY INCIDENCE

Shown below are statistical results calculated from the data of Tables 3 and 4. These results appeared earlier in more summary form in Tables 1 and 2 and in the accompanying textual materials.

A. Relationship of XYY to Height

(1) Of those XYY's discovered without regard to height, the average height was 71.1 inches (5 feet 11 inches); 53 percent were at least 72 inches (6 feet); 6.66 percent were at least 74 inches (6 feet 2 inches).

(2) Of those XYY's whose height was positively measured, the average height was 73.9 inches (6 feet 2 inches); 76.5 percent were at least 72 inches (6 feet); 41.2 percent were at least 74 inches (6 feet 2 inches).

⁸⁷ Bartlett *et al.*, *Chromosomes of Male Patients in a Security Prison*, 219 NATURE 351 (1968).

⁸⁸ Price & Whatmore, *supra* note 23.

⁸⁹ Price & Whatmore, *supra* note 36.

⁹⁰ Price *et al.*, *Criminal Patients with XYY Sex-Chromosome Complement*, LANCET, Mar. 12, 1966, at 565.

⁹¹ Nielsen *et al.*, *XYY Chromosomal Constitution in Criminal Psychopaths*, LANCET, Sept. 7, 1968, at 576.

⁹² Hunter, *Chromatin-Positive and XYY Boys in Approved Schools*, LANCET, Apr. 13, 1968, at 816.

⁹³ Nielsen, *supra* note 36.

⁹⁴ Casey *et al.*, *supra* note 23, at 860.

⁹⁵ Telfer *et al.*, *Incidence of Gross Chromosomal Errors among Tall Criminal American Males*, 159 SCIENCE 1249 (1968).

⁹⁶ Telfer *et al.*, *YY Syndrome in an American Negro*, LANCET, Jan. 13, 1968, at 95.

⁹⁷ Telfer *et al.*, *supra* note 95.

⁹⁸ Welch *et al.*, *supra* note 29.

⁹⁹ Goodman *et al.*, *Chromosomes of Tall Men*, LANCET, June 15, 1968, at 1318.

¹⁰⁰ Court Brown *et al.*, *Further Information on the Identity of 47 XYY Males*, 2 BRITISH MED. J. 325 (1968).

¹⁰¹ Kelly *et al.*, *supra* note 24.

¹⁰² Borgaonkar *et al.*, *supra* note 23.

¹⁰³ Leff & Scott, *supra* note 23.

¹⁰⁴ Forssman *et al.*, *supra* note 23.

¹⁰⁵ Lisker *et al.*, *YY Syndrome in a Mexican*, LANCET, Sept. 14, 1968, at 635.

¹⁰⁶ Hauschka *et al.*, *supra* note 14.

(3) Of those XYY's discovered because of a positive height factor,¹⁰⁷ the average height was 75.6 inches (6 feet 3½ inches).

B. Incidence of XYY's Among Surveyed Populations

(1) Of all individuals surveyed, 43/962 or 4.47 percent were XYY.

(2) Of all institutionalized individuals surveyed (with and without a minimum height limit), 43/926 or 4.64 percent were XYY; with some height restriction, 30/383 or 7.83 percent were XYY; with a height limit of at least 6 feet, 19/177 or 10.7 percent were XYY.

(3) Of normal individuals surveyed (Type Class N), 0/36 or 0.0 percent were XYY.

(4) Of all ordinary criminals surveyed (Type Class C), 6/108 or 5.56 percent were XYY.

(5) Of all ordinary mentally ill patients surveyed (Type Class M), 2/24 or 8.33 percent were XYY.

(6) Of those surveyed who were both mentally ill *and* anti-social (Type Class MI), 22/679 or 3.24 percent were XYY; with some height limit imposed, 11/160 or 6.88 percent were XYY; with minimum height limit 72 inches, 6/62 or 9.68 percent were XYY.

(7) Of those tall (at least 71 inches), mentally subnormal, and anti-social individuals (Type Class MS), 13/115 or 11.3 percent were XYY.

C. Behavioral Abnormality Among XYY's

1. The fraction 45/50 or 90 percent of the XYY's shown in Tables 3 and 4 were reported as exhibiting highly anti-social behavior. Of the remaining five, one is described as having difficulty satisfying employers,¹⁰⁸ one as very aggressive and often changing jobs,¹⁰⁹ one as obsessive-compulsive and over aggressive,¹¹⁰ one as mentally retarded, impulsive, and hyperactive,¹¹¹ and the remaining one as behaviorally and mentally normal.¹¹² Of the 50 XYY's reported, the 49 who were in some way abnormal represent 98 percent of the total.

¹⁰⁷ Not all of these subjects were discovered in surveys. Note the extreme height of some individual XYY's.

¹⁰⁸ Hauschka *et al.*, *supra* note 14.

¹⁰⁹ Lisker *et al.*, *supra* note 105.

¹¹⁰ Forssman *et al.*, *supra* note 23.

¹¹¹ Borgaonkar *et al.*, *supra* note 23.

¹¹² Court Brown *et al.*, *supra* note 100. It should be noted, however, that this subject was an X-/XYY mosaic, with 80 percent XYY.

2. Where such information was reported, 29/40 or 72.5 percent of the XYY's were considered to have below average intelligence.
3. Where such information was reported, 16/23 or 69.5 percent committed crimes against property, with a large fraction of these crimes involving arson. The studies of pre-pubertal XYY's included a significant tendency to destroy property by arson.¹¹³

¹¹³Cowie & Kahn, *supra* note 29 (8½-year old, mentally dull, violently aggressive and destructive, 4' 9" tall child); *see also* Mintzer & Sato, *supra* note 29 (severely malformed 7-year-old child described as very aggressive).

DENVER LAW JOURNAL

VOLUME 46

SPRING 1969

NUMBER 2

Member, National Conference of Law Reviews

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