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Intensive dysarthria therapy for younger children with cerebral palsy

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ABSTRACT

Aim To investigate if intervention targeting breath support, phonation and speech rate increases speech intelligibility and participation in conversational interactions of young children with dysarthria and cerebral palsy (CP).

Methods Fifteen children with dysarthria and CP (nine male, six female; 5-11 years (M=8, SD = 2); CP type: 8 spastic, 4 dyskinetic, 1 ataxia, 2 Worster Drought; GMFCS II-IV (median=II)) participated. Children received three sessions of individual therapy per week for six weeks. Intelligibility of single words and connected speech was compared across five points: one and six weeks before therapy, one, six and twelve weeks after therapy. Three familiar listeners and three unfamiliar listeners scored each recording. Participation in communicative interactions was measured using the FOCUS - Focus on the Outcomes of Communication Under Six. ANOVAs and paired t- tests were used to investigate change.

Results Mean speech intelligibility increased after therapy to familiar listeners (single words=10.8%, 95% CI 7.2-14.4%; connected speech=9.4%, 95% CI 4.8-14.1%) and unfamiliar listeners (single words=9.3%, 95% CI 6.8-11.8%; connected speech=10.5%, 95% CI 7.3-13.8%). FOCUS scores increased following therapy for parents (mean increase = 30.3, 95% CI 10.2, 50.4) and for teachers (28.25, 95% CI 14.4, 42.1)), but changes did not correlate with intelligibility. Wide variation was seen in response by individuals.

Interpretation Brief intensive therapy is associated with gains in intelligibility and communicative interactions for some younger children with dysarthria.

Running foot: Dysarthria therapy for younger children

What this paper adds

- A short course of dysarthria therapy can help young children increase the intelligibility of their speech
- The change in intelligibility scores between 6 weeks and 12 weeks post therapy were not statistically significant; examination of regression coefficients suggests that any reduction in intelligibility is likely to be modest in comparison with the improvement at the time of delivery.
- Increased participation in communication activities at home and school is observed following therapy focussing on breath support, phonation and speech rate for some children

Dysarthria is a ‘group of speech disorders resulting from abnormalities in the strength, speed, range, steadiness, tone, or accuracy of movements required for control of the respiratory, phonatory, resonatory, articulatory, and prosodic aspects of speech production’[1] (p5) and affects approximately 35% of young people with cerebral palsy[2].

In the World Health Organization’s International Classification of Functioning, Disability and Health[3] conceptual framework dysarthria is an impairment of speech function. Reductions in speech intelligibility arising from dysarthria cause activity limitations in the production of spoken messages in communication[4]. Recent research in the European study SPARCLE showed that children with cerebral palsy who have communication difficulties have reduced levels of participation[5] (involvement in life situations) and perceived quality of life in the area of interaction with parents[6]. Although we cannot assume that *all* children with communication difficulties in SPARCLE had dysarthria it is likely to affect the majority[2 7].

Speech and language therapy (SLT) aims to help children maximise their intelligibility, either through speech, other forms of natural communication such as gesture and facial expression, or with the use of augmentative and alternative communication systems. The implicit goal of therapy is to facilitate children’s interaction and their communicative participation in social, educational and family activities, for example sharing news with friends, discussing potential social outings with family, and taking part in a group discussion in class.. However, few studies have investigated the link between increased speech function and children’s successful engagement in interaction with peers, family and education staff at home and school by measuring communicative participation outcomes[8].

Recent research has shown that a dysarthria intervention, which focusses on controlling breath support, phonation and speech rate, can increase the speech intelligibility of older children with cerebral palsy[9]. The therapy was designed to be given as a one-off intensive course, to help children learn motor behaviours that they can use when needed; for example when speaking in background noise. Three immediate questions arose from that initial study: Are changes maintained in the medium term (e.g. three months) without further therapy? Is the therapy suitable for younger children (e.g. between five and eleven years of age)? And, Is the therapy associated with increased participation in conversations at home and school?[8 9] This second Phase II study used a group interrupted time series design, in which young children acted as their own controls, to address these questions.

METHOD

Participants

Children receiving therapy

We recruited 15 children with cerebral palsy and dysarthria (9 boys, 6 girls; age 5-11 years, mean = 8 years, SD = 2) via local speech and language therapists in the North East of England. Sample size was determined by feasibility, given the number of children that could be treated during a term, with restrictions imposed by children’s school timetables, length of the school day and holidays. Inclusion criteria comprised: diagnosis of cerebral palsy, aged 5-11 years, dysarthria judged moderate to severe by local therapists based on their clinical assessments. As in our previous study[9] exclusion criteria comprised: bilateral hearing impairments >50 dB HL (affecting ability to hear speech contrasts); severe visual impairments not correctable with spectacles (impairing ability to see therapy material clearly); profound cognitive impairments or difficulties following simple instructions. Eight children had bilateral spastic type cerebral palsy, four had dyskinetic type, one child had ataxic type and two children had Worster Drought[10], as diagnosed by neurodisability paediatricians. Gross Motor Function Classification System (GMFCS)[11] ranged from 2-4 (median = 2). Motor speech disorder was confirmed using the Verbal Motor Production Assessment for Children[12]. Children's spoken language ranged from short phrases to complex sentences, their mean length of utterance in morphemes, calculated using SALT[13] was 5.61 (SD 2.96). See Table 1 for children's characteristics.

Insert table 1 about here

Listeners
In order to rate speech intelligibility, we recruited three members of school staff who worked with each child as familiar listeners and 150 adults with no experience of people with cerebral palsy or disordered speech as unfamiliar listeners.

Measures
As in the previous study single word intelligibility was measured using the Children's Speech Intelligibility Measure[12], with different word lists allocated to each child at each recording.

Intelligibility of connected speech was measured from children's answers to simple questions (e.g. What do you like doing when you get home from school?) and repeated phrases (e.g. What's for dinner today?). Twenty questions were used. Five questions were selected at random for each child at each recording Children's answers were transcribed verbatim by the researcher and checked for accuracy with the child. Ten phrases were repeated at all recordings. Three were randomly selected from each recording for speech intelligibility rating.

Change in children's communicative participation in interactions in home and school was evaluated using the Focus on the Outcomes of Communication Under Six[14](FOCUS). This new outcome measure is grounded in the ICF conceptual framework and measures changes in communication by young children with any type of communication disorder, and the impact of these changes on children's communicative participation in home and school interactions with peers, teachers and family members. The FOCUS has separate scales for parents and clinicians, which are identical except for the wording referring to the relationship with the child.

To estimate the clinical significance of changes in speech intelligibility parents were also asked to rate the effectiveness of therapy on children's speech using a separate four point Likert scale (0 = negative effects, 1 =poor effects, 2=moderate effects, 3=good effects) developed for this study.

Procedure
County Durham and Tees Valley 1 Research Ethics Committee and UK National Health Service Trusts providing services to the participant children approved the study. Children's guardians provided written consent to participate and children gave written or verbal consent. Children's speech was recorded using an EDIROL R9 digital recorder and head mounted microphone. Two recordings were made at five different time points: six weeks before therapy (Time 1), one week before therapy (Time 2), one week (Time 3), six weeks (Time 4) and twelve weeks (Time 5) after therapy completion. Children continued any regular SLT up until the start of the experimental treatment. During the experimental therapy and for six weeks after its completion children did not receive other SLT. Having five time points allowed us to estimate change in speech intelligibility arising from maturation/usual therapy and the immediate and medium term effects of the experimental therapy. Parents and teachers

rated children's communication on the FOCUS one week before and 10-12 weeks after intervention.

The intervention provided in this study followed the same protocol as that used in our study with older children[9]. Children received three 35-40 minute individual sessions of therapy per week at school for six weeks Therapy focused on helping children to control their respiratory and phonatory effort, speech rate and phrase length/syllables per breath (see Pennington et al 2010 for details of the therapy) and following the principles of motor learning[15-20] . Speech recordings were transferred to iTunes software. One of the two recordings from each of the time points from each child was selected at random for familiar listeners. The order of presentation of the recordings from the five time points was randomised for each familiar listener. Both recordings from the five time points were heard by three unfamiliar listeners. Each unfamiliar listener was allocated three recordings at random, with the proviso that they heard the same child only once.

Listeners completed all ratings in one session. Recordings were played to listeners in standard conditions, at the original volume (i.e. no normalisation of volume/loudness). For the Children's Speech Intelligibility Measure listeners selected the word they had heard from a written list of ten phonetically similar words. For the connected speech conditions listeners heard a phrase and wrote down the words they had heard. Recordings were played once. All listeners were blind to the time points of the speech recordings. Percentage speech intelligibility was calculated by dividing the number of words heard correctly by the number of words in the recording. Twenty-one sessions were observed by a second therapist, who checked the adherence of the sessions to the protocol.

Statistical Analysis

Analysis of percentage intelligibility of single words and connected speech to familiar and unfamiliar listeners was undertaken using analysis of variance (ANOVA)[21], confidence intervals were based on 200 bootstrap samples[22] and paired t tests, as in our previous study

Paired t tests were used to compare pre and post therapy FOCUS scores. Spearman rank correlations were used to investigate associations between speech intelligibility and FOCUS scores. Analysis was undertaken with SPSS for Windows (version 17 SPSS Inc., Chicago, IL, USA).

RESULTS

Due to illness one child received only ten sessions of therapy. All other children received 14-18 sessions (n=14, mean=16, SD = 2, interquartile range 15 to 18).

Familiar listeners

For single words interrater reliability (mean intraclass correlation coefficient) was 0.47, with a 95% confidence interval (CI) of 0.34 to 0.61.

For each child we calculated a mean intelligibility score at each time point. Analysis of variance (assuming a normal error structure with children and occasions included as fixed effects) indicated significant variation between occasions ($F_{4,56}$=10.3;p<0.001). Most of the difference was between times 1 and 2 (before intervention) and times 3, 4 and 5 (after intervention). A contrast representing this difference was highly significant ($F_{1,56}$=29.1;p<0.001). With this contrast fitted, variation between the remaining occasions (between times 1 and 2 and between times 3, 5 and 4) was not significant ($F_{2,56}$=1.79;p=0.176). Variation between times 5 and times 1 to 4 capturing the long term effect was not significant ($F_{1,56}$=1.00;p=0.322). The estimated change between the preintervention and postintervention time points was an increase in single-word intelligibility of 10.8% (95% CI 7.2,14.4).

For connected speech the interrater reliability (mean intraclass correlation coefficient) was 0.31 (95% CI 0.16,0.46).

Variation between occasions was significant ($F_{4,56}$=4.20;p=0.005). Again, most of this variation was explained by a difference between the preintervention and postintervention recordings ($F_{1,56}$=10.8;p=0.002). Allowing for this difference, variation between times 1 and 2 and between times 3, 5 and 4 ($F_{2,56}$=0.41;p=0.669) and variation between times 5 and times 1 to 4 ($F_{1,56}$=0.59;p=0.446) was not significant. The estimated increase in connected speech intelligibility (between before and after intervention) was 9.4% (95% CI 4.8,14.1%).

Unfamiliar listeners

The interrater reliability for single words was 0.88 (95% CI 0.85,0.91).
Repeated-measures ANOVA indicated significant variation between occasions ($F_{9,120}$=6.94; p<0.001). Most of the difference was between times 1 and 2 (before intervention) and times 3, 4 and 5 (after intervention). A contrast representing this difference was highly significant ($F_{1,120}$=17.3; p<0.001). With this contrast fitted, variation between the remaining occasions (between times 1 and 2 and between times 3, 5 and 4) ($F_{2,120}$=0.41; p=0.665) and between times 5 and times 1 to 4 ($F_{1,120}$=0.73; p=0.393) was not significant. However after removing these 2 contrasts, there was a significant difference ($F_{1,127}$=4.70; p=0.032) between the two recordings (made on separate days) at each of the five time points, with intelligibility scores being lower on the second occasion. The estimated change in intelligibility after the intervention was an increase in single-word score of 9.3% (95% CI 6.8,11.8%) and the estimated difference between the 2 days within each time point was -2.7% (95% CI -5.1,-0.2%).Interrater reliability for connected speech was 0.92 (95% CI 0.90,0.94).

The estimated change in speech intelligibility after the intervention was an increase in connected-speech score of 10.5% (95% CI 7.3,13.8%). The change in speech intelligibility between the 2 days at each time point was -1.9% (95% CI -5.1, 1.3%), which did not differ significantly from zero. There was no evidence of other differences between the 5 time points.

Agreement between familiar and unfamiliar listeners

For single-word intelligibility the agreement between familiar and unfamiliar listeners was 0.94 (95% CI of 0.89, 0.96). In general, the mean difference between the intelligibility scores of the familiar and unfamiliar listeners across all children across all time points was 3.0% (95% CI 0.2,5.9%).

For connected-speech intelligibility the agreement between familiar and unfamiliar listeners was 0.87 (95% CI of 0.58,0.94). Scores were generally higher for familiar listeners than for unfamiliar listeners; the mean difference between familiar and unfamiliar listeners across all children across all time points was 9.5% (95% CI 5.1,14.0%).

Difference between single-word and connected-speech intelligibility

The mean difference between connected speech and single word scores was 4.6 (95% CI: -2.5, 11.6) for familiar listeners and -1.9 (95% CI: -8.8, 4.2) for unfamiliar listeners. The difference between these differences was 6.5 (95% CI: 2.8, 10.2).

FOCUS score

The mean change in FOCUS scores (post therapy minus pre therapy) was 30.3 (95% CI 10.2,50.4) for parents and 28.3 (95% CI 14.4,42.1) for teachers. Correlation between change in FOCUS score and change in speech intelligibility was very weak (parents: single word -0.07, connected speech 0.24; teachers: single word -0.21 connected speech 0.03).

Inset Table 2 about here
Insert Table 3 about here

Views on therapy
Children's ratings of the acceptability and effectiveness of the therapy were abandoned as it appeared that some children did not fully understand the task. Parents were asked to rate the effect of therapy for their child's speech (0=negative effects, 1=poor effects, 2=moderate effects and 3=good effects). Twelve of the 15 parents responded; 8 (66.7%) reported good effects and 4 (33.3%) moderate effects. For the parents who rated the therapy as having good effect mean gain in intelligibility was approximately 10%: familiar listeners rating single words speech mean gain=13.8% (95% CI 5.7,21.9); familiar listeners rating connected speech 9.8% (95% CI -2.2,21.8); unfamiliar listeners rating single words 13.2% (95% CI 5.7,20.7); unfamiliar listeners rating connected speech 9.0% (95% CI 1.9,16.0).

DISCUSSION

This exploratory study of response to dysarthria therapy by primary school age children replicated a previous study with older children[9]. Like its predecessor, this research suggests that a single intensive course of therapy focussing on controlling body functions of respiration and phonation and speech rate can increase the intelligibility of the speech of children with dysarthria and cerebral palsy, i.e. as classified by the ICF framework, an impairment-focussed intervention has an activity level outcome.

Results show that overall the group of younger children in this study and the older children in our previous study[9] increased their single word and connected speech intelligibility to both familiar and unfamiliar, naive listeners. Both studies show that gains were maintained for six weeks without further therapy. The current study extended outcome measurement to twelve weeks post therapy, at which point no change in speech intelligibility was observed, suggesting that motor routines are retained in the medium term without further intervention. However, there was considerable variation in children's response to the therapy in the current study. Taking ten percentage point change as clinically significant (from parents' ratings of therapeutic effect), we can see that participants C, F, and M increase in intelligibility in both single words and connected speech to familiar and unfamiliar listeners. Familiar listeners observed increases in intelligibility for participants A, D, G, H, J, L, N, and O, but this was not apparent to unfamiliar listeners. Three children's intelligibility increased between Time 1 and T2. This may be due to observation or due to effects of local usual therapy. Some children's intelligibility reduced in either single words or connected speech at Time 4 (participants A, E, G, H, M and O). In this small sample we could not see any associations in response and participant characteristics. For example, the youngest children in this study did not always have the least response to the therapy. Language comprehension should not predict response to therapy, as all participants were able to comprehend the grammatically simple instructions used in the therapy. But, some of the younger children may have a less well developed theory of mind, may not understand the impact of their speech production on the intelligibility of their message and may be less motivated to use new speech strategies[23]. The effect of comprehension should therefore be investigated further. It is also possible that response to therapy may vary according to impairment severity. Gains in speech intelligibility may be lower for children with profound or mild speech disorders, due to floor and ceiling effects, than for children with moderate impairments. Other factors that may affect response to therapy include type of motor disorder and the number of sessions attended. Each of these factors should be investigated by amalgamating current data from older and younger children.

There was also considerable variation between listeners in their ratings of children's speech intelligibility, and this may have contributed to the variation in intelligibility between children observed. We took the mean of three independent ratings of intelligibility. Models assuming a random normal error distribution fit these observations very well. Our use of three listeners was based on previous research, showing the need to restrict number of recordings heard to prevent learning effects[24], and feasibility. Having more listeners rate each recording would give a more precise estimate of intelligibility, and this should be borne in mind when planning studies involving intelligibility rating. However, increasing the number of listeners will entail increased research resources. There is more variability within familiar than unfamiliar listeners, which may be due to some listeners knowing the children better than others. But rater agreement may be more influenced by the large differences between children, which made it easier for unfamiliar listeners to be consistent in their listening tasks. Familiar listeners heard (in randomised order) samples from all time points for the child whom they knew, whereas unfamiliar listeners heard three different children.

The older children in our previous study[9] were more intelligible in single words than in connected speech to naive listeners, whereas the younger children were equally intelligible in single words as connected speech. Previous research has suggested that adults with mild to severe dysarthria are more intelligible in connected speech than in single words, due to the availability of top down processing. Such an advantage is not observed for people with profound impairments[25-27]. The lack of greater intelligibility in connected speech for the children we have studied is most probably due to the large variation between children and small sample size. Alternative explanations include difference between the tasks, the severity of children's dysarthria, and children's developing expressive language skills. Increasing length of utterance may create greater cognitive and language processing load for language learners, reduce attention to motor control and result in speech signal degradation[28]. The relationship between MLU, speech elicitation condition, motor speech impairment, listening task and intelligibility requires further exploration in children with dysarthria whose linguistic systems are still developing.

Results show increases in communicative participation for some children following intervention. Using the FOCUS parents and teachers reported that following therapy children participated in more communicative interactions and required less help to do so. We found no association between the gains in speech intelligibility and communicative participation as measured by the FOCUS, and this may be due to inadequate power. If not associated with increased intelligibility, the overall change in communication reported here may be due to therapeutic effects such as increased confidence, which parents anecdotally reported for some children, or placebo effects. It should also be noted that parents were keen for their children to receive intervention for speech and were not blinded to type of intervention or time of assessment. The lack of blinding will bias participation outcome measurement in this study. Further research, blinding of assessors to exact intervention type/focus, is needed for definitive testing of the effect on children's interaction and the association between speech intelligibility and impact on social communication.

For the parents who rated the therapy as having a good effect the increase in speech intelligibility was approximately 10%. Further work is needed to ascertain if clinically significant change relates only to speech intelligibility or if change in interaction behaviour or attitude (e.g. self confidence) is also required. Further work should also estimate the whether size of change judged as effective varies according to speech impairment severity. Goal attainment scaling could be used to investigate this issue[29].

This exploratory study suggests that a one-off intensive burst of therapy focussing on respiration, phonation and speech rate may be effective in increasing the intelligibility of some young children with CP and dysarthria. It has estimated of the variation in response to therapy and the variation in listener rating, provided further evidence of clinical significance of intelligibility change and supported the use of secondary outcome measures to evaluate generalised change in every day interaction. All of this information can be used to support the design of a definitive, fully powered trial of the clinical effectiveness of the intervention. Prior to such a trial, intermediate studies may be advised to examine generalisation of new motor speech behaviours outside therapy [15 30]; t and the success of therapy as delivered by other personnel (eg therapy assistants),

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Table I Individual child characteristics

Child	Age	Sex	CPtype	GMFCS	MLU	Parent FOCUS pretherapy	Parent FOCUS Post therapy	Teacher FOCUS Pre therapy	Teacher FOCUS Post therapy
A	11.00	M	Spastic	4	2.89	252.00	307	306	327
B	7.00	M	Spastic	4	2.30	221.00			
C	8.00	F	Dyskinetic	2	7.05	235.00	294	223	248
D	11.00	M	Ataxic	4	2.08	208.00		178	190
E	9.00	M	Spastic	2	5.10	159.00	188	259	273
F	6.00	M	Spastic	3	6.79	257.00	289	267	288
G	9.00	F	Dyskinetic	3	5.73			239	250
H	9.00	F	Dyskinetic	2	9.19	238	204		
I	6.00	M	Spastic	4	2.31			111	122
J	11.00	F	Spastic	2	5.77	203	224	212	247
K	11.00	M	Worster Drought	2	4.89				
L	11.00	M	Worster Drought	2	2.30	148	160	148	234
M	8.00	F	Dyskinetic	2	8.26	174	197	263	280
N	11.00	F	Spastic	2	10.16	257	309	258	294
O	5.00	M	Spastic	4	5.48	157	211	248	298

MLU = mean length of utterance in morphemes

Table II: Intelligibility to familiar and unfamiliar listeners at each time point

	Familiar listeners[a]										Unfamiliar listeners[b]									
	Single word percentage intelligibility					Connected speech percentage intelligibility					Single word percentage intelligibility					Connected speech percentage intelligibility				
Child	T1	T2	T3	T4	T5	T1	T2	T3	T4	T5	T1	T2	T3	T4	T5	T1	T2	T3	T4	T5
A	81.33	83.33	94.67	84.00	85.33	93.33	97.06	100.00	95.45	90.00	78.00	74.67	80.67	81.33	81.33	90.62	80.95	86.56	87.73	86.35
B	24.67	20.67	36.00	32.67	40.67	48.88	33.33	9.26	6.67	50.50	20.00	23.33	37.33	32.00	30.00	7.69	10.17	6.72	4.69	31.15
C	68.00	56.00	70.00	80.67	72.67	68.96	78.57	91.11	87.03	83.12	41.33	45.33	74.67	79.33	68.00	42.53	67.07	84.64	72.70	63.33
D	28.00	36.00	50.00	40.67	34.00	7.69	18.77	25.00	28.57	27.16	30.67	35.33	39.33	34.67	33.33	20.48	18.10	13.33	12.94	24.64
E	44.67	50.67	58.00	58.67	54.00	84.00	78.07	90.19	80.16	86.02	43.33	50.67	54.67	67.33	56.00	52.38	54.96	67.13	76.29	77.97
F	40.67	68.67	82.67	85.33	78.00	81.64	84.48	95.93	96.03	74.83	52.00	69.33	79.33	91.33	87.33	73.93	77.92	96.30	92.47	91.70
G	49.33	53.33	72.67	64.67	70.67	57.60	49.62	86.51	72.36	93.13	46.67	53.33	66.00	54.67	59.33	55.25	74.19	83.70	62.01	75.63
H	66.00	61.33	75.33	60.00	74.00	70.00	70.33	83.33	79.84	70.87	54.00	63.33	77.33	67.33	73.33	60.15	76.82	76.97	72.99	64.48
I	14.67	9.33	10.00	15.33	12.67	7.63	18.94	20.34	16.28	10.75	24.00	10.00	12.00	14.00	11.33	3.42	8.33	2.27	0.78	3.03
J	44.67	60.67	68.00	60.67	60.00	84.50	74.35	87.08	80.26	69.39	38.67	58.00	62.00	46.67	52.00	55.29	57.57	51.86	59.65	59.44
K	86.67	89.33	86.00	83.33	93.33	81.35	80.40	77.45	88.89	93.33	80.00	76.67	77.33	72.67	76.67	46.75	49.83	66.67	82.18	72.57
L	18.00	13.33	19.33	23.33	28.67	4.30	1.96	17.73	16.54	14.81	15.33	12.00	9.33	20.00	24.10	4.30	2.02	2.86	5.88	5.56
M	46.00	46.00	71.00	82.00	74.00	52.75	56.58	75.29	79.17	60.22	60.67	61.33	79.33	80.67	72.00	54.80	59.50	91.82	80.76	62.96
N	68.00	64.00	80.67	73.33	68.67	65.96	63.21	84.63	83.70	82.93	63.33	66.67	74.67	74.67	57.00	56.05	66.67	65.26	78.43	72.73
O	56.00	76.67	83.33	56.00	70.00	24.98	48.60	70.83	58.62	65.28	54.00	65.33	64.67	52.00	66.00	31.63	46.95	43.96	45.10	56.63

[a]Data from one randomly selected day at time point for familiar listeners. [b]Unfamiliar listeners rated speech from both days at each time point. Data reported here are from the same day as for familiar listeners. T1, 6 weeks before therapy; T2, 1 week before therapy; T3, 1 week after therapy completion; T4, 6 weeks after therapy completion; T5, 12 weeks after therapy completion.

Table III: Single-word and connected-speech intelligibility percentage scores by time by occasion for familiar and unfamiliar listeners

			Familiar listeners				Unfamiliar listeners			
			Single word speech		Connected speech		Single word speech		Connected speech	
Time	Occasion	n[a]	Mean	SD	Mean	SD	Mean	SD	Mean	SD
1	1	8	43.9	23.3	54.2	31.6	49.6	19.3	45.3	27.4
	2	7	55.0	20.6	57.1	31.9	45.1	20.4	36.8	24.9
	Total	15	49.1	22.1	55.6	30.6	47.5	19.6	41.2	26.1
2	1	9	63.6	14.7	73.6	14.7	52.1	21.0	47.1	27.1
	2	6	36.2	27.4	32.0	24.5	49.2	24.4	47.3	32.8
	Total	15	52.6	24.2	57.0	28.0	50.8	22.3	47.2	29.3
3	1	7	52.4	29.9	54.2	36.6	61.0	25.7	58.5	35.1
	2	8	73.9	15.0	79.4	23.5	59.3	22.2	55.3	32.9
	Total	15	63.8	24.9	67.6	32.0	60.2	23.6	56.9	33.5
4	1	8	57.4	27.7	62.1	34.9	60.7	23.5	53.7	31.0
	2	7	63.0	17.5	67.6	29.1	55.0	22.5	54.6	32.1
	Total	15	60.0	22.9	64.6	31.3	57.9	22.8	54.2	31.0
5	1	9	60.1	22.0	64.2	27.3	58.6	24.7	57.4	29.9
	2	6	62.7	25.7	65.8	30.4	60.1	20.6	55.9	24.7
	Total	15	61.1	22.7	64.8	27.5	59.3	22.4	56.7	27.1

[a]The number of children rated by familiar listeners; at each time point for each child we randomly selected the recording from either occasion 1 or occasion 2 (all children were rated on both occasions at each time point by unfamiliar listeners).