# The Visual Screening of Adjudicated Adolescents

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**Abstract**

*The New York State Optometric Association Vision Screening Battery (NYSOA) and the Developmental Eye Movement Test (DEM) were administered to 50 adjudicated adolescents in order to isolate which particular visual factors are most responsible for the learning difficulties of juvenile offenders. Fifty-four graduate students served as a control group. A multiple regression statistical analysis indicated that the Tracking and Convergence subtests of the NYSOA were statistically significant predictors of reading and language arts achievement scores. A chi-square statistical analysis revealed that the juvenile offenders scored significantly lower on the Tracking, Visual Acuity-Near, and Color Vision subtests. The most significant finding was the high failure rate of juvenile offenders on both tracking tests. Forty-eight percent failed the tracking subtest of the NYSOA. Sixty-eight percent failed one or more of the DEM subtests.*

**Key Words**

*adjudicated adolescents, juvenile offenders, vision screening*

The impact of juvenile delinquency on our society and its ramifications, such as crime, are well known and undisputed. American youth are being incarcerated at a continually increasing rate and cost. American prisons now hold an ever increasing number of prisoners as many juvenile offenders develop into adult criminals. In 1994 there was a total of 950,000 prisoners incarcerated at a cost of $35,000 to $60,000 per inmate.[1]

Although juvenile offenders are being confined for longer periods of time, incarceration has not yet proven to be successful in eliminating delinquent behavior.[1] Nevertheless, according to Judge McGee, [1] "Public policy with regard to crime has been reactive." States and the federal government have stiffened their laws and public policy regarding this issue and have been reactive rather than proactive. Several states, such as California, have passed legislation requiring mandatory life sentences after being convicted of three felonies. Virginia and other states have spent hundreds of millions of dollars on prison construction. Unfortunately, the number of criminals is increasing faster than our society can build penitentiaries to house them. Although incarcerating the present generation of criminals may be the only course of action currently, more of our resources must be invested in eliminating factors that may contribute to delinquent behavior in our future generations.

Numerous studies have been conducted to learn more about children who become classified as "juvenile delinquents." A multitude of hypotheses have been offered to explain why delinquent behavior emerges. Brier[2] believes that low intelligence, psychopathology in a parent, and difficulties in parental control are general risk factors that may predispose a child to demonstrate delinquent behavior. Wilson and Hernnstein[3] found that the majority of offenders fall in the low-normal to borderline range of intelligence. According to Quay[4] inadequate verbal skills were the primary contributor to the offenders' low IQ scores. Rutter and Giller[5] found that early criminal behavior and alcoholism were strong predictors of delinquency. The 1994 National Governors' Association[6] emphasized the crucial role that families play in development of criminal behavior. Both Kazen[7] and Snyder and Patterson[8] found parenting methods that were inconsistent, neglectful, or extremely strict and punitive to be predictors of delinquent behavior. According to Shoemaker,[9] anomie, social disorganization, poverty, and racism were found to increase the risk of delinquent behavior.

The incidence of learning disabilities in juvenile offenders is much higher as compared to the nonoffender population.[2] Much has been written concerning the increased risk of a juvenile developing delinquent behavior patterns in the presence of a learning disability. The exact nature of the link between a learning disability and increased risk of delinquent behavior in juveniles is not known. However, it is known that the probability of a child demonstrating delinquent behavior increases as the number of risk factors, such as low intelligence scores, presence of a learning disability, parents involved in criminal activity, poor parenting methods, alcoholism, racism, and poverty increase.[2]

In addition, several studies conducted since the 1960s have examined the link between learning disabilities, delinquency, and vision. Snow'[10] Bashara and Zaba,[11] Harris, [12] Stehli,[13] and Dzik[14] found that significant numbers of juvenile offenders had one or more visual deficiencies. Since 80% of all learning involves the visual system, it would be expected that youth with visual deficiencies would experience frustration in school which might lead to disruptive behavior and in some cases delinquent behavior. Certainly not all delinquents have visual problems. However, it is important to identify those who have visual difficulties, especially those that can be ameliorated. If identified, the visual deficiency would not combine with other predisposing factors to increase the risk of delinquent behavior.

Despite these previous studies, additional research is needed in order to isolate which particular visual factors are most responsible for the learning difficulties of juvenile offenders. The use of a comprehensive visual screening will add further insight into the contribution of individual visual measures toward academic achievement, as well as the significance of visual impairment in the juvenile delinquent population.

## METHODS

### Subjects

Subjects included 50 adjudicated adolescents and 54 graduate students. Of the 50 juvenile offenders 49 were African-American males. One subject was a Caucasian male. The median age of the juvenile offenders was 19 years. The 54 graduate students, volunteers from four graduate courses, ranged in age from 23 to 50, with a median age of 27. Nine of the graduate students were male, while 45 were female; four were African-American, while 50 were Caucasian.

### Screening Procedures

A graduate student was trained by an optometrist to administer the *New York State Optometric Association Vision Screening Battery (NYSOA Battery)*[15] and the *Developmental Eye Movement Test (DEM).*[16] The *NYSOA BATTERY* includes the following eight subtests: Tracking, fusion, acuity-distance, stereopsis, acuity-near, convergence, hyperopia, and color vision. Lieberman, Cohen, Stolzberg, and Ritty[17] gave support for the reliability and validity of the *NYSOA Battery.*

The following procedures were performed on all subjects for each subtest of the *NYSOA Battery*:

1. Tracking: Using a modified version of the King-Devick Saccadic Test, the subjects were asked to recite as rapidly as possible a series of 40 numbers horizontally arranged on each of three tests. Subjects failed this subtest if their scores were greater than one standard deviation above the NYSOA norms.
2. Fusion: Keystone Skills cards were used to evaluate vertical fusion at distance and horizontal fusion at close and distant proximities. Suppressions were indicated if either the horizontal line or the red objects were not reported. The subjects failed fusion if the line went through any figure other than the ball (vertical imbalance) or if they saw two or four balls (horizontal imbalance).
3. Acuity at distance: A Snellen chart at 20 feet was utilized. The subjects failed if their vision was 20/40 or worse in either eye or there was more than a two-line difference between their eyes.
4. Acuity at near: Acuity measurements at near were performed using a reduced Snellen chart at 13 inches. The failure criteria were the same as those for distance acuity.
5. Stereopsis : Wirt Circles were administered. Subjects failed if they were unable to achieve a minimum of 60 seconds of arc.
6. Convergence: The convergence nearpoint was evaluated using a non-accommodative target. The subject failed if the convergence nearpoint was four inches or greater.
7. Hyperopia: Subjects were asked to read the Snellen chart with +1.50 lenses. Failure on this test was marked by the ability to maintain the same visual acuity as measured in Procedure 1.
8. Color Vision: The Keystone Color Cards were presented in a stereoscope. Subjects failed if they were unable to read the numbers on the cards presented.

The tracking subtest of the *NYSOA Battery*, derived from the *King-Devick* Saccade Test, asks the subject to verbally call out and correctly name 40 numbers arranged in horizontal format similar to reading across a line of print. The faster the individual is able to call out the numbers, the more efficient and accurate the oculomotor system is considered. Slow performance represents an oculomotor inefficiency.

Garzia, Richman, Nicholson, and Gaines[16] have developed the *Developmental Eye Movement Test (DEM)*, which they believe has advantages over the *NYSOA King-Devick* modification. The *DEM* test addresses the role of automatic number calling (visual-verbal numbering skills) as a necessary component of a valid visual-verbal test of oculomotor functioning. Automatic numbering is factored out by incorporating a subtest which requires reading numbers in a vertical array. This vertical array of numbers, often used in reading tests, eliminates the requirement for horizontal eye movements. A high correlation is found between performance on this verbal subtest and reading comprehension ability.[16]

The horizontal subtest of the *DEM* measures the time required to read numbers in a horizontal array. The time is then adjusted to account for omission and addition errors. A ratio is computed by dividing the horizontal adjusted time by the vertical time. This mathematical ratio provides optometrists with important information that can aid in differential diagnosis by classifying failures as the result of poor automaticity of number calling, an oculomotor dysfunction or both.

The failure rate for each of the three subtests of the *DEM* (horizontal, vertical, and ratio) was set at the 31st percentile, which represents .5 standard deviation below the mean. The investigators decided to use the 31st percentile on the advice of Solan and Suchoff,[18] who stated that visual performance test scores below the 31st percentile "should be considered poor and represent a real dysfunction in a task or subject area."

Garzia, Richman, Nicholson, and Gaines[16] use the failure rate on the horizontal, vertical, and ratio subtests to form four clinical response types that they describe as follows: "Type I is characterized by normal performance in all subtest values. Type II is characterized by an abnormally increased horizontal time in the presence of relatively normal performance on the vertical subtest. The ratio would be higher than expected in this case. This behavior pattern would be characteristic of an oculomotor dysfunction. Type III is typified by a higher than normal horizon-

tal and vertical time but a normal ratio score. In this case there is poorly developed automaticity and the increased horizontal time is found because the baseline performance is abnormal. The ratio of the two scores, however, is normal. This is a representative case of a basic difficulty in automaticity of number naming. Type IV is a combination of Types II and III. Vertical time, horizontal time and ratio scores are all abnormal. This case represents an example of deficiencies in both automaticity and oculomotor skills."

### Statistical Analysis

A chi-square statistical technique determined if significantly more incarcerated juveniles failed the *NYSOA Battery* subtests compared with the control group comprised of graduate students. A multiple regression statistical technique determined if the subtests of the *NYSOA Battery* could predict juvenile offenders' reading, mathematics, language arts, and total achievment grade-equivalent scores. In statistical terms, failing one or more *NYSOA Battery* served as the predictors. Reading, mathematics, language arts, and total achievement grade-equivalent scores served as the criterion variables. The authors investigated whether juvenile offenders who failed a visual screening test were likely to perform poorly in reading, mathematics, and language arts. Language arts and mathematics achievement test scores were only available for 29 of the 50 juvenile offenders, while reading and total achievement measures were available for all 50 juvenile offenders. Total achievement scores were the average of reading, language arts, and mathematics. The achievement test variables were measured using the *Test of Adult Basic Education*[20]. The mean grade equivalent score of the juvenile offenders for total academic achievement was 4.96, equating the average achievement to nearly a fifth grade level.

The juvenile offenders were compared with eighth grade students in the *DEM's Norms Technical Manual* [19] rather than the control group. Eighth grade students were used as the comparison because control group scores on the *DEM* were not available and the oldest student scores in the *DEM's Norms Technical Manual* were those of eighth graders. Without a control group, no statistical analysis of the *DEM* scores were possible.

**Table 1**
**THE PERCENTAGE OF FAILURE OF JUVENILE OFFENDERS vs. GRADUATE STUDENTS ON THE NYSOA**

| | Populations | | | |
|---|---|---|---|---|
| Subtests | Juvenile Offenders | | Graduate Students | |
| | N=50 | % | N=54 | % |
| Tracking | 24 | 48[a] | 0 | 0 |
| Stereopsis | 11 | 22 | 11 | 20 |
| Visual Acuity-Near | 8 | 16[a] | 0 | 0 |
| Convergence | 5 | 10 | 3 | 6 |
| Hyperopia | 2 | 4 | 0 | 0 |
| Visual Acuity-Far | 2 | 4 | 7 | 13 |
| Color Vision | 4 | 8[b] | 1 | 2 |
| Fusion | 9 | 18 | 24 | 44[a] |
| Failed At Least One Subtest | 37 | 74 | 32 | 59 |

a indicates $p \leq .01$ and [b] indicates $p \leq .05$

## RESULTS

Table 1 shows the failure rate of incarcerated juvenile offenders compared with the control group on the *NYSOA Battery*. As can be seen, 48% of the juvenile offenders failed the tracking subtest, while all of the graduate students passed. A greater number of juvenile offenders failed visual acuity-near, convergence, hyperopia, and color vision. In addition, 74% of the juvenile offenders failed at least one *NYSOA Battery* subtest, compared to 59% of the graduate students. However, more graduate students failed visual acuity-far and fusion subtests. The latter results were expected and will be addressed later in this paper.

The differences in frequencies between the youth offenders and the graduate students were subjected to a chi-square statistical analysis in order to determine whether these differences were statistically significant. This analysis indicated the greater failure rate of the juvenile offenders was at the .01 level of significance for the Tracking and Visual Acuity-Near and the .05 level of significance for the Color Vision subtest. This analysis also revealed the greater failure rate of the graduate students was at the .01 level of significance for fusion. No other chi-square statistical test reached .05 or .01 levels of significance.

A multiple regression model was used to determine if the subtests of the *NYSOA Battery* could predict juvenile offenders' reading, mathematics, language arts, and total achievement grade-equivalent scores. None of the subtests of the *NYSOA Battery* reached the significance level for predicting mathematical achievement. The tracking and convergence subtests of the *NYSOA Battery* were statistically significant predictors of several academic achievement scores. Juvenile offenders who failed visual tracking tasks tended to have lower reading, language arts, and total achievement scores. Tracking accounted for 15% of the reading score variability, 18% of the language arts variability, and 19% of the total achievement variability. Convergence explained an additional 6% of total achievement variance. Thus, tracking and convergence combined explained 25% of the total variance for total academic achievement. The remaining variability is not accounted for by the *NYSOA Battery* visual screening measure.

Sixty-eight percent of the juvenile offenders failed one or more of the *Developmental Eye Movement Test* (DEM) subtests. Thirty-four percent failed the ver-

tical subtest; 42 % of the juvenile offenders failed the horizontal subtest; and 28 % failed the ratio subtest. The failure rate on the vertical, horizontal, and ratio subtests were used to identify Type I, Type II, Type III, and Type IV clinical response protocols.

Fifteen of the 50 juvenile offenders were classified as Type I clinical response as they passed all three subtests of the DEM. Four of 50 juvenile offenders were classified as Type II clinical response, oculomotor dysfunction, as they failed the horizontal and ratio subtests, and yet passed the vertical subtest. Ten of the 50 juvenile offenders were classified as Type III clinical response, deficiency in automaticity of number naming, as they failed both the vertical and horizontal subtests and yet passed the ratio subtest. Three of the 50 juvenile offenders were classified as Type IV clinical response, deficiencies in both oculomotor skills and automaticity, as they failed all three subtests. Lastly, the remaining 18 juvenile offenders failed one or more of the *DEM* subtests and therefore, did not fall into Type I -IV clinical response categories. These subjects may have failed the vertical subtest, and passed the horizontal subtest or passed both vertical and horizontal subtests, but failed the ratio subtest.

## DISCUSSION

The most significant finding of this research was the high failure rate of juvenile offenders on both tracking tests. Forty-eight percent failed the tracking subtest of the *NYSOA Battery*. Sixty-eight percent failed one or more of the *DEM* subtests. Fourteen percent were diagnosed with deficient oculomotor skills, and 26% were diagnosed with deficient automaticity of number naming. However, 77 % of those juvenile offenders diagnosed with deficient automaticity were classified as clinical response Type III, demonstrating difficulty in automaticity only. Twenty-three percent were classified as Type IV clinical response, demonstrating difficulties both in automaticity and ocular motility.

The higher failure rate of the juvenile offenders on the horizontal subtest, 42%, as compared with the vertical subtest, 34%, of the *DEM* lends credence to Garzia et al.'s[16] contention that the horizontal subtest is more challenging, The horizontal subtest, as opposed to the vertical subtest, has a visual-verbal component that requires sustained visual attention, a visual to vocal response, number recognition, and accurate oculomotor tracking skills. As noted above, nearly one-half of the juvenile offenders failed a horizontal measure of tracking on the *NYSOA Battery*. The juvenile offenders' poorer performance on the horizontal subtest was anticipated, as performance on both horizontal subtests requires the integration of visual and verbal information.

The significantly greater failure rate on the fusion subtest of the *NYSOA Battery* among the graduate student control was expected. Forrest[21] believes that many years of intensive nearpoint visual tasks, such as reading from computer screens, may interact with one's heredity and contribute toward visual difficulties. It was assumed that incarcerated juvenile offenders, with a median age of 19, had spent less time interacting with computers and books. Cumulative years of nearpoint visual stress may be a contributing factor to the fusion subtest failure rate among the graduate students.

The following findings, made possible by step-wise multiple regression, a multivariate statistical technique, are most interesting:

1. Twenty-five percent of the total variance of total academic achievement (reading, mathematics, language arts) could be explained by the tracking and convergence subtests.
2. Juvenile offenders who failed tracking tasks tended to have lower reading, language arts, and total achievement test scores.
3. Low scores on reading, language arts, and total achievement level, as measured by the *Test of Adult Basic Education*,[20] may be related to deficiency in tracking.
4. Mathematical achievement was not related to tracking.

The ability of deficiencies in visual skills, tracking and convergence, to explain 25% of total academic achievement is quite significant. These important visual skills needed for learning may not be detected with cursory measures, such as a Snellen screening. Juvenile offenders who have difficulty with tracking and convergence are likely to have difficulty with reading, a visual-verbal process that incorporates language acquisition and nearpoint visual skills. Such undetected visual problems may lead to academic difficulties which may be a contributor to juvenile delinquency.

The finding of a significant relationship between poor performance on reading and language arts measures of the *Test of Adult Basic Education* and the convergence and visual acuity-near subtests of the *NYSOA Battery* substantiated the importance of screening for nearpoint visual skills. These current findings concerning juvenile offenders' difficulties with nearpoint vision lends credence to earlier research investigations by Johnson and Zaba,[22-24] which found that illiterate adults, academically at-risk college students, and academically and behaviorally at-risk public school students all had significant difficulties with nearpoint visual measures.

Other professionals working with juvenile offenders are often not aware that vision is the process of deriving meaning from what is seen. These professionals may not realize that juvenile offenders are not standardly screened for tracking and other important nearpoint visual skills. In addition, other professionals involved in the criminal justice system may not realize that even exams by visual care specialist often do not include an adequate assessment of these important nearpoint visual skills. These same professionals may also not be aware that tracking, convergence, and other important visual skills can be improved through vision therapy.

Furthermore, juvenile offenders, themselves, are not likely to realize that they have deficient visual skills. Instead, they may believe that they have a learning or a reading disorder.. Such undetected visual problems are likely to frustrate many juvenile offenders. In fact, some juvenile offenders may have been so frustrated with their perceived inability to perform academic tasks, that they displayed disruptive behavior in school.

Although adjudicated juveniles have received various psychological, educational, and vocational treatments, most of these treatments have had limited effectiveness. It is difficult for a treatment program, particularly an academic one to be effective if the adolescent lacks adequate visual skills. Unless at-risk adolescents with visual impairments are properly diagnosed and treated, many offenders, such as those in the current study, may end up in the criminal justice system.

In summary, it is much more effective to prevent at-risk children from becoming juvenile offenders rather than dealing with ramifications once crimes have been committed. Although it is very difficult to determine the exact etiology of adolescent crime, vision must be ruled out as being a possible contributing factor. Garzia[25] believes that, "Knowledge about visual skills and reading is important for an optometrist because they are frequently the first collateral professional to evaluate a child with difficulties in reading." The optometrist must realize that he or she is a vital member of the multidisciplinary team addressing the issue of juvenile crime.


## Acknowledgment

The authors are most appreciative of the editorial comments of Ms. Heather Moskal, M.S.


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*EDITORIAL continued from page 2*

Have any thoughts or ideas on the subject?

Sincerely,
Greg

Hi Greg,

I like your ideas on the optimal distance correction. You raise many good points, especially about the fact that the determination is often trivialized, and thus eye care practitioners of both ilks are increasingly delegating the task to less qualified people, which paves the way for opticians wanting to "refract." By the way, how did you arrive at the +0.75's for your patient? It seems a rather drastic departure from the "refractive status" to me. And yes, I have run across similar situations with patients. It's interesting that when I do this, the student, or more likely the resident who works with me, asks why I modified the "refractive error" finding, and exactly how I determined the final Rx.. In other words, what are the variables that led me to consider the modification in the first place, and what are the variables that determine what I write on the prescription pad. These are superb questions, and in truth, I don't have superb answers. Nevertheless, I give some answers that seem to satisfy most students and residents, but do not totally satisfy me.

I believe it is worthwhile to bring your issue to the attention of the profession and I agree that it needs to get into the literature. An initial article should review all proposed methods for determining the distant refraction; this would include graphical analysis, OEP's 21-point refraction, the method you were taught at Pacific University, College of Optometry, where, I believe you start at near and then go to distance, and others, such as the regimen that Dr. Joe Miele has proposed from the lecture platform and in print. Hopefully, this will "light the fire," cause discussion and Letters to the Editor. But, until that article is written, let's start with asking people to specify the variables that I referred to above. And what role does the concept of emmetropization play in determining the best distance prescription for the younger patient?

My best,
Irwin

*Editor's note: The above represents two edited E-mail messages between Dr. Greg Kitchener, a member of the Optometric Extension Program Foundation's Board of Directors, and me. Dr. Kitchener responded to my questions, but in the hope that readers will give their ideas on the variables involved in determining the distance prescription, it is not included here. Both he and I welcome and anticipate your thoughts on this topic. We are of one mind that it is the basis for virtually all of what we do; yet, with the expansion of our scope of practice, it is increasingly thought to be a purely technical task.*


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Date accepted for publication:
October 7, 1998