Relation between deaf children’s phonological skills in kindergarten and word recognition performance in first grade

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Background: The aim of the present study was twofold: 1) to determine whether phonological skills measured in deaf prereaders predict their later phonological and reading skills after one year of reading instruction as is the case for hearing children; 2) to examine whether the age of exposure to a fully specified phonological input such as Cued Speech may explain the inter-individual differences observed in deaf children’s phonological and word recognition levels. Method: Twenty-one 6-year-old deaf prereaders and 21 hearing children of the same chronological age performed two phonological tasks (rhyme decision and generation tasks); they were re-assessed 12 months later and presented with other phonological tasks (rhyme decision and common unit identification tasks) and a written word choice test. Results: Phonological skills measured before learning to read predicted the written word recognition score the following year, both for hearing and for deaf participants. Age of onset of exposure to Cued Speech was also a strong predictor of phonological and written word recognition scores in beginning deaf readers. Conclusions: The evidence broadly supports the idea of a capacity for acquiring phonological skills in deaf children. Deaf children who are able to develop an implicitly structured phonological knowledge before learning to read will be better readers when this knowledge becomes explicit under the pressure of reading instruction. Keywords: Deafness, phonological skills, cued speech, reading development, longitudinal study.

Deaf children typically exhibit literacy difficulties. The majority of deaf children make poor reading progress during school education and, consequently, attain only a low reading level: 60% of deaf school leavers have a reading level below 4th grade (Conrad, 1979; Chamberlain & Mayberry, 2000; see review by Marshark & Harris, 1995). Studies conducted in the United States (Trezek & Malmgren, 2005) and in Europe (Leybaert & Alegria, 2003) have shown that deaf children, born to hearing parents, who use an oral mode of communication present less difficulties of reading acquisition than those who use sign language. The main reason is that phonological processing is critical in reading, even for deaf individuals.

In the assessment of phonological skills, two levels of phonological processing have to be distinguished: epi- and meta-phonological (Gombert, 1992). The epi-phonological processing is described as a phonological sensitivity to linguistic units such as rimes, syllables (in French at least) and phonemes. This phonological sensitivity contributes to the development of the phonologically structured lexicon (Metsala & Walley, 1998). In hearing children, rhyming ability emerges spontaneously at around 3 to 4 years of age (Read, 1978; Slobin, 1978), with some individual differences linked to the quality of their oral productions (Webster & Plante, 1995). Rhyming ability results from natural linguistic development and emerges before formal reading instruction (Morais, Bertelson, Cary, & Alegria, 1986). According to Gombert (1992), epi-phonological processing is implicit because the processed linguistic units are not directly accessible and manipulable. By contrast, meta-phonological processing has been defined as the ability to identify and manipulate the linguistic units in an intentional, explicit way. Common unit detection tasks on phonemes, syllables and rimes (Duncan, Seymour, & Hill, 1997) or phoneme deletion or substitution tasks (Lundberg et al., 1980) are usually used in order to evaluate meta-phonological ability (see review by Castles & Coltheart, 2004). The emergence of meta-phonological processing depends on both the pre-existing epi-phonological knowledge and the reading instruction which compels children to become aware of the segmental nature of oral language. Meta-phonological processing constitutes a good predictor of reading level (Ecalle & Magnan, 2002; Gombert, 1992).

The role of phonology in the acquisition of deaf individuals’ reading abilities has been documented by several studies. The evidence suggests that deaf good readers are better at rhyme judgement and rhyme production tasks than those who are poor readers, though these skills are typically less developed than in hearing readers (Campbell & Wright, 1988; Charlier & Leybaert, 2000; Dodd & Hermelin,

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precedes or follows excellence in reading in phonological awareness units which are ‘linguistically defined primitives’ (Trezek & Wang, 2006). The critical factor seems to be the development of accurate phonological representations on the base of the phonological units which are linguistically defined primitives related to articulatory gestures’ (Hanson, 1991).

Data obtained so far on deaf readers do not answer to the question of whether ‘phonological awareness precedes or follows excellence in reading in profoundly deaf individuals’ (Goldin-Meadow & Mayberry, 2001, p. 224). It is possible that deaf readers gain access to phonological units like syllables and phonemes through their experience with reading. On the other hand, phonological awareness could precede, and indeed favor, the development of reading in deaf readers. The only way to answer this question is to conduct longitudinal studies designed to measure deaf children’s phonological awareness before and during reading acquisition.

Few longitudinal studies evaluate whether reading development is predicted by early phonological skills in deaf children. Harris and Beech (1998) compared the performances of deaf children (from oral and signing backgrounds) to that of hearing children’s with an odd-man-out task (Bradley & Bryant, 1983) at the beginning of their first year of formal reading instruction, and of written word comprehension at different moments during the first year. Children were asked to indicate which of two pictures was named similar to the target picture (e.g., bed, red, pen). Deaf children’s performance at the odd-man-out task was significantly poorer than that of the hearing children. This measure correlated with reading progress for both the deaf and the hearing groups. Therefore, a possible conclusion could be that deaf children’s difficulty in reading development could result from poor implicit phonological skills prior to reading instruction. In a cross-sectional study of deaf children between 7 and 8 years old, Kyle and Harris (2006) found that phonological awareness was a significant correlate of reading ability before hearing loss was controlled for. However, after hearing loss was controlled for, only lip-reading skills and productive vocabulary remained significantly associated with reading achievement. The predictive power of implicit phonological skills on reading achievement during the first grade remains unanswered. The first objective of the present study is to examine this relationship through the use of regression analyses in a sample of deaf children educated orally in the French language.

One way of improving deaf children’s access to the phonological units of spoken language and, hence, to promote phonological awareness consists of using Cued Speech (CS) to communicate with them. CS was invented by Cornett (1967) to help deaf children to become efficient readers. CS aimed at resolving the ambiguity inherent in lipreading. In CS, the speaker complements the lip gestures of speech with manual cues. A cue consists of two parameters: the shape of the hand and the position of the execution around the mouth; hand shapes disambiguate the consonants and hand positions the vowels (cf. French version of CS on the following site: http://www.alpc.asso.fr/code01-c.htm). The integration of spoken and manual information leads to a single, unambiguous, phonological percept that children cannot deduce from either source alone (see Leybaert, Alegria, Hage, & Charlier, 1998; Leybaert & Alegria, 2003, for a detailed description).

Two studies have already shown that early and intensive exposure to CS favors the development of genuine rhyming ability in literate deaf participants (Charlier & Leybaert, 2000; LaSasso, Crain, & Leybaert, 2003). Charlier and Leybaert (2000) also documented that 5-year-old prereaders who were early CS users exhibited rhyme judgement skills equivalent to their chronological age-matched hearing controls, suggesting that this early exposure to a phonologically well-specified linguistic input could favor rhyme sensitivity prior to reading acquisition. However, no study has investigated the relationship between early exposure to CS and word recognition at the end of first grade. A second objective of the present study was to examine this relationship.

Although we anticipated differences between the performances of hearing and deaf participants in the phono- logical tasks and the written word choice test, we expected that 1) the meta-phonological skills in the first grade would be predicted by the epi- phonological skills in kindergarten and 2) both the epi- and meta-phonological tasks would correlate with individual written word recognition in deaf and hearing children. However, the contributions of the epi- and meta-phonological tasks to reading performance could be different in hearing and deaf children, reflecting the relative influence of implicit versus explicit phonological knowledge. We also expected that age of exposure to Cued Speech could be a strong predictor of phonological skills and written word recognition even after having controlled for specific characteristics of deaf children (i.e., hearing loss and speech intelligibility).

**Method**

**Participants**

Two groups of French-speaking participants, deaf and hearing children, took part in the longitudinal study. Twenty-one deaf children (11 boys and 10 girls) with severe to profound prelingual hearing loss were recruited from different French and Belgian specialized (N = 10) and regular (N = 11) schools. The mean age of the deaf children was 6 years 2 months at the beginning of the study (SD = 6.7 months; range 5 years 5 months to 7 years 3 months). All deaf children met the following criteria: a) no other significant handicapping conditions, and b) hearing loss onset prior to 12 months of age. Eight of them were fitted with coch-
leural implants (all except a profoundly deaf child had been implanted late, after the age of 3 years) and the other 13 wore hearing aids. Unaided (without prosthesis or cochlear implant), hearing loss was severe (between 70 and 90 dB at the better ear across three frequencies of the speech range (.5, 1, and 2 kHz)) for five of the children, and profound for the remaining 16 (mean hearing loss above 91 dB at the better ear). Only one deaf child had a deaf parent; the other 20 had hearing parents. All children were exposed to oral communication and received the French version of CS, although for different periods of time. Seven of them (mean age: 6 years) received CS at home from a mean age of 25 months \( (SD = 8.2 \text{ months}) \), meaning that at least one of their parents used it in daily communication. Seven other deaf children (mean age: 6 years 3 months) had been exposed to CS in their school, and inconsistently in their home environment, from a mean age of 56 months \( (SD = 9.2 \text{ months}) \). The remaining seven deaf children (mean age: 6 years 4 months) received CS for the first time when they entered first grade (mean age: 81 months; \( SD = 5.8 \text{ months} \)).

The control group consisted of 21 hearing prereaders (11 boys and 10 girls) with a mean age of 6 years 1 month \( (SD = 4.2 \text{ months}) \); range 5 years 5 months to 6 years 7 months).

**Tests administered and procedure**

All children were twice assessed individually: the first time in kindergarten (hereafter: KG, from to April to June, mean age: 6 years; 2 months), and the second time in first grade (hereafter: FG, after 10 months of reading instruction; mean age: 7 years; 2 months).

**SESSION 1: Kindergarten (KG).** Two epi-phonological tasks were presented to the children: a rhyme decision task and a rhyme generation task. The speech intelligibility level of deaf participants was measured at this point.

**Speech intelligibility measure.** Twenty-three bisyllabic CVCC words representable by pictures were selected from the usual vocabulary of deaf children in order to create the experimental trials for the rhyme decision task (see below). The speech intelligibility level of deaf participants was measured using these pictures. In a separate session, the first author gave the name of the pictures to each child individually and verified the child’s knowledge of each word. After having been familiarized with the material, children were asked to pronounce the name of the pictures. The experimenter or the speech therapist noted the child’s responses online. The speech level intelligibility was calculated on the basis of number of correct phonemes produced (max: 92 phonemes).

**Rhyme decision task.** An odd-man-out picture task was adapted for use with young deaf children from Harris and Beech’s (1998) tasks. Each trial consisted of three pictures: a model above and two tests pictures below (target and distracter). The experimenter named the three pictures to ensure that the child got access to the correct names. The child’s task was to choose the picture that rhymed with the model. Sixteen experimental trials were included, eight involving a common final syllable (e.g., model: *château*/lato/; target: man-

**SESSION 2: First Grade (FG).** The same participants were assessed 12 months later when attending FG. Three experimental tests were administered: 1) a rhyme decision task (epi-phonological processing); 2) a phonological common unit identification task (meta-phonological processing); and 3) a written word choice test (Ecalle, 2003). The Kohs cubes test was used to assess NVIQ (non-verbal intelligence).

**Phonological tasks: rhyme decision and common unit identification.** These two tasks consisted of the same material: a set of 96 pictures, of which 80 pictures were used for the experimental trials and 16 for training. The names of these pictures were all in the Manulex database (Lété et al., 2004). Each trial consisted of four pictures: the model which appeared above (e.g., *chalet*/[əl/]) and three test items which appeared below (e.g., target: *chapeau*/[aup/]; labial distracter: *jambon*/[o]/ and not labial distracter: *tissu*/[i]/). There were 20 randomized experimental trials. Ten trials involved bisyllabic words (CVVC) sharing a common syllable (initial or final as in *lutin*, patin, poney, carreau). The other ten trials involved monosyllabic CVVC words sharing a common initial phoneme (as in *tasse*, tour, douche, pull) or a common final phoneme (as in *bec*, sac, bague, lune). In the rhyme decision task, children had to choose the target item (out of three) that shared the phonological unit (syllable vs. phoneme in initial or final position) with the model. The score represented the correct responses over the 20 trials (hereafter: EpiFG). In the Common unit detection task, children had to say aloud the unit that was shared by the model and the target (Duncan et al., 1997). The score (Meta FG) represented the total number of correct responses (syllable or phoneme).

Before each experimental task, children were given 4 training trials. Oral language was used to communicate the instructions. Cues of CS were used when there were difficulties of comprehension. All the participants were tested individually.
Table 1 Group effects and means and (standard deviations) for all the experimental tasks

<table>
<thead>
<tr>
<th>Tasks</th>
<th>Session</th>
<th>Max.</th>
<th>Deaf, Mean (SD)</th>
<th>Hearing, Mean (SD)</th>
<th>Group effect</th>
<th>$\eta^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>SI</td>
<td>KG</td>
<td>92</td>
<td>68.80 (18.94)</td>
<td>12.67 (2.90)</td>
<td>$F(1, 40) = 4.04; p = .05$</td>
<td>9%</td>
</tr>
<tr>
<td>RD*</td>
<td>KG</td>
<td>16</td>
<td>11.00 (2.45)</td>
<td>16.38 (3.09)</td>
<td>$F(1, 40) = 21.17; p &lt; .0001$</td>
<td>35%</td>
</tr>
<tr>
<td>RG*</td>
<td>KG</td>
<td>–</td>
<td>.87 (.66)</td>
<td>1.95 (.85)</td>
<td>$F(1, 40) = .04; p = .83$</td>
<td>NS</td>
</tr>
<tr>
<td>NVIQ</td>
<td>FG</td>
<td>12</td>
<td>7.71 (2.00)</td>
<td>15.83 (2.34)</td>
<td>$F(1, 40) = 24.27; p &lt; .0001$</td>
<td>38%</td>
</tr>
<tr>
<td>RD*</td>
<td>FG</td>
<td>20</td>
<td>13.34 (3.51)</td>
<td>23.81 (5.55)</td>
<td>$F(1, 40) = 25.78; p &lt; .0001$</td>
<td>39%</td>
</tr>
<tr>
<td>CUI**</td>
<td>FG</td>
<td>20</td>
<td>9.28 (5.62)</td>
<td>9.28 (5.62)</td>
<td>$F(1, 40) = 9.00; p &lt; .005$</td>
<td>18%</td>
</tr>
<tr>
<td>R</td>
<td>FG</td>
<td>36</td>
<td>16.38 (6.39)</td>
<td>16.38 (6.39)</td>
<td>$F(1, 40) = 3.33; p &lt; .08$</td>
<td>7%</td>
</tr>
<tr>
<td>R task 1</td>
<td>FG</td>
<td>12</td>
<td>6.24 (3.08)</td>
<td>10.14 (1.71)</td>
<td>$F(1, 40) = 16.16; p &lt; .001$</td>
<td>29%</td>
</tr>
<tr>
<td>R task 2</td>
<td>FG</td>
<td>12</td>
<td>5.43 (2.06)</td>
<td>7.57 (2.54)</td>
<td>$F(1, 40) = 24.27; p &lt; .0001$</td>
<td>38%</td>
</tr>
<tr>
<td>R task 3</td>
<td>FG</td>
<td>12</td>
<td>4.71 (2.24)</td>
<td>6.10 (2.64)</td>
<td>$F(1, 40) = 25.78; p &lt; .0001$</td>
<td>39%</td>
</tr>
</tbody>
</table>

Notes: SI: Speech intelligibility measured in kindergarten with rhyme decision task’s material. RD: Rhyme decision; RG: Rhyme generation; NVIQ: Non-verbal intelligence assessed by the Kohs cubes test; CUI: Common Unit Identification; R: Reading test. 

*Epi-phonological tasks; **Meta-phonological task.

Written word choice test. This test consisted of three forced-choice tasks, each consisting of 12 items, in which the target word was presented as 1) a spoken word; 2) a picture; 3) a semantically related written word (for example: written model word: lit – bed – and written target item: chambre – bedroom) (Ecalle, 2003). In each task, children had to find the target word out of 5 items: the orthographically correct word (e.g., bateau, boat), a pseudo-homophone (baleau), a visually similar pseudoword (baleaue), a pseudoword sharing the initial letters (batte), and a nonword containing an illegal letter sequence (btaeua). The dependent variable was the number of correct responses (max: 36). Children were tested within their normal classrooms, without time limit.

Results

A binomial test was used to determine the probability that children responded at random. The results showed that the performances of both hearing and deaf children were significantly above chance level for all the experimental tasks.

An ANOVA was performed on each measure, with Group (Deaf vs. Hearing) as main factor. The analyses revealed that the hearing group achieved a higher degree of accuracy than the deaf group in all the experimental tasks (see Table 1).

Predictive power of the phonological skills in prereaders on phonological and reading skills in first grade

The issue is whether the epi-phonological abilities measured in KG and in FG predict 1) meta-phonological skills in FG (metaFG) and 2) written word recognition score in FG in deaf and in hearing participants. Therefore two sets of multiple regressions were carried out separately on the two groups.

We computed Z scores for the rhyme decision and for the rhyme generation tasks in KG, and the mean of these two Z scores was used as a unique predictor (score; EpiKG for epi-phonological skills in kindergarten).

In the first set of regression analyses, the dependent variable was the score of the common unit task (MetaFG) and the independent variables were chronological age, non-verbal intelligence (NVIQ), EpiKG and EpiFG. In a second set of regressions, the dependent variable was the word recognition score. The independent variables were chronological age, NVIQ, EpiKG, EpiFG and MetaFG.

The regression models were the following: we entered the independent variables in a fixed order. Then we tested the respective contribution of phonological skills measured in FG: EpiFG (model 4a) and MetaFG (model 4b). The results of these two sets of regressions are shown in Table 2.

After having controlled for the variability linked to the chronological age and NVIQ:

1. Meta-phonological skills in first grade (MetaFG) were significantly predicted by EpiKG (introduced at step 3; $R^2$ change = 21.1%) and EpiFG (introduced at step 4; $R^2$ change = 56%) in the hearing children; by contrast, only EpiFG predicted MetaFG (introduced at step 4; $R^2$ change = 48.5% of variance) in the deaf children.

2. The written word recognition score was significantly predicted by EpiKG, both in the deaf ($R^2$ change = 28.3%) and in the hearing children ($R^2$ change = 31.1%). In deaf children only, MetaFG introduced at the 4th step added a significant contribution to the explanation of variance of the reading score ($R^2$ change = 17.3%). Similar results were observed in deaf children when mean hearing loss was introduced in step 3 as independent variable. EpiKG predicted the written word recognition score (introduced at step 4; $R^2$ change = 56%).

Because no significant difference was observed between the deaf children with and without CI in all the tasks administered in KG and FG, we decided to keep them in a single group.

Although the contributions of our two epi-phonological tasks to reading performance may be decomposable, we emphasize them in the present context as reflecting a single factor.
change = 30.6%). Significant contribution of MetaFG (introduced at step 5; \( R^2 \) change = 20.6%) was also observed on the same score. None of the other predictors, including mean hearing loss, had a significant effect on the reading score.

### Predictive power of the age of exposure to Cued Speech on the development of phonological and word recognition skills: additional contribution of epi-phonological skills?

Our second research question was the effect of early exposure to CS on the development of phonological and word recognition skills. Two additional sets of regressions were carried out.

In the first set of regression analyses, we examined the impact of five independent variables: chronological age, NVIQ, mean hearing loss, speech intelligibility and age of exposure to CS on four dependent variables: EpiKG, reading score in FG, EpiFG and MetaFG. We entered the following variables in a fixed order into the regression model: chronological age (step 1), NVIQ (step 2), level of hearing loss with prosthesis or cochlear implant (step 3), speech intelligibility (step 4), and the age of exposure to CS (step 5). The results of this set of regressions are shown in Table 3.

None of the predictors, including age of exposure to CS, had a significant effect on EpiKG. Only hearing loss approached the conventional significance level (\( p = .07 \)). Age of exposure to CS only predicted the score of the written word choice test at the end of FG (\( R^2 \) change = 20.7%). Significant contributions of speech intelligibility (\( R^2 \) change = 23%) and age of exposure to CS (\( R^2 \) change: 23%) were also observed on EpiFG. Finally, MetaFG was marginally predicted by speech intelligibility (\( p = .08 \)), and significantly by age of exposure to CS (\( R^2 \) change: 34.6%).

In the last regression analysis, the dependent variable was the written word recognition score measured in FG. The independent variables were chronological age, NVIQ, age of exposure to CS, EpiKG, EpiFG and MetaFG. We entered the first four independent variables in a fixed order in the regression model. Then we tested the respective contribution of EpiFG (model 5a) and of MetaFG (model 5b). The results of this set of regressions are shown in Table 4.

After having controlled the variability linked to chronological age and NVIQ, the regression analysis shows that the written word recognition score was only predicted by the ‘age of exposure to CS’ (\( R^2 \)
change = 26.1%) and that EpiKG, introduced at the 3rd step, added a significant contribution to the explanation of variance of the reading score (R² change = 16.2%).

### General discussion

Relatively little is known about the developmental trajectory of reading skills in deaf children. Therefore the present research examines the possible predictors of literacy development through a longitudinal study. Two questions were addressed: 1) Do early and implicit phonological skills in deaf prereaders predict their later explicit phonological skills and written word recognition skills when they are beginning readers? 2) To what extent can the development of phonological and written word recognition skills at the end of FG be predicted by the age of exposure to Cued Speech?

Regarding the first question, our results do suggest similarities and differences between the two groups. Although the deaf children had lower performances than the hearing children in the rhyme decision task and the rhyme generation task in KG, their early and implicit phonological skills predicted written word recognition skills in FG. The difference lies in the fact that, contrary to the hearing children, only epi-phonological skills measured in first grade (and not in kindergarten) predicted meta-phonological skills in deaf children.

These results can be interpreted as follows: rhyme decision in KG could be carried out on the basis of a holistic processing (Cardoso-Martins, 1994) which does not require identification or manipulation of the phonological units. Deaf children can do this holistic processing on the basis of their phonological representations, elaborated on multimodal information provided by lipreading, articulatory feedback, and residual hearing (Campbell, Dodd, & Burnham, 1998; Dodd & Campbell, 1987; Harris & Moreno, 2006; Leybaert et al., 1998; Transler, 2001). These representations are probably underspecified because lipreading does not allow accurate perception of phonological contrasts like voicing, articulatory mode, or nasality (Erber, 1979). Many words have similar lipread patterns and thus exist as visual homophones in deaf children's internal lexicon. For example, jambon/z̃bɔ̃/and chameau/ʃamdo/ do not share any spoken phoneme but are visually homophonous. Deaf children succeeded on the rhyme decision task above chance level but as the visual homophones are not all real homophones, a larger number of errors were produced. A better performance in KG could thus be related to a better structured phonological lexicon in which the visual homophones are clearly distinguished one from the other (Metsala & Walley, 1998).

Deaf children also reached a lower word recognition level in FG than hearing children (reading delay from 8 to 2 months). These data confirm a delay in deaf children's reading development after 10 months of instruction (Harris & Beech, 1998), with inter-individual differences.

Our results suggest that the deaf children who produced fewer errors in implicit phonological tasks in KG were those who were more accurate at the written word choice test in FG. Implicit structured phonological knowledge in KG may, under the effect of the reading instruction, become conscious and beneficial for deaf children as is the case for hearing ones (Gombert, 1992). In our study, unlike in Kyle and Harris (2006), phonological awareness remained a significant correlate of deaf children's reading ability even after hearing loss was controlled for. Both studies differed in several respects which could explain this contrast. Kyle and Harris look at the cross-sectional relationships and the children were between 7 and 8 years old. We adopted a longitudinal approach and our children were younger (i.e., 6 years 2 months) at the first assessment.

Our second research question was whether early exposure to CS has an effect on the development of phonological and word recognition skills. In KG, only the degree of hearing loss explained inter-individual differences in epi-phonological skills, while neither speech intelligibility nor age of exposure to CS seem to have an effect. This contrasts with the pattern observed at the end of FG. Age of exposure to CS explained a significant proportion of variance of EpiFG, MetaFG, and the written word choice test, left unexplained by hearing loss and speech intelligibility. Children enrolled in KG are not aware of the utility of CS to perform these phonological tasks. They did not systematically produce the manual cues during rhyme generation tasks. In FG, they become aware that the spoken chain is built up of syllables and phonemes, and that CS could offer help in detecting common units, for example. This raises a very interesting developmental issue: phonologically well-structured information provided to children at an early point of development could have positive consequences only at a later point of development, after a phase of lexical restructuring (see Lexical Restructuring Model of Metsala & Walley, 1998) has occurred and/or after the external influence of reading instruction.

In conclusion, we have shown a) a relationship between early phonological skills developed through

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**Table 4: Results of multiple regressions on deaf sample. Dependent variable: Reading score in first grade**

<table>
<thead>
<tr>
<th>Dependent variable: Reading score</th>
<th>Deaf children (N = 21)</th>
</tr>
</thead>
</table>
| 1. Chronological age             | .026                   | .026 ns  
| 2. NVIQ                          | .128                   | .102 ns  
| 3. Age of exposure to CS         | .389                   | .261 .01  
| 4. EpiKG                         | -.551                  | .162 <.03  
| 5a. EpiFG                        | .568                   | .017 ns  
| 5b. MetaFG                       | .607                   | .056 ns  

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4. EpiKG .551 .162 <.03  
3. Age of exposure to CS .389 .261 .01  
2. NVIQ .128 .102 ns  
1. Chronological age .026 .026 ns  

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multimodal information and later word recognition level in deaf children, and b) the impact of a factor clarifying the phonological input addressed to the child, namely age of exposure to CS. Future research is needed to unravel the content of the variable ‘age of exposure’, for example whether it is the type of language experience or the type of processing that is developed by the children.

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Correspondence to

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