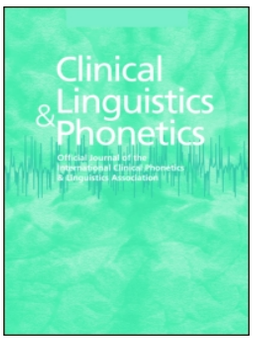

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The feasibility of assessing speech and non-speech function of the speech apparatus in adults with cerebral palsy

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ABSTRACT

This short note reports on observations concerning the *feasibility* of a set of speech and non-speech assessment tasks in an investigation of dysarthria in 21 adults (15 males/6 females; median 23 years) with cerebral palsy and concomitant cognitive impairment. The participants were assessed with nine tasks representing standard components of clinical dysarthria assessment (i.e. six speech and three non-speech tasks). The tasks were evaluated for their feasibility on the basis of common clinical criteria. Our results indicated that, overall, speech tasks were more feasible than non-speech tasks. Several participants showed signs of dysexecutive behaviour on some of the non-speech tasks, but not on the speech tasks. The current note provides tentative clues regarding the impact of cognitive deficits on the feasibility of assessment tasks in the diagnosis of dysarthria.

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Dysarthria; assessment; non-speech tasks; feasibility; cerebral palsy

Introduction

The relative importance of *non-speech tasks* involving the speech apparatus (e.g. single articulator movements and fast syllable repetition) in the assessment of dysarthria has been subject to long-standing discussions (e.g. Ballard et al., 2009; Maas, 2016; Weismer, 2006; Ziegler & Ackermann, 2013). Several authors raised issues concerning the validity of such tasks as predictors of speech motor function (Bunton, 2008; Ziegler, 2003). More recently, two studies of our group revealed dissociations between speech and non-speech oral movement rate measures in neurological patients of different aetiologies and thereby provided further empirical support for a sceptical view on the validity of such tasks as measures of speech impairment (Staiger, Schölderle, Brendel, Bötzel, & Ziegler, 2017a; Staiger, Schölderle, Brendel, & Ziegler, 2017b). As a methodological side-note of these papers, an unexpected finding regarding the *feasibility* of standard speech and non-speech assessment tasks was mentioned: In a substantial number of individuals with neurological disease, i.e. 32 out of 130, missing values resulting from an inability to meet task requirements were reported. Most interestingly, the vast majority of missing trials occurred in the two non-speech tasks administered in these studies. Among the six aetiological groups reported by Staiger and colleagues, the missing trials most often occurred in adults diagnosed with cerebral palsy (CP).

It is uncontroversial that non-speech tasks represent an indispensable instrument for specific diagnostic purposes, e.g. the assessment of cranial nerve function or the diagnosis

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of oral-facial apraxia. Yet, this short report deals with the use of such tasks as standard components of clinical speech assessment batteries. As a matter of fact, such tasks are implemented in virtually every known standard dysarthria assessment instrument, e.g. *Frenchay Dysarthria Assessment* by Enderby and Palmer (2012), *Dysartrieonderzoek* by Knuijt and Kalf (2007), *Untersuchung neurologisch bedingter Sprech-und Stimmstörungen* by Breitbach-Snowdon (2003), *Batterie d´Evaluation Clinique de la Dysarthrie* by Auzou and Rolland-Monnoury (2012) and *Motor Speech Disorder Assessment* by WEVOSYS (2010). One of the reasons why clinicians use non-speech tasks for the evaluation of speech is that they permit testing of the speech motor system without imposing the cognitive-linguistic demands that come along with speech tasks (Ballard, Robin, & Folkins, 2003; Folkins et al., 1995; Kent & Kent, 2000; Wang, Kent, Duffy, Thomas, & Weismer, 2004). In particular, these demands may have motivated several authors to explicitly recommend non-speech tasks for dysarthria assessment of individuals with CP (e.g. Crary, 1995; Thoonen, Maassen, Wit, Gabreels, & Schreuder, 1996; Wit, Maassen, Gabreels, & Thoonen, 1993), a neurological condition that is characterised by a particularly high incidence of cognitive deficits (Bottcher, 2010; Fennell & Dikel, 2001; Novak, Hines, Goldsmith, & Barclay, 2012).

Yet, considering the high incidence of missing trials in the CP subgroup included in the aforementioned studies by Staiger and colleagues, one may ask if this argument is actually valid, i.e. if individuals with CP indeed have more trouble with speech (e.g. text reading and sentence repetition) than with the allegedly more simple non-speech tasks.

In this note, we expand on these concerns by reporting further observations related to task *feasibility*. For this purpose, we (re-)analysed the assessment tasks employed in two previous studies (Staiger et al., 2017a, 2017b), complementing them by still unpublished feasibility data from several additional speech and non-speech tasks. We aim to obtain first evidence if speech tasks are less feasible than non-speech tasks in adults with cognitive impairment due to CP. Moreover, we will provide tentative clues regarding the cognitive deficits possibly underlying feasibility limitations in dysarthria assessment.

Methods

The procedures reported here were part of a more comprehensive investigation of speech and non-speech activities of the speech apparatus. This investigation, which stipulated the administration of an assessment battery of a total of 15 speech and non-speech tasks, formed the basis for both the studies mentioned earlier (Staiger et al., 2017a, 2017b) and the current report. The ethics committee of the medical school of the Ludwig-Maximilians-University, Munich, Germany, approved all experimental procedures. Participants or their carers gave informed consent for participation in the study.

Participants

All the participants involved in the current report had a confirmed diagnosis of CP (different subtypes, see Table 1). We only included individuals who used speech as their primary communication mode (with or without supportive Augmentative and Alternative Communication (AAC) devices) and were capable of sustaining a 60 min assessment (for further inclusion criteria, we refer to Staiger et al., 2017b). From the CP group reported in

Table 1. Participants with cerebral palsy: demographic and clinical data.

	group data (n = 21)
Age (median, range)	23, 19–56 years
Gender (male, female)	15, 6
CP type (*n*)	
Spastic	16
Dyskinetic	3
Mixed spastic–dyskinetic	2
GMFCS level (*n*)	
I	1
II	0
III	4
IV	13
V	3
Severity of dysarthria (median, range[1])	2.7, 1.4–3.7
Percentage intelligibility (median, range[2])	76.2, 0.7–97.5
Naturalness (median, range[3])	3.5, 1.5–4.8

[1]Mean scores over nine ratings of functional dimensions on 5-point scales (0 = *very severe disorder*, 4 = *no disorder*).
[2]Measured by a sentence transcription task reported in Schölderle et al. (2016).
[3]Relative to a 5-point scale (1 = *very unnatural*, 5 = *completely natural*), see Schölderle et al. (2016).

previous investigations, we excluded one person who did not complete all relevant assessment tasks due to schedule difficulties, resulting in a final sample of 21 individuals. Table 1 lists the demographic and clinical data. As can be seen from the Gross Motor Function Classification System (GMFCS) scores (Palisano et al., 1997), the majority of participants had a severe form of CP. The severity of dysarthria, which had been assessed through expert ratings on nine dysarthria scales (according to the BoDyS protocol, see Ziegler, Staiger, Schölderle, & Vogel, 2017), ranged from very mild to severe. Moreover, measures of speech intelligibility and naturalness also pointed at a broad range of speech impairments in this sample (see Table 1).

The participants were referred from a centre specialised in treating individuals with CP and other motor disabilities. All of them had a diagnosis of a 'cognitive disability'. In the German health system, this diagnosis is exclusively made in individuals with an Intelligence quotient (IQ) score of <70 (in line with ICD-10 criteria). The exact results of the participants' IQ tests, however, were not available at the time of our study. Only three of the participants were able to complete a vocational training that was particularly adapted to the special needs of adults with cognitive deficits, while all of the others visited sheltered workshops for persons with multiple disabilities. All participants had adequate hearing and at most minor visual deficiencies.

Assessment tasks and feasibility criteria

We will report on nine tasks (three of them were part of the studies by Staiger and colleagues), most of which represent standard components of clinical dysarthria assessment. Six of them were speech tasks (*conversational speech, sentence repetition, description of a picture story, text reading, supported reading* and *word repetition*), three were non-speech tasks (*rapid syllable repetition, single articulator movements* and *repetitive articulator movements*).

In clinical assessment, these tasks serve to evaluate specific parameters of vocal tract function. *Rapid syllable repetition*, for instance, is examined to analyse the target parameter *maximum articulation rate*. Accordingly, *feasibility* was defined as the potential to

elicit responses that allow for a satisfactory analysis of the specific target parameter of each task.[1] Since there are no universally accepted criteria for when this precondition is fulfilled (e.g. how many trials of *rapid syllable repetition* are required to estimate *maximum articulation rate* reliably?), we applied rather conservative feasibility criteria that were assumed to reflect common practice in clinical assessment (e.g. one trial of each task/subtask is sufficient). In the following, we will shortly describe the tasks and outline their respective feasibility criteria. Details concerning recording techniques and analysis methods, which are of minor relevance here, can be looked up in Staiger et al. (2017a, 2017b). All the tasks were administered by the same examiner.

The first four tasks represent subtests of a German assessment tool for dysarthria, the *Bogenhausen Dysarthria Scales* (BoDyS, see Schölderle, Staiger, Strecker, Lampe, & Ziegler, 2016; Ziegler et al., 2017):

Conversational speech (CONV): Speech was elicited by semi-structured interview questions inquiring on leisure activities.

Sentence repetition (SENT): We asked the participants to repeat five sentences varying in length (4–12 syllables) and mode (declarative and interrogative) after auditory presentation.

Picture story (PICT): Speech was elicited by a cartoon consisting of four pictures.

Text reading (READ$_{Text}$): Participants were required to read out a standard text of approximately 90 words.

Following a traditional diagnostic approach (Darley, Aronson, & Brown, 1969; Duffy, 2013), speech samples such as those provided by the BoDyS (e.g. text reading and conversational speech) are elicited to permit comprehensive auditory evaluations of speech. Hence, each of the BoDyS tasks was considered *feasible* in a speaker, if the elicited speech sample allowed for judgments on all relevant speech dimensions (i.e. *respiration, voice, articulation and resonance* and *prosody*). As regards ratings on respiration and prosody, this implied that at least short passages of continuous speech (approximately 2–3 intonation phrases) were produced.

Supported reading (READ$_{Support}$): Since a relevant number of participants were expected to experience problems with *Text reading*, we additionally examined a *Supported reading* task. A shorter text (74 words) was designed avoiding complex syntax and unfamiliar words. We split the text into six passages of 2–3 intonation phrases each. In order to alleviate reading and working memory requirements, each individual passage was presented simultaneously as written text on a screen and auditorily over loudspeakers.

Similar to the BoDyS tasks, READ$_{\text{Support}}$ was administered for the purpose of comprehensive auditory analyses. Hence, the task was considered *feasible* in a participant if the recordings allowed for such evaluations. Again, since this included ratings of respiratory and prosodic parameters, the participants had to produce the passages continuously without interruptions related to reading difficulties.

Word repetition (WORD): The word repetition task contained 48 two-syllabic words that were systematically varied regarding six phonetic parameters (voicing, place of

[1]This criterion was also applied in Staiger et al. (2017a, 2017b) – their 'missing trials' accordingly match to what is defined here as non-feasible.

articulation, etc.). We instructed participants to repeat the stimuli after auditory presentation.

The phonetic target parameters addressed with this task can only be analysed if a participant repeats the target words as stipulated (i.e. no paraphasias, neologisms or null responses; self-corrections and re-starts were allowed). The WORD task was considered *feasible* in a participant if this was the case in at least half (24/48) of her/his responses.

Rapid syllable repetition (RSR): Two non-alternating ('*bababa*…', '*dadada*…') and one alternating syllable sequence ('*badabada*…') were assessed. We instructed the participants to repeat the syllables as fast as possible, but still precisely. Each sequence was administered in two trials.

The target parameter usually addressed by RSR tasks is maximum articulation rate. To determine this variable, a sufficiently long, uninterrupted string of repeated syllables is required (Ziegler, 2002). We considered the RSR task *feasible* in a participant, if a string of at least six consecutive syllables not interrupted by an inspiration was available for at least one trial of each sequence.

Single articulator movements (SAM): We administered a set of 24 movements typically employed in common dysarthria assessment batteries (e.g. 'purse your lips', 'open your mouth'; see for instance Enderby, 2004). The items were elicited on imitation, and the responses were video-recorded. Each item was assessed in one trial.

Tasks of this type usually serve to evaluate articulator movements with regard to strength, symmetry, rate and precision. Accordingly, an item was discarded if no attempt to move the addressed articulator was visible, e.g. in null responses, substitutions or perseverations.[2] Moreover, items were discarded if the participant´s reaction was not visible (neither on the video nor during the actual examination) due to disease-related phenomena (e.g. hyperextension of the neck and involuntary body movements). The SAM task was considered *feasible* in a participant if at least half of the items (12/24) were available.

Repetitive articulator movements (RAM): Two tasks were elicited: *waving the tongue between the corners of the mouth* and *alternately pursing and spreading the lips*. We instructed the participants to perform these movements as fast as possible but still accurately. Each of the two subtasks was elicited on imitation, and the responses were video-recorded. Two trials were administered for each task.

Since assessment tasks of the RAM type aim to examine the coordination, regularity and the rate of articulator movements under the condition of rapid alternations of movement direction, a trial was discarded from the analyses if no definite (at least attempted) movement alternation was visible. Moreover, individual trials were discarded if a participant showed null responses, perseverations or substitutions of one of the movement components. Again, the restricted visibility of the participant's response on the video due to disease-related motor problems was a further exclusion criterion. The RAM task was classified as *feasible* in a participant if at least one trial of each of the two subtasks was available.

Based on the criteria thus specified, all the assessment tasks were classified as *feasible* or *non-feasible* for each participant. Importantly, assistance through enlarged pictures/fonts, multiple presentations of stimuli and simplified instructions were always provided if

[2]Note that a most severely disordered execution of a movement was not interpreted as a null response.

required and did not lead to the classification as *non-feasible* as long as the requested response could be elicited.

Results

Four speech tasks (CONV, SENT, PICT and WORD) and the non-speech task SAM were feasible in all participants. Among the speech tasks, $READ_{Text}$ caused most difficulties (*non-feasible* in 5/21 participants, i.e. 24%), whereas $READ_{Support}$ resulted in minor problems (*non-feasible* in 2/21 participants, i.e. 9%). The lowest feasibility rate of all the nine tasks was obtained for RAM (*non-feasible* in 8/21 participants, i.e. 38%). The RSR task was *non-feasible* in 5/21 participants (24%).

In order to compare the individual speech and non-speech tasks more directly with one another, we used cross-tabulation. Table 2 shows comparisons for all pairs of speech and non-speech tasks. It can be seen that there was a substantial number of individual comparisons in which several of the participants had difficulties with the non-speech task (especially with RSR and RAM), while they completed the speech task without any restrictions (light grey cells in Table 2). Overall, this pattern occurred in 75/378 individual comparisons (6 speech × 3 non-speech tasks = 18 pairs; 18 pairs × 21 participants = 378 individual comparisons). The opposite pattern (i.e. the participants had difficulties with the speech, but not the corresponding non-speech task) occurred very rarely (18/378 individual comparisons) and affected only the two reading tasks $Read_{Text}$ and $Read_{Support}$.

Figure 1 plots the overall percentages of participants for which the speech and the non-speech tasks were feasible versus non-feasible. A χ^2 test of these counts revealed that, overall, the proportions of feasible cases differed significantly between the types of tasks, with the speech tasks being more feasible ($\chi^2(1) = 10.1$, $p < 0.01$).

In order to elucidate the factors potentially limiting task feasibility, the participants' responses were analysed qualitatively. The 90-word reading text ($READ_{Text}$) imposed excessive demands on five participants with only *rudimentary reading abilities*. Due to multiple reading errors, self-corrections and breakdowns, four participants were entirely unable to produce connected speech in this task. One other speaker refused to execute the task, explaining that he could not read at all. Interestingly, three of the five reading-impaired speakers managed to produce a sufficient amount of connected speech in $READ_{Support}$, while two participants still produced self-corrections and hesitations in almost every intonation phrase.

As regards the four remaining speech tasks (CONV, SENT, PICT and WORD), all participants fulfilled the feasibility criteria without restrictions. In WORD, they all had 48 (100%) valid responses.

In the RSR task, five participants were unable to produce an uninterrupted string of six syllables in any of the six trials. In five other cases, only one single trial of one of the sequences had to be excluded, i.e. the task was still *feasible* in these participants. Interruptions of syllable chains were predominantly due to *articulatory breakdowns and subsequent re-starts*. In the alternating sequence '*badabada…*', *sequencing errors with self-corrections* were also prevalent.

In the SAM task – classified as *feasible* in all participants – 3–6 individual items had to be discarded in four cases (e.g. due to dysexecutive behaviour, see next paragraph). The remaining 17 patients had 24 (100%) valid responses.

Table 2. Cross-tabulations comparing the feasibility of speech (columns) and non-speech (rows) tasks. White cells indicate cases in which both speech and non-speech tasks were feasible (+) or non-feasible (–); coloured cells indicate cases in which the speech task was feasible, whereas the non-speech tasks was not (light grey) or the other way around (dark grey). Cells include absolute number of cases and percentage.

			CONV		SENT		PICT		$READ_{Text}$		$READ_{Support}$		WORD	
			+	–	+	–	+	–	+	–	+	–	+	–
			21 (100%)	0 (0%)	21 (100%)	0 (0%)	21 (100%)	0 (0%)	16 (76%)	5 (24%)	19 (91%)	2 (9%)	21 (100%)	0 (0%)
RSR	+	16 (76%)	16 (76%)	0 (0%)	16 (76%)	0 (0%)	16 (76%)	0 (0%)	12 (57%)	4 (19%)	14 (66%)	2 (10%)	16 (76%)	0 (0%)
	-	5 (24%)	5 (24%)	0 (0%)	5 (24%)	0 (0%)	5 (24%)	0 (0%)	4 (19%)	1 (5%)	5 (24%)	0 (0%)	5 (24%)	0 (0%)
SAM	+	21 (100%)	21 (100%)	0 (0%)	21 (100%)	0 (0%)	21 (100%)	0 (0%)	16 (76%)	5 (24%)	19 (90%)	2 (10%)	21 (100%)	0 (0%)
	-	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
RAM	+	13 (62%)	13 (62%)	0 (0%)	13 (62%)	0 (0%)	13 (62%)	0 (0%)	10 (48%)	3 (14%)	11 (52%)	2 (10%)	13 (62%)	0 (0%)
	-	8 (38%)	8 (38%)	0 (0%)	8 (38%)	0 (0%)	8 (38%)	0 (0%)	6 (28%)	2 (10%)	8 (38%)	0 (0%)	8 (38%)	0 (0%)

CONV: conversational speech, SENT: sentence repetition, PICT: picture story, $READ_{Text}$: text reading, $READ_{Support}$: supported reading, WORD: word repetition, RSR: rapid syllable repetition, SAM: single articulator movements, RAM: repetitive articulator movements.

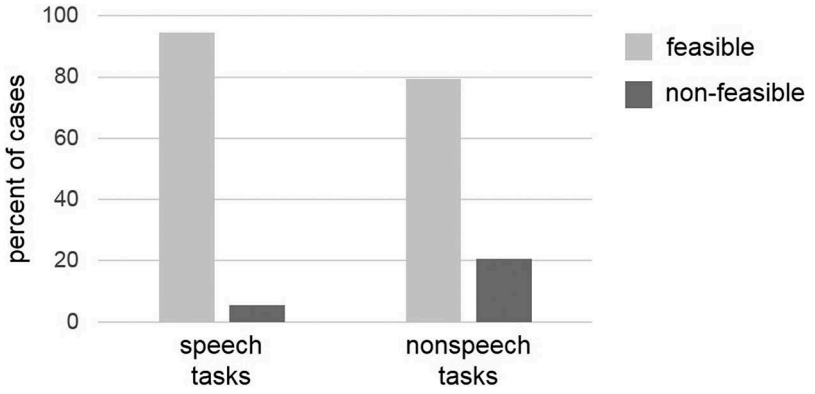

Figure 1. Percentage of feasible versus non-feasible cases (i.e. participants for whom a task was classified feasible or non-feasible) for the speech and non-speech tasks, respectively.

The RAM task was scored *non-feasible* in five persons who did not attempt to alternate the individual movements during any of the trials of the two subtasks. Another three participants managed to produce alternations in only one of the two subtasks, which also resulted in a classification as *non-feasible*. Of note, in three further cases, one individual trial (1/4) had to be discarded, which did not limit feasibility according to our criteria. Notably, the SAM and RAM tasks provoked *overt signs of cognitive/executive impairment* that did not occur in any of the other assessment tasks. For instance, the participants obviously *misunderstood instructions, perseverated* or *substituted movements* and showed *disinhibition behaviours* (e.g. imitation during demonstration despite multiple reinstructions), which resulted in discarding of the corresponding trials/items. Moreover, *motor signs of increased effort* (e.g. excessive tone, involuntary movements and hyperextension of the neck) were more prevalent in these tasks than in any other. In cases in which these symptoms obstructed the visibility of the participants' responses on the video, they also led to the exclusion of the item.

Discussion

Even though non-speech tasks are considered cognitively and linguistically simple, the results of this study suggest that they are not more feasible than speech tasks in the assessment of individuals with cognitive impairment due to CP. Pooled across all tasks, our data even pointed to the opposite, i.e. that non-speech tasks are *less feasible* than speech tasks.

While our observations indicated that in some cases feasibility of non-speech tasks was limited by increased motor effort, the most critical limitations seemed to be related to cognition. Therefore, our results are at odds with the assumption that the cognitive demands imposed by non-speech tasks are overall lower as compared to speech tasks (Ballard et al., 2003; Folkins et al., 1995; Kent & Kent, 2000; Wang et al., 2004). More probably, both types of tasks impose different, highly specific challenges on the examined individual.

Elicitation of *speech* samples may become challenging for the cognitively impaired persons as soon as a task requires advanced reading abilities. In the present study, several participants struggled when confronted with a longer reading text. Importantly, though, through specific

adaptations of this task (e.g. shortened text and audio-visual presentation), 3/5 reading impaired participants were able to produce samples of continuous speech that were appropriate for comprehensive analyses.

Notably, the cognitive limitations of the individuals included in this study did not interfere with the requirements of the applied word and sentence repetition tests. Hence, these tasks provide appropriate means to complete phonetic-articulatory analyses even in cognitively impaired individuals.

As regards *non-speech* tasks, different requirements may challenge cognitively impaired adults. For instance, many tasks are elicited through visual imitation, hence are anchored in a *visual-spatial* reference frame. Movements of the speech organs, however, are primarily related to targets in the *auditory-acoustic* domain (i.e. sounds/syllables of the speaker's language, see Guenther, Ghosh, & Tourville, 2006). The unfamiliar sensorimotor requirements of visual imitation may call for a level of flexibility that cognitively impaired adults may not dispose of. Bizzozero et al. (2000), who developed standard norms on a battery of single articulator movement tasks, found that performance may vary considerably even in neurologically healthy persons, and that age and education are significant influencing factors.

Other non-speech tasks are demanding due to their *maximum performance* requirement. Individuals with a reduced motivational drive may not be able to cope with this demand. Furthermore, the requirement of achieving maximum repetition rates under unfamiliar kinematic conditions (e.g. a constant jaw positioning required for rapid syllable repetition, see Kent, 2015) could entail exceptionally high attentional and executive loads. The requirements of the RSR and RAM tasks, for instance, resemble those of *Luria's three-step test*. This motor sequencing task is known to be sensitive to various forms of cognitive impairment (e.g. Weiner, Hynan, Rossetti, & Falkowski, 2011) and represents an established component of the assessment of executive function (see, e.g. the *Frontal Assessment Battery* by Dubois, Slachevsky, Litvan, & Pillon, 2000). In our participants, such factors may have resulted in null responses, perseverations and disinhibition behaviours, which we did not observe in any of the speech tasks. Nonetheless, these speculations about the potential influence of cognitive deficits on the feasibility of specific assessment tasks must be considered preliminary. Since the participants' cognitive disabilities were beyond the scope of the study from which these data originated, further data characterizing the quality and severity of their cognitive impairment are lacking.

The present research note contributes to the ongoing debate on the value of non-speech tasks for the assessment of dysarthria. A wealth of theoretical arguments as well as empirical data seems to support that non-speech motor assessments are not predictive of speech performance (Staiger et al., 2017a, 2017b; Ziegler, 2002, 2003; Ziegler & Ackermann, 2013; see Maas, 2016; for an opposing view). The present study for the first time also suggests that non-speech tasks may lack their alleged advantage of being more simple, hence, more feasible than speech tasks. This finding is not only relevant for the assessment of persons with CP but also for dysarthria assessment in general, given that many neurologic diseases that cause dysarthria also result in accompanying cognitive impairment (e.g. Parkinson's disease).

The preliminary data reported here could be a starting point for more systematic investigations of feasibility issues in speech assessment, with specific consideration of

three aspects: (1) A systematic neuropsychological assessment of the major cognitive domains (e.g. attention, working memory and executive functions) should be conducted to identify the factors determining the feasibility of diagnostic tasks. (2) The prospective studies should include participants covering a wide severity range regarding cognitive and speech deficits, in order to be able to discover potential associations and dissociations. The current sample contained only adults who communicated mainly verbally (and for whom comprehensive speech assessment is indicated therapeutically), which may have caused a severity bias. (3) The participants' experience with speech therapy in general and with therapeutic applications of the assessed speech and non-speech tasks in particular should be controlled for. In the current sample, four persons did not have any experience with speech therapy. Among those who received speech therapy, nine indicated, in an informal interview, that they were familiar with non-speech tasks, while eight reported that they were not. Moreover, standard assessments of literacy should be included in future prospective studies.

A problem that will remain is that the diversity of standard assessment tasks limits the application of uniform feasibility criteria across tasks. Therefore, future research should be based on feasibility criteria mapping clinical standards as closely as possible.

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Declaration of interest

The authors report no declarations of interest.

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References

Auzou, P., & Rolland-Monnoury, V. (2012). *Batterie d'évaluation clinique de la dysarthrie*. Isbergues, France: Ortho Edition.

Ballard, K. J., Robin, D. A., & Folkins, J. W. (2003). An integrative model of speech motor control: A response to Ziegler. *Aphasiology*, *17*(1), 37–48. doi:10.1080/729254889

Ballard, K. J., Solomon, N. P., Robin, D. A., Moon, J. B., Folkins, J. W., & McNeil, M. R. (2009). Nonspeech assessment of the speech production mechanism. *Clinical Management of Sensorimotor Speech Disorders*, *2*, 30–45.

Bizzozero, I., Costato, D., Sala, S. D., Papagno, C., Spinnler, H., & Venneri, A. (2000). Upper and lower face apraxia: Role of the right hemisphere. *Brain*, *123*(11), 2213–2230. doi:10.1093/brain/123.11.2213

Bottcher, L. (2010). Children with spastic cerebral palsy, their cognitive functioning, and social participation: A review. *Child Neuropsychology*, *16*(3), 209–228. doi:10.1080/09297040903559630

Breitbach-Snowdon, H. (2003). *UNS: Untersuchung neurologisch bedingter Sprech-und Stimmstörungen*. Köln, Germany: Prolog, Therapie-und Lernmittel.
Bunton, K. (2008). Speech versus nonspeech: Different tasks, different neural organization. *Seminars in Speech and Language*, *29*(4), 267–275. doi:10.1055/s-0028-1103390
Crary, M. A. (1995). Clinical evaluation of developmental motor speech disorders. *Seminars in Speech and Language*, *16*, 110–124. doi:10.1055/s-2008-1064114
Darley, F. L., Aronson, A. E., & Brown, J. R. (1969). Differential diagnostic patterns of dysarthria. *Journal of Speech, Language and Hearing Research*, *12*(2), 246–269. doi:10.1044/jshr.1202.246
Dubois, B., Slachevsky, A., Litvan, I., & Pillon, B. (2000). The FAB A frontal assessment battery at bedside. *Neurology*, *55*(11), 1621–1626. doi:10.1212/WNL.55.11.1621
Duffy, J. R. (2013). *Motor speech disorders: Substrates, differential diagnosis, and management* (3 ed.). St. Louis, Missouri: Mosby Incorporated.
Enderby, P. (2004). *Frenchay dysarthria assessment*. Austin, TX: Pro-ed.
Enderby, P., & Palmer, R. (2012). *FDA-2: Frenchay Dysarthrie Assessment - 2* (2 ed.). Idstein, Germany: Schulz-Kirchner.
Fennell, E. B., & Dikel, T. N. (2001). Cognitive and neuropsychological functioning in children with cerebral palsy. *Journal of Child Neurology*, *16*(1), 58–63. doi:10.1177/088307380101600110
Folkins, J. W., Moon, J. B., Luschei, E. S., Robin, D. A., Tye-Murray, N., & Moll, K. L. (1995). What can nonspeech tasks tell us about speech motor disabilities? *Journal of Phonetics*, *23*(1), 139–147. doi:10.1016/S0095-4470(95)80038-7
Guenther, F. H., Ghosh, S. S., & Tourville, J. A. (2006). Neural modeling and imaging of the cortical interactions underlying syllable production. *Brain and Language*, *96*(3), 280–301. doi:10.1016/j.bandl.2005.06.001
Kent, R. D. (2015). Speech and nonspeech oral movements: Classification and comparison. *American Journal of Speech-Language Pathology*, *24*, 750–762.
Kent, R. D., & Kent, J. F. (2000). Task-based profiles of the dysarthrias. *Folia Phoniatrica Et Logopaedica*, *52*(1–3), 48–53. doi:10.1159/000021512
Knuijt, S., & Kalf, J. G. (2007). Dysatrieonderzoek; drie nieuwe beoordelingsinstrumenten beschikbaar. *Logopaedie En Phoniatrie*, *79*, 412–417.
Maas, E. (2016). Speech and nonspeech: What are we talking about? *International Journal of Speech-Language Pathology*, *19(4)*, 1–15.
Novak, I., Hines, M., Goldsmith, S., & Barclay, R. (2012). Clinical prognostic messages from a systematic review on cerebral palsy. *Pediatrics*, *130*(5), 1285–1312. doi:10.1542/peds.2012-0924
Palisano, R., Rosenbaum, P., Walter, S., Russell, D., Wood, E., & Galuppi, B. (1997). Development and reliability of a system to classify gross motor function in children with cerebral palsy. *Developmental Medicine & Child Neurology*, *39*(4), 214–223. doi:10.1111/j.1469-8749.1997.tb07414.x
Schölderle, T., Staiger, A., Strecker, K., Lampe, R., & Ziegler, W. (2016). Dysarthria in adults with cerebral palsy: Clinical presentation and impacts on communication. *Journal of Speech, Language and Hearing Research*, *59*, 216–229. doi:10.1044/2015_JSLHR-S-15-0086
Staiger, A., Schölderle, T., Brendel, B., Bötzel, K., & Ziegler, W. (2017a). Oral motor abilities are task dependent: A factor analytic approach to performance rate. *Journal of Motor Behavior*, *49*(5), 482–493. doi:10.1080/00222895.2016.1241747
Staiger, A., Schölderle, T., Brendel, B., & Ziegler, W. (2017b). Dissociating oral motor capabilities: Evidence from patients with movement disorders. *Neuropsychologia*, *95*, 40–53. doi:10.1016/j.neuropsychologia.2016.12.010
Thoonen, G., Maassen, B., Wit, J., Gabreels, F., & Schreuder, R. (1996). The integrated use of maximum performance tasks in differential diagnostic evaluations among children with motor speech disorders. *Clinical Linguistics & Phonetics*, *10*(4), 311–336. doi:10.3109/02699209608985178
Wang, Y., Kent, R. D., Duffy, J. R., Thomas, J. E., & Weismer, G. (2004). Alternating motion rate as an index of speech motor disorder in traumatic brain injury. *Clinical Linguistics & Phonetics*, *18*(1), 57–84. doi:10.1080/02699200310001596160

Weiner, M. F., Hynan, L. S., Rossetti, H., & Falkowski, J. (2011). Luria's three-step test: What is it and what does it tell us? *International Psychogeriatrics*, *23*(10), 1602–1606. doi:10.1017/S1041610211000767

Weismer, G. (2006). Philosophy of research in motor speech disorders. *Clinical Linguistics & Phonetics*, *20*(5), 315–349. doi:10.1080/02699200400024806

WEVOSYS. (2010). *Motor speech disorder assessment. lingWAVES-Modul*. Forchheim, Germany: Author.

Wit, J., Maassen, B., Gabreels, F. J., & Thoonen, G. (1993). Maximum performance tests in children with developmental spastic dysarthria. *Journal of Speech and Hearing Research*, *36*(3), 452–459. doi:10.1044/jshr.3603.452

Ziegler, W. (2002). Task-related factors in oral motor control: Speech and oral diadochokinesis in dysarthria and apraxia of speech. *Brain and Language*, *80*, 556–575. doi:10.1006/brln.2001.2614

Ziegler, W. (2003). Speech motor control is task-specific. Evidence from dysarthria and apraxia of speech. *Aphasiology*, *17*(1), 3–36. doi:10.1080/729254892

Ziegler, W., & Ackermann, H. (2013). Neuromotor speech impairment: It's all in the talking. *Folia Phoniatrica Et Logopaedica*, *65*(2), 55–67. doi:10.1159/000353855

Ziegler, W., Staiger, A., Schölderle, T., & Vogel, M. (2017). Gauging the auditory dimensions of dysarthric impairment: Reliability and construct validity of the Bogenhausen Dysarthria Scales (BoDyS). *Journal of Speech, Language, and Hearing Research*, *60*(6), 1516–1534. doi:10.1044/2017_JSLHR-S-16-0336