The Effect of Choreoathetoid Movements on the Quick Neurological Screening Test

Peg Ingolia

The effect of choreoathetoid movements and learning disabilities on children's performances on the Quick Neurological Screening Test was assessed in 43 6-to 8-year-old boys. The subjects were selected based on the presence or absence of choreoathetoid movements and on the presence or absence of learning disabilities. The Quick Neurological Screening Test, a 15-item test designed to identify children with learning problems, was administered. Items from the test were divided into two parts—six items thought to be influenced by the presence of choreoathetoid movements, and nine items not thought to be influenced by such movements.

The results indicated that the learning-disabled boys performed less well than non-learning-disabled subjects on the six items thought to be affected by choreoathetoid movements. The presence of choreoathetoid movements was not a significant factor. Neither the presence of a learning disability nor the presence of choreoathetoid movements was found to be a significant factor in performance on the remaining nine items.

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Occupational therapists frequently evaluate and treat learning-disabled children with varied types of dysfunction. Many methods for the assessment of behavioral parameters associated with learning disabilities (LD) and neurological dysfunction are currently used in the fields of therapy, education, and medicine. Evaluations of involuntary movements, particularly choreoathetoid movements, are made in many of the assessment procedures. One assessment tool, the Quick Neurological Screening Test (QNST), has been shown to be accurate in identifying children with LD. The test does not assess choreoathetoid movements, but it would appear that the presence of choreoathetoid movements may result in poor performance on certain items of the test. The primary purpose of this study is to determine whether the presence of choreoathetoid movements affects children's performance on aspects of the Quick Neurological Screening Test (QNST). Another purpose is to further validate the use of the QNST to differentiate between LD and non-LD children.

Review of the Literature

Choreoathetoid Movements. Many authors have described small, involuntary, writhing, and jerky movements of the fingers, which are seen both in young normal children and in children who have various types of dysfunction.
of central nervous system dysfunction, such as cerebral palsy (2), hyperactivity (3), learning disabilities (4-7), also delinquency (3), and severe emotional disturbances (3, 8). Terms including choreoathetoid and choreiform have been used to characterize these types of movements.

The determination of the presence or absence of choreoathetoid movements is part of the standard pediatric neurological examination (4) and of the neurological examination of children with minor neurological dysfunction, as outlined by Touwen (9). The testing procedure by which the presence or absence of choreoathetoid movements are observed was first described by Schilder and is referred to as the Schilder's Arm Extension Test (10).

Subsequently, several clinicians (5, 8, 9, 11) have incorporated Schilder's Arm Extension Test into evaluation procedures.

Choreoathetoid movements have been reported in young normal children. Beginning in infancy, children progress through developmental stages and behavioral manifestations change with increasing age. Choreoathetoid movements are thought to be one of these manifestations that is present in young children in the normal population, and disappears with advancing age (2). Schilder reports that newborns move their hands in "choreoathetotic fashion." (10, p 162). According to Graziani, Mason, and Cracco (6), "In the normal child under six years of age, frequent irregular jerking movements of the outstretched arms and fingers can be observed...these choreiform movements usually disappear at six to nine years of age." (p 155) Gubbay (2) states that most normal children under the age of 8 years exhibit choreiform movements and that the movements disappear, for the most part, by age 12. Wolff and Hurwitz (8) report a study showing a similar trend.

Gubbay (2) also says that, in addition to varying from child to child, choreiform movements may vary from time to time within the same child, depending upon extrinsic factors—for example, the child's emotional state. Rutter et al corroborated this finding (12), by adding that choreiform movements were sometimes more apparent after strenuous exercise or when the child was upset. They even suggest that it may be unreliable to identify children who demonstrate only slight choreiform movements, and suggest reserving the identification of choreiform movements for those children with consistently marked movements. According to Rutter and colleagues, another variable influencing choreoathetoid movements is sex: boys were found to exhibit choreiform movements more often than girls (12).

Choreoathetoid Movements as a Soft Neurological Sign. Choreoathetoid movements are considered to be a soft neurological sign and are frequently used in the identification and diagnosis of children with minimal brain dysfunction (MBD) and LD (3-5, 7). It appears that an important factor differentiating choreoathetoid movements as a hard sign from choreoathetoid movements as a soft sign is the severity of the involuntary movements (9). Another important factor is whether or not the choreoathetoid movements appear in conjunction with other frank neurological damage—for example, cerebral palsy (9). When discussing choreoathetoid movements as a soft sign, Ayres (11) states that "choreoathetosis is seen as a problem of insufficient motor inhibition." (p 293)

Some authors feel that a traditional neurological examination is inadequate in assessing the integrity of a learning-disabled child's nervous system and have suggested alternative examinations that include the observation of soft signs (4, 5, 13, 14). Most of the examinations do not attempt to identify a localized site of neurological deficit or to evaluate sensory functions or frank reflexes. Rather, they emphasize the consideration of signs and factors together and how they may in turn affect a child's functional performance in tasks involving motor skills, spatial understanding, perceptual tasks, and the integration of various modalities for adaptation to demands in the environment. Peters et al (13) suggest an examination that includes the evaluation of hopping, skipping, rapid alternating hand movements, associated movements, and writing to dictation. The subtle manifestations of neurological deficit, soft signs, include clumsiness and extraneous movements. Lerner (15) also discusses soft signs, stating that they are not the gross deviations, but rather, the more subtle, minor symptoms including mild coordination problems, mild tremors, visual-motor difficulties, delayed speech development, and poor reading and arithmetic skills.

Several authors have stressed age as an essential factor in the assessment of soft neurological signs in children (5, 14, 16, 17); that is, as age increases, soft signs decrease. Kingsbourne (16) says that, if an LD child were younger, the symptoms he exhibits would be normal and that the presence of choreiform movements in LD may represent a maturational delay. Denckla (18) suggests that soft signs may be separated into the categories of "developmental" and "neurological." Like Kings-
bourn, she believes that developmental soft signs may be expected to decrease with age and would be considered normal in a younger child. These include substitutions in articulation or persistence of extinction to double simultaneous proximal-distal stimulation. Neurological soft signs are subtle, but are not considered to be normal during the course of development. Examples of neurological soft signs include choreiform movements, tremors, asymmetries of tone and reflexes, anomalies of posture and gait, nystagmus, and dysdiadochokinesia or dysmetria.

Functional Implications of Choreoathetoid Movements. TOUR- wen (9) says that choreiform movements are linked with coordination and fine motor problems and the combination of choreiform movements and fine motor difficulties is often seen in children with learning and behavior problems who also exhibit minor neurological dysfunction. Ayres (11) reports that choreoathetoid movements, which are not particularly noticeable under normal conditions, may prove to be a detrimental factor in the performance of activities requiring fine motor coordination. The incoordination resulting from choreoathetoid movements may interfere with the use of a pencil, and drawn lines may appear jerky, rather than smooth and fluid (20).

Assessment of Learning Disabilities in School-Age Children. Since many older children with choreoathetoid movements also exhibit learning difficulties, the assessment and identification of these children becomes essential to their treatment and schooling. There are many tests that in some way evaluate the neurological integrity of children with LD or minor neurological dysfunction. These tests examine children's ability to use basic processes in a complicated manner in order to perform academic, motor, and social activities (20-23). A recent test, the Quick Neurological Screening Test (QNST), was developed by Mutti, Sterling, and Spalding (1) to assist psychologists and school personnel in the identification of children, from 5 through 17 years of age, who have learning disabilities. The 15 tasks evaluate soft neurological signs and are adapted from pediatric neurological examinations. Three populations of subjects are differentiated by the QNST: children who show no abnormal neurological signs and are achieving age-appropriate tasks; children who do show definite abnormal neurological signs (mild or marked), and children who do not exhibit definite neurological signs but yet are not performing at age-appropriate levels. The latter group is that which is referred to as LD. The authors state that the QNST is not intended to yield a definitive diagnosis for neurological handicaps, but rather, to identify children who may exhibit difficulties in school (1).

The QNST can be administered in 20 to 30 minutes. Separate scores are assigned for the child's performance on each of the 15 tasks. The 15 scores are then summed, resulting in the total score, which is categorized as "High," indicating a high probability that the child will experience difficulties in the classroom; "Suspicious," or "Normal," which almost always is achieved by children who will probably not have learning disabilities.

Spalding (1) reports that the QNST successfully discriminates between LD and non-LD populations. Sterling and Sterling (24) compared the QNST with a physical-neurological examination for effectiveness in identifying children with neurological dysfunction and found 96 percent agreement between the two testing methods. Reliability statistics yielded a correlation of .69 between expert examiners and minimally trained teachers administering the QNST (25). A slightly higher correlation of .71 was reported in a test-retest study that involved two examiners. For specific tasks of the QNST, Yamamara (1) reported a reliability coefficient ranging from a somewhat low .41 to a very high .93, indicating that some items are much more reliable than others.

To summarize the current literature, there is support for the view of choreoathetoid movements as a normal developmental occurrence in the young child as well as an abnormal indicator of maturational delay or neurological dysfunction when seen in the older child. These choreoathetoid movements are considered to affect performance negatively on certain behavioral tasks. These tasks are often included in tests to assess LD or neurological dysfunction. Since choreoathetoid movements may adversely affect children's performance, it will be both useful and informative to study the relationship between the presence of LD and choreoathetoid movements in children's actual performance on the QNST.

Hypotheses
The following hypotheses were investigated:

1. Children exhibiting choreoathetoid movements will score less well on the six tasks of the QNST thought to be affected by choreoathetosis than will children without these movements; and there will be no difference in the performances of children with and without choreoathetoid movements on the other nine items of the test.

2. LD children will perform less
well than non-LD children on both sets of items.
3. There will be a Group (LD, non-LD) by Choreoathetoid Movement interaction.

**Methods**

**Subjects.** The subjects included in this study consisted of 43 boys, age 6 to 8 years, selected on the presence or absence of choreoathetoid movements and the presence or absence of LD. They were assigned to one of four groups: 1. LD boys with choreoathetoid movements; 2. LD boys without choreoathetoid movements; 3. non-LD normal achieving boys with choreoathetoid movements; and 4. non-LD normal achieving boys without choreoathetoid movements.

All subjects were reported to have a full-scale IQ score between 85 and 115. The LD subjects were either medically or educationally diagnosed as children with learning disabilities or learning problems. The non-LD subjects were performing at age-appropriate and grade-appropriate levels, as determined by the classroom teachers. Subjects who demonstrated involuntary writhing movements during the Schilder's Arm Extension Test (10) required each child to stand with eyes closed, arms extended in front at shoulder height, forearms pronated, and fingers spread wide apart. The child then counted to 20 while the examiner observed any involuntary writhing or twitching movements. Both mild and pronounced finger movements were characterized as choreoathetoid movements, and they were distinguished from posturing movements. Posturing movements were classified as larger flexion and extension type movements of a nonwrithing quality. Wrist and arm movements were not considered in this study.

The Quick Neurological Screening Test (QNST) (1), a screening tool to identify school problems in children from 5 through 17 years of age, subjects as a function of Group and Choreoathetoid Movements

<table>
<thead>
<tr>
<th>Group</th>
<th>Choreoathetoid Movements</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Learning Disabled</td>
<td>Present</td>
<td>9</td>
<td>93.78</td>
<td>7.61</td>
</tr>
<tr>
<td></td>
<td>Absent</td>
<td>12</td>
<td>95.17</td>
<td>4.47</td>
</tr>
<tr>
<td>Nonlearning Disabled</td>
<td>Present</td>
<td>10</td>
<td>82.70</td>
<td>5.14</td>
</tr>
<tr>
<td></td>
<td>Absent</td>
<td>12</td>
<td>86.00</td>
<td>8.73</td>
</tr>
</tbody>
</table>
ence, was the evaluation instrument used. The test consists of 15 tasks that include hand skill, eye tracking, reproduction of sound patterns, identification of simultaneous tactile stimulation, various gross motor skills, and behavioral irregularities.

Procedure. The procedures included a pre-testing and a testing phase. During the pre-testing phase, inter-rater reliability was established for the Schilder's Arm Extension Test, and the examiner was trained in the administration of the QNST.

To establish inter-rater reliability for the Arm Extension Test, five children from the Boston University Occupational Therapy Clinic were videotaped during the performance of the test. The videotape was then viewed by the principal investigator and another therapist, who had been trained by the principal investigator in the determination of the presence or absence of choreoathetoid movements. Posturing movements were clearly differentiated from choreoathetoid movements, with both explanation and demonstration being used to supplement the tape. The two raters then jointly observed seven children in the performance of the Arm Extension Test and independent ratings were made by both raters. The rate of agreement was 100 percent on the presence or absence of choreoathetoid movements.

Training the principal investigator in the administration of the QNST included a review of the training tape (26) and examination of the test manual (1). Two experienced therapists also examined the QNST and independently identified items they thought would be particularly influenced by choreoathetosis. Of the 15 items of the test, 6 were considered to be influenced by choreoathetosis and 9 were not. Both therapists agreed on the identified items with those items considered sensitive to choreoathetosis being: hand skill, figure recognition and production, finger to nose, thumb and finger circle, rapidly reversing repetitive hand movements, and arm and leg extension.

During the testing phase, the examinee (not the principal investigator) administered the Schilder's Arm Extension Test to each child individually and before any other testing was performed. The examiner was unaware of the LD or non-LD classification of each child before testing. She was trained by the principal investigator on the identification of choreoathetoid movements through the use of demonstration, explanation, and the videotape of the five children. She was also trained in the use of the Southern California Sensory Integration Tests and clinical observations and was thus already familiar with the criteria for determining the presence or absence of choreoathetoid movements.

The QNST was administered to each child on the same day and following the Arm Extension Test. The principal investigator administered the QNST according to the standardized procedure. She was naive about the presence or absence of choreoathetoid movements in each child.

To be certain that both examiners in the study agreed concerning the presence or absence of choreoathetoid movements, six subjects were re-evaluated by the examiners. After each child performed the Arm Extension Test and the QNST according to the usual procedure, he was retested with the Arm Extension Test while both examiners scored his performance simultaneously and independently. The rate of agreement between the examiners was 100 percent for the six subjects.

Results

The effects of LD and choreoathetoid movements on the subjects' performance on two aspects of the QNST were studied: 1. the total score of the six items that were believed to be influenced by choreoathetoid movements (Q-Choreo), and 2. the total score of the nine items that were not expected to be influenced by the presence of choreoathetoid movements (Q-Nonchoreo). A higher score indicated a poorer performance.

An analysis of covariance, with age as the covariate and the presence or absence of choreoathetoid movements and group (LD, non-LD) as the two independent factors, was performed for each of the two dependent measures, Q-Choreo and Q-Nonchoreo. Age was used as a covariate since there were significant age differences between the LD and the non-LD subjects.

Q-Choreo. Performance on the six Q-Choreo items was found to be significantly different between the LD and the non-LD subjects: $F(1,38) = 22.81$, $p < .01$, with LD children receiving higher (poorer) scores than the non-LD subjects. There were no significant differences as a function of the presence or absence of choreoathetoid movements: $F(1,38) = 0.19$. There were also no significant Group by Choreoathetoid Movement interactions, $F(1,38) = 0.12$. The means and standard deviations of the Q-Choreo scores as a function of Group and Choreoathetoid Movements are presented in Table 2.

Q-Nonchoreo. When analyzing the Q-Nonchoreo category, neither Group, $F(1,38) = 1.36$, nor Choreoathetoid Movements, $F(1,38) = 0.14$, were found to be significant factors. Also, the Group by Choreoathetoid Movements interaction was not significant, $F(1,38) = 1.17$. The means and standard deviations
of the Q-Nonchoreo scores as a function of Group and Choreoathetoid Movements are presented in Table 2.

Additional Analysis. Although it is not optimal to analyze the total QNST score since analyzing both the entire test and subparts of the test uses the same data and thereby violates an assumption of analysis of variance, it was thought that knowledge of the subjects’ overall performance was relevant. With that caution in mind, the data were analyzed to see whether the presence of choreoathetoid movements affected the overall test score, and whether the test did in fact discriminate between the LD and non-LD subjects. It was found that Group was a significant factor, \( F(1,38) = 11.28, p < .01 \), with LD subjects scoring less well. However, Choreoathetoid Movements was not a significant factor, \( F(1,38) = 0.25 \), and there was not a significant Group by Choreoathetoid Movement interaction, \( F(1,38) = 0.34 \).

Discussion
Data analysis indicates that the presence of choreoathetoid movements did not interfere with most functional fine motor tasks as has been thought (9, 11), and only laboratory studies detect the effects of mild choreoathetoid movements.

The presence of LD was a significant factor in the subjects’ performance on the total QNST; and this suggests that the test is in fact valid since it discriminates between the LD and the non-LD subjects. The finding that Group was a significant factor of the Q-Choreo category but not the Q-Nonchoreo category suggests that some tasks may be better discriminators than others, at least in the age range studied. In looking at the tasks themselves, the Q-Choreo items appeared to be mainly fine motor tasks, whereas the Q-Nonchoreo items appeared to involve gross motor, sequencing, tactile, and memory skills. More research needs to be done to delineate which tasks are the best predictors of LD and whether certain subtypes of LD can be identified by

<table>
<thead>
<tr>
<th>Type of Item</th>
<th>Group</th>
<th>Choreoathetoid Movements</th>
<th>Present</th>
<th>Absent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q-Choreo</td>
<td>Learning Disabled</td>
<td>Mean</td>
<td>18.56</td>
<td>17.17</td>
</tr>
<tr>
<td></td>
<td></td>
<td>S D</td>
<td>5.95</td>
<td>4.22</td>
</tr>
<tr>
<td></td>
<td>Nonlearning Disabled</td>
<td>Mean</td>
<td>13.90</td>
<td>12.83</td>
</tr>
<tr>
<td></td>
<td></td>
<td>S D</td>
<td>2.51</td>
<td>3.85</td>
</tr>
<tr>
<td>Q-Nonchoreo</td>
<td>Learning Disabled</td>
<td>Mean</td>
<td>23.11</td>
<td>24.08</td>
</tr>
<tr>
<td></td>
<td></td>
<td>S D</td>
<td>6.01</td>
<td>4.92</td>
</tr>
<tr>
<td></td>
<td>Nonlearning Disabled</td>
<td>Mean</td>
<td>24.60</td>
<td>21.67</td>
</tr>
<tr>
<td></td>
<td></td>
<td>S D</td>
<td>3.96</td>
<td>5.68</td>
</tr>
</tbody>
</table>
various performance patterns on this test.

The Quick Neurological Screening Test appears to have potential for use by occupational therapists. It evaluates soft neurological signs, rather than purely academic problems, and children with soft signs are frequently the types of children seen by occupational therapists. The QNST has the advantage of extending the age range of tests such as the Meeting Street School Screening Test (21) and the Miller Assessment for Pre-Schoolers (22). The use of the QNST as a screening tool for specific types of problems, such as sensory integrative dysfunction, needs to be investigated.

Summary
The nature of choreoathetoid movements as a soft neurological sign in learning-disabled children was reviewed. Their normal and abnormal occurrence was discussed, as were the functional implications for children with choreoathetoid movements. The Quick Neurological Screening Test was presented as a tool for identifying children with learning problems. The relationships between the presence of choreoathetoid movements and LD and performance on the QNST were studied. The results of this investigation failed to confirm the hypothesis that the presence of choreoathetoid movements would adversely affect children's performance on items thought to be sensitive to the presence of such movements. However, the presence of LD was found to be an important factor in the subjects' performance of those items.

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