Editor's Choice

Developmental trajectories of receptive and expressive communication in children and young adults with cerebral palsy

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This article is commented on by Pennington on pages 917–918 of this issue.

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ABBREVIATIONS

BSCP	Bilateral spastic cerebral palsy
ICF-CY	International Classification of Functioning, Disability and Health –Children and Youth version
NSCP	Non-spastic cerebral palsy
USCP	Unilateral spastic cerebral palsy
VABS	Vineland Adaptive Behavior Scales

AIM The aim of this study was to determine the developmental trajectories of expressive (speech) and receptive (spoken and written language) communication by type of motor disorder and intellectual disability in individuals with cerebral palsy (CP).
METHOD The development of 418 participants (261 males, 157 females; mean age 9y 6mo [SD 6y 2mo], range 1–24y; Gross Motor Function Classification System (GMFCS) level I [*n*=206], II [*n*=57], III [*n*=59], IV [*n*=54], V [*n*=42]) was followed for 2 to 4 years in a longitudinal study. Communication performance was measured using the Vineland Adaptive Behavior Scales. The type of motor disorder was differentiated by type of CP as unilateral spastic (USCP, *n*=161), bilateral spastic (BSCP, *n*=202), and non-spastic (NSCP, *n*=55), while intellectual disability was determined by IQ or school type (regular or special). A multilevel analysis was then used to model the developmental trajectories.
RESULTS The most favourable development of expressive communication was seen in USCP (vs BSCP β [SE]-2.74 [1.06], NSCP β [SE]-2.67 [1.44]). The difference between the development trajectory levels of children with and without intellectual disability was smaller for children with USCP than for those with BSCP and NSCP. For receptive communication, the most favourable development was found for all children with USCP and for BSCP or NSCP without intellectual disability (vs intellectual disability β [SE]-4.00 [1.16]). Development of written language was most favourable for children without intellectual disability (vs intellectual disability β [SE]-23.11 [2.85]).
INTERPRETATION The development of expressive communication was found to be most closely related to type of motor disorder, whereas the development of receptive communication was found to be most closely related to intellectual disability.

Individuals with cerebral palsy (CP) may experience communication difficulties from infancy onwards.[1,2] The difficulty of these communication problems ranges from severe (non-speaking) to mild (the individual requires a slower pace of conversation as extra time is needed to understand or compose a message).[1] Communication is essential for social participation in society;[3,4] moreover, communication difficulties are associated with problems in child–parent interaction and social participation with other significant persons.[4]

In the International Classification of Functioning, Disability and Health – Children and Youth version (ICF-CY), communication performance is one of nine domains covered by the ICF construct 'Activities & Participation'. Communication performance is defined as a person transmitting and receiving messages in different environments: a person transmits a message by speech (expressive communication) and receives a message by means of spoken and written language (receptive communication).[1] The communication difficulties associated with CP are multifactorial[2] and are related not only to the characteristics of the condition (gross motor impairment, vision, hearing, epilepsy), but also to personal (education, behavioural problems) and environmental (siblings, parental stress, social economical status) factors.[5,6] These factors all potentially influence the communication performance of the individual. In previous studies, differences in communication difficulties have often been described in relation to the severity of CP according to their Gross Motor Function Classification System (GMFCS) level.[4,7] Using this classification system, a different (and less favourable) developmental trajectory of communication performance was found only for individuals functioning at GMFCS level V.[7] Differences in developmental trajectories between individuals functioning at GMFCS levels I to IV were less pronounced.[6]

A large European study showed that differences in communication performance for individuals with CP is less related to their GMFCS level and more related to the type of motor disorder they have.[8] Motor disorders are classified into types based on abnormal patterns of posture and/or movement, in combination with measurements of muscle tone and limb involvement, including spastic CP (posture and movement dependent tone regulation disorder) with one (unilateral) or both (bilateral) sides of the body involved. Other motor disorders (ataxic CP and dyskinetic CP) are described as non-spastic CP.[9] The aforementioned European study found that individuals with non-spastic CP had greater communication difficulties compared with individuals with spastic CP.[8]

In addition to factors related to CP, a strong association between communication difficulties and intellectual disability has also been reported.[5,7,8] Individuals with intellectual disability have more problems with expressive communication (speech) and receptive communication (comprehension of spoken and written language) than do those without intellectual disability.[5,7] To the best of our knowledge, no data are yet available on the developmental trajectories of expressive and receptive communication within types of motor disorder, or of the influence of intellectual disability on these trajectories.

Communication is an essential aspect of social participation and inclusion in society is the targeted goal of rehabilitation treatment. Therefore, as communication is essential for interaction between persons in daily living and communication difficulties interfere with natural interactions, greater insight into the development of communication performance is needed.[2] The findings of the present longitudinal study may identify subgroups at risk of communication difficulties and may enhance the development of programmes to enable individuals with CP to participate more independently in social interactions.

The aim of this study, therefore, was to determine the developmental trajectories of expressive (speech) and receptive (spoken and written language) communication by type of motor disorder and intellectual disability in individuals with CP in the Netherlands.

What this paper adds

- This study indicates different developmental trajectories of expressive and receptive communication skills in cerebral palsy (CP).
- Expressive communication development is more closely related to the type of motor disorder.
- Expressive communication development was most favourable in unilateral spastic CP.
- The development of receptive communication skills is most closely related to intellectual (dis)ability.

METHOD

Study design and participants

This study was performed as part of the prospective longitudinal research programme 'PEdiatric Rehabilitation Research In the Netherlands' (PERRIN), which was launched in 2000 as a collaboration between four university medical centres and several rehabilitation centres in the Netherlands. For the present study, data on 418 children with CP were combined from four age cohort studies in the PERRIN research programme: 0–5 (aged 1 and 2y at baseline, n=93), 5–9 (aged 5 and 7y at baseline, n=114), 9–16 (aged 9, 11, and 13y at baseline, n=108), and 16–24 (aged 16–20y at baseline, n=103). Within each age cohort, data were collected yearly over the course of 2 years (5–9) or 3 years (0–5, 9–16), or bi-yearly over 4 years (16–24; see Fig. 1). The recruitment process of these studies has been described in detail elsewhere.[10–13] In short, all eligible individuals had a clinical diagnosis of CP. Individuals were excluded if they had been diagnosed with additional diseases or disorders affecting motor functioning or if they or their caregiver lacked a basic knowledge of the Dutch language. Young adults with an intellectual disability (based on school type; regular or special) were also excluded.[10] The young adult cohort study aimed to determine the course and determinants of daily activities and participation from the perspective of the young adults themselves. The instruments used to assess this information were not suitable for individuals with intellectual disability and, therefore, they were excluded from the study. Informed consent was obtained from each patient and/or their parents or formal caregiver. Ethical approval for the study was obtained from the medical ethics committee of each participating centre.

Characteristics of CP

The condition of individuals with a clinical diagnosis of CP was described by functional mobility, classified using the Gross Motor Function Classification System (GMFCS) as levels I to V, and by type of motor disorder: unilateral spastic CP (USCP), bilateral spastic CP (BSCP), or non-spastic CP (NSCP, including dyskinetic, ataxic). The spread of type of motor disorder, epilepsy (more than one episode in the past year), hearing impairment, and vision impairment across the age cohorts is shown in Table I.

Measures of communication performance

Communication performance was determined using the validated Dutch version of the Vineland Adaptive Behavior Scales (VABS) survey.[14,15] The VABS survey is a reliable and validated instrument,[14,16,17] developed to assess the performance of children aged from 0 to 18 years 11 months, with or without any disability.[17] The VABS survey measures the child's performance by means of a semi-structured interview with the parents or caregivers

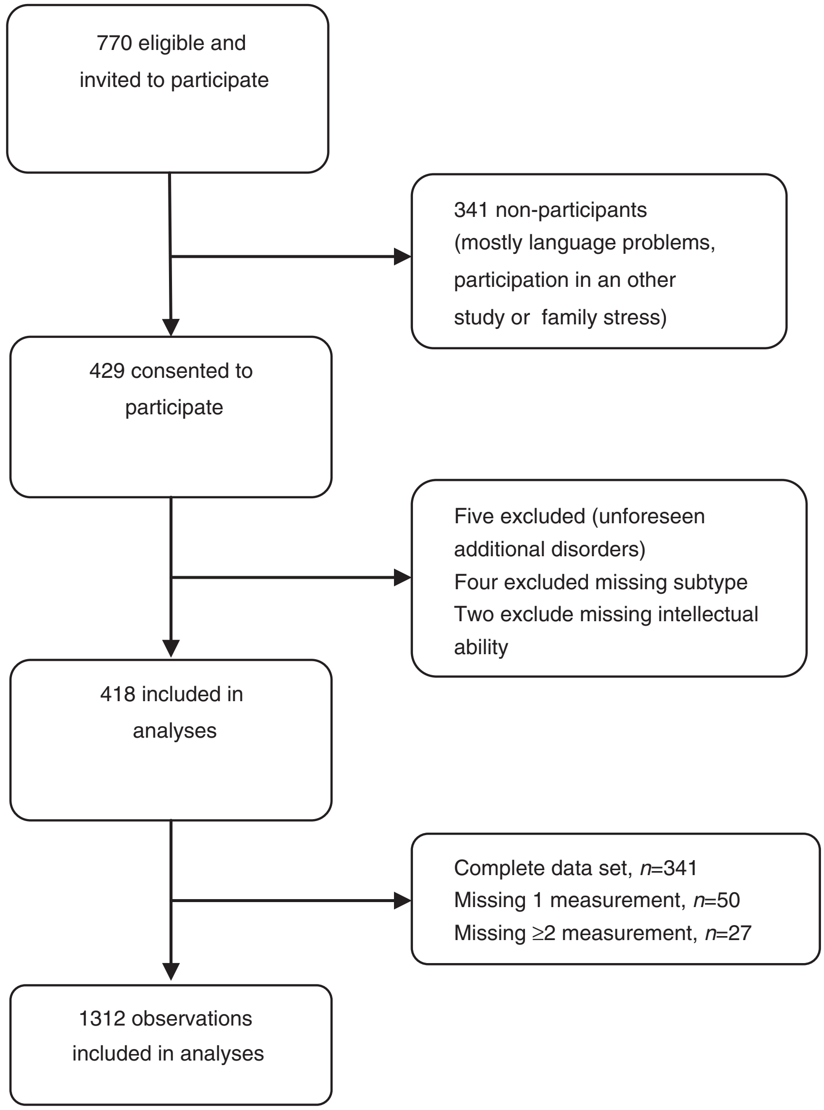

Figure 1: Flow diagram of study population.

according to current functioning of the child in daily living (irrespective of the use of aids). One of the four domains is 'communication', which contains 67 items on how a child uses expressive communication (e.g. 'uses phrases containing a noun and a verb, or two nouns'), receptive communication (e.g. 'follows instructions requiring an action and an object'), and uses and understands written language (e.g. 'prints or writes at least 10 words from memory'). Items are listed in developmental order and are divided into the following response categories: 0 (never performed), 1 (sometimes or partially performed) or 2 (usually or habitually performed). Accordingly, raw communication scores ranged between 0 and 134 and were compared with the VABS reference values, derived from 3000 children with typical development in north-west America. For the toddlers, the Dutch translation of the VABS screener was used, containing only the relevant items for this age group (expressive and receptive domain, not written language).[18] For the young adults, only data on written language were assessed.

Intellectual disability

The measurement for intellectual disability was determined through IQ testing either directly (Snijders–Oomen non-verbal intelligent test [SON-R[19]] for toddlers [n=93] and Raven's Coloured Progressive Matrices[20] for children [n=114]) or indirectly according to school type (adolescents [n=108] and young adults [n=103]). 'No intellectual disability' was defined as IQ ≥70 (n=128) or attending a regular education programme (n=180) (in a regular school or in a school providing special education for physically disabled children). 'Intellectual disability' was defined as an IQ <70 (n=79) or attending a special education programme in special schools (n=31) for children with an intellectual

Table I: Participant characteristics at baseline (n=418)

Characteristic	Unilateral spastic cerebral palsy	Bilateral spastic cerebral palsy	Non-spastic cerebral palsy	Total (n)
Without intellectual disability, n (%)				
Total	142 (88)	136 (67)	30 (55)	308 (74)
Toddlers (0–5y)	30 (21)	18 (13)	1 (3)	49 (16)
GMFCS level (I–III/IV–V), *n*	30/0	13/5	1/0	44/5
Epilepsy	7 (23)	4 (21)	0 (0)	13 (27)
Hearing impairment	0 (0)	0 (0)	0 (0)	0 (0)
Vision impairment	2 (7)	1 (6)	0 (0)	3 (6)
Children (5–9y)	35 (25)	37 (27)	7 (24)	79 (26)
GMFCS level (I–III/IV–V), *n*	35/0	33/4	7/0	75/4
Epilepsy	4 (11)	1 (3)	0 (0)	5 (6)
Hearing impairment	1 (3)	0 (0)	1 (14)	2 (3)
Vision impairment	8 (23)	13 (35)	1 (14)	22 (28)
Adolescents (9–16y)	34 (24)	34 (25)	9 (30)	77 (25)
GMFCS level (I–III/IV–V), *n*	34/0	25/9	7/2	66/11
Epilepsy	2 (6)	1 (3)	0 (0)	3 (4)
Hearing impairment	2 (6)	1 (3)	0 (0)	3 (4)
Vision impairment	2 (6)	4 (12)	2 (22)	8 (10)
Young adults (16–24y)	43 (30)	47 (35)	13 (43)	103 (33)
GMFCS level (I–III/IV–V), *n*	43/0	34/13	13/0	90/13
Epilepsy	4 (9)	1 (2)	0 (0)	5 (5)
Hearing impairment	1 (2)	1 (2)	0 (0)	2 (2)
Vision impairment	2 (5)	5 (11)	1 (8)	8 (8)
With intellectual disability, n (%)				
Total	19 (12)	66 (33)	25 (45)	110 (26)
Toddlers (0–5y)	11 (58)	31 (47)	2 (8)	44 (40)
GMFCS level (I–III/IV–V), *n*	9/2	11/20	0/2	20/24
Epilepsy	8 (73)	15 (48)	1 (50)	24 (55)
Hearing impairment	1 (9)	3 (10)	1 (50)	5 (11)
Vision impairment	4 (36)	8 (26)	0 (0)	12 (27)
Children (5–9y)	5 (26)	19 (29)	11 (44)	35 (32)
GMFCS level (I–III/IV–V), *n*	5/0	7/12	4/7	16/19
Epilepsy	1 (20)	8 (42)	4 (36)	13 (37)
Hearing impairment	1 (20)	0 (0)	5 (45)	6 (17)
Vision impairment	0 (0)	8 (42)	3 (27)	11 (31)
Adolescents (9–16y)	3 (16)	16 (24)	12 (48)	31 (28)
GMFCS (I–III/IV–V), *n*	3/0	5/11	3/9	11/20
Epilepsy	3 (100)	3 (19)	4 (33)	10 (32)
Hearing impairment	1 (33)	1 (6)	1 (8)	3 (10)
Vision impairment	1 (33)	6 (38)	7 (58)	14 (45)
Total	161 (39)	202 (48)	55 (13)	418 (100)

Values are expressed as *n* (%) except for Gross Motor Function Classification System (GMFCS) levels.

disability based on IQ testing (with or without physical disabilities).

Statistical analysis

Descriptive statistics were computed for CP characteristics using SPSS software, version 20 (IBM SPSS Statistics; IBM Corp., Armonk, NY, USA). Multilevel analyses were performed using MLwiN (version 2.21; Graduate School of Education, University of Bristol, Bristol, UK) to analyse the developmental trajectories of the communication subdomains. Raw scores of domains of expressive communication, receptive communication, and written language were used. Because data for several age cohorts were combined, with repeated measures for the same patient, three levels were defined: observations (level 3) were clustered within participants (level 2) and participants were clustered within age cohorts (level 1). The developmental trajectories of the communication subdomains were modelled by type of motor disorder and intellectual disability for children and adolescents aged from 1 year to 16 years (expressive and receptive communication) or from 5 to 24 years (written language). Data on individuals with intellectual disability and USCP were available up to age 11 years and for those with BSCP and NSCP up to age 16 years. Based on the observed data, age was included in the model as an independent continuous variable, both linear (age) and squared (age^2). Type of motor disorder was included as two dummy variables (with USCP as reference variable) and intellectual disability as a dichotomous variable (with 'no intellectual disability' as reference category). Each model of the communication subdomains included age and age^2. The likelihood ratio test was used to evaluate whether a random regression coefficient for age and age^2 needed to be considered in the models. Next, the type of motor disorder and intellectual disability were added to the model one by one to evaluate the influence on the communication subdomains. To evaluate the influence of the type of motor disorder and intellectual disability on the developmental trajectory of the communication subdomains, a two-way interaction of age (both linear and squared) by type of motor disorder and by intellectual disability was included, and the three-way interactions of age (both linear and squared) by type of motor disorder and by intellectual disability were entered into the model. The likelihood ratio test was used at each step to evaluate the additional value of the added determinant and the Wald statistic (for 1df) was used to evaluate the significance of the relationship between the outcome measures and determinants.[21] The reference category was alternated to determine differences between the developmental trajectories of the type of motor disorder.

RESULTS

The complete data set included 1312 observations of 418 participants ([261 males, 157 females; mean age 9y 6mo [SD 6y 2mo], range 1–24y; and by intellectual disability [with intellectual disability, n=110; Table II]). Overall, all GMFCS levels were represented in the study population: level I, n=206; level II, n=57; level III, n=59; level IV, n=54; and level V, n=42 (see Appendix S2, online supporting information).

The regression coefficients of the final models of the developmental trajectories of communication performance on expressive communication, receptive communication and written language are shown in Table II. It was not necessary to include a random regression coefficient in any of the models (based on the ratio likelihood test). The developmental trajectories of the individuals with CP and those of children with typical development (derived from the 3000 children from north-west America) are included in the figures as a reference.

Expressive communication

The developmental trajectories (ages 1–16y) of expressive communication differed by type of motor disorder. The most favourable development trajectory (highest level) of expressive communication was found for children with USCP (p<0.01 vs BSCP and NSCP), followed by those with BSCP (p=0.01 vs NSCP). The difference between the trajectory levels of children with and without intellectual disability was smaller for children with USCP than for those with BSCP or NSCP (Fig. 2a).

Receptive communication

The developmental trajectories (age 1–16y) of receptive communication were not significantly different between types of motor disorder. However, the trajectories were dependent on type of motor disorder and different between children with and without intellectual disability (Table II, based on two-way interactions between age and

Table II: Regression coefficients of the developmental trajectories of expressive communication, receptive communication, and written language by type of motor disorder

	Vineland Adaptive Behavior Scales communication subdomains					
	Expressive communication		Receptive communication		Written language	
Type of motor disorder	Regression coefficient (SE)	Wald statistic (1df)	Regression coefficient (SE)	Wald statistic (1df)	Regression coefficient (SE)	Wald statistic (1df)
Constant	−0.19		16.71		−31.61	
Age	10.80 (0.58)		1.55 (0.22)		7.96 (0.68)	
Age^2	−0.43 (0.03)		−0.06 (0.01)		−0.22 (0.03)	
Unilateral spastic CP	0 ref		0 ref		0 ref	
Bilateral spastic CP	4.19 (3.42)	ns	−1.65 (1.16)	ns	−0.05 (2.28)	ns
Non-spastic CP	7.86 (6.98)	ns	−2.31 (2.49)	ns	5.30 (3.40)	ns
Age × unilateral spastic CP	0 ref		0 ref		0 ref	
Age × bilateral spastic CP	−2.43 (0.47)	<0.01	0.25 (0.27)	ns	−0.12 (0.38)	ns
Age × non-spastic CP	−5.79 (1.32)	<0.01	−0.37 (0.45)	ns	−0.41 (0.62)	ns
Age^2 × unilateral spastic CP	0 ref		0 ref		0 ref	
Age^2 × bilateral spastic CP	0.12 (0.04)	<0.01	−0.01 (0.02)	ns	0.01 (0.01)	ns
Age^2 × non-spastic CP	0.30 (0.06)	<0.01	0.03 (0.02)	ns	−0.01 (0.02)	ns
Intellectual disability	−0.56 (3.51)	ns	−4.00 (1,16)	<0.01	−23.11 (2.85)	<0.01
Age × intellectual disability	−1.15 (1.02)	ns	0.79 (0.35)	0.02	−6.70 (1.05)	<0.01
Age^2 × intellectual disability	0.06 (0.07)	ns	−0.04 (0.03)	ns	0.30 (0.09)	<0.01
Age × unilateral spastic CP × intellectual disability	0 ref		0 ref		0 ref	
Age × bilateral spastic CP × intellectual disability	−2.74 (1.06)	0.01	−0.85 (0.36)	0.02	0.76 (0.76)	ns
Age × non-spastic CP × intellectual disability	−2.67 (1.44)	ns	−2.02 (0.49)	<0.01	1.05 (0.08)	<0.01
Age^2 × unilateral spastic CP × intellectual disability	0 ref		0 ref		0 ref	
Age^2 × bilateral spastic CP × intellectual disability	0.09 (0.09)	ns	0.03 (0.03)	ns	−0.15 (0.08)	0.05
Age^2 × non-spastic CP × intellectual disability	0.09 (0.11)	ns	0.13 (0.04)	<0.01	−0.17 (0.09)	0.04

ns, not significant.

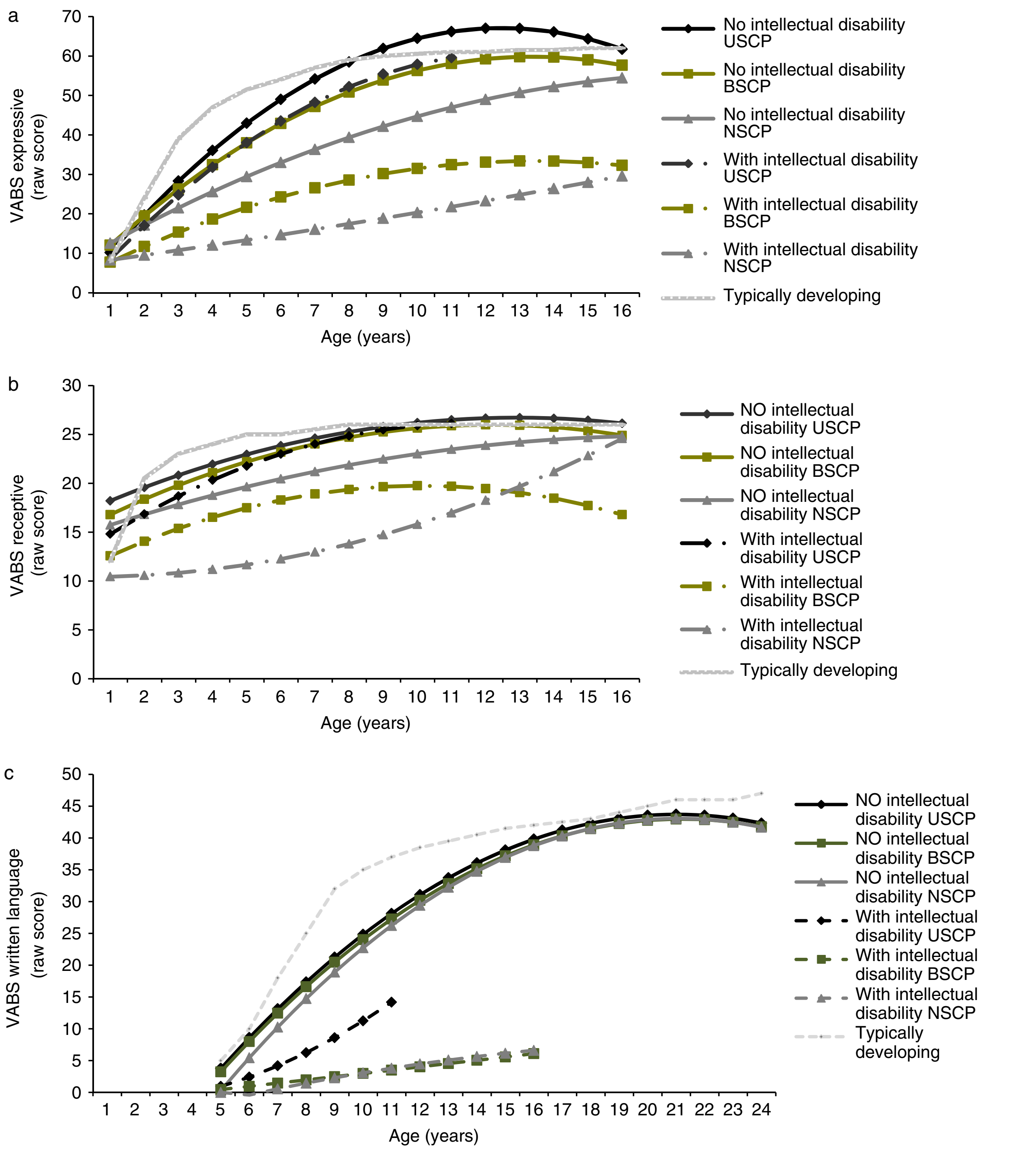

Figure 2: Modelled developmental trajectories of (a) expressive communication and (b) *receptive communication*, for ages 1 to 16 years, and (c) *written language*, for ages 5 to 24 years, by type of motor disorder. The higher scores for unilateral spastic cerebral palsy (USCP) without intellectual disability are model driven. In addition, the delayed rate of development compared with the children with typical development is model driven. The decreased trajectory of receptive communication of bilateral spastic cerebral palsy (BSCP) is the result of only a few data points after the age of 12 years. No data were available for children older than 11 years with USCP and intellectual disability. NSCP, non-spastic cerebral palsy; VABS, Vineland Adaptive Behavior Scales.

intellectual disability). In children with USCP, no differences in trajectory levels were found between children with and without intellectual disability, while in children with BSCP or NSCP, lower and less favourable trajectories were found for children with intellectual disability (Fig. 2b).

Written language

The developmental trajectories (age 5–24y) of the use and understanding of written language were not significantly different between types of motor disorder. However, as with receptive communication, trajectories differed for children with and without intellectual disability (Table II, based on the two-way interaction between age and type of motor disorder) and dependent on the type of motor disorder. Development started at the age of 5 years and showed a steep incline among children without intellectual disability, with a smaller difference in children with intellectual disability and USCP than in those with BSCP or NSCP (Fig. 2c).

DISCUSSION

In the present study, developmental trajectories for communication performance (expressive communication, receptive communication, and written language) in children and adolescents with CP in the Netherlands were estimated by type of motor disorder and intellectual disability. Type of motor disorder and intellectual disability were both related to communication performance. More importantly, these relationships differed for expressive communication (speech), receptive communication (spoken and written language). Type of motor disorder was most closely related to the developmental trajectory of expressive communication, whereas intellectual disability was most closely related to the developmental trajectories of receptive communication.

Examining the influence of type of motor disorder and intellectual disability in more detail and in relation to the different subdomains of communication, we found that expressive communication (speech) was most affected in BSCP and NSCP, in agreement with other researchers.[22] This relationship is to be expected, as speech is especially sensitive to and affected by involuntary face muscle movements and loss of voluntary motor control, both of which are more often present in children with BSCP and NSCP. Our finding that children with intellectual disability have greater difficulties with expressive communication than those without intellectual disability also agrees with earlier reports.[7,22] However, in the present study this finding was dependent on the type of motor disorder, something that was not reported in previous studies. Instead, earlier studies focussed on the relationship between expressive communication and intellectual disability in relation to severity of CP (GMFCS[22] or a three-level Gross Motor Scale[7]) – with conflicting findings. Thus, the present results emphasize the value of examining communication difficulties in relation to the additional information provided by type of motor disorder.

Receptive communication (comprehension of spoken language and written language) was influenced more by intellectual disability than by type of motor disorder. Children and adolescents without intellectual disability showed fewer difficulties with receptive communication. It was already known from previous cross-sectional studies that children without intellectual disability have fewer difficulties with language and the use of sentences.[5,7,22] The relevance of the current findings is that we were able to determine the influence of intellectual disability on the development trajectory of receptive communication skills. The substantial influence of intellectual disability on receptive communications skills (processing and understanding spoken and written language) reflects the complexity of this communication subdomain and emphasizes the relationship between verbal intelligence and receptive communication skills.[23] However, the receptive communication skills mentioned above provide only a general indication of a child's intellectual skills. In the present study the measurement for intellectual disability was based both on direct and indirect (based on school type) IQ testing. Consequently, it was not possible to differentiate between mild (IQ=50–70) and severe (IQ<50) intellectual disability. Moreover, for the children with the most severe levels of lowered gross motor functioning, other instruments are more appropriate (e.g. Computer-Based instrument for Low motor Language Testing (C-BiLLT) for measuring the child's level of communication skills, and should be used to tailor teaching approaches.[24]

It is unclear whether the less favourable development of receptive communication due to intellectual disability is influenced by educational factors (school type). Based on test results before entering, special education is more tailored to the child's needs. In order to prevent under- or overestimation of the child's level of communication skills, accurate identification of the child's level of communication skills is vital in ensuring that the most appropriate educational targets and teaching strategies are used.

For effective communication in daily living, it is necessary to both express (send) messages as well as to receive and understand messages, and to be able to alternate between the two. Therefore, analogous to the GMFCS, a classification system for communication in children with CP was recently developed; the Communication Function Classification System.[25] A limitation of the current study is that the Communication Function Classification System was not included in the data set because it was not yet developed at the time of measurement. The VABS measures expressive and receptive communication from the caregiver's perspective, which is potentially open to bias, especially for those patients with severe motor impairment.

Furthermore, we classified the type of motor disorder according to the Surveillance of Cerebral Palsy in Europe. According to this classification, the BSCP subtype is the most heterogeneous and includes children with a predominant involvement of the legs (diplegia), as well as children in whom both arms and legs are more or less severely affected (quadriplegia). It is most likely that children with a predominantly leg involvement will experience fewer difficulties in expressive speech; however, this was not examined in the present study. In addition, it is most likely that for toddlers the dyskinetic subtype will not yet have developed. The results of the BSCP subtype as a group could, therefore, be more favourable than for children with quadriplegic involvement.

In addition, the presence of epilepsy and vision and/or hearing impairments can influence the communication performance of the child. Although the incidence of these disease characteristics is available and presented for each age cohort, the number of observations in the present study did not allow further analysis or evaluation into the influence of these characteristics on the developmental trajectories.

Despite this, the present study makes a noteworthy contribution to the field of rehabilitation medicine as a result of the longitudinal study design used. Longitudinal data are essential when studying clinical change in individuals with CP, something that is not possible with cross-sectional studies. Future research should focus on the developmental trajectories of expressive and receptive communication of non-verbal children with CP. In addition, for both verbal and non-verbal children future research with larger sample sizes is needed to determine the potential influence of other disease characteristics (i.e. epilepsy, vision and hearing impairments, or personal and environmental factors) on these developmental trajectories.

CONCLUSION

Knowledge of the developmental trajectories of expressive and receptive communication skills is useful. The results of the present study show that development of expressive communication, although based on parent report and, therefore, open to bias, is more closely related to the type of motor disorder. In addition, receptive communication is more closely related to the intellectual ability to process and understand others and to understand the meaning of written language. This emphasizes the importance of accurately assessing the receptive communication skills of children with CP.

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SUPPORTING INFORMATION

The following additional material may be found online:

Appendix S1: Members of the PERRIN+ Study Groups.

Appendix S2: Baseline characteristics of the participants.

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