Reliability and validity of the Dutch-language version of the Viking Speech Scale

Name:	I.E.M. Spaans
Student number:	6004997
Version:	Final
Date:	27-6-2019
Education:	Clinical Language, Speech and Hearing Sciences, program in Clinical Health Sciences, Faculty of Medicine, Utrecht University, The Netherlands
Supervisor:	Dr. J.J.M. Geytenbeek
Lecturer:	Dr. R. Zwitserlood
Institution:	Amsterdam UMC, location VUmc, Amsterdam, The Netherlands
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LIST OF ABBREVIATIONS AND RELEVANT DEFINITIONS

C-BiLLT	**Computer-Based Instrument for Low Motor Language Testing**
CP	**Cerebral Palsy**
CP-CaLL	**Cerebral Palsy-Communication and Language Learning**
CFCS	**Communication Function Classification System**
CVI	**Cerebral Visual Impairment**
GMFCS	**Gross Motor Functioning Classification System**
GMFCS-E&R	**Gross Motor Functioning Classification System-Expanded & Revised**
ICS	**Intelligibility in Context Scale**
MACS	**Manual Ability Classification System**
SLT	**Speech language therapist**
VSS	**Viking Speech Scale**
WMA	**World Medical Association**

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ENGLISH ABSTRACT

Title

Reliability and validity of the Dutch-language version of the Viking Speech Scale.

Background

Children with cerebral palsy (CP) are classified using functional classification systems. The Viking Speech Scale (VSS) is used to classify speech. A Dutch-language version is not yet available.

Aim

To determine the reliability and validity of the Dutch-language version of the VSS (VSS-NL) and the association of VSS-NL-level with motor type of CP and with the functional profiles for gross motor-, communication-, and manual functioning.

Method

A prospective, cross-sectional, observational study was conducted. Fifty-five children with CP (32 males, mean age 6;3 years, SD 1;6 years) participated.

VSS-NL Classification of the speech language therapist (SLT)1 (researcher), SLT2 (of the child), parent and physiatrist were compared.

Convergent and discriminant validity was examined with the Intelligibility in Context Scale-Dutch (ICS-NL) and the Computer Based Instrument for Low Motor Language Testing (C-BiLLT).

Inter- and intrarater reliability was determined by weighted Kappa. Validity, and associations with type of CP, Gross Motor Function Classification System (GMFCS), Manual Ability Classification System (MACS), Communication Function Classification System (CFCS), were determined with Spearman's coefficient.

Results

Excellent interrater agreement between SLT1 and SLT2 (k=0.926), good for SLT1-parent, (k=0.669), SLT1-physiatrist, SLT2-parent (k=0.707), SLT2-physiatrist, and parent-physiatrist (k=0.729). Intrarater agreement was excellent for SLTs1-SLTs2 (k=1.000), very good for physiatrists (k=0.891) and good for parents (k=0.783).

Convergent validity was strong (r=-0.745), and discriminant validity moderate (r=-0.484). We found moderate associations with motor type of CP (r=0.467), GMFCS (r=0.537), CFCS (r=0.572) and MACS (r=0.500).

Conclusion

The VSS-NL is a reliable and valid system to classify the speech performance of children with CP (≥ 4 years), and classifications can be reliably performed by SLTs, parents and physiatrists.

Recommendations

Implementation of the VSS-NL in the Netherlands to classify the speech performance of children with CP.

Keywords

Cerebral Palsy, Speech, Children, Classification

NEDERLANDSE SAMENVATTING

Titel

Betrouwbaarheid en validiteit van de Nederlandstalige versie van de Viking Speech Scale.

Achtergrond

Kinderen met cerebrale parese (CP) worden geclassificeerd met functionele classificatiesystemen. De Viking Speech Scale (VSS) wordt gebruikt om het spreken te classificeren maar een Nederlandstalige versie is nog niet beschikbaar.

Doel

Het bepalen van de validiteit en betrouwbaarheid van de Nederlandstalige versie van de VSS (VSS-NL) en de associatie met type CP en met de functionele classificatiesystemen voor groffe motoriek, communicatie en handfunctie.

Methode

Een prospectief, cross-sectioneel, observationeel onderzoek werd uitgevoerd waaraan vijfenvijftig kinderen met CP (32 jongens, 23 meisjes, gemiddelde leeftijd 6;3 jaar, SD 1;6 jaar) deelnamen.

De VSS-NL-classificaties door logopedist 1 (onderzoeker), logopedist 2 (van het kind), ouder en revalidatiearts werden vergeleken.

Convergente en discriminante validiteit werden onderzocht met de Schaal voor Verstaanbaarheid in de Context (ICS-NL) en de Computer Based Instrument for Low Motor Language Testing (C-BiLLT).

Inter- en intrabeoordelaarsbetrouwbaarheid werden bepaald met gewogen Kappa.

De validiteit en de associaties met type CP, Gross Motor Function Classification System (GMFCS), Communication Function Classification System (CFCS), Manual Ability Classification System (MACS) werden bepaald met Spearmans correlatiecoëfficiënt.

Resultaten

De interbeoordelaarsbetrouwbaarheid was uitstekend tussen logopedist 1-logopedist 2 (k=0.926), goed tussen logopedist 1-ouder (k=0.669) , logopedist 1-revalidatiearts (k=0.679), logopedist 2-ouder (k=0.707), logopedist 2-revalidatiearts (k=0.743), ouder-revalidatiearts

(*k*=0.729). De intrabeoordelaarsbetrouwbaarheid was uitstekend voor logopedisten 1 en 2 (*k*=0.1000), erg goed voor revalidatieartsen (*k*=0.891), goed voor ouders (*k*=0.783).
De convergente validiteit was sterk (*r*=-0.745), de discriminante validiteit was matig (*r*=-0.484). We vonden matige associaties met type CP (*r*=-0.467), GMFCS (*r*=-0.537), CFCS (r=0.572), MACS (*r*=0.500).

Conclusie

De VSS-NL is een betrouwbaar en valide systeem om de spraak van kinderen met CP (≥ 4 jaar) te classificeren.

Aanbevelingen

Implementatie van de VSS-NL in Nederland zodat de spraak van kinderen met CP kan worden geclassificeerd.

Trefwoorden

Cerebrale Parese, Spraak, Kinderen, Classificatie

1. INTRODUCTION AND RATIONALE

Cerebral palsy (CP) is a neurological developmental disorder of movement and posture, occurring before the first year of life. The European prevalence is approximately 1.8 per 1.000 live births.[1] CP is often accompanied by disturbances of sensation, perception, cognition, communication, behaviour, epilepsy, and by secondary musculoskeletal problems.[2] The diagnosis of CP is based on clinical characteristics but does not include the consequences of the disability. CP can be classified according to the type of underlying gross motor impairment, i.e. spastic, dyskinetic and ataxic. In addition, functional classifications should be used, in order to classify children's abilities at the activity and participation level.[3] This follows directly from the recommendations for consistent description of children with cerebral palsy.[4]

The Cerebral Palsy-Communication and Language Learning (CP-CaLL) project is a Dutch longitudinal prospective cohort study of spoken language comprehension development in children with CP and of factors that could influence this development. Children with CP, aged 1;6 to 11 years, subdivided into three cohorts are assessed yearly, over a period of four years.[5] The level of spoken language comprehension is determined by using the Computer Based Instrument for Low Motor Language Testing (C-BiLLT), specifically developed for children with CP.[6] In addition, medical information such as motor type of CP, MRI results, personal and environmental factors and classification of functional abilities are collected.

In the context of the CP-CaLL project, the following systems are applied: the Dutch-language versions of the expanded and revised Gross Motor Function Classification System (GMFCS-E&R, further referred to as GMFCS) for gross motor functioning, the Communication Function Classification System (CFCS) for communication, the Manual Ability Classification System (MACS) for manual functioning, and the English-language version of the Viking Speech Scale (VSS) for speech.[7–10] Except for the VSS, which contains four levels, all classification systems describe five levels of functioning with level I being least affected to level V corresponding to the most severe impairment in functioning (See Table 1 for an overview of the classification systems).

The VSS classifies speech production of children with CP aged four years and above. The level of impairment is determined by the extent to which speech motor abilities influence speech parameters and by the intelligibility of speech (Table 2).[10] At four years of age, children should be intelligible to unfamiliar adults out of context and speech development is usually completed by seven years of age. [11–17] An advantage of the VSS is that it is easy to apply by parents, speech and language therapists (SLTs), and healthcare professionals.[10]

Depending on differences in measurement and outcomes, the estimated prevalence of speech motor problems in children with CP ranges widely from 36% to 90%.[18,19] Despite this

range in numbers, it is demonstrated that motor speech problems are experienced by a considerable percentage of children with CP.[20,21] Speech motor problems are related to speech intelligibility and therefore determine the level of impairment. When speech motor problems increase and intelligibility decreases, participation within the home, school and community becomes more difficult.[10,19] Reduced speech intelligibility is a predictor for restrictive communication patterns and may be related to children's quality of life.[22,23]
It is therefore important to classify speech performance in children with CP. As mentioned above, the VSS is developed for this purpose. Earlier studies demonstrated good reliability and validity of the original English-language version of the VSS and of the versions translated in seven European languages.[10,24] However, a Dutch-language version of the VSS is still not available. As a result, the VSS, although recommended in the Dutch multidisciplinary guideline for children with CP, has not yet been implemented in clinical practice.[25] Therefore a Dutch version of the VSS is warranted.
The only Dutch-language instrument to classify intelligibility of speech is the Intelligibility in Context Scale: Dutch (ICS-NL), a seven-item parent reported scale, assessing children's speech intelligibility in the context with several communicative partners.[26,27] However, this scale is not specifically developed for children with CP. Moreover, the ICS-NL has been developed in such a way that only parents can assess the intelligibility in different contexts. Finally, the ICS-NL only describes intelligibility while the VSS is developed to classify the presence of speech motor problems and describes both intelligibility and speech performance.[10]

1.1 Aim

The main aim of this study is to determine the reliability and validity of the Dutch-language version of the VSS in children with CP. In addition, we investigated the association of the VSS-NL-level with motor type of CP, GMFCS-, CFCS-, and MACS-level.

2. METHODS

2.1. Study design and participants

A prospective, cross-sectional and observational study was conducted.
At the start of their participation in the CP-CaLL project, children were assigned into one of the three age cohorts: 1;6 – 4;0 years (cohort 1), 4;0 – 6;0 years (cohort 2) and 6;0 – 9;0 years (cohort 3). For the current study, children who entered cohorts 2 and 3 were selected. Data collection took place between January 2019 and May 2019. Inclusion criteria were: (1) children aged 4;0 to 10;0 years with a confirmed diagnosis of CP, (2) classified in any

CFCS-, GMFCS- and MACS-level, (3) and at least one parent being a native speaker in Dutch language. Exclusion criteria were children with a history of severe auditory problems (threshold level for the better ear of ≥31 dB), severe visual perceptive problems (visual acuity of <0.3 in the better eye with correction), severe cerebral visual impairment or blindness, and children with metabolic, genetic or other neurological disorders.
The CP-CaLL project was approved by the Medical Ethics committee of the VU University Medical Centre Amsterdam (No. 2017.255). All parents provided written informed consent.

2.2. VSS-NL

The original VSS was translated into Dutch by two teams of independent translators (health professionals) who are Dutch native speakers and have proficiency in technical English. The international guidelines were followed and a back-translation procedure according to the Protocol for Translation of the Viking Speech Scale provided by the original authors, was used.[28,29] The Dutch-language version was discussed on phrasing and terminology (including accuracy, specificity and correct understanding) by two focus groups: one panel of Belgian-Flemish health professionals in the field (not involved in the forward translation) and a panel of parents and caregivers of patients of the target age group. Subsequently, a reverse translation was conducted which was checked and approved by the authors of the original VSS, resulting in a final version for the Dutch-language area, the VSS-NL. (Appendix 1) (https://eu-rd-platform.jrc.ec.europa.eu/sites/default/files/SCPE-NET-Annexes-WP4-Viking-Speech-Scale-NL.pdf)

2.3. Procedure

Each child was classified four times on the VSS-NL by speech language therapist (SLT)1 (researcher), SLT2 (SLT of the child), one parent, and a physiatrist through direct observation during a short conversation of several minutes with a familiar adult in their daily environment. The raters independently filled out a questionnaire including questions on date, name and date of birth of the child and the background of the rater. They were provided with instructions and a description of the VSS-NL and were asked to determine the level of speech production according to this information. Interrater reliability for the VSS-NL was calculated among the four rater groups in pairs: SLT1-SLT2; SLT1-parent; SLT1-physiatrist; SLT1-parent; SLT2-physiatrist; SLT2-parent. To determine intrarater reliability, 14 children were rated again within 2-4 weeks by all raters.
Convergent validity was determined comparing the scores of the ICS-NL, with the level of parent's ratings of the VSS-NL. In order to determine discriminant validity, VSS-NL-levels, as classified by SLT1, were compared with the scores of a dissimilar task, in this case the level

of spoken language comprehension.[30] For this purpose, the Computer-Based instrument for Low motor Language Testing (C-BiLLT) was used, a Dutch spoken language comprehension test specifically developed for children with CP and complex communication needs, standardized for children aged 1;6 to 7;0 years.[6] C-BiLLT test scores acquired within the last six months were included in this study. Comparison between VSS-NL and the C-BiLLT was based on centile scores. A centile score of <3 was defined as a severe delay, a score of 3 to 15 as a mild delay, a score of >15 as no delay in spoken language comprehension. Since the C-BiLLT provides centile scores for children aged 1;6 to 7;0 years, only children up to that age were included in the analysis of the discriminant validity of the VSS.
In addition, information on motor type of CP, GMFCS-, CFCS- and MACS-levels was described, as reported in the child's medical record. The association of the VSS-NL level, as classified by SLT1, with motor type of CP, and level of GMFCS, CFCS and MACS was determined. Motor type of CP was classified according to the guidelines of the Surveillance of Cerebral Palsy in Europe (SCPE) into five groups: 1) spastic unilateral, 2) spastic bilateral, 3) dyskinetic, 4) ataxic, 5) non-classifiable.

2.4. Sample size

A sample size of 50 participants is advised in reliability studies and a minimum of 50 participants is recommended for validation studies in which correlation coefficients are calculated.[31]

2.5. Statistical Analysis

The inter- and intrarater reliability of the VSS-NL were determined by using Cohen's Kappa with linear weighting and 95% confidence intervals (CI). The rater groups were compared in pairs, resulting in six comparisons. Kappa statistics are defined as follows: <0.20, poor; 0.21 to 0.40, slight agreement; 0.41 to 0.60, fair; 0.61 to 0.8, good; 0.81 to 0.91, very good; >0.92, excellent agreement.[32]
We used Spearman's correlation coefficient to determine the association of VSS-NL with 1) ICS-NL, 2) C-BiLLT, 3) motor type of CP, 4) level of GMFCS, CFCS and MACS. Spearman's correlation of <0.20 is defined as very weak, 0.20 to 0.40 as weak, 0.40 to 0.60 as moderate, 0.60 to 0.80 as strong, and ≥0.80 as very strong.[33]
Analyses were performed using SPSS Statistics: version 24.0.[34] A probability level of $p<0.05$ was considered statistically significant.

2.6. Ethics

This study is part of the CP-CaLL project (No. 2017.255). The Medical Ethics Review committee (METC) of VU University Medical Centre concluded that The Medical Research Involving Human Subjects Act (WMO) does not apply to the project (6 June 2017).
The study is conducted according to the principles of the Declaration of Helsinki (64th WMA, 2013) and the General Data Protection Regulation (Algemene verordening gegevensbescherming, AVG).[35,36] Because this study included children, the code of conduct relating to expressions of objection by minors participating in medical research was applicable.[37] Measurements took place in the educational or home environment of the child, were not invasive and were part of usual care.

3. RESULTS

3.1. Participants

Fifty-five children, (32 males, 23 females) aged 4;0 to 10;0 years, (mean 6;03 [SD 1;06]) participated. The characteristics of the participating children are represented in Table 3.

3.2. Reliability of the VSS-NL

The interrater reliability for the six rater groups was: excellent agreement between SLTs1-SLTs2 (weighted *k*=0.926, 95% CI 0.864-0.988), good agreement between SLTs1-parents (weighted *k*= 0.669, 95% CI 0.530-0.807), SLTs1-physiatrists (weighted *k*= 0.679, 95% CI 0.558-0.801), SLTs2-parents (weighted *k*= 0.707, 95% CI 0.568-0.847), SLTs2-physiatrists (weighted *k*= 0.743, 95% CI 0.628-0.858), and parents-physiatrists (weighted *k*= 0.729, 95% CI 0.598-0.860) (Table 4a-f).
The intrarater reliability was excellent for SLTs1 and SLTs2 (*k*=1.000), very good for physiatrists (*k*=0.891, 95% CI 0.750-1.033), and good for parents (*k*=0.783, 95% CI 0.545-1.021) (Table 5a-d).

3.3. Validity of the VSS-NL

Convergent validity, as investigated with the ICS-NL, showed a significant negative strong correlation (*r*= -0.801, p=0.000). Discriminant validity, as investigated with the C-BiLLT (n=38), showed a significant negative moderate correlation (*r*= -0.519 p=0.003) (Table 6).

3.4. Association of the VSS-NL level with motor type of CP, levels of GMFCS, CFCS, and MACS.

A significant positive moderate correlation was found between the levels of VSS-NL and (1) motor type of CP (r=0.467, p=0.002), (2) GMFCS-levels (r=0.529, p=0.000), (3) CFCS-levels (r=0.562, p=0.000), and (4) MACS-levels (r=0.500, p=0.002) (Table 6).

4. DISCUSSION

In this study, the VSS was translated into Dutch following the international guidelines and using a back-translation procedure. We determined the reliability and the validity of the VSS-NL. In addition, the association between the level of VSS-NL and motor type of CP, GMFCS-, CFCS-, and MACS-level was determined.

Reliability of the VSS-NL

The interrater reliability was excellent between the SLTs unfamiliar (SLTs1) and those familiar with the child (SLTs2). Our results are in line with Hustad et al. (2016), who detected a very good agreement among SLTs assessing speech. In their study, no distinction was made in the familiarity with the child.[38] The high levels of agreement among SLTs, might be explained by the fact that SLTs are experienced and trained in assessing performance of speech. Our results indicate that speech of children with CP using the VSS-NL, can be classified either by SLTs familiar or unfamiliar with the child.

Agreement was good for all other rater groups. These findings are in line with previous studies in which the interrater reliability ranged from fair to very good.[10,36]

In the original study of the VSS by Pennington et al. 2013, the reliability for classifications based on case notes was higher than for those based on direct observation. Classifications based on direct observation must be performed immediately while case notes can be re-read and allow time for reflection which may be an advantage. Nevertheless, the current study demonstrated good agreement in classifications through direct observation. This indicates that the VSS-NL can be used reliably through direct observation by SLTs (familiar and unfamiliar with the child), parents and physiatrists.

The good reliability of the VSS-NL is in line with the results of Virella et al. 2016. They compared three systems for classification of communication in children with CP: VSS, CFCS and Functional Communication Classification System (FCCS). The VSS showed the highest level of agreement and was the most easy to apply. It is for this reason that the Surveillance of Cerebral Palsy in Europe (SCPE) included only the VSS to classify speech (as a form of expressive communication) in their register for surveillance purposes.[24]

In accordance with literature, we found excellent to good intrarater reliability for all rater groups.[10,39] These findings demonstrate that measurements by the same rater are consistent over time and thereby confirm the reliability of the VSS-NL.

Validity of the VSS-NL

The strong correlation between ICS-NL and VSS-NL indicates that they both measure intelligibility of speech reflecting the convergent validity of the VSS-NL. A most recent study of Pennington et al, 2019, determined that speech intelligibility scores were predictive for VSS-levels, thereby confirming the construct validity of the VSS.[40]

The use of the VSS-NL contains some advantages over the ICS-NL. First, the VSS-NL is developed to classify the presence of speech motor problems and describes both intelligibility and speech performance. Second, it can be applied by SLTs, healthcare professionals and parents. Finally, in the VSS-NL, an extensive description of the speech is given for all levels, while in the ICS-NL the degree of intelligibility is reflected in one word (always, usually, sometimes, rarely or never). Consequently, the VSS-NL is the most appropriate system to classify speech performance in children with CP.

The moderate correlation found between the C-BiLLT (language comprehension) and the VSS-NL (speech performance) may reflect the complexity of the interaction between speech motor skills and language impairment. The interaction between these two domains remains complicated and is not yet fully understood.[38,41] In children with CP, motor impairments may lead to speech motor problems or absence of speech. However, speech motor problems are not necessarily responsible for impaired language comprehension. In fact, studies have shown that non-speaking children with CP can develop adequate language comprehension skills even in the absence of speech.[42–44] It is therefore recommended to assess both speech performance and spoken language comprehension in children with CP.

In line with literature, the strong convergent validity and moderate discriminant validity of the recent study confirm the construct validity of the VSS-NL.[40]

Associations with motor type of CP, GMFCS, CFCS and MACS

Concerning motor type of CP, studies reported that motor speech impairment was significantly related to the subtype of CP and more common in bilateral spastic CP and dyskinetic CP compared to unilateral spastic CP.[18,45] In our sample, children with bilateral spastic CP were most represented with 52%, unilateral spastic CP with 33% and dyskinetic CP with 7%. This might explain the moderate associations between the VSS-NL and motor type of CP. In order to make a stronger statement about the association between motor type of CP and VSS, it is therefore recommended to compare the distribution of VSS-levels across subtypes. However, this analysis was not within the scope of the current study.

The moderate correlation found between VSS-NL and GMFCS is in line with previous studies.[39,46] It was concluded that gross motor function did not play a significant role for speech motor function. However, in these studies, as in ours, the percentage of children with GMFCS V was relatively low. There are indications though, that particularly children with the highest GMFCS-levels have an increased risk of oral motor impairment.[18] In addition, in children with dyskinetic CP, a strong correlation between GMFCS and VSS was found.[45] Speech production is underpinned by motor processes and it is therefore obvious that children in the dyskinetic group exhibit severe limitations in speech production resulting in high correlations between the VSS and GMFCS in this group.
In summary, it appears that measuring gross motor functioning is not sufficient to predict a child's speech motor functioning. This underlines the importance to classify speech performance in children with CP.

In addition, we found a moderate association between VSS-NL and CFCS. Similar findings were reported in a study with children with dyskinetic CP.[45] In contrast, two studies found a very strong association.[19,46] In the sample of Choi et al. (2018 b), bilateral spastic CP, in which speech motor problems are more common, was overrepresented with almost 80%.[46] Bilateral spastic CP is the most heterogeneous subtype including children with diplegia, as well as children with quadriplegia. However, this distinction is not reflected in the classification according to the guidelines of the SCPE. By applying the classification of the SCPE, the percentage of children with diplegia remains unknown. It is most likely though, that children with diplegia, with predominant involvement of the legs, will experience less difficulties in speech performance or communication.[47] Following the classification of the SCPE causes uncertainty about the characteristics of the samples and restricts the comparison of studies. This limitation is indeed already a topic for discussion in literature and the current study emphasizes the importance to address this problem.[47]
Speech, language and communication interact very closely and speech motor impairment is reflected to some degree in both VSS and CFCS.[46] Nevertheless, neither CFCS nor VSS captures both speech performance and communication ability. Thus, the use of both classification systems is needed to comprehensively describe speech performance and communication ability in children with CP.

In the current study, a moderate relation was found between VSS-NL and MACS (r=0.50) which was confirmed by one study.[39] In contrast, Choi et al. (2018 b) and Monbaliu et al.

(2017) reported strong and moderate to strong relations respectively.[45,46] However, as mentioned before, the association between the VSS-NL and MACS in those studies may be affected by the distribution of subtypes and the severity of CP.
To summarize, the differences in samples used in studies with regard to motor type and severity of CP emphasize the heterogeneity of CP and may affect the association between VSS and other functional classification systems.

Strengths and limitations
The first strength of our study is the sample which is representative in terms of age, motor type and severity of CP. Furthermore, participants were recruited throughout the Netherlands, which increases generalizability. Second, the reliability was thoroughly examined between four rater groups. Finally, this study responds to the call of Pennington et al. 2013, to investigate the reliability and validity of the VSS across countries and languages.[10] Our results are in line with the SCPE-guideline which states that the VSS is a reliable and valid system to classify speech performance in children with CP and can be applied for international surveillance.[48]
This study also comprises some limitations. The first limitation is the relatively small sample size. However, the results show small confidence intervals thereby confirming the accuracy of the measurements. Finally, it was intended that all children would be assessed by direct observation. Due to lack of time on the physiatrist's side, it cannot be ruled out that some classifications were based on case notes. Nevertheless, literature shows that both classifications methods are reliable and we assume it has not affected the results.

Further research
Levels of GMFCS and MACS in children with CP usually remain stable over time but the stability of the VSS has not been examined yet.[49,50] The VSS classifies speech production of children with CP aged four years and above. However, at four years of age, speech development is not yet completed. It is not clear to what extent the maturation of speech leads to changes in VSS-NL levels and how frequently speech performance should be reclassified. Another aspect that needs further investigation is whether the VSS-NL is able to detect clinically important changes after an intervention.[51,52] Currently, the CP-CaLL project is being conducted. In the context of this project the speech development of children with CP is investigated using the VSS-NL. The results may reveal some of the issues concerning stability, reclassification, and responsiveness of the VSS-NL.

Because the Eating and Drinking Ability Classification System (EDACS) is not included in the CP-CaLL project, the association between VSS-NL and the EDACS was not investigated.

However, speech motor- and eating and drinking abilities may well be associated as they both rely on oral-motor skills. A strong relationship between VSS and EDACS has previously been confirmed.[53] Further research could focus on the extent to which these two scales complement or overlap each other. It is intended to include the EDACS in the CP-CaLL project in the near future thereby creating the possibility to investigate its relationship with the VSS-NL.

5. CONCLUSION

The great similarities between our results and the findings in previous studies imply that the VSS-NL is a reliable and valid system to classify speech performance in children with CP in the Dutch language area. Classifications can be reliably performed by SLTs who are familiar or unfamiliar with the child, but also by parents and physiatrists. Implementation of the VSS-NL enables healthcare professionals and parents to communicate in a uniform way about the child's speech performance. In addition, wider use of the VSS-NL can make an important contribution to consistent classification of children with CP and appliance for international surveillance.

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Appendix 1. Tables

Table 1. *Levels of functioning of classification systems*

	Level I	Level II	Level III	Level IV	Level V
GMFCS-E&R	Walks without limitations	Walks with limitations	Walks using a hand-held mobility device	Self-mobility with limitations: May use powered mobility	Transported in a manual wheelchair
CFCS	Effective sender and receiver with unfamiliar and familiar partners	Effective but slower sender and/or receiver with unfamiliar and/or familiar partners	Effective sender and receiver with familiar partners	Inconsistent sender and/or receiver with familiar partners	Seldom effective sender and receiver even with familiar partners
MACS	Handles objects easily and successfully	Handles most objects but with somewhat reduced quality and/or speed of achievement	Handles objects with difficulty; needs help to prepare and/or modify activities	Handles a limited selection of easily managed objects in adapted situations	Does not handle objects and has severely limited ability to perform even simple actions

Note: GMFCS-E&R=General Motor Function Classification System Expanded and Revised, MACS=Manual Ability Classification System, CFCS=Communication Function Classification System

Table 2. *Levels of speech production of the Viking Speech Scale*

	Level I	Level II	Level III	Level IV
VSS	Speech is not affected by motor disorder	Speech is imprecise but usually understandable to unfamiliar listeners	Speech is unclear and not usually understandable to unfamiliar listeners out of context	No understandable speech

Note: VSS=Viking Speech Scale

Table 3: *Characteristics of the participants*

Variables	Number of participants (percentage)	Missing
Male; Female	32 (58%); 23 (42%)	
Mean age in years [SD]	6.03 [1.06],	
Age range	4.0-10.0	
GMFCS	I: 8 (18%); II: 14 (30%); III: 7 (15%); IV: 13 (28%); V: 4(9%)	9
CFCS	I: 8 (18%); II: 10 (22%); III: 10 (22%); IV: 16 (36%); V: 1(2%)	9
MACS	I: 5 (14%); II: 13 (35%); III: 12 (32%); IV: 6 (16%); V: 1(3%)	9
Type of CP: unilateral spastic bilateral spastic dyskinetic ataxic non-classifiable	 14 (33%) 22 (52%) 3 (7%) 0 (0%) 3 (7%)	13

Note: GMFCS-E&R=General Motor Function Classification System, MACS=Manual Ability Classification System, CFCS=Communication Function Classification System; CP: cerebral palsy.

Table 4: *Interrater reliability of the VSS-NL.*

(a)		SLT2				
		I	II	III	IV	Total
SLT1	I	16	1	0	0	17
	II	2	12	0	0	14
	III	0	0	7	0	7
	IV	0	0	2	12	14
	Total	18	13	9	12	52

(a) SLT1-SLT2 (weighted K=0.926, 95% CI 0.864-0.988);

(b)		Parent				
		I	II	III	IV	Total
SLT1	I	10	6	0	0	16
	II	5	8	0	0	13
	III	1	1	4	0	6
	IV	0	1	4	8	13
	Total	16	16	8	8	48

(b) SLT1-Parent (weighted K= 0.669, 95% CI 0.530-0.807);

(c)		Physiatrist				
		I	II	III	IV	Total
SLT1	I	7	8	0	0	15
	II	5	6	2	0	13
	III	0	2	5	0	7
	IV	0	0	3	11	14
	Total	12	16	10	11	49

(c) SLT1-Physiatrist (weighted K= 0.679, 95% CI 0.558-0.801);

(d)		Parent				
		I	II	III	IV	Total
SLT2	I	10	6	0	0	16
	II	4	8	0	0	12
	III	1	1	6	0	8
	IV	0	1	2	8	11
	Total	15	16	8	8	47

(d) SLT2-Parent (weighted K= 0.707, 95% CI 0.568-0.847);

(e)		Physiatrist				
		I	II	III	IV	Total
SLT2	I	9	8	0	0	17
	II	3	6	2	0	11
	III	0	2	7	0	9
	IV	0	0	1	11	12
	Total	12	16	10	11	49

(e) SLT2-Physiatrist (weighted K=0.743, 95% CI 0.628-0.858);

(f)		Physiatrist				
		I	II	III	IV	Total
Parent	I	10	4	0	0	14
	II	2	9	3	1	15
	III	0	1	6	2	9
	IV	0	0	1	7	8
	Total	12	14	10	10	46

(f) Parent-Physiatrist (weighted K=0.729, 95% CI 0.598-0.860)

Note: CI= confidence interval, SLT1= speech language therapist-researcher, SLT2= speech language therapist of the child

Table 5: *Intrarater reliability of the VSS-NL.*

(a)		T2 SLT1				
		I	II	III	IV	Total
T1 SLT1	I	6	0	0	0	6
	II	0	3	0	0	3
	III	0	0	1	0	1
	IV	0	0	0	4	4
	Total	6	3	1	4	14

(a) T1 SLT1-T2 SLT1 (weighted K=1.000)

(b)		T2 SLT2				
		I	II	III	IV	Total
T1 SLT2	I	6	0	0	0	6
	II	0	3	0	0	3
	III	0	0	1	0	1
	IV	0	0	0	4	4
	Total	6	3	1	4	14

(b) T1 SLT2-T1 SLT2 (weighted K=1.000)

(c)		T2 Physiatrist				
		I	II	III	IV	Total
T1 Physiatrist	I	3	2	0	0	5
	II	0	3	0	0	3
	III	0	0	2	0	2
	IV	0	0	0	4	4
	Total	3	5	2	4	14

(c) T1 Physiatrist-T2 Physiatrist (weighted K=0.891, 95% CI 0.750-1.000)

(d)		T2 Parent				
		I	II	III	IV	Total
T1 Parent	I	3	0	0	0	5
	II	0	3	1	0	4
	III	0	0	1	0	1
	IV	0	0	0	2	2
	Total	3	5	2	2	12

(d) T1 Parent-T2 Parent (weighted K=0.783, 95% CI 0.545-1.000)

Note: CI= confidence interval, SLT1= speech language therapist-researcher, SLT2= speech language therapist of the child

Table 6: *Correlation between VSS-NL and C-BiLLT, ICS-NL, motor type of CP, GMFCS, CFCS and MACS*

	VSS-NL	
	Correlation	p-value
C-BiLLT	-0.519	0.003
ICS-NL	-0.801	0.000
Motor type of CP	0.467	0.002
GMFCS	0.529	0.000
CFCS	0.562	0.000
MACS	0.500	0.002

Note: VSS-NL Viking Speech Scale: Dutch; C-BiLLT: Computer Based Instrument for Low Motor Language Testing; ICS-NL: Intelligibility in Context Scale: Dutch; CP: Cerebral Palsy; GMFCS Gross Motor Function Classification System; MACS Manual Ability Classification System; CFCS Communication Function Classification System;

Appendix 2. Viking Speech Scale – Dutch

Viking Speech Scale, 2010©

Lindsay Pennington, Tone Mjøen, Maria da Graça Andrada, Janice Murray

(Nederlandse vertaling: Irene Spaans, Maaike de Kleijn, Emma Vaillant & Joke Geytenbeek, met dank aan de Belgische focusgroep Els Ortibus, Nathalie Rommel, Greet Gelin & Katrijn Miermans)

Doel

Deze classificatieschaal is ontwikkeld om de spraakproductie van kinderen te classificeren. Het gemak waarmee kinderen zichzelf kunnen uiten met gebruik van andere communicatiemethoden wordt met behulp van andere schalen gescoord.

Spraakproductie is afhankelijk van de controle en coördinatie van verschillende lichaamsfuncties, waaronder ademhaling en ademcontrole, fonatie (het trillen van de stembanden tijdens het spreken waardoor er stemgeving is) en de beweging van de lippen en de tong voor de articulatie. Motorische stoornissen bij cerebrale parese kunnen van invloed zijn op de afzonderlijke functies, wat leidt tot verschillende spraakpatronen (bijvoorbeeld: verminderde ademcontrole kan leiden tot problemen met het controleren van het spreekvolume; afwijkende beweeglijkheid van de stembanden wordt geassocieerd met een hese of schorre stem; door verminderde articulatie is het onmogelijk bepaalde medeklinkers te produceren etc.). De mate waarin deze functies zijn aangedaan varieert sterk van kind tot kind. We weten dat de spraakfuncties adequaat zijn als de woorden door luisteraars correct worden verstaan. Hoewel verstaanbaarheid strikt genomen een maat is voor activiteit (het overbrengen van een boodschap) is het direct gerelateerd aan de functie van spraak en kan het helpen bij het maken van onderscheid tussen de verschillende niveaus van beperking.

De Viking Speech Scale is ontwikkeld voor het gebruik bij kinderen van 4 jaar en ouder.

De classificatieschaal heeft vier niveaus. Kinderen met cerebrale parese die op niveau I worden ingedeeld, hebben geen of nauwelijks problemen in de spraakproductie in vergelijking met zich normaal ontwikkelende kinderen. De spraakontwikkeling is meestal voltooid op de leeftijd van zeven jaar. Op de leeftijd van vier jaar zouden kinderen die een normaal spraakontwikkelingspatroon volgen verstaanbaar moeten zijn voor onbekende volwassenen buiten de context. Zij hebben geen problemen met het reguleren van de luidheid van de spraak; hun spraak klinkt niet open- of gesloten nasaal (alsof ze verkouden zijn); hun stem klinkt helder, niet schor en ze kunnen, net als volwassenen, een passend intonatiepatroon gebruiken in een gesprek. Kinderen van vier tot zes jaar mogen echter nog enkele onvolkomenheden in de spraak hebben. Ze vervangen sommige medeklinkers (bijvoorbeeld: ‘r’ wordt ‘l’) en laten onbeklemtoonde lettergrepen weg (bijvoorbeeld: ‘tefoon’ in plaats van ‘telefoon’)

De schaal is ordinaal. Het is niet de verwachting dat de verschillen tussen de niveaus gelijkmatig verdeeld zijn, of dat kinderen gelijkmatig over de niveaus verdeeld zullen zijn.

Instructie

Vul de informatie in het onderstaande vak in.

Lees hieronder de beschrijvingen van de spraak van kinderen. Omcirkel op pagina 3 het niveau dat de spraak van het kind het beste beschrijft.

Beoordeel de **gebruikelijke** spraak van het kind, met andere woorden beoordeel de manier waarop het kind gewoonlijk spreekt en niet hoe het kind zou kunnen spreken.

Scoor het niveau waarop het kind verstaanbaar is **voor vreemden en onbekende gesprekspartners**. Bekenden van het kind (zoals ouders, leerkrachten) zijn vertrouwd met de spraak van het kind, herkennen woorden op basis van eerder gebruik in de context en kunnen het kind beter verstaan dan de meeste andere luisteraars.

Beschrijvingen van de spraak

I. De spraak wordt niet beïnvloed door de motorische stoornis.

Kinderen op Niveau I volgen het normale patroon van spraakontwikkeling. Ze kunnen enkele onvolkomenheden van de spraak vertonen, vergelijkbaar met andere kinderen van dezelfde leeftijd of met hetzelfde ontwikkelingsniveau.

Bij kinderen op Niveau II wordt de spraak beïnvloed door de motorische stoornis. Hoewel de spraak meestal verstaanbaar is, verloopt de spraakontwikkeling afwijkend en klinkt de spraak anders dan bij kinderen van dezelfde leeftijd of met hetzelfde ontwikkelingsniveau.

II. De spraak is onnauwkeurig maar meestal verstaanbaar voor onbekende luisteraars.
De luidheid van de spraak is voldoende voor een één-op-één gesprek. De stem kan hees of schor klinken, maar dit beïnvloedt de verstaanbaarheid niet. De articulatie is onnauwkeurig: de meeste medeklinkers worden geproduceerd, maar de articulatie verslechtert bij langere uitingen. Hoewel deze moeilijkheden opvallen, is de spraak meestal verstaanbaar voor onbekende luisteraars **buiten de context**.

Bij Kinderen op Niveau II wordt de spraak beïnvloed door hun motorische stoornis. De spraak klinkt misschien zwak, log, onduidelijk of de luidheid is niet aangepast aan de situatie, maar de spraak is doorgaans verstaanbaar zonder aanwijzingen uit de context.

Bij Kinderen op Niveau III wordt de spraak in meerdere functies ernstig beïnvloed door hun motorische stoornis (bijvoorbeeld: ademcontrole, beweging van de stembanden/stem, articulatie). De ernstige moeilijkheden die de kinderen hebben om elke functie te beheersen zorgen er samen voor dat de spraak van het kind erg moeilijk verstaanbaar is zonder aanwijzingen uit de context.

III. De spraak is onduidelijk en meestal niet verstaanbaar voor onbekende luisteraars buiten de context.

Moeite met de ademcontrole die nodig is voor de spraak – kan één woord per uiting produceren en/of de spraak is soms te hard of juist te zacht om verstaanbaar te zijn. De stem kan schor klinken, de toonhoogte kan plotseling veranderen. De spraak kan opvallend hypernasaal zijn. Er wordt een zeer beperkt aantal medeklinkers geproduceerd. Door de ernst van de problemen is de spraak moeilijk verstaanbaar buiten de context.

Kinderen op Niveau III gebruiken spraak als middel om te communiceren. Hun spraak kan verstaanbaar zijn voor onbekende volwassenen wanneer ze in losse woorden spreken. Wanneer ze in langere zinnen spreken, zijn er slechts enkele woorden verstaanbaar.

Kinderen op Niveau IV kunnen klanken produceren, maar kunnen geen woorden of woordbenaderingen produceren die onbekende luisteraars buiten de context kunnen verstaan.

IV. Geen verstaanbare spraak

Lees hierboven de beschrijvingen van de spraak van de kinderen. Omcirkel het niveau dat de spraak van het kind het beste beschrijft.

I. De spraak wordt niet beïnvloed door de motorische stoornis.

II. De spraak is onnauwkeurig maar meestal verstaanbaar voor onbekende luisteraars.

III. De spraak is onduidelijk en meestal niet verstaanbaar voor onbekende luisteraars buiten de context.

IV. Geen verstaanbare spraak.

Naam van het kind ……

Geboortedatum ……

Ingevuld door ……

Relatie tot het kind ……

Datum van classificatie ……