Research in Developmental Disabilities 34 (2013) 4115–4124

Contents lists available at ScienceDirect

Research in Developmental Disabilities

Young children with language difficulties: A dimensional approach to subgrouping

Rianne Jansen [a,b,*], Eva Ceulemans [c], Jolien Grauwels [c], Jarymke Maljaars [a,b], Inge Zink [d,e], Jean Steyaert [b,f,g], Ilse Noens [a,b]

[a] KU Leuven, Parenting and Special Education Research Unit, Belgium
[b] KU Leuven, Leuven Autism Research (LAuRes), Belgium
[c] KU Leuven, Methodology of Educational Sciences Research Unit, Belgium
[d] KU Leuven, Department of Neurosciences, ExpORL, Belgium
[e] UZ Leuven, Department of Otorhinolaryngology, Head and Neck Surgery, Belgium
[f] KU Leuven, Department of Neurosciences, Child and Adolescent Psychiatry, Belgium
[g] University of Maastricht, Department of Clinical Genetics, The Netherlands

ARTICLE INFO

Article history:
Received 7 June 2013
Received in revised form 12 August 2013
Accepted 14 August 2013
Available online

Keywords:
Language difficulties
Early diagnosis
Cluster analysis
Intentional communication
Symbol understanding

ABSTRACT

A dimensional approach was used to create bottom-up constructed subgroups that captured the behavioral heterogeneity in 36 Dutch-speaking children with language difficulties. Four subgroups were delineated based upon differences in cognitive ability, symbol understanding, joint attention and autism spectrum disorder related characteristics. Children with a different developmental disorder were found within a single cluster. Therefore, the results of this study suggest that bottom-up constructed subgroups might capture the heterogeneous behavioral profiles of young children with developmental difficulties in a more meaningful way. Furthermore, joint attention and symbol understanding seem important skills to assess in young children presenting with language difficulties.

© 2013 Elsevier Ltd. All rights reserved.

1. Introduction

The first signs of language comprehension and production are important hallmarks in the development of young children, providing them with new opportunities to express themselves and engage in social interaction. During the toddler and preschool period, however, language difficulties are among the most common developmental problems encountered by clinicians (Buschmann et al., 2008). Nonetheless, the heterogeneity among these children presents challenges when predicting their developmental trajectories and need for intervention (Kelly, 1998). Although language difficulties are temporary for the majority of children, some continue to experience language difficulties later in life (Dale, Price, Bishop, & Plomin, 2003). Moreover, early language difficulties may be the core symptom of a specific language impairment (SLI) or may signal the presence of a broader developmental disorder such as intellectual disability (ID) or autism spectrum disorder (ASD) (Buschmann et al., 2008; Conti-Ramsden & Durkin, 2012; Miniscalco, Nygren, Hagberg, Kadesjö, & Gillberg, 2006; Westerlund, Bergkvist, Lagerberg, & Sundelin, 2002).

1.1. Challenges in early diagnostic decision making

For some decades, considerable attention has been devoted to the early detection of neurodevelopmental disorders in young children with developmental problems. Early diagnostic decision making has been fostered by research reports on

* Corresponding author at: KU Leuven, Parenting and Special Education Research Unit, Belgium. Tel.: +32 16325778.
E-mail address: rianne.jansen@ppw.kuleuven.be (R. Jansen).

0891-4222/$ – see front matter © 2013 Elsevier Ltd. All rights reserved.
http://dx.doi.org/10.1016/j.ridd.2013.08.028

positive outcomes for young children who engaged in early intervention programs (see for example McEachin, Smith, and Lovaas (1993) on the effectiveness of early intervention in children with ASD). The complex behavioral profiles of rapidly developing young children are, however, difficult to compare to the fixed sets of static diagnostic criteria (Hudziak, Achenbach, Althoff, & Pine, 2007) stated in the recently used classification manuals of the American Psychiatric Association (DSM-IV-TR; 2000) and World Health Organization (ICD-10; 1992).

The DSM-IV-TR and ICD-10 are top-down constructed since the delineation of developmental disorders is primarily based on expert opinion (Pickles & Angold, 2003). Within these frameworks, developmental disorders are conceptualized as categorical entities that "cut nature at his joints" (Widiger, 1997, p. 263). Specific diagnostic requirements have led to sharp dividing lines between different diagnostic categories that are considered to be qualitatively distinct from one another and from typical development (First, 2005; Kraemer, Noda, & O'Hara, 2004; Widiger & Samuel, 2005). Nonetheless, accumulating evidence revealed overlap in the behavioral profiles of individuals with a different clinical diagnosis (Rutter, 2011; Widiger & Samuel, 2005), for example in preschool children with SLI or ASD.

One of the most significant changes in the recently introduced DSM-5 (American Psychiatric Association, 2013) is the explicit recognition of the spectrum nature of autism by replacing the DSM-IV-TR separate diagnostic subgroups with a single umbrella term "Autism Spectrum Disorder" and adding a severity scale. Also new in DSM-5 is that language development is no longer included in the ASD criteria; clinicians will be able to diagnose ASD and Language Disorder in one individual (Lai, Lombardo, Chakrabarti, & Baron-Cohen, 2013). However, the decision to provide a formal diagnosis of ASD and/or Language Disorder is still based on static criteria with specific cut-off points or rules.

1.2. Behavioral overlap between diagnostic categories: the example of SLI and ASD

Children with receptive and/or expressive language difficulties in the presence of average nonverbal intellectual abilities and typical sensory as well as neurological development may receive a clinical diagnosis of SLI. Autism spectrum disorders, by contrast, are characterized by impairments in social interaction and communication, and a restricted pattern of activities (American Psychiatric Association, 2000). Although mutually exclusive in DSM-IV-TR and ICD-10, characteristics of both disorders are identified in the behavioral profiles of some children (Bishop, 2003; Michelotti, Charman, Slonims, & Baird, 2002). As indicated above, SLI and ASD classifications will not be mutually exclusive anymore following DSM-5 guidelines.

Cluster analysis on the linguistic and communicative abilities of children with SLI has consistently revealed a subgroup of children predominantly characterized by pragmatic difficulties (Conti-Ramsden, Crutchley, & Botting, 1997; Van Daal, Verhoeven, & Van Balkom, 2004), a domain where deficits have been uniquely associated with ASD (Tager-Flusberg, 1996). Other ASD related characteristics – such as social difficulties and repetitive and stereotyped behaviors – are present in the behavioral profiles of some children with SLI as well, although to a lesser extent than their ASD counterparts (Leyfer, Tager-Flusberg, Dowd, Tomblin, & Folstein, 2008; Loucas et al., 2008). Preschool children with ASD often experience a delayed as well as distorted language development (Boucher, 2012). Moreover, the particular difficulties of these children in the domains of phonology and grammar resemble those of children with SLI (Geurts & Embrechts, 2008). Echolalia, stereotyped language, and limited joint attention abilities may discriminate between children in both groups since these features were found more frequently in (the developmental history of) children with ASD (Ventola et al., 2007). Moreover, language regression has been considered specific for children with ASD (Pickles et al., 2009).

1.3. Categorical and dimensional characterization of psychopathology: complementary approaches

While the behavioral profiles of some children fit into diagnostic prototypes stated within the DSM and ICD, others present with characteristics of several developmental disorders. The clinical diagnosis established for these children, may partly depend on the experience of the clinician to whom the child is referred (Gillberg, 2010) and this may lead to diagnostic substitution in later life (Bishop, Whitehouse, Watt, & Line, 2008). Drawbacks of categorical diagnostic frameworks led some researchers to conclude that dimensional models will provide a more valid description of atypical development (Widiger & Samuel, 2005). Detailed information regarding children's strengths and weaknesses across dimensions of functioning will capture subthreshold symptomatology and may reveal prognostic information, which in turn may lead to more differentiated intervention programs (First, 2005; Gillberg, 2010; Rutter, 2011; Widiger & Samuel, 2005).

Such a paradigm shift, however, is difficult to establish in societies where the demarcation of diagnostic subgroups is embedded in research as well as clinical practice (Kendler & First, 2010). In addition, conclusive evidence on the nature of dimensions that should be included in these models is lacking to date (see Lord and Jones (2012) for an example in the field of ASD). Nonetheless, a dimensional approach is important and will be more prominent using DSM-5 to complement the categorical paradigm to psychopathology (Regier, Narrow, Kuhl, & Kupfer, 2009). Prolonged dimensional assessment may lead to more valid classification of categorically defined, developmental disorders in rapidly developing young children (Gillberg, 2010; Markiewicz & Pachalska, 2007). Moreover, large data sets on the abilities of children with developmental difficulties may lead to bottom-up constructed subgroups that capture the heterogeneity among these children in a more meaningful way (Kendler & First, 2010).

1.4. A dimensional approach toward young children with language difficulties

Studies that included children with language difficulties regardless of their clinical diagnosis are rather scarce to date. Nevertheless they revealed that language difficulties often co-occur with cognitive delays and restricted adaptive abilities, especially in children with mixed receptive-expressive language difficulties (Buschmann et al., 2008; Carson, Klee, Perry, Muskina, & Donaghy, 1998). Limited social abilities have been reported as part of the behavioral profiles of some children with language difficulties as well (Carson et al., 1998; Rice, Sell, & Hadley, 1991; Tervo, 2007). No study – to the best of our knowledge – has assessed these children's mastery of two linguistic prerequisites: intentional communication and symbol formation.

1.5. Intentional communication, symbol formation, and language development

The communicative acts of most one-year-old, typically developing children serve a variety of purposes, since by this time they have learned to communicate for the functions of behavior regulation, joint attention, and the initiation or continuation of a social interaction (Bruner, 1981). Both behavior regulation and joint attention require the division of a child's attention between an object and a communication partner, while the primary goal is to influence someone's behavior or focus of attention, respectively, (Coupe O'Kane & Goldbart, 1998; Prizant, Wetherby, & Rydell, 2000). Typically developing children and children with ID tend to communicate more frequently for joint attention purposes as opposed to children with ASD. In the latter group, communicative acts are mainly elicited for the purpose of behavior regulation (Maljaars, Noens, Jansen, Scholte, & Van Berckelaer-Onnes, 2011; Shumway & Wetherby, 2009; Wetherby, Watt, Morgan, & Shumway, 2007). Positive relationships between the amount of joint attention initiated by children with ASD and their receptive as well as expressive language abilities were found across studies (Maljaars et al., 2011; Toth, Munson, Meltzoff, & Dawson, 2006; Watt, Wetherby, & Shumway, 2006).

Bates (1979) identified symbol formation as a second important linguistic prerequisite since awareness of symbol–referent relationships is central to language comprehension and production. To compare children's symbolic abilities across developmental domains, several studies analyzed the relationship between language and symbolic play. Positive associations were found between symbolic play and receptive and/or expressive language development, both for typically developing children (Lewis, Boucher, Lupton, & Watson, 2000; Lyytinen, Poikkeus, & Laakso, 1997) and children with SLI (Rescorla & Goossens, 1992). Others, however, caution against a straightforward relationship (Lewis, 2003; Terrell, Swartz, Prelock, & Messick, 1984) since diminished symbolic play abilities may also result from difficulties in planning, the flexibility to use objects outside their regular contexts, or a lack of internal motivation (Jarrold, 2003).

Although joint attention may be central to symbolic thought (Mundy, 2011), several studies underlined the importance of separate assessment of both linguistic prerequisites in young children (Määttä, Laakso, Tolvanen, Ahonen, & Aro, 2012; Maljaars, Noens, Scholte, & Van Berckelaer-Onnes, 2012).

1.6. Aim of the study

Young children with language difficulties often present with complex behavioral profiles that are difficult to compare to the fixed sets of diagnostic criteria stated in top-down constructed frameworks as DSM and ICD. The conjunction of a dimensional and categorical approach is considered to be a fruitful way forward in enhancing our understanding of developmental problems. The aim of this study, therefore, was to delineate bottom-up constructed, more homogeneous subgroups of young children with language difficulties based on the interrelatedness of these children's abilities across dimensions of functioning.

2. Methods

2.1. Participants

Thirty-six children (30 boys, 6 girls) between 24 and 46 months of age ($M = 33.36$, $SD = 6.82$ months) participated in this study. The children were raised in a monolingual Dutch-speaking household and performed at least one standard deviation below the mean on the receptive and/or expressive subscale of a standardized language test. This threshold was chosen to include children with mild as well as more severe language difficulties. In addition, all children obtained a nonverbal mental age equivalence score of 15 months or more on a standardized test of cognitive development. Children were included regardless of their clinical diagnosis. Due to the nature of their language difficulties, however, children with severe motor impairments, uncorrectable visual impairments, known neurological deficits or a genetic syndrome were excluded from participation. All children were screened for normal hearing. Cognitive and linguistic characteristics of the children are summarized in Table 1.

The majority of the children ($n = 22$) experienced mixed receptive-expressive language difficulties, meaning that they scored at least one standard deviation below the mean on both the receptive and expressive subscale of a standardized language test. Thirteen children experienced expressive language difficulties in the presence of at least average receptive abilities. Average expressive but limited receptive language abilities were found in only one child. Although most children

Table 1
Cognitive and linguistic age equivalent scores in months.

	Range	*M*	*SD*
Nonverbal mental age equivalent	15.0–50.0	30.93	8.95
Receptive language age equivalent	11.0–40.5	25.69	7.85
Expressive language age equivalent	11.0–34.5	20.49	5.95

were involved in an extended diagnostic evaluation trajectory at the time of data-analysis, some had already received a multidisciplinary diagnosis of ID ($n = 7$), ASD ($n = 4$), or ASD with co-occurring ID ($n = 2$). Clinical signs of ASD were found in the behavioral profiles of ten children, although a definite clinical diagnosis could not (yet) be established.

2.2. Instruments

2.2.1. Linguistic abilities

The full range of linguistic abilities could not be covered by any of the norm-referenced, Dutch language instruments available to date. Therefore, either the Dutch version of the Nonspeech Test (NNST: Zink & Lembrechts, 2000) or the Dutch version of the Reynell Scales for Language Development (RTOS: Schaerlaekens, Zink, & Van Ommeslaeghe, 2003) were administered to evaluate children's receptive and expressive language abilities. The NNST evaluates pre-linguistic as well as more formal aspects of language in children with linguistic age equivalent scores between 12 and 21 months. The linguistic abilities of children with more mature language were assessed by means of the RTOS. Adequate psychometric properties of reliability and validity were reported for both instruments (Evers, Braak, Frima, & Van Vliet-Mulder, 2009–2011; Zink, Van Ommeslaeghe, Stroobants, Janssen, & Schaerlaekens, 1993). In addition, the Dutch version of the MacArthur Communicative Development Inventories (N-CDI: Zink & Lejaegere, 2003, 2007) was used for children whose limited on-task behavior prevented formal expressive language evaluation. The short-forms of this parental questionnaire are suited for children with linguistic age equivalent scores between 8 and 37 months. The N-CDI was found to be a reliable and valid measure of linguistic abilities in young children (Zink & Lejaegere, 2003, 2007). For receptive language abilities, all scores were based on individual assessment results (NNST: 31%; RTOS: 69%). The majority of the expressive language scores were based on either the NNST or RTOS (53% and 23.5%, respectively), only a small part was based on parent report (23.5%). In this study, high correlations were found between N-CDI age expressive equivalent scores and those obtained by formal language testing ($r = .90$). Because several participants in this study were chronologically older than the normative sample of the receptive and expressive language instruments used, age equivalents based on raw scores were used for analyses.

2.2.2. Cognitive abilities

Nonverbal cognitive abilities were assessed using either the Dutch version of the Bailey Scales of Infant Development – Second Edition (BSID-II-NL: Van der Meulen, Ruiter, Lutje Spelberg, & Smrkovsky, 2002) or the revised version of the Snijders-Oomen Nonverbal Intelligence Test (SON-R 2½-7: Tellegen, Winkel, Wijnberg-Williams, & Laros, 1998). The nonverbal mental scale of the BSID-II-NL is suited for children with mental age equivalent scores between 12 and 30 months. Research regarding the psychometric properties of this scale is scarce but suggested sufficient internal consistency (Van der Meulen et al., 2002). The SON-R 2½-7 was administered to children with more mature cognitive abilities. This Dutch test for nonverbal intelligence comprises six subtests and was found to be a valid and reliable measure of nonverbal cognitive abilities in young children (Evers et al., 2009-2011).

2.2.3. Adaptive abilities

Adaptive abilities were evaluated by means of the Vineland Screener 0–6 years NL (Scholte, Van Duijn, Dijkxhoorn, Noens, & Van Berckelaer-Onnes, 2008). This parental questionnaire comprises 76 items clustered around the domains of communication, socialization, daily living skills, and motor skills. Adequate psychometric properties of reliability and validity have been reported (Scholte et al., 2008). Items requiring a certain amount of linguistic abilities (e.g., 'apologizes for unintentional mistakes') were excluded from analyses. For the remaining items, moderate to strong correlations (r values $> .67$) existed between children's abilities across domains of functioning. Therefore, raw scores were summed to obtain an adaptive behavior composite score.

2.2.4. Symbol understanding

Symbol formation was operationalized as children's mastery of picture–referent relationships. The ability to understand such relations was assessed by means of an adapted version of the doll house experiment, developed by Bebko, McCrimmon, and McFee (2006), which is based on the object-retrieval tasks of DeLoache and Burns (1994). The adapted version of the doll house experiment comprises seven tasks with verbal instructions minimized as much as possible (Maljaars et al., 2012). The first two tasks require memorization of a small figurine (shown in 3D in task 1 and in 2D in task 2) in order to retrieve the identical figurine from a covered box with six different figurines. In the remaining tasks, a three-floor doll house with familiar objects of furniture (bed, bath, table, high-chair, closet, and kitchenette) is used. In each trial, an image of the small figurine's hiding place is shown and the child is asked to retrieve the figure from the doll house. The tasks increase in

difficulty due to manipulation of the visibility of the figurine in the doll house (from visible in task 3 to non-visible in the remaining tasks) and the image shown to the child (from realistic photographs in tasks 3, 4, and 5 to colored photographs of comparable real-life pieces of furniture in task 6, to black/white pictograms in task 7). Due to the limited attention span of most young children, the number of trials was reduced from six trials in tasks 1, 2, and 3 to three trials in the remaining tasks. Since children's understanding of picture–referent relationships is primarily assessed in tasks 4, 5, 6, and 7, the number of correct trials in these tasks were summed to obtain a composite score for symbol understanding.

2.2.5. Intentional communication

Communicative abilities were evaluated using the behavior sample of the Communication and Symbolic Behavior Scales: Developmental Profile (CSBS DP: Wetherby & Prizant, 2002). During a semi-structured observation, intentional communication is elicited by means of attractive play materials, such as a wind-up toy, a balloon, or bubbles. Video recordings of the behavior samples were transcribed and coded. Using the criteria of Wetherby and Prizant (1993), intentional communication was defined as a gesture, vocalization, or verbalization that was spontaneously directed toward an adult and served a communicative function. The original coding scheme was adapted (Maljaars et al., 2011) so that each identified communicative act was ascribed to the function category of behavior regulation, social interaction, or joint attention. This approach enabled more detailed differentiation in intentional communicative abilities between children.

2.2.6. ASD related characteristics

The severity score of the Autism Diagnostic Observation Schedule (ADOS: Lord, Rutter, Dilavore, & Risi, 1999) was used as an index for the amount of ASD related features present in each of the children (Gotham, Pickles, & Lord, 2009). During a semi-structured observation, abilities with regard to communication, reciprocal social interaction, and play are elicited. Module 1 or 2 was administered, depending on the expressive language abilities of the child. The severity score is based on the revised algorithms proposed by Gotham, Risi, Pickles, and Lord (2007) and can be compared across modules. In a sample of 1248 Dutch-speaking children, De Bildt et al. (2011) confirmed, at least for Module 1, the value of this metric as a severity measure of ASD related characteristics.

2.3. Procedure

Participants were prospectively and consecutively recruited from the Multidisciplinary University Center for Speech-Language Pathology and Audiology and the Center for Developmental Disabilities both affiliated to the University Hospitals of Leuven (Flanders, Belgium). Parents of all children who fulfilled the inclusion criteria received oral and written information on the content of the research project. After informed consent was signed, data on children's linguistic and cognitive abilities were retrieved from their clinical files, as assessment of these abilities was part of the diagnostic evaluation trajectory in either recruitment center. During a two hour assessment session additional tasks were administered in the presence of the children's parents. The order of tasks was based on the attention span, on-task behavior, and motivation of the child. Short breaks were given when necessary and adapted (in number and duration) to the needs of the individual child. The design of this study was approved by the medical ethical board of the University Hospitals of Leuven.

2.4. Data analyses

K-means cluster analysis was used to delineate empirically derived, more homogeneous subgroups within the sample of young children with language difficulties described above. This algorithm was chosen because of its suggested robustness to smaller sample sizes (Steinley & Brusco, 2011). Moreover, the *K*-means algorithm can be easily adapted to handle the missing data (using a weighted least squares approach (Kiers, 1997)), a method favored above imputing data based on the corresponding variable's mean, observed for those children ($n = 12$) who did not complete the doll house experiment.

K-means cluster analysis uses an iterative procedure and the final partitioning depends, therefore, on the selected start partitioning. To circumvent the problem of local optima (Steinley, 2003), the algorithm was repeated a 1000 times; each time using a different randomly generated start partitioning. Dimensions of functioning included in the *K*-means algorithm are summarized in Table 2. Inclusion of variables was based on theoretical grounds. Moderate to strong correlations existed between the nonverbal cognitive abilities of the children and their adaptive behavior ($r = .76$, $p < .001$), amount of symbol understanding ($r = .84$, $p < .001$) and both receptive ($r = .84$, $p < .001$) and expressive ($r = .70$, $p < .001$) language abilities. Therefore, mental age equivalent scores were not included as a separate variable. Prior to *K*-means cluster analysis, *z*-scores were computed (i.e., standardized scores with a mean of zero and standard deviation of one) to eliminate arbitrary scale differences among the variables. Differences between the abilities of children belonging to different cluster subgroups were retrieved using ANOVA followed by a Tukey-Kramer post hoc test and intra-group differences were analyzed using paired-sample *t*-tests. All analyses were performed in the statistical software packages MATLAB and SPSS.

3. Results

Based on a plot of the percentage of variance explained versus the number of clusters (Schepers, Ceulemans, & Van Mechelen, 2008) as well as on clinical and theoretical interpretability of the results, a four-cluster solution was chosen to

Table 2
Dimensions of functioning included in *K*-means cluster analysis.

Dimension	Instrument	Metric
Adaptive behavior	Vineland Screener 0–6 years NL	Composite score
IC for behavior regulation	CSBS DP	Rate per minute
IC for social interaction	CSBS DP	Rate per minute
IC for joint attention	CSBS DP	Rate per minute
Symbol understanding	Dollhouse experiment	Composite score
Receptive language abilities	NNST, RTOS, N-CDI	Age equivalent score
Expressive language abilities	NNST, RTOS, N-CDI	Age equivalent score
ASD related characteristics	ADOS	Severity score

Note. IC, intentional communication.

delineate the sample of young children with language difficulties into more homogeneous subgroups. The average behavioral profile of each cluster is displayed in Fig. 1 and Table 3. Information regarding the language difficulties and clinical diagnosis of the children in each cluster is presented in Table 4.

The first cluster consisted of six children (all boys) who experienced mixed receptive-expressive language difficulties. The children within this cluster initiated more communication for the purpose of behavior regulation ($M = 1.40$, $SD = 0.52$) as opposed to joint attention ($M = 0.36$, $SD = 0.17$; $t = 5.33$, $p = .003$). Their average mental age equivalent score ($M = 18.92$, $SD = 3.0$ months) was low when compared to the other three clusters ($F = 19.48$, $p < .001$; Tukey-Kramer: p values $<.01$) and this is reflected in the cluster's relatively low position on the dimensions of adaptive behavior, symbol understanding, and both receptive and expressive language. Moreover, this is the only cluster for which the average mental age equivalent score is significantly lower than the chronological age ($t = 4.68$, $p = .005$). Therefore, this cluster is referred to as 'low-functioning'.

The average mental age equivalent score of the second cluster ($M = 40.44$, $SD = 5.8$ months), by contrast, was the highest of all cluster subgroups (Tukey-Kramer: p values $<.05$). Due to its corresponding position on the dimensions of adaptive

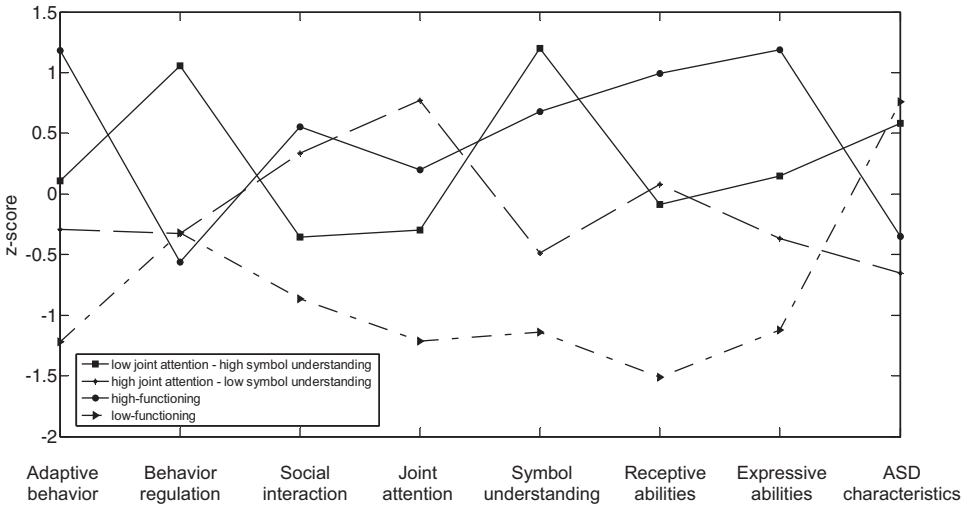


Fig. 1. The average behavioral profile for each of the four clusters of children with language difficulties.

Table 3
Between-cluster differences in children's abilities across dimensions of functioning.

	Cluster				ANOVA	
	Low-functioning	High-functioning	+JA − SU	−JA + SU	*F*	*p*
Adaptive abilities (composite score)	27.17^{a}	59.50^{c}	39.64^{b}	45.00^{b}	15.78	<.001
Behavior regulation (rate per minute)	1.40^{a}	1.23^{a}	1.39^{a}	2.37^{b}	8.41	<.001
Social interaction (rate per minute)	0.08^{a}	0.43^{b}	0.38^{ab}	0.21^{ab}	3.95	.017
Joint attention (rate per minute)	0.36^{a}	1.26^{bc}	1.62^{c}	0.94^{ab}	9.20	<.001
Symbol understanding (composite score)	0.00^{a}	7.00^{b}	2.50^{a}	9.00^{b}	17.53	<.001
Receptive language abilities (months)	14.00^{a}	33.39^{c}	26.32^{b}	25.00^{b}	19.14	<.001
Expressive language abilities (months)	13.92^{a}	27.44^{c}	18.32^{ab}	21.33^{b}	15.13	<.001
ASD related characteristics (severity score)	4.67^{b}	3.00^{ab}	2.55^{a}	4.40^{b}	5.80	.003

Note. Cluster means indicated with a different superscript differ significantly from each other at .05 level based on Tukey-Kramer post hoc tests. +JA − SU = high joint attention – low symbol understanding; −JA + SU = low joint attention – high symbol understanding.

Table 4
Clinical information per cluster subgroup.

	Cluster			
	Low-functioning	High-functioning	+JA − SU	−JA + SU
Linguistic profile (*n* of participants)				
Receptive difficulties	0	1	0	0
Expressive difficulties	0	4	7	2
Mixed receptive-expressive difficulties	6	4	4	8
Clinical diagnosis (*n* of participants)				
ID	3	1	2	1
ASD	0	0	2	2
ID with co-occurring ASD	2	0	0	0
Clinical signs of ASD[a]	4	1	2	3

Note. [a]Clinical signs of ASD were found in children with and without a clinical diagnosis of ID. ID, intellectual disability; ASD, autism spectrum disorder; +JA − SU, high joint attention – low symbol understanding; −JA + SU, low joint attention – high symbol understanding.

behavior, symbol understanding, and language, this cluster is referred to as 'high functioning'. This cluster consisted of nine children (seven boys, two girls) with heterogeneous language difficulties. They initiated as much communication for the purpose of joint attention ($M = 1.26$, $SD = 0.67$) as for the purpose of behavior regulation ($M = 1.23$, $SD = 0.56$; $t = -1.39$, $p = .93$).

The children within the third and fourth cluster were comparable with regard to their nonverbal cognitive abilities (cluster 3: $M = 28.73$, $SD = 5.59$; cluster 4: $M = 32.25$, $SD = 6.23$; Tukey-Kramer: $p = .52$). Both clusters obtained a mid-position on the dimensions of adaptive behavior and language, while cluster membership was distinguished by the number of joint attention acts, children's mastery of symbol understanding, and the identified amount of ASD related characteristics.

The third cluster consisted of eleven children (all boys) of whom the majority ($n = 7$) had expressive language difficulties. Few ASD related characteristics were identified and the number of joint attention acts initiated by the children was the highest of all clusters. Nevertheless, the children's mastery of symbol understanding was limited and comparable to the low-functioning cluster. Therefore, this cluster is referred to as 'high joint attention and low symbol understanding' (+JA − SU).

The previously described profile of relative strengths and weaknesses was reversed for the children in the fourth cluster. This cluster consisted of ten children (six boys, four girls) of whom the majority ($n = 8$) experienced mixed receptive-expressive language difficulties. This cluster's position on the dimension of symbol understanding was relatively high and comparable to the high-functioning cluster. However, the children in this cluster initiated only a limited amount of joint attention acts ($M = 0.94$, $SD = 0.54$) and communicated primarily for the purpose of behavior regulation ($M = 2.37$, $SD = 0.64$; $t = 5.25$, $p = .001$). Therefore, this cluster is referred to as 'low joint attention and high symbol understanding' (−JA + SU). The amount of ASD related characteristics identified in this cluster subgroup was relatively high and comparable to the low-functioning cluster.

4. Discussion

Language difficulties of young children may be temporary in nature or signal the presence of a developmental disorder (Buschmann et al., 2008; Conti-Ramsden & Durkin, 2012; Dale et al., 2003; Miniscalco et al., 2006; Westerlund et al., 2002). Although early diagnostic decision making has been encouraged, the behavioral profiles of rapidly developing young children are complex and often difficult to compare to categorical diagnostic prototypes stated within DSM-IV-TR and ICD-10 (Hudziak et al., 2007). Drawbacks of these primarily top-down constructed frameworks have underlined the importance of a dimensional approach in complementing the categorical paradigm to psychopathology (First, 2005; Gillberg, 2010; Rutter, 2011; Widiger & Samuel, 2005). In this study, the abilities of a broadly defined group of young children with language difficulties were analyzed by means of a dimensional approach. This enabled the delineation of bottom-up constructed subgroups based on the interrelatedness of children's abilities across domains of functioning.

4.1. Bottom-up constructed subgroups of young children with language difficulties

Four subgroups of children with fairly similar profiles of strengths and weaknesses could be delineated. Two subgroups were mainly distinguished by differences in overall level of functioning since nonverbal cognitive abilities in the high-functioning subgroup were significantly more mature than those in the low-functioning subgroup. Although the high-functioning subgroup was significantly older than the low-functioning subgroup, the difference between nonverbal mental age and chronological age was only significant in the low-functioning subgroup. The other two subgroups, however, were comparable with regard to their level of cognitive functioning and revealed dissociation in children's mastery of two linguistic prerequisites delineated by Bates (1979). More specifically, dissociation was found between children's tendency to communicate for joint attention purposes and their mastery of symbol understanding. This dissociation should, however, be interpreted with caution since symbol understanding could not be assessed – either due to a lack of symbolic capacity, task

comprehension, or limited on-task behavior – in about half of the children comprising either subgroup. Nevertheless, the results are in line with previous findings that stressed the importance of separate assessment of both linguistic prerequisites, at least in young children (Määttä et al., 2012; Maljaars et al., 2012).

Children in both the low-functioning and −JA + SU subgroup communicated primarily for the purpose of behavior regulation while initiating few joint attention acts. Such a pattern of intentional communication has been found characteristic for children with ASD (Maljaars et al., 2011; Shumway & Wetherby, 2009; Wetherby et al., 2007). The majority – although not all – of the children comprising these two cluster subgroups were indeed diagnosed with or suspected of this developmental disorder. Positive relationships between amount of joint attention and receptive and expressive language development have been reported for children with ASD (Maljaars et al., 2011; Toth et al., 2006; Watt et al., 2006). Consistent with these findings, almost all children comprising the low-functioning and −JA + SU subgroup experienced difficulties in both language domains. The relationship between symbol understanding and language is less clear since studies reported inconsistent findings with regard to the existence and nature of such a relationship (Lewis, 2003; Lewis et al., 2000; Lyytinen et al., 1997; Rescorla & Goossens, 1992; Terrell et al., 1984). In this study, heterogeneous profiles of language difficulties were found in those subgroups characterized by restricted symbol understanding: the low-functioning and +JA − SU subgroup.

Children diagnosed with or suspected of ASD were found within the +JA − SU subgroup as well, a subgroup characterized by relatively high amounts of joint attention initiations and few ASD related characteristics. This finding stresses the importance of disentangling the quantity of joint attention acts from their quality. Large within-group differences were found in studies analyzing the rate of communication for joint attention purposes initiated by children with ASD (Maljaars et al., 2011; Shumway & Wetherby, 2009; Wetherby et al., 2007). Therefore, some of these children will differ from typically developing peers mainly with respect to the quality of their communicative behavior (Shumway & Wetherby, 2009), an aspect that is not sufficiently incorporated in both the CSBS DP and Module 1 of the ADOS.

4.2. Limitations and future directions

Research samples in which young children with language difficulties are more similar with regard to their nonverbal cognitive abilities enable the differentiation of behavioral profiles in which strengths and weaknesses are less dependent on a child's overall level of functioning. Only two of the cluster subgroups delineated in this study were comparable in this respect. The dissociation between these children's joint attention abilities and their mastery of symbol understanding should be interpreted with care and warrants further attention. The strength of this study is the bottom-up approach in delineating clusters in young children with language difficulties. However, cluster analysis only generates hypotheses about possible clusters, which have to be validated on independent, larger, samples later on. Future research might also extend beyond the dimensions of functioning included in this study. Information regarding children's gross and fine motor skills (Hill, 2001) as well as the quality of their social behavior (Ventola et al., 2007) might lead to a more complete picture of the behavioral profiles of young children with language difficulties.

4.3. Implications for clinical practice

The results of this study carry implications for diagnostic assessment and intervention in young children with language difficulties. Language difficulties are often embedded in complex behavioral profiles (Buschmann et al., 2008; Carson et al., 1998; Rice et al., 1991; Tervo, 2007) in which strengths and weaknesses are best captured by means of a dimensional approach.

Current findings indicated joint attention and symbol understanding as important dimensions that should be included in the diagnostic assessment of young children presenting with language difficulties. Accurate assessment of both linguistic prerequisites in clinical practice will however be challenging since norm-referenced instruments that measure these abilities in a time-efficient manner are lacking to date. Nevertheless, specific intervention programs that stimulate joint attention and/or expand the range of symbolic play activities are associated with positive collateral effects on children's cognitive, linguistic, and social abilities (Kasari, Gulsrud, Freeman, Paparella, & Hellemann, 2012; Kasari, Paparella, Freeman, & Jahromi, 2008; O'Connor & Stagnitti, 2011), which in turn foster children's opportunities to engage in language learning situations (Adamson, Romski, Bakeman, & Sevcik, 2010; Mundy, 2011).

The problems that some children with language difficulties seem to experience with the symbolic properties of words, pictures, and objects also carry implications for the use of augmentative communication (AC) strategies, since they often require an understanding of symbol–referent relationships. Only AC strategies suited to children's level of sense-making may expand their receptive and/or expressive communication abilities and therefore reduce the amount of challenging behavior that can result from a limited understanding of the environment or restricted possibilities to communicate one's needs and interests (Van Daal et al., 2004).

Multidisciplinary, long-term dimensional assessment is not only important for the establishment of individualized intervention plans, but should also inform diagnostic decision making in children whose language difficulties signal the presence of a developmental disorder (Gillberg, 2010; Markiewicz & Pachalska, 2007). Moreover, accumulating studies on the abilities of large, broadly defined groups of children with developmental problems may lead to the refinement of diagnostic criteria or the delineation of new diagnostic subgroups that capture the interrelatedness of these children's abilities in a more meaningful way.

Acknowledgements

We are thankful to all participating children and their parents. Special thanks to the Multidisciplinary University Center for Speech-Language Pathology and Audiology and the Center for Developmental Disabilities. This research was funded by a doctoral dissertation grant from the KU Leuven awarded to Rianne Jansen and a grant from the Research Council of the KU Leuven (IDO/080/013) awarded to Jean Steyaert and Ilse Noens.

References

Adamson, L. B., Romski, M., Bakeman, R., & Sevcik, R. A. (2010). Augmented language intervention and the emergence of symbol-infused joint engagement. *Journal of Speech, Language, and Hearing Research, 53*, 1769–1773.
American Psychiatric Association. (2000). *Diagnostic and statistical manual of mental disorders* (4th ed., (text revision)). Washington, DC: APA.
American Psychiatric Association. (2013). *Diagnostic and statistical manual of mental disorders* (5th ed.). Arlington, VA: American Psychiatric Publishing.
Bates, E. (1979). Intentions, conventions, and symbols. In E. Bates, L. Benigni, I. Bretherton, L. Camaioni, & V. Volterra (Eds.), *The emergence of symbols: Cognition and communication in infancy* (pp. 33–68). New York, NY: Academic Press.
Bishop, D. V. M. (2003). Autism and specific language impairment: Categorical distinction or continuum? In G. Bock & J. Goode (Eds.), *Autism: Neural basis and treatment possibilities* (pp. 213–226). Chichester, UK: John Wiley & Sons.
Bishop, D. V. M., Whitehouse, A. J. O., Watt, H. J., & Line, E. A. (2008). Autism and diagnostic substitution: Evidence from a study of adults with a history of developmental language disorder. *Developmental Medicine & Child Neurology, 50*, 341–345.
Boucher, J. (2012). Research review: Structural language in autistic spectrum disorder – Characteristics and causes. *Journal of Child Psychology and Psychiatry, 53*, 219–233.
Bruner, J. (1981). The social context of language acquisition. *Language & Communication, 1*, 155–178.
Buschmann, A., Jooss, B., Rupp, A., Dockter, S., Blaschtikowitz, H., Heggen, I., et al. (2008). Children with developmental language delay at 24 months of age: Results of a diagnostic work-up. *Developmental Medicine & Child Neurology, 50*, 223–229.
Carson, D. K., Klee, T., Perry, C. K., Muskina, G., & Donaghy, T. (1998). Comparisons of children with delayed and normal language at 24 months of age on measures of behavioral difficulties, social and cognitive development. *Infant Mental Health Journal, 19*, 59–75.
Conti-Ramsden, G., Crutchley, A., & Botting, N. (1997). The extent to which psychometric tests differentiate subgroups of children with SLI. *Journal of Speech, Language, and Hearing Research, 40*, 765–777.
Conti-Ramsden, G., & Durkin, K. (2012). Language development and assessment in the preschool period. *Neuropsychology Review, 22*, 384–401.
Coupe O'Kane, J., & Goldbart, J. (1998). Assessment of early communication. In J. Coupe O'Kane & J. Goldbart (Eds.), *Communication before speech: Development and assessment* (pp. 56–66). London, UK: David Fulton Publishers.
Dale, P. S., Price, T. S., Bishop, D. V. M., & Plomin, R. (2003). Outcomes of early language delay: I. Predicting persistent and transient language difficulties at 3 and 4 years. *Journal of Speech, Language, and Hearing Research, 46*, 544–560.
De Bildt, A., Oosterling, I. J., Van Lang, N. D. J., Sytema, S., Minderaa, R. B., Van Engeland, H., et al. (2011). Standardized ADOS scores: Measuring severity of autism spectrum disorders in a Dutch sample. *Journal of Autism and Developmental Disorders, 41*, 311–319.
DeLoache, J. S., & Burns, N. M. (1994). Early understanding of the representational function of pictures. *Cognition, 52*, 83–110.
Evers, A., Braak, M. S. L., Frima, R. M., & Van Vliet-Mulder, J. C. (2009–2011). *Commissie Testaangelegenheden Nederland – Documentatie [Committee for Psychometric Evaluation of Psychological Tests of the Dutch Institute of Psychologists]*. Amsterdam, NL: Boom Test Uitgevers.
First, M. B. (2005). Mutually exclusive versus co-occurring diagnostic categories: The challenge of diagnostic comorbidity. *Psychopathology, 38*, 206–210.
Geurts, H. M., & Embrechts, M. (2008). Language profiles in ASD, SLI, and ADHD. *Journal of Autism and Developmental Disorders, 38*, 1931–1943.
Gillberg, C. (2010). The ESSENCE in child psychiatry: Early symptomatic syndromes eliciting neurodevelopmental clinical examinations. *Research in Developmental Disabilities, 31*, 1543–1551.
Gotham, K., Pickles, A., & Lord, C. (2009). Standardizing ADOS scores for a measure of severity in autism spectrum disorders. *Journal of Autism and Developmental Disorders, 39*, 693–705.
Gotham, K., Risi, S., Pickles, A., & Lord, C. (2007). The autism diagnostic observation schedule: Revised algorithms for improved diagnostic validity. *Journal of Autism and Developmental Disorders, 37*, 613–627.
Hill, E. L. (2001). Non-specific nature of specific language impairment: A review of the literature with regard to concomitant motor impairments. *International Journal of Language and Communication Disorders, 36*, 149–171.
Hudziak, J. J., Achenbach, T. M., Althoff, R. R., & Pine, D. S. (2007). A dimensional approach to developmental psychopathology. *International Journal of Methods in Psychiatric Research, 16*(S1), S16–S23.
Jarrold, C. (2003). A review of research into pretend play in autism. *Autism, 7*, 379–390.
Kasari, C., Gulsrud, A., Freeman, S., Paparella, T., & Hellemann, G. (2012). Longitudinal follow-up of children with autism receiving targeted interventions on joint attention and play. *Journal of the American Academy of Child & Adolescent Psychiatry, 51*, 487–495.
Kasari, C., Paparella, T., Freeman, S., & Jahromi, L. B. (2008). Language outcome in autism: Randomized comparison of joint attention and play interventions. *Journal of Consulting and Clinical Psychology, 76*, 125–137.
Kelly, D. J. (1998). A clinical synthesis of the "late talker" literature: Implications for service delivery. *Language, Speech, and Hearing Services in Schools, 29*, 76–84.
Kendler, K. S., & First, M. B. (2010). Alternative futures for the DSM revision process: Iteration v. paradigm shift. *The British Journal of Psychiatry, 197*, 263–265.
Kiers, H. A. L. (1997). Weighted least squares fitting using ordinary least squares algorithms. *Psychometrika, 62*, 251–266.
Kraemer, H. C., Noda, A., & O'Hara, R. (2004). Categorical versus dimensional approaches to diagnosis: Methodological challenges. *Journal of Psychiatric Research, 38*, 17–25.
Lai, M.-C., Lombardo, M. V., Chakrabarti, B., & Baron-Cohen, S. (2013). Subgrouping the autism "Spectrum": Reflections on DSM-5. *PLoS Biology, 11*, e1001544.
Lewis, V. (2003). Play and language in children with autism. *Autism, 7*, 391–399.
Lewis, V., Boucher, J., Lupton, L., & Watson, S. (2000). Relationships between symbolic play, functional play, verbal and non-verbal ability in young children. *International Journal of Language & Communication Disorders, 35*, 117–127.
Leyfer, O. T., Tager-Flusberg, H., Dowd, M., Tomblin, J. B., & Folstein, S. E. (2008). Overlap between autism and specific language impairment: Comparison of Autism diagnostic interview and Autism diagnostic observation schedule scores. *Autism Research, 1*, 284–296.
Lord, C., & Jones, R. M. (2012). Annual research review: Re-thinking the classification of autism spectrum disorders. *Journal of Child Psychology and Psychiatry, 53*, 490–509.
Lord, C., Rutter, M., Dilavore, P. C., & Risi, S. (1999). *Autism diagnostic observation schedule (ADOS)*. Los Angeles, CA: Western Psychological Services.
Loucas, T., Charman, T., Pickles, A., Simonoff, E., Chandler, S., Meldrum, D., et al. (2008). Autistic symptomatology and language ability in autism spectrum disorder and specific language impairment. *Journal of Child Psychology and Psychiatry, 49*, 1184–1192.
Lyytinen, P., Poikkeus, A.-M., & Laakso, M.-L. (1997). Language and symbolic play in toddlers. *International Journal of Behavioral Development, 21*, 289–302.
Määttä, S., Laakso, M.-L., Tolvanen, A., Ahonen, T., & Aro, T. (2012). Developmental trajectories of early communication skills. *Journal of Speech, Language, and Hearing Research, 55*, 1083–1096.
Maljaars, J., Noens, I., Jansen, R., Scholte, E., & Van Berckelaer-Onnes, I. (2011). Intentional communication in nonverbal and verbal low-functioning children with autism. *Journal of Communication Disorders, 44*, 601–614.

Maljaars, J., Noens, I., Scholte, E., & Van Berckelaer-Onnes, I. (2012). Language in low-functioning children with autistic disorder: Differences between receptive and expressive skills and concurrent predictors of language. *Journal of Autism and Developmental Disorders, 42*, 2181–2191.
Markiewicz, K., & Pachalska, M. (2007). Diagnosis of severe developmental disorders in children under three years of age. *Medical Science Monitor, 13*(2), 89–99.
McEachin, J. J., Smith, T., & Lovaas, O. I. (1993). Long-term outcome for children with autism who received early intensive behavioral treatment. *American Journal on Mental Retardation, 97*, 359–372.
McFee, K. H. L. (2006). *Understanding the symbolic nature of pictures in children with autism [Master's thesis]*. York University.
Michelotti, J., Charman, T., Slonims, V., & Baird, G. (2002). Follow-up of children with language delay and features of autism from preschool years to middle childhood. *Developmental Medicine & Child Neurology, 44*, 812–819.
Miniscalco, C., Nygren, G., Hagberg, B., Kadesjö, B., & Gillberg, C. (2006). Neuropsychiatric and neurodevelopmental outcome of children at age 6 and 7 years who screened positive for language problems at 30 months. *Developmental Medicine & Child Neurology, 48*, 361–366.
Mundy, P. (2011). The social behavior of autism: A parallel and distributed information processing perspective. In D. G. Amaral, G. Dawson, & D. H. Geschwind (Eds.), *Autism spectrum disorders* (pp. 149–171). New York, NY: Oxford University Press.
O'Connor, C., & Stagnitti, K. (2011). Play, behavior, language and social skills: The comparison of a play and a non-play intervention within a specialist school setting. *Research in Developmental Disabilities, 32*, 1205–1211.
Pickles, A., & Angold, A. (2003). Natural categories or fundamental dimensions: On carving nature at the joints and the rearticulation of psychopathology. *Development and Psychopathology, 15*, 529–551.
Pickles, A., Simonoff, E., Conti-Ramsden, G., Falcaro, M., Simkin, Z., Charman, T., et al. (2009). Loss of language in early development of autism and specific language impairment. *Journal of Child Psychology and Psychiatry, 50*, 843–852.
Prizant, B., Wetherby, A., & Rydell, P. (2000). Communication intervention issues for young children with autism spectrum disorders. In A. M. Wetherby & B. M. Prizant (Eds.), *Autism spectrum disorders: A transactional developmental perspective* (pp. 193–224). Baltimore, MD: Paul H. Brookes.
Regier, D. A., Narrow, W. E., Kuhl, E. A., & Kupfer, D. J. (2009). The conceptual development of DSM-V. *The American Journal of Psychiatry, 166*, 645–650.
Rescorla, L., & Goossens, M. (1992). Symbolic play development in toddlers with expressive specific language impairment (SLI-E). *Journal of Speech and Hearing Research, 35*, 1290–1302.
Rice, M. L., Sell, M. A., & Hadley, P. A. (1991). Social interactions of speech- and language-impaired children. *Journal of Speech and Hearing Research, 34*, 1299–1307.
Rutter, M. (2011). Research review: Child psychiatric diagnosis and classification: Concepts, findings, challenges and potential,. *Journal of Child Psychology and Psychiatry, 52*, 647–660.
Schaerlaekens, A., Zink, I., & Van Ommeslaeghe, K. (2003). Reynell Taalontwikkelingsschalen. *Handleiding tweede versie [Reynell Scales for Language Development. Manual second edition]*, Lisse, NL: Swets Test Publishers.
Schepers, J., Ceulemans, E., & Van Mechelen, I. (2008). Selecting among multi-mode partitioning models of different complexities: A comparison of four model selection criteria. *Journal of Classification, 25*, 67–85.
Scholte, E., Van Duijn, G., Dijkxhoorn, Y., Noens, I., & Van Berckelaer-Onnes, I. (2008). *Handleiding Vineland Screener 0-6 jaar [Manual Vineland Screener 0-6 years NL]*. Leiden, NL: PITS.
Shumway, S., & Wetherby, A. M. (2009). Communicative acts of children with autism spectrum disorders in the second year of life. *Journal of Speech, Language, and Hearing Research, 52*, 1139–1156.
Steinley, D. (2003). Local optima in K-means clustering: What you don't know may hurt you. *Psychological Methods, 8*, 294–304.
Steinley, D., & Brusco, M. J. (2011). Evaluating mixture modeling for clustering: Recommendations and cautions. *Psychological Methods, 16*, 63–79.
Tager-Flusberg, H. (1996). Brief report: Current theory and research on language and communication in autism. *Journal of Autism and Developmental Disorders, 26*, 169–172.
Tellegen, P. J., Winkel, M., Wijnberg-Williams, B. J., & Laros, J. A. (1998). *Snijders-Oomen Niet-verbale intelligentietest, SON-R 2½-7: Handleiding en verantwoording [Snijders-Oomen Non-verbal Intelligence Test, SON-R 2½-7: Manual]*. Lisse, NL: Swets Test Publishers.
Terrell, B. Y., Schwartz, R. G., Prelock, P. A., & Messick, C. K. (1984). Symbolic play in normal and language-impaired children. *Journal of Speech and Hearing Research, 27*, 424–429.
Tervo, R. C. (2007). Language proficiency, development, and behavioral difficulties in toddlers. *Clinical Pediatrics, 46*, 530–539.
Toth, K., Munson, J., Meltzoff, A. N., & Dawson, G. (2006). Early predictors of communication development in young children with autism spectrum disorder: Joint attention, imitation, and toy play. *Journal of Autism and Developmental Disorders, 36*, 993–1005.
Van Daal, J., Verhoeven, L., & Van Balkom, H. (2004). Subtypes of severe speech and language impairments: Psychometric evidence from 4-year-old children in the Netherlands. *Journal of Speech, Language, and Hearing Research, 47*, 1411–1423.
Van der Meulen, B. F., Ruiter, S. A. J., Lutje Spelberg, H. C., & Smrkovsky, M. (2002). *Bayley Scales of Infant Development – Second edition – Nederlandse bewerking [Bayley Scales of Infant Development – Second edition – Dutch version]*. Lisse, NL: Swets Test Publishers.
Ventola, P., Kleinman, J., Pandey, J., Wilson, L., Esser, E., Boorstein, H., et al. (2007). Differentiating between autism spectrum disorders and other developmental disabilities in children who failed a screening instrument for ASD. *Journal of Autism and Developmental Disorders, 37*, 425–436.
Watt, N., Wetherby, A., & Shumway, S. (2006). Prelinguistic predictors of language outcome at 3 years of age. *Journal of Speech, Language, and Hearing Research, 49*, 1224–1237.
Westerlund, M., Bergkvist, L., Lagerberg, D., & Sundelin, C. (2002). Comorbidity in children with severe developmental language disability. *Acta Paediatrica, 91*, 529–534.
Wetherby, A., & Prizant, B. (1993). *Communication and symbolic behavior scales – Normed edition*. Baltimore, MD: Paul H Brookes.
Wetherby, A., & Prizant, B. (2002). *Communication and symbolic behavior scales: Developmental profile – First normed edition*. Baltimore, MD: Paul H Brookes.
Wetherby, A. M., Watt, N., Morgan, L., & Shumway, S. (2007). Social communication profiles of children with autism spectrum disorders late in the second year of life. *Journal of Autism and Developmental Disorders, 37*, 960–975.
Widiger, T. A. (1997). The construct of mental disorder. *Clinical Psychology: Science and Practice, 4*, 262–266.
Widiger, T. A., & Samuel, D. B. (2005). Diagnostic categories or dimensions? A question for the diagnostic and statistical manual of mental disorders – fifth edition. *Journal of Abnormal Psychology, 114*, 494–504.
World Health Organization. (1992). *The ICD 10 classification of mental and behavioral disorders: Clinical descriptions and diagnostic guidelines*. Geneva, CH: Author.
Zink, I., & Lejaegere, M. (2003). *N-CDIs: Korte vormen [N-CDIs: Short forms]*. Leuven, BE: Acco.
Zink, I., & Lejaegere, M. (2007). *N-CDI 3*. Leuven, BE: Acco.
Zink, I., & Lembrechts, D. (2000). *NNST: Nederlandstalige Nonspeech Test. Handleiding [NNST: Dutch version of the Nonspeech Test. Manual]*. Leuven, BE: Acco.
Zink, I., Van Ommeslaeghe, K., Stroobants, R., Janssen, P., & Schaerlaekens, A. (1993). *Reynell Taalontwikkelingsschalen. Psychometrische verantwoording en analyse [Reynell Scales for Language Development. Psychometric data]*. Nijmegen, NL: Berkhout Nijmegen B V.