Speech Intelligibility of Flemish Children as Judged by Their Parents

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Key Words

Speech intelligibility · Child speech · Judgement of parents · Normative values

Abstract

Objective: Reduced intelligibility is a central concern in speech-impaired children, especially for parents. The main purpose of this study was to develop normative data for the intelligibility of Flemish-speaking boys and girls (age 2;06–5;0 years) as judged by their parents. Additionally, the influence of familiarity, gender and age of the child was determined. **Patients and Methods:** Word, sentence and story productions of 163 healthy children (83 boys and 80 girls) between 2;06 and 5;0 years were transcribed by their own parents. Speech intelligibility was determined according to the intelligibility index described by Shriberg. Additionally, a panel of 12 unfamiliar judges listened to the recordings of a subgroup of 24 randomly selected children. **Results:** Speech intelligibility improved with increasing age and was around 90% for children aged 4;6–5;0 years. Boys and girls performed equally on the task. For the intelligibility of words, mothers scored significantly better than unfamiliar listeners did. **Conclusion:** The reported normative speech intelligibility data provide important reference information for speech pathologists who assess child speech. Moreover, it enables them to measure the effect of a specific therapeutic approach and the spontaneous transfer to daily speech.

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Introduction

Reduced speech intelligibility is a central concern in speech-impaired children, especially for the parents. To evaluate speech intelligibility, objective assessment procedures are needed. Speech intelligibility can be defined as ‘what is understood by the listeners of the phonetic realization of speech’ [1]. De Bodt et al. [2] defined intelligibility as a product of a series of interactive processes such as phonation, articulation, resonance and prosody. Besides these basic competences of the speaker, Kent and Miolo [3] suggested that a number of other factors affect speech intelligibility, such as the nature of the spoken material, the context of communication, the listener’s familiarity with the speaker, contextual support for the message to be transmitted, clarity of the visual and acoustic signals of speech, and other environmental and linguistic factors. Due to the multiple influencing variables, procedures for speech intelligibility are not widely described and they are seldom used by practicing speech-language pathologists.

For the assessment of the intelligibility of English-speaking children, Kent and Miolo [3] provide a clear review of the existing procedures. They classified 19 assessment procedures into 6 categories, primarily based on the linguistic level of the test material (e.g. single word, sentences, continuous speech and conversations) and manner of judgement (word identification or rating scales).

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Schiavetti [4] described only two kinds of procedures to quantify the intelligibility of conversational speech, namely scaling procedures and word identification tests. In scaling procedures the listeners estimate the proportion of words correctly understood, whereas in word identification tests the listeners attempt to determine exactly what was said.

In the case of a word identification test, intelligibility can be expressed in terms of the percentage of words that are correctly understood in a speech sample, according to the 'intelligibility index' as described by Shriberg et al. [5]. This principle was used in several evaluation procedures for the assessment of intelligibility of English-speaking children. For example, Morris et al. [6] described the 'preschool speech intelligibility measure', based on the 'assessment of intelligibility of dysarthric speech' [7]. In this test, the 3;06- to 5-year-old children were asked to repeat 50 words, whereby each word was randomly chosen from one of the 50 lists consisting of 12 phonetically similar words. Furthermore, Gordon-Branan and Hodson [8] obtained intelligibility measurements in the continuous speech of 48 English-speaking prekindergarten children (mean age: 4;7 years) with varying levels of phonological proficiencies and determined the percentage of words understood by unfamiliar listeners in a known context. When the percentages of the children with 'severe intelligibility involvement (i.e., least intelligible)' were excluded, the intelligibility scores ranged from 68 to 100% with a mean of 85%. In a study by Chin et al. [9], 47 normal-hearing English-speaking children also reached adult-like or near-adult-like intelligibility around the age of 4 years. This seems to be consistent with the findings of previous studies by Weiss [10] and Coplan and Gleason [11].

Whereas the 'intelligibility index' described by Shriberg et al. [5] is a cross-linguistic method, the English word list proposed by Morris et al. [6] cannot be used as an evaluation procedure for the intelligibility of non-English-speaking children in Flanders, the northern part of Belgium. In this region, Dutch is the majority language. The pronunciation of Standard Dutch is co-determined by the dialect surrounding the speaker. A popular term used for the variety of the Dutch language spoken in the northern part of Belgium is 'Flemish'.

Although objective and systematic procedures for measuring intelligibility are an important addition to the speech-language pathologist's testing protocol, no standardised procedures have been described to determine the percentage of speech intelligibility of Flemish-speak-

ing children so far. Until now, the intelligibility of Flemish children has been assessed using scaling procedures. In addition, the speech production of Flemish children is often examined by a conventional articulation test in which Dutch speech sounds and clusters in all permissible syllable positions are elicited. Such procedures require comparison of the child's abilities with those of adults and evaluate only the sound production, and not the intelligibility as described above.

The main purpose of this study was to obtain normative data for the intelligibility of Flemish-speaking children as judged by their parents, their most important communication partners. These data can provide important reference information for speech pathologists assessing speech development and its disorders. Intelligibility judgements can be affected by multiple factors [3], specifically, the listener's familiarity with the speaker. A number of authors [12–15] have suggested that a judge who is personally familiar with the speaker may have an advantage in understanding what is being said. Moreover, several studies [16–18] found an overall superior performance of mothers over other listener groups (including the fathers). Therefore, in this study we examined the influence of the familiarity with the speaker and some other factors, such as gender (normative data for boys and girls) and age of the child. It was hypothesised that intelligibility percentages would change as a function of age and familiarity.

Methods

Participants

The parents of 181 children randomly recruited from 14 normal preschool kindergartens located in Flanders agreed to participate in the study. Before testing, the parents were asked for important information concerning the hearing, neurological, motor and physical development of the child. In addition, the spontaneous speech of each child was judged on speech, language, voice or resonance abnormalities by 2 experienced speech pathologists (N.B., S.G.). So, 18 children were excluded because of multilingualism ($n = 11$), insufficient cooperation ($n = 4$) and resonance or phonation disorders ($n = 3$). The remaining group of participants included 163 healthy children ranging in age from 2;06 to 5 years with a mean age of 3;07 years. There were 83 boys (mean age: 3;07 years) and 80 girls (mean age: 3;07 years). To measure the effect of age, the children were divided into five age categories, as presented in table 1.

The parents, preferably both, acted as judges. Before participation, all parents were questioned about any hearing problems at present or in the past. Three participants with a history of hearing impairment or doubts about it were excluded. In 57 cases, 1 of the parents was unable to participate because of organizational rea-

Table 1. Age of the 163 subjects

	Category 1 (2;06–3;0 years)		Category 2 (3;0–3;06 years)		Category 3 (3;06–4;0 years)		Category 4 (4;0–4;06 years)		Category 5 (4;06–5;0 years)	
	girls	boys	girls	boys	girls	boys	girls	boys	girls	boys
Number	16	19	17	18	18	20	19	19	10	7
Total	35		35		38		38		17	

Table 2. Mean intelligibility scores (%) and standard deviations for each age category

Subtest	Category 1 (2;06–3;0 years)		Category 2 (3;0–3;06 years)		Category 3 (3;06–4;0 years)		Category 4 (4;0–4;06 years)		Category 5 (4;06–5;0 years)	
	mean	SD	mean	SD	mean	SD	mean	SD	mean	SD
Words	77.88	12.42	85.81	9.3	92.18	9.5	90.31	8.53	90.78	7.19
Sentences	45.42	27.80	62.85	25.64	77.63	18.76	80.90	21.51	90.52	18.82
Storytelling	54.41	29.40	66.25	25.66	86.11	21.81	82.12	24.85	92.26	15.53

SD = Standard deviation.

sons. In 55 cases only the mother and in 5 cases only the father listened to the recording. For the remaining 103 participants both parents actually participated.

Procedure and Materials

The Dutch intelligibility test ‘Percentage Spraakverstaanbaarheid bij kinderen’ (Percentage Speech Intelligibility in Children) [19] was used to measure speech intelligibility. This test consists of three subtests: naming words, producing sentences and telling a story (‘Appendix A’). In the first and second subtests, 25 words and 7 sentences, respectively, were elicited by a picture-naming test. In the third subtest, the child told a short story using 4 illustrations.

The recordings and judgement sessions took place in a noiseless room at the school or at home. Two speech pathologists (N.B., S.G.) elicited the words and sentences in the children and encouraged them verbally when necessary. At the same time, they recorded the speech samples (Sony ICD-SX56 recorder) to present them to the parents afterwards in the absence of the child (laptop, Toshiba M70 with sound card and acoustic amplifier Monacor MKA-60SET/WS). The parents could listen twice to each word, sentence or story. They were asked to write down what they understood of the phonetic realisation of the child’s speech. Both parents were instructed to operate completely independently. In case they had absolutely no idea about the meaning of a production, they were asked to leave the response blank. In case of doubt, they were asked to guess. Afterwards, the investigator counted the words correctly understood and determined an intelligibility percentage according to the ‘intelligibility index’ as described by Shriberg et al. [5]. If there was a morphological difference between the production of the child and the answer of the parents, it was

handled as a correct answer because the content remained largely the same. Nonetheless, such differences were rare (less than 20 times) because most target words are uninflected.

In 24 children (12 boys and 12 girls randomly selected from each of the age categories), the parents were asked to score the same speech sample again with a time interval of 4 weeks and without reference to their first transcription. The formula ‘words identically transcribed/all words transcribed’ was applied, and so, a percentage of point-to-point group agreement of 88% was found.

Additionally, a panel of 12 first-year students in speech-language pathology (women ranging in age from 18 to 22 years, with a mean age of 19;03 years) who were not familiar with the speech of toddlers listened to the recordings of another subgroup of 24 randomly selected children (mean age: 3;04 years).

Statistical Analysis

SPSS for Windows (version 12.0) was used for the statistical analysis of the data. For the comparison between boys and girls and the comparisons between mothers, fathers, familiar and unfamiliar listeners, the non-parametric Mann-Whitney U test and the Wilcoxon signed ranks test were performed, respectively, with a 5% significance level. In case of multiple comparisons, Bonferroni corrections were applied. Consequently, to compare the judgements of parents and unfamiliar listeners α was divided by the number of comparisons ($n = 6$) and a significance criterion of 0.008 was used.

Fig. 1. Mean intelligibility scores for words, sentences and story-telling for each age category as judged by both parents.

Results

Normative data (means and standard deviations) of the intelligibility of young children as judged by their parents [19] are presented in table 2. Intelligibility for words, sentences and storytelling increased with age. Word intelligibility percentages increased from 77.88% for group 1, for mothers and fathers, to 90.78% for group 5. Sentence intelligibility increased from 45.42% for group 1 to 90.52% for group 5. Storytelling intelligibility increased from 54.41% for group 1 to 92.26% for group 5. These developments until the fifth age category are shown in figure 1. In table 3, one can see that the differences of word, sentence and storytelling intelligibility scores between the three youngest age categories are significant ($p < 0.05$). None of the differences between the three highest age categories are significant, except for the sentence intelligibility in age category 5, which is significantly higher than sentence intelligibility of age category 4.

As can be seen in table 4, there were no significant differences between boys and girls. For the subtest 'words', a significant difference ($p < 0.05$) was found between the scores of mothers and fathers: maternal intelligibility scores were significantly higher than paternal intelligibility scores. On the other hand, no significant differences were observed for the subtests 'sentences' and 'storytelling' (table 5). The results of the comparison between parents' scores and scores of unfamiliar listeners are represented in table 6. For word intelligibility, results indi-

Table 3. Comparison of the intelligibility scores of the different age categories

Subtests	Words	Sentences	Story-telling
Category 1 vs. category 2	0.001*	0.000*	0.032*
Category 2 vs. category 3	0.000*	0.003*	0.000*
Category 3 vs. category 4	0.089	0.132	0.339
Category 4 vs. category 5	0.996	0.006*	0.177

Category 1 = 2;06-3;0 years; category 2 = 3;0-3;06 years; category 3 = 3;06-4;0 years; category 4 = 4;0-4;06 years; category 5 = 4;06-5;0 years. Wilcoxon signed ranks test (significant at * $p < 0.05$).

Table 4. Comparison of intelligibility scores (%) for boys and girls

Subtests	Mean score for		Median score for		p
	boys	girls	boys	girls	
Words	87.04	86.43	88.00	88.00	0.83
Sentences	65.51	71.90	70.00	80.00	0.07
Storytelling	72.44	75.55	77.00	88.50	0.31

Mann-Whitney U test ($p < 0.05$ = significant).

Table 5. Comparison of fathers' judgements (%) and mothers' judgements (%)

Subtests	Mean score for		Median score for		p
	mothers	fathers	mothers	fathers	
Words	88.41	84.27	92.00	87.00	0.00*
Sentences	70.74	65.59	77.00	77.00	0.11
Storytelling	75.54	71.58	85.00	85.00	0.11

Wilcoxon signed ranks test (significant at * $p < 0.01$).

cated that mothers were significantly better at identifying the words than unfamiliar listeners. This trend of a maternal advantage disappeared for sentences and storytelling intelligibility. In judgments of their children's speech, fathers showed no significant difference from unfamiliar listeners.

Table 6. Comparison of parents' judgements (%) and unfamiliar listeners' judgements (%)

				Median (1)	Median (2)	p
Mother word	(1)	unfamiliar word	(2)	84.00	72.00	0.00*
Mother sentence	(1)	unfamiliar sentence	(2)	60.00	53.00	0.24
Mother story	(1)	unfamiliar story	(2)	69.00	85.00	0.35
Father word	(1)	unfamiliar word	(2)	78.50	72.00	0.06
Father sentence	(1)	unfamiliar sentence	(2)	53.50	53.00	0.82
Father story	(1)	unfamiliar story	(2)	65.50	85.00	0.71

Wilcoxon signed ranks test (significant at * $p < 0.008$ after Bonferroni correction).

Discussion

Increasing the overall speech intelligibility is the main goal of treatment in children with a speech impairment. To the best of our knowledge, research regarding the intelligibility of Flemish normal-speaking boys and girls (age 2;06–5;0 years) has not yet been reported and no standardised procedures have been described so far. Because the parents are the most important communication partners of these children, the purpose of the present study was to provide normative values for the intelligibility of words, sentences and storytelling [19] as judged by their parents.

As hypothesized, scores for intelligibility improved with increasing age of the child. After age 3;06–4;0, the intelligibility scores were not significantly related to age. This is consistent with several other studies in which normal-hearing children reached near-ceiling speech intelligibility also around the age of 4 years [8–11]. The decrease in the magnitude of differences between age categories with increasing age can be partially explained by the findings of Van den Broecke et al. [20], who found almost no errors on single phonemes from the age of 3;06 years in Flemish-speaking children.

Although language performance is generally better among girls than among boys [21, 22] and girls begin talking earlier [23] and acquire vocabulary faster [24], no significant differences could be found between the intelligibility scores for normal Flemish boys and girls in this study. To the best of our knowledge, previous studies concerning child intelligibility do not mention any differences between boys and girls either.

In our study, intelligibility scores for the children in the oldest age category reached a value around 90% (table 2), whereas adult-like intelligibility as described in other studies [8–11] is expected to approach 100%. A pos-

sible explanation for this difference can be the large number of other factors affecting speech intelligibility, such as the nature of the spoken material, the context of communication, the listener's familiarity with the speaker, contextual support for the message to be transmitted, clarity of the visual and acoustic signals of speech, and other environmental and linguistic factors [3, 25–27]. The fact that in this study only audio-recorded speech samples were presented to the parents is different from daily conversations, in which conversation partners receive non-verbal information from gestures, facial expression and context. Besides, in this study an existing list of words and sentences and a fixed story were imposed on the children, whereas in spontaneous speech the children choose the context and the sentence structure themselves. So, restricted linguistic skills could have played a part in the apparent reduced maximum intelligibility score. In the youngest age categories, those restricted syntactic and morphologic skills can also account for the reduced sentence and story intelligibility in comparison with word intelligibility. As illustrated in figure 1 and table 2, the respective scores for word, sentence and story intelligibility seem to approach each other with increasing age, which can also be attributed to children's increasing syntactic and morphologic skills. Because of these inherent limitations of a structured test as suggested in this study, several studies [27–29] have argued for the use of connected speech samples for assessing intelligibility. However, conversational speech samples also have limitations, such as the lack of control and knowledge of the speech material and the time-consuming procedure. A possible correlation between the intelligibility scores obtained by our procedure and the intelligibility of spontaneous conversational speech is an interesting subject for further research.

Furthermore, some significant differences between intelligibility scores of fathers, mothers and unfamiliar listeners were found in this study. Several previous studies demonstrated the advantage of familiar judges compared to unfamiliar listeners concerning speech intelligibility [12–15]. Our comparison between parents' scores and scores of the unfamiliar judges indicated that mothers were significantly better than fathers and unfamiliar listeners in identifying words. These findings are in agreement with the English intelligibility measures in several studies [16–18], which found that mothers were significantly better than all other listeners (including fathers) at identifying the words being spoken. This maternal advantage disappeared in the subtest sentence and storytelling. On the other hand, the significant difference between the word intelligibility scores of fathers and mothers is associated with a 4% intelligibility difference, which is well within the test-retest reliability of about 8% as reported by Yorkston and Beukelman [30] for their test. Therefore, although statistically significant, the difference between fathers and mothers in our study should be interpreted with caution. So, further research in a larger number of participants, including formal measures of contact time with the child and also educational level of the parents, may be needed to find out to what extent parents understand their child better.

In conclusion, the findings of the present study provide normative values for the words, sentences and storytelling intelligibility [19] for normal Flemish-speaking boys and girls (age: 2;06–5;0 years) as judged by their parents. Kwiatkowski and Shriberg [27] found a significant difference between what the caregivers thought they understood and the amount of speech they accurately understood, as assessed by words or utterances. Decreased results of speech intelligibility compared with the available normative data can document and convince the parents of the possible presence of a speech impairment of their child. On the other hand, the reported normative speech intelligibility data provide important reference information for speech pathologists who assess articulation and articulation disorders. With these normative data the effect of a specific therapeutic approach and the spontaneous transfer to daily speech can be measured and compared. Because of the inherent limitations of the selected speech material in this study, we suggest additional measures for speech-impaired children, such as a judgement of spontaneous speech and conventional language and articulation tests to form a complete picture of the speech and language skills of the child. In addition, the test procedure proposed in this study is a convenient and non-time-consuming method which can function as an informative addition to the conventional testing protocol in Flemish-speaking children.

Appendix A

Adaptation Procedure

Appel	(apple)	['apəl]
Leeuw	(lion)	['le:w]
Vork	(fork)	['vɔrk]
Koffie	(coffee)	['kɔfi:]
Sleutel	(key)	['slətəl]

Words

1. bal	(ball)	[bal]	14. boom	(tree)	[bo:m]
2. mes	(knife)	[mɛs]	15. schoen	(shoe)	[sXun]
3. aap	(monkey)	[a:p]	16. huis	(house)	[hœys]
4. bad	(bath)	[bat]	17. lepel	(spoon)	['le:pəl]
5. olifant	(elephant)	['o:lifant]	18. pop	(doll)	[pɔp]
6. telefoon	(telephone)	[te:le:'fo:n]	19. boek	(book)	[buk]
7. bed	(bed)	[bet]	20. bloem	(flower)	[blum]
8. eten	(eating)	['e:tən]	21. tafel	(table)	['ta:fəl]
9. trein	(train)	[trɛɪn]	22. kat	(cat)	[kat]
10. boot	(boat)	[bo:t]	23. slapen	(sleeping)	['sla:pən]
11. banaan	(banana)	[ba'na:n]	24. toilet	(toilet)	[twɑ'let]
12. muts	(cap)	[mœts]	25. duim	(thumb)	[dœym]
13. hond	(dog)	[hɔnt]			

Sentences

De hond is stout geweest. (The dog has been naughty.)

[də] ['hɒnt] [ɪs] [stɔyt] [gə'we:st]

De schoen zit in de tas. (The shoe is in the bag.)

[də] ['sXun] ['zɪt] [ɪn] [də] [təs]

Het paard gaat eten. (The horse is going to eat.)

[hət] [pa:rt] [ga:t] ['e:tən]

Deze meneer heeft een baard, die meneer heeft geen baard. (This man has a beard, this man has no beard.)

['de:zə] [mə'ne:r] [he:ft] [ən] [ba:rt], [di] [mə'ne:r] [he:ft] [ge:n] [ba:rt]

Het kind zingt een liedje aan de telefoon. (The child sings a song on the telephone.)

[hət] ['kɪnt] [zɪŋt] [ən] ['li:cə] [a:n] [də] [te:le:'fo:n]

Op mijn pyjama staan mooie bloemen. (There are beautiful flowers on my pyjama.)

[ɔp] [mɛɪn] [pi:'ja:mɑ] [sta:n] ['mo:jə] ['blumən]

Met die sleutel kan je de koffer openmaken. (With this key you can open the box.)

[mɛt] ['de:zə] ['slətəl] [kən] [jə] [də] ['kɒfər] ['o:pən'ma:kən]

Storytelling

'The story of the monkey who received a banana from a man.'

Example of a possible story according to the pictures presented:

De man (meneer) geeft een banaan aan de aap. (The man gives a banana to the monkey.)

[də] [mən] [ge:ft] [ən] [bəna:n] [a:n] [də] [a:p]

De aap eet de banaan op. (The monkey eats the banana.)

[də] [a:p] [e:t] [də] [bəna:n] [ɔp]

De aap gooit de schil weg. (The monkey throws the peel away.)

[də] [a:p] [go:jt] [də] [sXɪl] [wɛX]

De man glijdt uit/valt over de schil. (The man slips over the skin.)

[də] [mən] [glɛɪt] [o:vər] [də] [sXɪl]

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