Rules for the classification of younger children with Nonverbal Learning Disabilities and Basic Phonological Processing Disabilities

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Abstract

Rules for the classification of Nonverbal Learning Disabilities (NLD) and Basic Phonological Processing Disabilities (BPPD) that had been generated and tested on older children (ages 9–15) were applied to younger children (ages 7–8). The goal was to evaluate the applicability of these classification rules for a younger population with NLD and BPPD, and to make revisions if necessary. These rules were used to differentiate these two subtypes of learning disabilities using levels and patterns of performance on motor/psychomotor, tactile/perceptual, visual–spatial, auditory–perceptual, problem solving, and language measures. An experienced child-clinical neuropsychologist classified each child. Only those children who received a classification of NLD or BPPD by the neuropsychologist and those who met criteria for definite or probable NLD and BPPD as defined by the rules were used in this study. Revisions were made to these rules for younger children. Revised rules allow for their use as a source of information to assist a clinician in deciding whether a comprehensive neuropsychological evaluation would be valuable. They may also be useful for research purposes.

Keywords: Neuropsychological deficits; Children; Learning disabilities; Neuropsychology; Neuropsychological assessment

There have been many studies designed to delineate the patterns of neuropsychological assets and deficits in older children (9–15 years of age) with learning disabilities (LD). Often, these studies have used a Verbal IQ–Performance IQ split (e.g., Rourke, Dietrich, & Young).
or patterns of academic achievement (e.g., Rourke & Strang, 1978) as a basis to separate children into groups. The goal of these studies was to identify and classify various LD subtypes. As the body of research in this area has increased, two reliable subtypes of LD have emerged.

One of these LD subtypes exhibits relative deficits in some language skills and in reading and spelling, and relative proficiencies in motor/psychomotor, tactile/perceptual, visual–spatial, and problem-solving skills. This LD subtype is now referred to as Basic Phonological Processing Disabilities (BPPD). Some dimensions of BPPD are seen as causative and sequential (i.e., primary → secondary → tertiary → verbal) whereas some of the dimensions are thought to be dependent (i.e., academic and psychosocial; Rourke, 1995). A model of the contents and dynamics of BPPD are shown in Figure 1.

Another subtype of children with LD demonstrates deficits in the following areas: motor/psychomotor, tactile/perceptual, visual–spatial, problem solving, and mechanical arithmetic. In addition, children with this LD subtype have relative strengths in some linguistic abilities and in single-word reading and spelling. This group of children exhibits the syndrome of Nonverbal Learning Disabilities (NLD) (Rourke, 1989, 1995). Some dimensions of NLD are seen as causative and sequential (i.e., primary → secondary → tertiary → verbal), whereas some of the dimensions are thought to be dependent (i.e., academic and psychosocial; Rourke, 1995). The content and dynamics of NLD are outlined in Figure 2.

For an explanation of the neuropsychological assets and deficits and their developmental dynamics, the interested reader is referred to Rourke, van der Vlugt, and Rourke (2002).

One of the investigations that contributed to the validity of the classification of younger children (ages 7–8 years) into the NLD and BPPD subtypes was that of Ozols and Rourke (1988). In this study, children with LD were divided into three groups based on their Reading, Spelling, and Arithmetic scores on the Wide Range Achievement Test (WRAT). Children in Group 1 had equal deficiencies in Reading, Spelling, and Arithmetic. Group 2 consisted of children who exhibited lower Reading and Spelling scores than Arithmetic scores, although all areas were impaired. Group 3 was made up of children who had higher Reading and Spelling scores than Arithmetic scores, as compared to age-appropriate norms. In this study, several significant differences between the groups were in evidence. Specifically, Group 3 performed better than groups 1 and 2 on some measures of auditory perceptual and language skills, and groups 1 and 2 performed better than Group 3 on some measures of visual–spatial skills.

Recently (Pelletier, Ahmad, & Rourke, 2001), classification rules for NLD and BPPD have been generated for older (9- to 15-year-old) children. These rules were meant to provide an objective method for the classification of the two LD subtypes. However, these rules have not yet been tested on younger children (ages 7–8 years). In this connection, Rourke et al. (1973) did not find the same clear cut differences on measures of verbal, auditory–perceptual, visual–perceptual, problem solving, motor and psychomotor performance in younger children with LD who were chosen for study on the basis of differences in VIQ and PIQ that were found in older children. Thus, it is important that the rules generated for older children who exhibit NLD or BPPD be replicated and/or revised for use with younger children.

The purpose of the present study was to apply and revise the Pelletier et al. (2001) classification rules by differentiating younger children with NLD and BPPD using their patterns of scores on problem solving, psychomotor/motor, visual–spatial, tactile/perceptual,
Fig. 1. Content and dynamics of BPPD.
Fig. 2. Content and dynamics of NLD.
auditory–perceptual, and language measures. The generation of such rules could be of assistance to clinicians in deciding whether a comprehensive neuropsychological assessment is needed at a relatively young age. If early assessments are carried out, then early interventions to aid in the child’s development may be possible. Also, such rules may be of use for research purposes.

1. Method

1.1. Participants

One hundred and twenty-four (114 BPPD and 10 NLD) participants, ages 7 and 8 years, were selected from a database of over 5000 children. The 102 males and 22 females had been previously assessed by an experienced clinical neuropsychologist and were classified as having LD. The database generated in this exercise is stored in a mainframe computer at the University of Windsor. It contains the age, gender, language, psychological test scores, and other relevant information of each child that has been collected since the 1960s. Inclusion criteria for this study were as follows: (1) English as the primary language; (2) no primary emotional disturbance, evidence of sensory deficit, or of environmental/educational deprivation; and (3) Wechsler Full Scale IQ (FSIQ) greater than or equal to 85.

In order for an individual to receive a definite categorization of BPPD (Pelletier et al., 2001), the first seven of the following features or 7–10 of these features would be manifested: (1) Category Test (Reitan & Davison, 1974) performance within one standard deviation of the mean; (2) Tactual Performance Test (Reitan & Davison, 1974) Right, Left, and Both hand performance times become progressively better vis-à-vis the norms; (3) Wide Range Achievement Test (WRA T; WRA T-R: Jastak & Jastak, 1965, 1984) Standard Scores for Reading and Spelling are below 80; (4) two of Wechsler Intelligence Scale for Children Object Assembly, Block Design, and Picture Arrangement subtests were the highest of the Performance scale; (5) performance of at least two standard deviations below the mean on three of subtests 9, 10, 11, and 12 of the Underlining Test (Rourke & Petrauskas, 1977); (6) Wechsler Intelligence Scale for Children (Wechsler, 1949, 1974, 1991) Verbal Intelligence Quotient (VIQ) less than Performance Intelligence Quotient (PIQ) by at least 10 points; (7) three of Speech–Sounds Perception (Reitan & Davison, 1974), Auditory Closure (Kass, 1964), Sentence Memory (Benton, 1965), and Phonemically Cued Verbal Fluency were below average; (8) two of Wechsler Intelligence Scale for Children Vocabulary, Information, Digit Span subtests are the lowest of the Verbal scale; (9) Grip Strength (Reitan & Davison, 1974) and Grooved Pegboard Test (Knights & Moule, 1968) performance are within one standard deviation of the mean or are above the mean; (10) less than two errors were made on simple tactile imperception or suppression (Reitan & Davison, 1974), finger agnosia (the inability to identify the correct finger when touched; Reitan & Davison, 1974), or astereognosis (difficulties in identifying objects when placed in the hand; Reitan & Davison, 1974) for shapes/forms versus dysgraphesthesia (a deficit in the identification of numbers or symbols written on the fingertips; Reitan & Davison, 1974) of at least one standard deviation below the mean. If a child had five or six of these characteristics, a designation of probable BPPD was assigned. Exhibiting three or
four of these features was categorized as questionable BPPD. The probability of BPPD was designated as low if the child was showing only one or two of these traits.

To receive a definite classification of NLD (Pelletier et al., 2001), either the first five of the following features was present or seven or eight of these features had to be demonstrated: (1) less than two errors on simple tactile perception and suppression versus finger agnosia, finger dysgrafesthesia, and astereognosis composite more than one standard deviation below the mean; (2) WRAT standard scores for Reading were at least eight points higher than that for Arithmetic; (3) two of Wechsler Intelligence Scale for Children Vocabulary, Similarities, and Information were the highest of the Verbal scale; (4) two of Wechsler Intelligence Scale for Children Block Design, Object Assembly, and Coding subtests were the lowest of the Performance scale; (5) Target Test (Reitan & Davison, 1974) at least one standard deviation below the mean; (6) Grip Strength was within one standard deviation of the mean or above the mean versus a Grooved Pegboard Test more than one standard deviation below the mean; (7) Tactual Performance Test Right, Left, and Both hand performance times became progressively worse vis-à-vis the norms; (8) Wechsler Intelligence Scale for Children (Wechsler, 1949, 1974, 1991) Verbal Intelligence Quotient (VIQ) greater than Performance Intelligence Quotient (PIQ) by at least 10 points. Five or six of these traits constituted probable NLD, whereas three or four were categorized as questionable NLD, and one or two of these represented a low probability of NLD (Pelletier et al., 2001).

The profiles of children who were classified as having either NLD or BPPD by an experienced neuropsychologist were examined in relation to the rules for classification. The children not only had to meet the criteria for definite or probable NLD or definite or probable BPPD, according to the rules, but also had to receive an LD classification from the neuropsychologist to be included in this study.

1.2. Measures

The tests used to generate the rules for classification can be divided into seven categories; academic achievement, motor/psychomotor, tactile/perceptual, visual–spatial, auditory/perceptual, language and problem solving: (1) The WRAT Reading, Spelling, and Arithmetic Scales were used as measures of academic achievement. (2) The motor/psychomotor tests included the Grip Strength Test and the Grooved Pegboard Test. (3) Tests included in tactile/perceptual assessments were Finger Agnosia, Fingertip Writing, Tactile Form Recognition, and Tactile Perception. (4) The tests used to evaluate visual–spatial skills and abilities were the Wechsler Intelligence Scale for Children PIQ, Digit Symbol Coding, Picture Completion, Picture Arrangement, Object Assembly, and Block Design Subtests, the Category Test, the Underlining Test, and the Target Test. (5) Auditory–perceptual measures included the Wechsler Intelligence Scale for Children Arithmetic and Digit Span Subtest, the Speech-Sounds Perception Test, and the Auditory Closure Test. (6) Language was assessed using the Wechsler Intelligence Scale for Children VIQ, Comprehension, Information, Similarities, and Vocabulary Subtests, the Sentence Memory Test, and the Verbal Fluency Test. (7) Problem solving skills were evaluated using the Tactual Performance Test. The tests administered are well-known and will not be described here. For a more elaborate explanation of these tests, see Rourke, Fisk, and Strang (1986).
Table 1
Descriptive statistics for handedness, age, and gender

<table>
<thead>
<tr>
<th>Gender</th>
<th>Handedness</th>
<th>n</th>
<th>R</th>
<th>L</th>
<th>Mean age (years)</th>
<th>S.D.</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>NLD</td>
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<td>6</td>
<td>1</td>
<td>7.9</td>
<td>0.7</td>
<td>7.1–8.9</td>
</tr>
<tr>
<td></td>
<td>F</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>8.2</td>
<td>0.6</td>
<td>7.8–8.9</td>
</tr>
<tr>
<td>BPPD</td>
<td>M</td>
<td>95</td>
<td>81</td>
<td>14</td>
<td>8.3</td>
<td>0.5</td>
<td>7.0–8.9</td>
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<tr>
<td></td>
<td>F</td>
<td>19</td>
<td>16</td>
<td>3</td>
<td>8.0</td>
<td>0.6</td>
<td>7.1–8.9</td>
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</tbody>
</table>

2. Results

Descriptive statistics for the age, gender, and handedness of the 124 children who met the criteria for inclusion are described in Table 1.

Of the 114 children who met criteria for classification as BPPD, 7.9% were classified as definite BPPD and 92.1% were classified as probable BPPD. Applicability of the rules for BPPD ranged from a high of 94.4% to a low of 25.7%.

Of the 10 children who met criteria for classification as NLD, 1 was classified as definite NLD and 9 were classified as probable NLD. Applicability of the rules for NLD ranged from a high of 90% to a low of 10%.

Fig. 3. Comparison of rules in younger and older BPPD children.
Fig. 4. Comparison of rules in younger and older NLD children.

The percentages of children to which each rule applied were plotted as a comparison of younger and older children starting with the rules that were most similar on the left side and proceeding to the rules that were most discrepant on the right side. The results for BPPD are presented in Figure 3; those for NLD, in Figure 4.

The most highly similar BPPD rule between younger and older children was the one requiring that “two of the Wechsler Vocabulary, Information, and Digit Span subtests are the lowest of the Verbal scale”. The most highly dissimilar BPPD rule was a Grip Strength and Grooved Pegboard Test performance within one standard deviation of the mean or above.

For NLD, the smallest difference was found between younger and older children on the rule “two of Wechsler Intelligence Scale for Children Vocabulary, Information, Digit Span subtests are the lowest of the Verbal scale”. The most highly discrepant NLD rule was “less than two errors were made on simple tactile perception and suppression versus finger agnosia, finger dysgraphesthesias, and astereognosis composite greater than one standard deviation below the mean.”

3. Discussion

Because the rules for classification of BPPD and NLD differ somewhat in the percentages to which they apply to older and younger children, a revision of these rules was necessary in order for them to maximize their applicability for younger children. The rules were arranged in a hierarchy according to the order in which they applied to the participants. The newly revised rules are contained in Table 2.
For clinicians without access to comprehensive neuropsychological test data, there are a few rules that should provide evidence regarding whether or not the child should be referred for a comprehensive neuropsychological evaluation. For BPPD, this would include rules 4, 5, 6, and 8 from Table 2. The NLD rules that do not require neuropsychological measures are 2, 3, 6, and 7 from Table 2.

As illustrated in Figure 1, the primary neuropsychological deficit of BPPD is thought to be in some dimensions of auditory perception and language skills. In this connection, it is interesting to note that rule 1, which is related to auditory perception of speech sounds, ap-

### Table 2

**Rules for 7- to 8-year-olds (BPPD)**

1. Three of Speech-Sounds Perception, Auditory Closure, Sentence Memory, and Phonemically Cued Verbal Fluency are below average (94.4%).
2. Grip Strength and Grooved Pegboard Test performance within one standard deviation of the mean or above (89.5%).
3. Category Test performance within one standard deviation above or below the mean (83.3%).
4. Wechsler Intelligence Scale for Children VIQ < PIQ by at least 10 points (66.7%).
5. Two of Wechsler Intelligence Scale for Children Vocabulary, Information, Digit Span subtests are the lowest of the Verbal scale (57.0%).
6. Two of Wechsler Intelligence Scale for Children Object Assembly, Block Design, and Picture Arrangement subtests are the highest of the Performance scale (53.5%).
7. Tactual Performance Test Right, Left, and Both hand performance times become progressively better vis-à-vis the norms (39.6%).
8. WRAT Standard Scores for Reading and Spelling are below 80 (37.2%).
9. Performances at least two standard deviations below the mean on three of subtests 9, 10, 11, and 12 of the Underlining Test (33.3%).
10. Less than two errors are made on simple tactile imperception or suppression, finger agnosia, or astereognosis for shapes/forms versus dysgraphesthesia at least one standard deviation below the mean (25.7%).

Particularly notable regarding this ranking of the rules/criteria is that criteria #1, 2, and 3 are evident 83.3–94.4% of the time. It would appear that dropping #10 as a criterion would, in all likelihood, have no appreciable effect on classification/diagnostic accuracy. The strict application of criteria #1 through 3 should result in very few false positives or false negatives.

**Notes**

(a) It should be clear that there is some overlap in the tests that contribute to some of these rules.
(b) These rules are very much in need of refinement, even after the rather impressive results of our first concurrent validity study.
(c) The following criteria are currently under investigation:
   - the first 7 features: definite BPPD
   - 7 to 10 of these features: definite BPPD
   - 5 or 6 of these features: probable BPPD
   - 3 or 4 of these features: questionable BPPD
   - 1 or 2 of these features: low probability of BPPD

**Rules for 7- to 8-year olds (NLD)**

1. Target Test at least one standard deviation below the mean (90.0%).
2. Two of Wechsler Intelligence Scale for Children Block Design, Object Assembly, and Coding subtests are the lowest of the Performance scale (90.0%).
Table 2 (Continued)

(3) Two of Wechsler Intelligence Scale for Children Vocabulary, Similarities, and Information are the highest of the Verbal scale (80.0%).
(4) Tactual Performance Test Right, Left, and Both hand times become progressively worse vis-à-vis the norms (77.8%).
(5) Grip Strength within one standard deviation of the mean or above versus Grooved Pegboard Test greater than one standard deviation below the mean (70.0%).
(6) Wechsler Intelligence Scale for Children VIQ > PIQ by at least ten points (70.0%).
(7) WRAT standard score for Reading is at least 8 points higher than Arithmetic (60.0%).
(8) Less than two errors are made on simple tactile perception and suppression versus finger agnosia, finger dysgraphesthesia, and astereognosis composite greater than one standard deviation below the mean (10.0%).

Particularly notable regarding this ranking of the rules/criteria is that criteria #1, 2, and 3 are evident 80–90% of the time. It would appear that dropping #8 as a criterion would, in all likelihood, have no appreciable effect on classification/diagnostic accuracy. The strict application of criteria #1 through 3 should result in very few false positives or false negatives.

Notes
(a) It should be clear that there is some overlap in the tests that contribute to some of these rules.
(b) These rules are very much in need of refinement, even after the rather impressive results of our first concurrent validity study.
(c) The following criteria are currently under investigation:
   - the first 3 features: definite NLD
   - two of the first 3 features and one of 4 and 5: definite NLD
   - criteria 4, 5, 6, and 7: probable NLD
   - only two of criteria 1 through 7: questionable NLD
   - none of criteria 1 through 7: low probability of NLD

plied to the highest percentage of children (94.4%). As illustrated in Figure 2, the primary neuropsychological deficits of NLD are thought to be in some dimensions of tactile and visual perception and in complex psychomotor skills. The rules related to visual perception (rules 1 and 2) applied to the highest percentage of children (90%).

It must be stressed that these rules should be used only to determine whether a comprehensive neuropsychological evaluation would be worthwhile. These rules are not a substitute for a thorough neuropsychological examination.

In addition to the sensitivity of these rules for identifying children with NLD and BPPD they are also specific. That is, none of the children classified as probable or definite NLD met criteria for classification of probable or definite BPPD. Furthermore, none of the children classified as probable or definite BPPD met criteria for classification of probable or definite NLD.

3.1. Limitations to the present investigation

There are several limitations of the present study that are important to mention. First, there was the small number of the NLD subjects. This small sample size in conjunction with the exclusion of children who spoke English as a second language and those with environmental/sensory deprivation, and/or an emotional disturbance may have put a limit on the extent to
which these rules can be generalized. Moreover, it may be the case that it is difficult to diagnose children with NLD at such a young age. In a recent study (Ahmad, Rourke, & Drummond, 2002), it was found that a group of adults with NLD evidence significantly worse neuropsychological deficits a group of children with NLD in terms of magnitude. Thus, it is probable that younger children do not present with the extent of disabilities (i.e., with the moderate to severe deficits) that may eventually be the case.

The restrictions that the children’s primary language must be English and that they must not have been exposed to environmental deprivation or have sensory deficits or have a primary emotional disturbance may have also excluded BPPD children who may be at high risk for psychosocial and academic difficulties. Furthermore, only children with an average Full Scale IQ were included in this study. It would also be beneficial to examine how these rules apply to children with below-average IQ scores. The results of one study (Ralston, Fuerst, & Rourke, 2003), for example, suggested that the psychosocial profiles of children with below-average IQ are quite similar to those of children with LD.

The recent abandonment of VIQ and PIQ indexes on the WISC-IV may appear to pose a problem for application of these rules. However, the other rules, including those using the WISC subtests (although Object Assembly has been removed), remain applicable and account for a large percentage of classification accuracy in any case. The accuracy of the Verbal Comprehension Index (VCI) and Perceptual Reasoning Index (PRI) differences and the new subtests (Matrix Reasoning, Picture Concepts, Word Reasoning, Letter-Number Sequencing, and Cancellation) in classification is yet unknown, but would most likely be comparable to VIQ − PIQ differences and similar Verbal and Performance subtests from the other WISC versions. Investigations to test this hypothesis would be beneficial.

3.2. Summary

The results of this study point to differences between younger and older children with two subtypes of LD on neuropsychological tests. A revision of these rules applicable to older children was formed in an objective manner and should be useful to clinicians and researchers to help determine whether a younger child should be included or excluded from a BPPD or NLD classification. Furthermore, the ability to make this determination at a younger age is important as it may allow for earlier referral to a clinical neuropsychologist and intervention/treatment.

It is clear that the principal differentiating features of these two sets of disabilities relate to their “primary” assets and deficits. The clinical implication of this finding is that these deficits should be treated early and these assets should be employed to compensate for the deficits when it is appropriate to do so. For further clinical implications the interested reader is referred to Rourke et al. (2002) for extensive discussions of treatment planning for children who exhibit NLD and BPPD.

References

Rourke, B. P., & Petrauskas, R. J. (1977). *Underlining Test (Revised)*. Windsor, Ont.: University of Windsor, Department of Psychology.