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An analysis of the criteria used to diagnose children with Nonverbal Learning Disability (NLD)

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Based on a review of the literature, the diagnostic criteria used for children with nonverbal learning disabilities (NLD) were identified as follows: (a) low visuospatial intelligence; (b) discrepancy between verbal and visuospatial intelligence; (c) visuoconstructive and fine-motor coordination skills; (d) visuospatial memory tasks; (e) reading better than mathematical achievement; and (f) socioemotional skills. An analysis of the effect size was used to investigate the strength of criteria for diagnosing NLD considering 35 empirical studies published from January 1980 to February 2011. Overall, our results showed that the most important criteria for distinguishing children with NLD from controls were as follows: a low visuospatial intelligence with a relatively good verbal intelligence, visuoconstructive and fine-motor coordination impairments, good reading decoding together with low math performance. Deficits in visuospatial memory and social skills were also present. A preliminary set of criteria for diagnosing NLD was developed on these grounds. It was concluded, however, that—although some consensus is emerging—further research is needed to definitively establish shared diagnostic criteria for children with NLD.

Keywords: Nonverbal learning disability; Review; Diagnostic criteria; Learning disabilities; Visuospatial abilities.

In the area of learning and developmental disabilities, there is a subgroup of children who are competent in verbal domains, with a high verbal IQ, but weak in nonverbal domains and visuospatial abilities in particular, encountering serious adaptive and learning difficulties. These children are observable clinically and need psychological support, though neither the *Diagnostic and Statistical Manual of Mental Disorders, text revision* (*DSM-IV-TR*; American Psychiatric Association, 2000) nor the *International Classification of Diseases and Related Disorders* (ICD-10; World Health Organization, 1992) mentions a specific category capable of describing them.

Different labels have been used in an effort to define these children appropriately, for example, *nonverbal disorders of learning* (Myklebust, 1975), *nonverbal learning syndrome* (Rourke, 1989, 1995), *visuospatial learning disability* (Cornoldi, Venneri, Marconato, Molin, & Montinari, 2003), and *right hemisphere developmental learning disability*

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(Tranel, Hall, Olson, & Tranel, 1987). Johnson and Myklebust (1967; Myklebust, 1975) coined the term *nonverbal disorders of learning* and tried to define these children's characteristics. They focused particularly on some nonverbal learning domains that could lead to selective deficits: (a) *perception*, for example, the ability to encode the whole part of a configuration and to learn through pictures; (b) *processing of gestures*, for example, giving meaning to visual movements; (c) *motor learning*, for example, the ability to learn motor patterns, such as those required in handwriting or using objects such as scissors; (d) *body image*, for example, visualization of one's own body, associated with digital agnosia; (e) *spatial orientation,* for example, the ability to establish a spatial relationship between the body and other objects and to recall spatial locations; and (f) *left-right orientation*, for example, laterality delay, dysfunctions of which could be associated with Gerstmann syndrome (Gerstmann, 1940; i.e., digital agnosia, dyscalculia, and dysgraphia). Johnson and Myklebust also hypothesized two additional nonverbal domains that could be impaired: *social perception*, for example, the ability to adapt and to anticipate the consequences of one's own behavior in response to socially relevant information and the *regulation of attention/monitoring systems*, for example, the child's ability to "scan, select, and hold internal events in a manner consistent with his circumstances" (Johnson & Myklebust, 1967, p. 300).

The Myklebust proposal received relatively little attention, while the same could not be said of the work done by Rourke (1989, 1995), who interpreted nonverbal learning disorders as a unitary entity, referring to a "syndrome" of nonverbal learning disabilities (NLD), and specified a pattern of relative *assets* and *deficits* for describing the features of NLD. In Rourke's (1995) model, primary neuropsychological assets and deficits lead to secondary assets and deficits, also arriving at academic and socioemotional assets and deficits. The main deficits in the NLD setting concerned "weaknesses" in visual-spatial-organizational processing, bilateral tactile-perceptual abilities, psychomotor skills, and novel problem solving. These deficits resulted in academic (primarily mechanical arithmetic) and social/emotional maladaptive behavior. Rourke proposed to extend the NLD clinical profile to at least three different situations (see Fine Semrud-Clikeman, Bledsoe, & Musielak, 2013; Spreen, 2011, for critical reviews): (a) cases with other diagnoses, such as Asperger syndrome, velo-cardio-facial syndrome (22q11 deletion), Turner syndrome, agenesis of the corpus callosum, etc., who also have a nonverbal deficit profile; (b) cases with a specific nonverbal disorder who do not have severe academic difficulties; and (c) cases with a specific nonverbal disorder who also have severe learning problems. Moreover, Rourke and coauthors observed that the pattern of deficits in children with NLD appeared to change over time with changing demands at school and at home (Casey, Rourke, & Picard, 1991; Ozols & Rourke, 1991; Rourke, 1989, 1995; Rourke & Finlayson, 1978).

Criteria for Diagnosing Children with NLD According to the Literature

For the time being, the majority of researchers and clinicians agree that the profile of NLD clearly exists (but see Spreen, 2011, for an exception), but they disagree on the need for a specific clinical category and on the criteria for its identification. Around 50 years on, there is still no consensus on the criteria for diagnosing children with NLD, nor is it clear which of the various criteria used to do so have the greatest discriminatory power. As a consequence, not only is this disorder not included in the clinical classification systems but the related research and practice have not been adequately developed.

Pelletier, Ahmad, and Rourke (2001) and Drummond, Ahmad, and Rourke (2005) tried to define the criteria for diagnosing children with NLD, for 9- to 15-year-olds and for 7- to 8-year-olds, respectively. Their criteria mentioned the following points: (a) tactile perception impairments; (b) reading better than mathematical achievement; (c) at least two of the following subtests on the Wechsler (1974, 1991) Intelligence Scale for Children (WISC)—Vocabulary, Similarities, and Information—obtain the highest results on the Verbal scale; (d) at least two WISC subtests—Block Design, Object Assembly, and Coding—obtain the lowest results on the Performance scale; (e) poor visuoconstructive skills; (f) motor-coordination impairments; (g) tactile performance impairments; and (h) a verbal intelligence quotient (VIQ) at least 10 points higher than the performance intelligence quotient (PIQ) on the WISC. While five or six of these traits meant a likely diagnosis of NLD for the older children (9–15 years old), for the younger ones (7–8 years old), three criteria were considered sufficient for the diagnosis, that is, visuoconstructive impairments and differences in the subtests on the Verbal and Performance scales in the WISC (above Items 3 and 4).

Pennington suggested (1991), on the other hand, that primary deficits in children with NLD lie in mathematics, handwriting, and drawing and that problems with social cognition, attention, and concept formation could be seen as related symptoms. Cornoldi et al. (2003) similarly argued that, for NLD to be considered a learning disability (LD), the diagnosis must first ascertain whether the general criteria for an LD are met. They consequently focused on academic shortcomings relating to visuospatial deficits, considering emotional and social problems as possible associated symptoms. In particular, Cornoldi and coauthors (Cornoldi, Dalla Vecchia, & Tressoldi, 1995; Cornoldi, Rigoni, Tressoldi, & Vio, 1999; Cornoldi & Vecchi, 2003) argued that a crucial factor underlying the difficulties encountered by children with NLD was represented by their visuospatial working memory (VSWM) deficits, which might explain why NLD children fail in a number of activities (mathematics, drawing, spatial orientation, etc.) assumed to involve VSWM. Other researchers did not consider VSWM as a selection criterion for diagnosing children with NLD, however, although some of them (e.g., Dimitrovsky, Spector, Levi-Shiff, & Vakil, 1998; Harnadek & Rourke, 1994; Tranel et al., 1987) administered visuospatial memory tasks.

Conflicting results have emerged from research examining the diagnostic value of the social skills of children with NLD. In fact, social and emotional problems have been among the inclusion criteria for selecting children with NLD in a good deal of the published research, but no studies have reported objective measures of social functioning as a selection criterion, and only two aspects of social functioning have been analyzed thoroughly, that is, (a) emotion comprehension and (b) social perception and social relation skills. Both Pennington (1991) and Cornoldi et al. (2003) argued, moreover, that social problems may be typically associated but are not a primary feature of children with NLD, in contrast with Rourke's proposal (1995).

Overview of the Study

In short, partially divergent definitions of NLD have been suggested and the lack of shared, clearly defined criteria may have prevented this condition from being included in the diagnostic manuals, making any critical analysis of the syndrome very difficult. The present study was designed to shed light on this topic by analyzing which criteria were most often used in the scientific literature on NLD and the entity of the typical differences (in standardized scores) identified in these criteria between NLD groups and controls. We could only use a part of the literature on NLD, since one of the main problems we encountered in analyzing the literature was that the criteria used were sometimes only described, while no quantitative values (i.e., means and standard deviations) were reported, and there was no reference to the tests used.

Since the current study aimed to analyze all the possible criteria for identifying NLD children, we considered both the variables used as diagnostic criteria and the variables studied in groups of otherwise-identified NLD children. We calculated the classic effect size index (Cohen, 1988), which refers to the degree of association/correlation between two or more variables. This index affords an interpretation of the magnitude of the effect size of different variables; given the heterogeneity of the criteria used in the literature, we assumed that the index would enable us to compare the values of different criteria.

Our review revealed that the criteria used by most researchers focused on the discrepancy between performance (or visuospatial) and verbal IQ and low math achievement, though these criteria were quantified differently in different studies. For instance, as already mentioned, Rourke recommended at least 10 points of discrepancy between verbal and performance IQ (Drummond et al., 2005; Pelletier et al., 2001), whereas Petti et al. (2003) used 12 points of discrepancy, Chow and Skuy (1999) used 15 points, and so on. A similar variability was also evident for math achievement and the other criteria considered in the various studies. The effect size index should therefore give us a value indicating the severity of the NLD group's impairment, that is, whether the difference in visuospatial intelligence between children with NLD and controls is greater than the difference between these two groups in terms of their math achievement performance.

The effect size index was calculated for two kinds of variables: (a) variables used as internal criteria for selecting children with NLD (that is, verbal and performance IQ; visuoconstructive and fine-motor skills; achievement in reading and mathematics); and (b) dependent variables (mainly visuospatial memory; emotion comprehension; social skills) examined in groups of children with a diagnosis of NLD.

METHOD

A literature search was conducted to identify studies published on children with NLD. Medline, Web of Science, ERIC, and PsycINFO were searched for publications from January 1980 to February 2012 using combinations of keywords such as *nonverbal learning disability/disorder*, *visuospatial learning disability/disorder*, and *right hemisphere learning disability/disorder*. The articles retrieved were also examined for further relevant publications. We limited our search to studies in English, in peer-reviewed journals. We initially found 66 publications. These publications were afterwards selected on the basis of the exclusion and inclusion criteria listed below. Using this procedure, 35 papers were identified.

Study Selection

Exclusion and inclusion criteria were used to identify the articles relevant to our analysis.

Studies with the following characteristics were excluded:

- Publications that had not been peer reviewed;
- Literature reviews;
- Books and chapters;
- Dissertations and theses;
- Peer-reviewed publications in languages other than English with no translation available;
- Single-case studies; although most of these studies (Bieliauskas, 1990; Mammarella, Coltri, Lucangeli, & Cornoldi, 2009; Mammarella et al., 2006; Nichelli & Venneri, 1995; Sparrow, 1990) mentioned the criteria used to identify the case of NLD, data obtained on single cases ($n = 1$) were not included in our analysis;
- Research concerning NLD not as a specific disorder, but in association with genetic or neurological development dysfunctions (Turner syndrome, Williams syndrome, velo-cardio-facial syndrome, neurofibromatosis type 1, intellectual disability, and so on) or acquired disorders (brain tumors, brain injury, brain lesions, and so on), or Asperger syndrome.

To be included in our analyses, the studies had to mention the criteria adopted to select children with NLD and to provide some quantitative data on their assessment. Only publications in which a group of children with NLD was compared with a group of typically developing controls and/or another clinical group were included. It is worth noting that NLD cases were compared with children who had specific language impairments in the studies by Fisher and DeLuca (1997), Chow and Skuy (1999), Worling, Humphries, and Tannock (1999), Humphries, Cardy, Worling, and Peets (2004), Yu, Buka, McCormick, Fitzmaurice, and Indurkhya (2006), Hendriksen et al. (2007), Schiff, Bauminger, and Toledo (2009), Antshel and Khan (2008), and Galway and Metsala (2011), while Mammarella et al. (2009) compared NLD cases with children who had reading disabilities, and Lepach and Petermann (2011) compared them with children who had memory impairments.

Selection of the Criteria

The 35 studies included in our review are listed in Table 1, which also summarizes the criteria reportedly used by the authors to select children with NLD. The two most frequently adopted criteria were verbal and visuospatial IQ (28 studies), either separately or as a discrepancy measure, and achievement in reading and mathematics (31 studies), again either separately or as a discrepancy measure. Visuoconstructive and motor coordination deficits were often considered too (in 20 and 15 studies, respectively). It is worth noting that there was a discrepancy between the criteria mentioned by the authors (as shown in Table 1) and those that presented quantitative data and could then be considered in our effect size analysis.

In order to represent all the criteria mentioned in the studies, we therefore analyzed two types of variable: (a) those used as internal criteria for selecting children with NLD and (b) those used as dependent variables.

Variables Used as Internal Criteria for Selecting Children with NLD

1. Low visuospatial intelligence compared to controls: This criterion was often used but was not defined in the same way in the various studies; it was mentioned in 28 studies,

Table 1 Diagnostic Criteria Used by Researchers to Diagnose Children with NLD.

Study	VIQ > PIQ	Verbal/Spatial Discrepancy	Visuoconstructive and Fine-Motor Impairment	VSWM Impairment	Reading	Mathematics	Social Skills
1. Tranel et al. (1987)	From 13 to 38 points		Low scores in the Rey complex figure	Low scores in the Benton Visual Retention test (Benton, 1974)	Good reading achievement	Poor math achievement	Low social and emotional abilities
2. Casey et al. (1991)	10 points		Low scores in the Target test and in the Grooved Pegboard Test		Reading > Math (10 pts)	Math < Reading (10 pts)	
3. Harnadek and Rourke (1994)	10 points		Low scores in the Target test and in the Grooved Pegboard Test	Low scores in the Tactual Perceptual test –Memory and Location	Reading > Math (10 pts)	Math < Reading (10 pts)	
4. Gross-Tsur, Shalev, Manor, and Amil (1995)	VIQ > PIQ and VIQ > 85		Soft neurological signs on the left side of the body			Math achievement 1 year below class level	Emotional and interpersonal behavioral disorders
5. Cornoldi et al. (1995)		Verbal PMA > Spatial PMA (Thurstone & Thurstone, 1963)				Poor math achievement	
6. Fisher and DeLuca (1997)	9 points and VIQ > 79		Low scores in the Target test and in the Grooved Pegboard Test		Reading > Math (10 pts)	Math < Reading (10 pts)	

(*Continued*)

Table 1 (Continued).

Study	VIQ > PIQ	Verbal/Spatial Discrepancy	Visuoconstructive and Fine-Motor Impairment	VSWM Impairment	Reading	Mathematics	Social Skills
7. Fisher, DeLuca, and Rourke (1997)	9 points and VIQ > 79		Low scores in the Target test and in the Grooved Pegboard Test		Reading > Math (10 pts)	Math < Reading (10 pts)	
8. Dimitrovsky et al. (1998)				*z* scores < 0 in the Benton Visual Retention test (Benton, 1974) and *z* scores > 0 in the Rey auditory verbal test	>2 years below grade level in special education classes		
9. Cornoldi et al. (1999)	15 points		Poor handwriting	Low scores in VSWM tasks		Poor math achievement	Low social abilities
10. Worling et al. (1999)	10 points	VIQ > 85 PIQ < 85			Reading > Math	Math < Reading Math < 25th percentile	
11. Chow and Skuy (1999)	15 points		Poor visual-motor integration and fine motor coordination	Visuospatial and organizational problems	Reading > Math; Reading decoding > Reading comprehension	Math < Reading	Poor socioemotional functioning

(*Continued*)

Table 1 (Continued).

Study	VIQ > PIQ	Verbal/Spatial Discrepancy	Visuoconstructive and Fine-Motor Impairment	VSWM Impairment	Reading	Mathematics	Social Skills
12. Pelletier et al. (2001)	10 points	a. Two of WISC Object Assembly, Block Design, and Coding subtests score lowest on the Performance scale; and b. Two of WISC Vocabulary, Similarity, Information, subtests score highest on the Verbal scale	Low scores in the Target test and in the Grooved Pegboard Tactual Performance tests		Reading > Math (8 pts)	Math < Reading (8 pts)	
13. Petti et al. (2003)	12 points					1 standard deviation lower than VIQ	
14. Venneri et al. (2003)		Vocabulary > Block Design (WISC)		Low scores in VSWM tasks	>30th percentile		
15. Forrest (2004)		VCI > POI of 12 points (WISC)	Low scores in the Target test and in the Grooved Pegboard Test		Reading > Math (8 pts)	Math < Reading (8 pts)	
16. Humphries et al. (2004)	10 points				Reading > Math (10 pts)	Math < Reading (10 pts); Math < 25th percentile	

(*Continued*)

Table 1 (Continued).

Study	VIQ > PIQ	Verbal/Spatial Discrepancy	Visuoconstructive and Fine-Motor Impairment	VSWM Impairment	Reading	Mathematics	Social Skills
17. Drummond et al. (2005)	10 points	See Pelleiter et al. (2001)	Low scores in the Target test and in the Grooved Pegboard and Tactual Performance tests		Reading > Math (8 pts)	Math < Reading (8 pts)	
18. Liddell and Rasmussen (2005)	10 points	See Pelleiter et al. (2001)		Low scores in visual memory	Reading > Math; Reading decoding > Reading comprehension	Math < Reading	Low scores in the Children's Behavior Checklist
19. Mammarella and Cornoldi (2005a)		Verbal PMA > Spatial PMA (Thurstone & Thurstone, 1963)		Low scores in VSWM tasks			
20. Mammarella and Cornoldi (2005b)	10 points			Low scores in VSWM tasks			
21. Yu et al. (2006)						Math lower than predicted	
22. Antshel and Joseph (2006)			Impaired visuospatial abilities and motor coordination more marked in the left side		Reading > Comprehension Reading > Math	Math < Reading	Poor social interaction

(*Continued*)

Table 1 (Continued).

Study	VIQ > PIQ	Verbal/Spatial Discrepancy	Visuoconstructive and Fine-Motor Impairment	VSWM Impairment	Reading	Mathematics	Social Skills
23. Hendriksen et al. (2007)	10 points	See Pelleiter et al. (2001)	Low scores in the VMI test		Reading > Math	Math < Reading	
24. Semrud-Clikeman and Glass (2008)		Vocabulary > Block Design (WISC)	Low scores in the VMI test and Rey complex figure		Reading ≥ 85	Math below average	
25. Antshel and Khan (2008)			Impaired visuospatial abilities and motor coordination more marked in the left side		Well-developed Reading	Poor mechanical arithmetic	Deficits in social perception, judgment, and interaction
26. Schiff et al. (2009)			Low scores in the Benton Visual Retention test (Benton, 1974)	Low scores in the Benton Visual Retention test (Benton, 1974)		Poor math achievement	
27. Mammarella et al. (2009)	10 points	See Pelleiter et al. (2001)			>50th percentile		
28. Semrud-Clikeman, Walkowiak, Wilkinson, and Christopher (2010)		Vocabulary > 85 (WISC)	Low scores in the VMI test and Rey complex figure and in scores in the Purdue Pegboard test (Tiffin, 1968)		>50th percentile	<15th percentile	Low scores in the Social Skills Rating Scale
29. Semrud-Clikeman, Walkowiak, Wilkinson, and Portman Minne (2010)		Vocabulary > 85 (WISC)	Low scores in the VMI test and in scores in the Purdue Pegboard test (Tiffin, 1968)			1 standard deviation lower than IQ	Low scores in the Social Skills Rating Scale

(*Continued*)

Table 1 (Continued).

Study	VIQ > PIQ	Verbal/Spatial Discrepancy	Visuoconstructive and Fine-Motor Impairment	VSWM Impairment	Reading	Mathematics	Social Skills
30. Grodzinsky, Forbes, and Bernstein (2010)	10 points	VCI > POI of 10 points (WISC)	Low scores in the Grooved Pegboard Test		Reading > Math	Math < Reading	
31. Bloom and Heath (2010)					Reading > 85; Reading > Math	Math < 80; Math < Reading	
32. Mammarella, Lucangeli, and Cornoldi (2010)				Low scores in VSWM tasks	>50th percentile	Poor math achievement	
33. Mammarella and Pazzaglia (2010)		Verbal PMA > Spatial PMA (Thurstone & Thurstone, 1963)		Low scores in VSWM tasks	>50th percentile		
34. Galway and Metsala (2011)	10 points		Low scores in the Target test <25th percentile in handwriting skills and in in the Grooved Pegboard Test		>30th percentile	<25th percentile	
35. Lepach and Petermann (2011)		VIQ > PIQ	Low scores in drawing tasks				

but only 13 reported quantitative data. In five studies (Cornoldi et al., 1995; Mammarella & Cornoldi, 2005a; Mammarella & Pazzaglia, 2010; Semrud-Clikeman & Glass, 2008; Venneri, Cornoldi, & Garuti, 2003), only one test was used to measure visuospatial abilities. Some researchers (Forrest, 2004; Grodzinsky et al., 2010) used the Perceptual Organization Index (POI) or the Perceptual Reasoning Index (PRI), which are factorial indexes of the WISC-III and IV, respectively (Wechsler, 1991, 2003); others (Pelleiter et al., 2001; but see also Drummond et al., 2005; Liddell & Rasmussen, 2005; Mammarella et al., 2009) indicated that WISC subtests had to present the worst scores in children with NLD; and some authors did not consider IQ as a criterion (Antshel & Khan, 2008; Bloom & Heath, 2010; Mammarella et al., 2010; Schiff et al., 2009). To calculate the effect size, we considered Studies 6, 10, 11, 13, 14, 15, 16, 24, 25, 27, 33, 34, and 35 (see Table 1).
2. High verbal intelligence: Like the previous criterion, verbal abilities were measured using a single test by Cornoldi et al. (1995), Venneri et al. (2003), Mammarella and Cornoldi (2005a), Semrud-Clikeman and Glass (2008), and Mammarella and Pazzaglia, (2010). Some researchers (Forrest, 2004; Grodzinsky et al., 2010) used the verbal comprehension factorial index (VCI) of the WISC-III or IV (Wechsler, 1991, 2003), respectively. Some did not consider IQ as a criterion (Antshel & Khan, 2008; Bloom & Heath, 2010; Mammarella et al., 2010; Schiff et al., 2009). Finally, Semrud-Clikeman, Walkowiak, Wilkinson, and Christopher (2010), and Semrud-Clikeman, Walkowiak, Wilkinson, and Portman Minne (2010) only considered children with a vocabulary subtest score higher than 85. Seventeen studies (i.e., 3, 6, 10, 11, 13, 14, 15, 16, 19, 24, 25, 27, 28, 29, 32, 34, and 35) were analyzed.
3. Discrepancy between verbal and visuospatial intelligence: The discrepancy between measures of verbal and performance IQ in children with NLD was mentioned as a criterion in 24 papers, but only 16 studies reported means and standard deviations (i.e., 2, 9, 10, 11, 13, 14, 15, 16, 18, 20, 22, 24, 27, 33, 34, and 35) and could be analyzed with the effect size index.
4. Poor visuoconstructive and fine-motor skills: (We considered together the two aspects because some of the tests included both motor and visuoconstructive requests). This criterion was considered in 21 studies, but only seven of them reported quantitative data (i.e., 3, 15, 23, 24, 28, 29, and 34). Most of the studies detected difficulties in this area using the Rey-Osterrieth Complex Figure (ROCF; Osterrieth, 1944), the Visual-Motor Integration (VMI) test (Beery & Buktenica, 2006). We also included in this category the studies that used the Target test (Reitan, 1966), the Grooved Pegboard and Tactual Performance tests (Kløve, 1963), and the study of Galway and Metsala (2011) reporting poor handwriting in children with NLD. Some studies (Casey et al., 1991; Grodzinsky et al., 2010) did not compare NLD children with a control group, so they were not included in our analyses. Moreover, studies mentioning neurological signs on the left side of the body could not be considered as they did not report quantitative values (Antshel & Joseph, 2006; Antshel & Khan, 2008; Chow & Skuy, 1999; Gross-Tsur et al., 1995).
5. Low mathematics achievement: This criterion was mentioned in various studies (Antshel & Khan, 2008; Cornoldi et al., 1999; Galway & Metsala, 2011; Gross-Tsur et al., 1995; Mammarella et al., 2009; Mammarella et al., 2010; Schiff et al., 2009; Semrud-Clikeman & Glass, 2008; Semrud-Clikeman, Walkowiak, Wilkinson, & Christopher, 2010, Tranel et al., 1987). Specifically, Studies 3, 5, 6, 10, 13, 14, 16, 21, 22, 23, 24, 25, 26, 28, 29, 31, 32, and 34 all covered this aspect. We could not consider

the studies that failed to report statistical analyses and/or means and standard deviations (Cornoldi et al., 1999; Galway & Metsala, 2011; Mammarella et al., 2009).

6. High reading decoding achievement: Either medium or good reading skills were often mentioned as a criterion for diagnosing children with NLD (Antshel & Khan, 2008; Dimitrovsky et al., 1998; Galway & Metsala, 2011; Mammarella et al., 2009, 2010; Semrud-Clikeman & Glass, 2008; Semrud-Clikeman, Walkowiak, Wilkinson, & Christopher, 2010; Tranel et al., 1987; Venneri et al., 2003). The following studies were analyzed: 3, 6, 10, 13, 14, 16, 21, 22, 23, 24, 25, 26, 27, 28, 29, 31, and 34. Some papers were excluded because they provided no information on statistical analyses and/or means and standard deviations, that is, Dimitrovsky et al. (1998); Cornoldi et al. (1999); Mammarella et al. (2010).
7. Discrepancy between reading and math achievement: Many studies mentioned the discrepancy between reading and mathematical skills as a criterion for selecting children with NLD (e.g., Bloom & Heath, 2010; Casey et al., 1991; Chow & Skuy, 1999; Drummond et al., 2005; Fisher & DeLuca, 1997; Fisher et al., 1997; Forrest, 2004; Grodzinsky et al., 2010; Harnadek & Rourke, 1994; Hendriksen et al., 2007; Humphries et al., 2004; Liddell & Rasmussen, 2005; Pelletier et al., 2001; Worling, Humphries, & Tannock, 1999). The effect size of the following studies was calculated: 2, 3, 6, 10, 13, 16, 18, 21, 22, 23, 24, 25, 26, 28, 29, 31, and 34. We could not consider the studies that provided no statistical analyses and/or means and standard deviations (Drummond et al., 2005; Forrest, 2004; Pelleiter et al., 2001) or that did not compare NLD children with a control group (Grodzinsky et al., 2010; Liddell & Rasmussen, 2005).

Dependent Variables in Studies on Children with NLD. Our selection of diagnostic criteria derived from the variables used to identify children with NLD did not cover all the critical aspects of NLD children mentioned in the literature. In particular, VSWM (Cornoldi et al., 1995, 1999; Mammarella & Cornoldi, 2005a, 2005b) and socioemotional skills (Pennington, 1991; Rourke, 1995) were mentioned by several authors as possible markers of NLD. None of the studies considered VSWM performance when selecting children with NLD, however, and when weak socioemotional skills were mentioned as a selection criterion (see Table 1), no descriptive statistics or statistical analyses were reported. For the purposes of our analysis, we consequently considered these VSWM and socioemotional skills as dependent variables.

1. Poor visuospatial working memory performances: A number of studies (e.g., Cornoldi et al., 1995, 1999; Mammarella & Cornoldi, 2005a, 2005b) showed that children with NLD fail in VSWM tasks. Studies 3, 5, 9, 11, 14, 19, 20, 32, 33, and 35 were selected for the purposes of calculating the effect size index. In the light of empirical evidence derived both from experimental research (Lecerf & de Ribaupierre, 2005; Logie, 1995; Mammarella, Pazzaglia, & Cornoldi, 2008) and NLD studies (Cornoldi et al., 2003; Mammarella et al., 2010), we also decided to further analyze visual and spatial memory tasks separately. Specifically, based on previous findings (Lecerf & de Ribaupierre, 2005; Logie, 1995; Mammarella et al., 2008), visual tasks were defined as those involving the recall of shapes, colors, and/or textures (Studies 3, 5, 9, 11, 32, 33, and 35 were analyzed), while spatial tasks were those requiring the recall of spatial locations and spatial sequences (Studies 3, 5, 9, 11, 14, 19, 20, and 32 were analyzed).

2. Socioemotional impairments: In six studies, this aspect was considered as a selection criterion for children with NLD (Chow & Skuy, 1999; Cornoldi et al., 1999; Gross-Tsur et al., 1995; Liddell & Rasmussen, 2005; Semrud-Clikeman, Walkowiak, Wilkinson, & Christopher, 2010; Tranel et al., 1987), but no data were reported. We therefore considered socioemotional skills as dependent variables (i.e., Studies 8, 13, 21, 22, 23, 29, 31, and 34). These studies were also further distinguished between those analyzing emotion comprehension and those focusing on social problems. Five researchers studied emotion comprehension in children with NLD (i.e., 8, 13, 29, 31, and 34). The tests they used were: the Diagnostic Analysis of Nonverbal accuracy (DANVA; e.g., Petti et al., 2003); the Ekman and Friesen (1976) pictures of facial affect (Bloom & Heath, 2010; Dimitrovsky et al., 1998); the emotional cue score in the Child and Adolescent Social Perception (CASP) test (Galway & Metsala, 2011; Semrud-Clikeman, Walkowiak, Wilkinson, & Portman Minne, 2010); and the Social Problem Solving Measure (Galway & Metsala, 2011). Six studies analyzed social skills in children with NLD (13, 21, 22, 23, 29, and 31).

Analyses

The classic effect size index (*d*) proposed by Cohen (1988) was calculated to establish the magnitude of differences identified. This index expresses "the degree to which the phenomenon is present in the population" (Cohen, 1988, p. 9); hence, in this case, more specifically, *d* describes the mean standardized difference in the criteria used for selecting children with NLD. The magnitude of the effect sizes was interpreted according to Cohen's (1988) guidelines ($d = 0.20$ small; $d = 0.50$ medium; $d = 0.80$ large). For example, a *d* value of 0.5 indicated that the mean value in the NLD group for a particular selection criterion differed from the value found in a control group or another clinical group by half a standard deviation, corresponding to a medium effect size. In terms of the correlations, a higher *d* corresponds to a stronger association between the variables considered. The I^2 statistic proposed by Higgins and Thompson (2002) was also calculated. This statistic describes the amount of total variation across studies due to heterogeneity rather than to chance. The range of I^2 values lies between 0% and 100% (negative values are set to 0), where 0% indicates no observed heterogeneity, and higher percentages suggest very little consistency in the effect sizes across the studies. As Higgins and Green suggested (2006), the value of *d* was adjusted using random or fixed effect models after considering the degree of heterogeneity. The analyses were conducted using Comprehensive Meta-Analysis (Borenstein & Rothstein, 2001) and StatDirect.

It is worth noting that a small proportion of the studies considered had used more than one measure of a particular selection criterion. Given the similarity of these measures, we averaged the effect sizes emerging from them in each study (i.e., Antshel & Joseph, 2006; Bloom & Heath, 2010; Cornoldi et al., 1995; Dimitrovsky et al., 1998; Galway & Metsala, 2011, for visuoconstructive skills and finemotor, and for emotion comprehension; Harnadek & Rourke, 1994; Hendriksen et al., 2007; Mammarella & Cornoldi, 2005b; Mammarella & Pazzaglia, 2010, for visual and spatial memory; Mammarella et al., 2010, also for math achievement; Petti et al., 2003; Semrud-Clikeman & Glass, 2008; Semrud-Clikeman, Walkowiak, Wilkinson, Portman Minne, 2010, also for social skills; Yu et al., 2006).

Table 2 Summary of Effect Size Indices (d, r, I^2) Obtained Considering Variables Used as Internal Criteria for Selecting Children with NLD.

Selection Criteria	Number of Participants						
	NLD	Controls	d	95% CI	r	I^2	95% CI[c]
Visuospatial intelligence	204	197	−2.18[a]	−2.81/−1.54	−.74	82.9	70.4/88.7
Verbal intelligence	305	476	0.49[a]	0.07/0.91	.24	84.9	77.1/89.1
Discrepancy between visuospatial and verbal intelligence	247		−1.69[b]	−1.90/−1.49	−.65	77.8	63.3/84.9
Visuoconstructive and fine-motor skills	146	368	−1.30[a]	−1.44/−1.15	−.55	79.4	66/86
Mathematical achievement	416	768	−1.08[a]	−1.50/−0.66	−.48	89.6	85.9/91.9
Reading achievement	369	721	0.32[a]	−0.18/0.82	.16	92.3	89.8/94
Discrepancy between math and Criteria for diagnosing NLD reading achievement	370		−1.21[b]	−1.36/−1.05	−.52	77.2	62.7/82.4

Notes. The studies used to calculate each index are listed in the text.
[a]Given the high value of the heterogeneity index, d was calculated using a random effect analysis (see DerSimonian & Laird, 1986).
[b]For dependent samples, d was calculated using a fixed effect analysis (see DerSimonian & Laird, 1986).
[c]95% uncertainty intervals are calculated as proposed by Higgins and Thompson (2002).

RESULTS

Separate analyses were conducted to synthesize the data available for the different criteria. The results concerning the internal criteria for diagnosing children with NLD are shown in Table 2, while those considering dependent variables in studies on children with NLD are given in Table 3.

Variables Used as Internal Criteria for Selecting Children with NLD

As shown in Table 2, the magnitude of d varies as a function of the criteria used to select children with NLD. Specifically, d values for visuospatial intelligence, discrepancies

Table 3 Summary of Effect Size Indices (d, r, I^2) Considering Dependent Variables Not Included Among the Diagnostic Criteria in Studies on Children with NLD.

Selection Criteria	Number of Participants						
	NLD	Controls	d[a]	95% CI	r	I^2	95% CI[b]
Visuospatial memory	266	265	−0.65	−0.87/−0.42	−.31	77.2	67.7/82.8
Visual memory	151	148	−0.39	−0.65/−0.14	−.20	66.4	37.9/78.6
Spatial memory	184	186	−0.92	−1.29/−0.55	−.42	80.7	68.5/86.7
Socioemotional skills	228	428	−0.68	−0.87/−0.49	−.32	83.6	79.4/86.6
Emotion comprehension	97	211	−0.78	−1.07/−0.49	−.36	75.1	59.7/82.9
Social skills	166	641	−0.62	−0.86/−0.38	−.29	86.8	82.6/89.5

Note. The studies used for each index are listed in the text.
[a]Given the high value of the heterogeneity index, d was calculated using a random effect analysis (see DerSimonian & Laird, 1986).
[b]95% uncertainty intervals are calculated as proposed by Higgins and Thompson (2002).

between verbal and visuospatial intelligence, visuoconstructive and fine-motor skills, math achievement, and discrepancies between reading and math achievement could be expected to lie in the higher range, while the differences in verbal intelligence and reading achievement (if any) should fall within the range of small effect sizes (see Cohen's 1988 guidelines). It is worth noting that the heterogeneity analysis (Table 2) showed that all the variables considered were characterized by high I^2 values. As suggested by Higgins, Thompson, Deeks, and Altman (2003), we would tentatively attribute the adjectives *low*, *moderate*, and *high* to I^2 values of 25%, 50%, and 75%, meaning that, for each of the criteria used to diagnose NLD, there was a substantial variability in the findings emerging from different studies that was not due to chance alone.

Dependent Variables in Studies on Children with NLD

Table 3 shows the magnitude of d and the heterogeneity analyses for variables that were not used as selection criteria but were nonetheless found relevant. Our findings showed that the d values lie in the medium range for both visuospatial (working) memory and socioemotional impairments. When these variables were broken down, however, the d values lay in the large range for spatial (working) memory tasks, while they were medium for emotion comprehension and social skills, and small for visual (working) memory tasks (see Cohen's 1988 guidelines). The heterogeneity analysis revealed moderate I^2 values for visual memory and high values for the other variables, showing a substantial variability in the findings of the various studies that was not due to chance alone.

In short, combining the results obtained with the variables used as internal criteria and those considered as dependent variables, the strongest criteria for selecting children with NLD were visuospatial intelligence and the discrepancy between verbal and visuospatial intelligence. We do not give the values in absolute IQ scores because different measures were adopted, but it is noteworthy that a Cohen's $d = 1$ would correspond to a difference of 15 points in the traditional IQ measures, and our analysis revealed group differences substantially higher than 1.5 standard deviations from the mean. Visuoconstructive and fine-motor skills, discrepancy between math and reading achievement, math achievement, and spatial memory tasks also coincided with high effect sizes, while visuospatial memory and socioemotional skills revealed a medium effect size. Finally, the lowest values were seen for verbal intelligence, visual memory, and reading achievement. In fact, children with NLD did not differ substantially from typically developing children in terms of verbal intelligence, visual memory tasks, and reading achievement.

DISCUSSION

The main aim of the present study was to shed light on the relevance of the selection criteria used to diagnose children with NLD. As summarized in Table 1, researchers have adopted different criteria to study children with NLD. One of the difficulties encountered in researching in the field of learning disabilities lies in that children with the same diagnosis may have different clinical symptoms. For example, in the area of calculation, Murphy, Mazzocco, Hanich, and Early (2007) showed that the cognitive characteristics of children with mathematical learning disabilities varied depending on how this LD was defined and what measures were used to assess the children's performance. The same can be said of children with NLD. It is therefore crucial to arrive at a consensus on the criteria to use for their diagnosis. We aimed to identify the most important criteria for diagnosing NLD by examining not only the frequency with which different criteria are used but also the typical severity of NLD children's weaknesses emerging when a given criterion was used.

Overall, our findings suggest that the criterion for diagnosing children with NLD that produces the highest effect size is their lesser visuospatial intelligence compared to controls. Judging from the *d* values, a second set of important criteria includes the following aspects: discrepancy between visuospatial and verbal intelligence, poor visuoconstructive and fine-motor skills, discrepancy between math and reading achievement, and mathematical achievement. A third category of the aspects considered includes visuospatial memory and socioemotional skills. Our literature review thus enabled us to arrange the criteria for diagnosing NLD in order of relevance and showed that the two most widely used criteria are associated with measures of IQ and achievement, revealing weaknesses in visuospatial intelligence and mathematics coinciding with relatively adequate verbal intelligence and reading decoding skills. Diagnostic criteria associated with more specific weaknesses in visuoconstructive and fine-motor skills were often considered too, and some studies also collected measures of motor coordination, though the assessment in this case was limited mainly to the use of a specific type of test (the Grooved Pegboard Tactual Performance tests), which is not widely used.

Only a medium effect size emerged for visuospatial memory and socioemotional skills. It is worth noting, however, that these aspects were not used as diagnostic criteria but were the consequence of an independent measure and this obviously reduced the size of the difference between NLD children and controls. Our analysis also supported the relevance of distinguishing between visual and spatial memory tasks, as suggested in the literature derived from experimental (Della Sala, Gray, Baddeley, Allamano, & Wilson, 1999; Logie & Marchetti, 1991) and developmental research (Hamilton, Coates, & Heffernan, 2003; Pickering, Gathercole, & Peaker, 1998). In fact, a high effect size emerged for spatial memory impairments in children with NLD ($d = -0.92$), while the effect size was low for visual memory impairments ($d = -0.39$). Although visuospatial memory impairments were not mentioned as a selection criterion in the studies conducted by Rourke and coworkers (Drummond et al., 2005; Pelletier et al., 2001), or in the seminal paper by Johnson and Myklebust (1967), they nonetheless emerged from our analysis, which pointed to the importance of this potential criterion. Apart from the work carried out by Harnadek and Rourke (1994) and by Chow and Skuy (1999), the other research contributions on spatial memory entered in our review came from the Italian group (Cornoldi et al., 1995, 1999; Mammarella & Cornoldi, 2005a, 2005b; Mammarella et al., 2010; Venneri et al., 2003). This might expose our findings to a number of biases, but the data were obtained in different groups of participants (not only Italian but also Scottish) and replicated over several years. In addition, the low *d* value that emerged for visual memory tasks (from much the same studies) showed that the effect size for spatial memory was not due to any particular weakness of the groups of NLD children tested. Further research could therefore focus on spatial working memory deficits for the purpose of selecting children with NLD.

As regards socioemotional skills, we further distinguished between emotion comprehension and social skills ($d = -0.78$; $d = -0.62$, respectively), though the value of this finding is limited by the absence of reliable objective measures in most of the studies considered. When a weakness in socioemotional competence was mentioned as a selection criterion (see Table 1), no descriptive statistics or statistical analyses were provided. Our analysis only included studies that investigated emotion comprehension and social skills in NLD as dependent variables. It is worth adding that some research findings were not consistent. For instance, Semrud-Clikeman, Walkowiak, Wilkinson, and Portman Minne (2010) found NLD children weak in terms of internalizing symptoms and social skills, while Petti et al. (2003) found much the same scores in NLD children and controls. This may be because the children were administered different tests: Petti et al. used the Personality Inventory for Children–Revised (PIC-R; Lachar, 1982), while Semrud-Clikeman, Walkowiak, Wilkinson, and Portman Minne (2010) used the Behavior Assessment System for Children–2 (BASC–2; Reynolds & Kamphaus, 2002). It is also important to bear in mind that Forrest (2004) and Grodzinsky et al. (2010) suggested that there may be different NLD profiles, so the samples considered by Petti et al. (2003) and Semrud-Clikeman, Walkowiak, Wilkinson, and Portman Minne (2010) may not have been comparable. Little (1993) reviewed 13 studies and concluded that the relationship between NLD and emotional difficulties is uncertain because the related research has been conducted on small samples with no control groups and applying different definitions of NLD (see also Spreen, 2011). Be that as it may, if social and emotional skills are crucial to the diagnosis of children with NLD, further studies should aim to define not only which aspects of social and emotional skills are impaired in children with NLD (possibly using the same criteria for their diagnosis) but also whether all NLD children reveal impairments in these aspects, or whether different profiles are differently impaired, as Forrest (2004) and Grodzinsky et al. (2010) suggested (see also Fine et al., 2013; Semrud-Clikeman & Glass, 2008).

To sum up, analyzing the most important studies conducted on NLD may help us to pinpoint the most suitable criteria for diagnosing the condition, but caution is needed when it comes to interpreting the data emerging from our analysis. In particular, the heterogeneity values that we found were high: This could stem from the paucity of studies considered in the separate analyses and/or from the different procedures and tests used to select children with NLD. Taking visuospatial intelligence as an example, we found a high effect size, but the value of I^2 was 82.9%. Looking at Table 1, it is easy to see a potential cause of heterogeneity. In particular, the criterion adopted in many cases was a discrepancy between verbal and visuospatial intelligence, which could also be associated with a relatively good visuospatial intelligence (in performance) if the verbal component is very high. Some authors selected children with a 10-point difference between their verbal and performance IQ ratings (e.g., Casey et al., 1991; Humphries et al., 2004; Worling et al., 1999), while others considered 12 (Petti et al., 2003) or 15 points (Cornoldi et al., 1995). All of the WISC scales were used in some studies, only a few subtests in others (Semrud-Clikeman & Glass, 2008; Venneri et al., 2003), and different intelligence scales were used in a handful of studies (Cornoldi et al., 1995; Mammarella & Cornoldi, 2005a; Mammarella & Pazzaglia, 2010). Finally, some studies (Drummond et al., 2005; Liddell & Rasmussen, 2005; Pelletier et al., 2001) considered both the differences between Verbal and Performance IQs, and shortcomings in certain subtests. Much the same heterogeneity emerged for the other criteria examined.

Other limits of our analysis lie in that only published studies and quantitative data were considered: ignoring unpublished studies (which tend to reveal smaller effect sizes) and the symptoms used by clinicians may have biased our findings by either increasing the likelihood of finding larger effect sizes (Rosenthal, 1991) or reducing the importance of clinical symptoms that are not easy to measure (for a review of the symptoms mainly used by clinicians, see Solodow et al., 2006). Overall, our analysis can nonetheless be seen as an attempt to summarize the available data.

Possible Criteria for Diagnosing Children with NLD

We agree with Spreen, who argued that a diagnosis of NLD "should not be used in clinical practice unless it is supported by solid research findings" (2011, p. 437) and unambiguous diagnostic criteria. The outcomes of the present review goes to show the difficulties involved, while pointing to a potential approach to the diagnosis of NLD but also offering some important elements. Based on our findings, we could tentatively propose five criteria for diagnosing children with NLD, though we are well aware that our research is only a starting point on the path towards find a consensus among researchers. Of these tentative criteria, the first criterion should necessarily be met for a diagnosis of NLD to be considered, and at least two of the Criteria 2 to 4 should be met, while the fifth could be considered as a possible associated criterion. These five criteria are outlined below:

1. Poor visuospatial intelligence with a relatively good verbal intelligence: We have already mentioned the differences in the use made in previously published research of this criterion. Pelletier et al. (2001) proposed a discrepancy of at least 10 points between WISC verbal and performance IQs, but this criterion seems to us too weak as it fails to reflect a statistically significant departure from the population-based normative data obtained with the WISC test (Wechsler, 1974, 1991). In addition, the latest version of the WISC test (WISC-IV; Wechsler, 2003) does not allow for the calculation of both verbal and performance IQ; only factorial indices can be calculated and the focus is on more specific verbal and visuospatial (perceptual) indexes. We, therefore, suggest considering a marked discrepancy between pure measures of verbal and perceptual/visuospatial intelligence, obtained with a battery of intellectual subtests, for example, a marked discrepancy between the VCI and POI/PRI factorial indices of the WISC. This criterion appears to be the most crucial and should be essential to a diagnosis of NLD, although its exact definition seems to be debatable. In our view, the discrepancy should be considerable (at least one standard deviation [*SD*]) and the criterion should not be applied to cases with discrepancies in the highest or lowest IQ ranges, for example, when a high verbal intelligence is associated with an adequate visuospatial intelligence (e.g., higher than 95), or when a low verbal intelligence (e.g., <85) is associated with a very poor visuospatial intelligence.
2. Visuoconstructive and fine-motor impairments: The tests used in the papers analyzed in the current review were the Visual-Motor Integration test (VMI; Beery & Buktenica, 2006), the Rey-Osterrieth Complex Figure (ROCF; Osterrieth, 1944), the Target test (Reitan & Davison, 1974), and the Grooved Pegboard test as a measure of fine-motor skills. Here again, the procedures may change according to the children's age and the tests used for the diagnosis. If only one measure is obtained, then a child's performance can be considered low if it is one standard deviation below the norm. We recommend obtaining more than one measure of visuoconstructive skills; however, for example, both the VMI, the ROCF, and at least one measure should be more than 1.5 standard deviation lower than the mean.
3. Poor mathematical achievement at school coinciding with a relatively good reading decoding ability: Here again, a high effect size ($d = -1.21$) was found for this situation. Forrest made the point (2004; see also Spreen, 2011) that there are inconsistencies

between research findings and clinical observations on NLD children's difficulties with mathematics, which are not the same as those usually seen in children with mathematical learning disabilities. To give an example, NLD children do not usually have trouble recalling arithmetical facts, but they make visuospatial errors in written calculations (i.e., confusing columns, carrying/borrowing errors) and write mirrored numbers (see Osmon, Smerz, Braun, & Plambeck, 2006). In a recent paper, Mammarella et al. (2010; see also Venneri et al., 2003) showed that arithmetical difficulties are typically associated with NLD but also argued that spatial working memory difficulties may be prevalent. This would explain why the pattern of NLD children's mathematical difficulties may emerge more clearly from a qualitative analysis than from the overall scores in a standardized test, in which children may partly compensate with their intact verbal skills. Forrest (2004) and Grodzinsky et al. (2010) also suggested that only a particular profile of NLD (named, respectively, visuospatial disability category and concept integration disorder) coincides with failures in mathematics. Hence, our recommendation that the diagnosis be based on a discrepancy of at least one standard deviation between reading decoding (which is preserved) and math achievement (which is impaired) and the mathematical difficulty is associated with spatial errors emerging from a qualitative analysis. Drummond et al. (2005) pointed out, however, that this criterion cannot strictly be applied if the NLD label is used before a child is 8 years old (i.e., before a stable measure of academic achievement is feasible).

4. Spatial working memory deficits: As mentioned earlier, spatial memory was not considered in previous studies as a possible criterion for selecting children with NLD, but our analysis showed a substantial difference in spatial memory performance between NLD children and controls. We suggest the criterion is met when the child has a performance at least one standard deviation below the normative mean if only one measure of spatial working memory is obtained or is at least 1.5 standard deviation below in one test if two or more tests assessing spatial working memory are used.
5. Emotional and social difficulties: In our view, this should be an additional criterion for identifying a specific subtype of children with NLD. As Grodzinsky et al. suggested (2010), emotion comprehension and social impairments should be manifest both at home and at school and should be measured by clinical interview and observation. As these aspects are not easy to assess using psychological tests, we suggest administering behavior-rating scales and clinical interviews to parents and teachers.

CONCLUSIONS

Our study aimed to analyze the relevance of criteria used to diagnose children with NLD and, more importantly, to prompt a debate that should lead to a consensus among researchers and clinicians studying NLD. To improve our knowledge in this field, a primary aim must surely be to ensure that different researchers and clinicians are talking about the same category of children when they use the label *nonverbal learning disability*. To achieve this, diagnostic criteria need to be clearly defined. We lay no claim to our criteria being certain and/or final; instead, they should be seen as an attempt to start bringing order to 30 years of research.

The NLD label specifically indicates the presence of a learning disability, suggesting some degree of failure in academic achievement (in the absence of any intellectual deficit), but our study clearly showed that the inclusion/exclusion criteria adopted for other types of LD have never been used restrictively for the diagnosis of NLD, although all the studies on the topic have included a general implicit indication that NLD children had difficulties at school associated with an average intelligence. Spreen (2011) argued that children with NLD are not prototypical of cases with learning disabilities because many of their impairments are not academic in the usual sense and not as *specific* as the definition of LD suggests (see Hammill, 1990). Children with LD are characterized by a marked discrepancy between their general intellectual ability and their academic achievements in reading, writing, or calculation. Our findings showed, on the other hand, that only one of the criteria for diagnosing NLD concerns academic achievement (i.e., mathematical skills), but these children may have other difficulties that need to be considered (see Cornoldi et al., 2003) in academic areas such as drawing, geography, and so on, as a consequence of their weaknesses in visuoconstructive and spatial memory. Unlike children with other forms of LD, children with NLD may have academic weaknesses, but not dramatically poor school results, and they reveal a modest discrepancy between their IQ and their academic achievements in reading, writing, and mathematics, particularly as far as their total IQ is concerned (due to their limited visuospatial intelligence). The discrepancy between achievement and IQ is higher when only verbal intelligence and a large range of different school activities are considered (e.g., drawing and math, as implied by the short visuo-spatial (SVS) questionnaire proposed by Cornoldi et al., 2003). The academic difficulties of children with NLD may also correlate with emotional and social problems, which are typically considered an exclusion criterion for the diagnosis of LD.

While the focus on LD may be misleading, the more generic label "nonverbal disability" might also be confusing; instead, we might use a term such as "specific nonverbal disorder" (or "specific visuospatial disorder," so that the label mentions the main issue, rather than the nonissue). Given the now widespread use of the term NLD, however, and in the absence of any consensus, the term NLD will remain as the most readily comprehensible for the time being.

A final problem concerns the specificity of the disorder. We agree with Spreen (2011) that NLD cannot be used as an umbrella term covering different pediatric disorders (including Asperger syndrome, Turner syndrome, velo-cardio-facial syndrome, callosal agenesis, etc.). In our view, the diagnosis of NLD should only be applied to children with a discrepancy between their verbal and visuospatial intelligence combined with visuoconstructive and spatial working memory impairments and academic difficulties, possibly reflecting on their social and emotional skills, but in the absence of the abovementioned diagnoses.

If the criteria for a diagnosis of NLD are clear and broadly shared, this will benefit research and practice, making both less open to misinterpretation. In particular, research could examine many aspects that are still unclear in more detail and in well-defined groups. Further studies should thoroughly analyze the relevance of visuospatial memory and of socioemotional skills in children with NLD and the existence of different subtypes of NLD. It is worth adding that our study could not consider the role of perceptual deficits in children with NLD, although both Johnson and Myklebust (1967) and Rourke (1989, 1995) suggested the possibility of such deficits being involved. Only two studies (Mammarella & Pazzaglia, 2010; Semrud-Clikeman, Walkowiak, Wilkinson, & Christopher, 2010) reported findings obtained by means of visual perception tests conducted to compare NLD children and controls. This aspect needs to be analyzed in more depth. Finally, research on different profiles needs to be improved, as suggested by Forrest (2004) and Grodzinsky et al. (2010).

In conclusion, we are certain that an appropriate diagnosis of NLD is helpful to researchers and clinicians and particularly for the children involved and their families, since it draws attention to children who have a number of severe problems, but who do not fit into other diagnostic categories. To improve research and practice in this field, however, a consensus is needed on the definition of this disorder and the criteria for its diagnosis. The present review has attempted to offer some suggestions in this direction.

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