This article examines the role of mode of acquisition (MoA) of word meanings in reading comprehension: children acquire word meanings using perceptual information (e.g., hearing, seeing, or smelling the referent) and/or linguistic information (e.g., verbal explanations). A total of 72 deaf and 99 hearing children between 7 and 15 years of age performed a self-paced reading task. Comprehension scores increased with age in both groups, but reading speed increased over age only for the hearing participants. For both groups, reading times on linguistically acquired words were longer than on perceptually acquired words. Although deaf children scored lower than hearing children in both conditions, comprehension scores for both groups were lower on linguistic items than on perceptual items. Thus, MoA influences reading comprehension, but the deaf show difficulty on both the perceptual and the linguistic items.

Many studies have shown that, on average, deaf adolescents perform at the mean reading comprehension level of 9-year-old hearing students (Allen, 1986; Conrad, 1979; Holt, 1993; Holt, Traxler, & Allen, 1997; Karchmer & Mitchell, 2003; Traxler, 2000). A recent study yielded even lower results: Dutch 7- to 20-year-old deaf students on average performed at the level of 7-year-old hearing students, and only 4% were reading at an age-appropriate level (Wauters, van Bon, & Tellings, 2006). This article examines whether mode of acquisition (MoA) of word meanings can partly explain these differences in reading comprehension between deaf and hearing students. We will first discuss why knowledge of word meanings is an important factor in reading comprehension and lay out the construct of MoA. Next, we will focus on the relevance of MoA for language and reading development in deaf children. At the end of the introduction we will explain how we use a self-paced reading procedure and text-related questions to study the processing of words differing in MoA by deaf and hearing children when solving a reading comprehension task.

Hoover and Gough (1990) describe reading comprehension as the product of written word identification and linguistic comprehension. Studies on written word identification in deaf students show varying results (Burden & Campbell, 1994; Fischler, 1985; Harris & Beech, 1998; Kyle & Harris, 2006; Merrills, Underwood, & Wood, 1994; Wauters, van Bon, & Tellings, 2006). Taken together, these studies suggest that word identification problems can explain deaf children’s reading comprehension problems only to a minor degree. Limited linguistic comprehension therefore must be the main cause.

Linguistic comprehension refers to the ability to use semantic information at the word level and to derive sentence and discourse interpretations. Deaf students have been found to lag behind hearing students in many factors that are related to linguistic comprehension, such as metacognitive strategies.
(e.g., Paul, 2003; Strassman, 1997), memory span (Marschark & Mayer, 1998), syntax knowledge (Berent, 1996; Kelly, 1998; Paul, 2003), figurative language (Paul, 2003), and vocabulary size (Kelly, 1996; Marschark, Lang, & Albertini, 2002; Paul, 2003). One aspect of linguistic comprehension is knowledge of word meanings (vocabulary). Aarnoutse and van Leeuwe (1988) found vocabulary to be the most significant predictor of reading comprehension in hearing children. Deaf students show lower vocabulary levels than hearing students (Kelly, 1996; Marschark et al., 2002; Paul, 1996). Garrison, Long, and Dowaliby (1997) found that vocabulary items on a reading comprehension test were more difficult for deaf than for hearing college students. Their regression analysis showed that word and world knowledge together explained 60% of the variance in reading comprehension, with word knowledge accounting for the largest part. Kyle and Harris (2006), in their study with 7- and 8-year-old deaf children who scored low on a sentence comprehension task, found that productive vocabulary explained 28% of the variance in addition to the 41% explained by hearing loss and nonverbal IQ. From these studies it can be concluded that lexical knowledge is an important factor in deaf students’ reading comprehension ability.

**Mode of Acquisition**

At this point, MoA of word meanings comes into play. MoA is a relatively new construct that refers to the type of information children utilize in acquiring the meaning of a word or a sign. For instance, for acquiring the word or sign meaning “red” the child will utilize mainly perceptual information about redness. She plays with a red ball; wears a red dress; and contingent upon this information, people around her use the spoken, written, or fingerspelled word “red” or the sign “red.” By contrast, for acquiring the meaning of “century,” the child will use linguistic information. Someone explains “century” to her in spoken, written, fingerspelled, or signed language; she reads about it in a dictionary; or she infers what “century” means from written, spoken, fingerspelled, or signed information.

Schreuder, Flores d’Arcais, and Glazenborg (1984) make a distinction similar to but somewhat different from MoA, namely, between perceptually based information and conceptual or knowledge-based information. In the same vein, Madole and Oakes (1999) differentiate between perceptual and conceptual categorization. The distinction of Schreuder et al. (1984) differs from MoA in that their “conceptual/knowledge-based information” encompasses nonlinguistic inferences, whereas our “linguistic information” strictly refers to linguistic input (from which the child may make inferences, see the example above). Madole and Oakes refer to the way children categorize, whereas our distinction refers to the input children get.

MoA follows up on the notion of concepts as interrelated knowledge structures (e.g., Nelson, 1991; Sharkey, 1990). Knowledge of a word’s meaning can be understood as the interrelated array of the many different associations one has with that word, both linguistic associations (e.g., “bread is made of flour and yeast,” but also expressions like “our daily bread”) and perceptual associations (e.g., the smell and taste of freshly baked bread). These associations are acquired gradually when a child grows up and her knowledge structures become richer and richer. Initially, the child will know “blue” only as a color but later it will know “blue” also from figurative expressions. Thus, mental correlates of word meanings are developing entities of complex linguistic and perceptual information mixtures. Both types of input are required for rich word meanings to develop, but in different proportions for different words and dependent on the age and the developmental level of the child. Several studies confirm this hypothesis. Gleitman, Cassidy, Nappa, Papafragou, and Trueswell (2005) discuss the contribution of different types of information in mapping meanings to “easy” (i.e., concrete) and “hard” (i.e., abstract) content words. Adult participants watched silenced video clips of a mother and a child interacting in a natural situation. Participants heard a beep whenever the mother used a particular target word and then had to guess the target word. Clearly, participants here mapped words onto referents through combining perceptual and social information while having hardly any linguistic information. Gleitman et al. (2005) then changed the input. They added other content words in the mother’s speech or the syntax to the video clips with the beeps, or the participants did not see the
video clips but only got the content words or the syntax or both. Thus, there were “linguistic information only,” “perceptual and social information only,” and combined conditions. Gleitman et al. found that different types of information are used for learning different types of words (i.e., concrete and abstract ones). Golinkoff and Hirsh-Pasek (2006), Moore, Angelopoulos, and Bennett (1999), and Pruden, Hirsh-Pasek, Golinkoff, and Hennon (2006) showed that children use perceptual and linguistic information together with social and cognitive cues to learn new words. At first, in a relatively simple way, younger children associate words only with their perceptual referents; later they make use of social cues, for instance, following the speaker’s eye gaze to find out what she is talking about. More experienced word learners utilize a wider subset of cues, relying on some cues more than others.

We do not suggest hereby that perceptual and linguistic information will be sufficient to acquire concepts and word meanings. Clark (2006) states that in learning the meaning of a new term, children need to identify its reference, learn its conventional meaning, and find out how it is linked to other lexical expressions. For instance, although the perceptual information necessary for learning color names is available already very early in life, they are more difficult to learn than terms for objects or actions, probably because children need to work out that color is a property, not an object or an action (Clark, 2006). Samuelson and Smith (2007) showed that children use inferential knowledge about the properties of objects, both when categorizing in a nonlinguistic way and when learning object names, implicating that inferential knowledge is based on perceptual as well as linguistic information. It is the role of perceptual versus linguistic information in word meaning acquisition that is central to the concept of MoA.

Earlier research has shown that MoA can be reliably measured by asking adults to judge the MoA of words or signs on a five-point scale (Wauters, Tellings, van Bon, & van Haafte, 2003; Tellings & Wauters, in press). Primary school reading texts contain increasingly more words acquired through linguistic information with increasing grades, whereas these texts do not differ in their amount of concrete and imageable words (Wauters et al., 2003). Furthermore, MoA is a factor in the reading comprehension of deaf and hearing children (Wauters, van Bon, Tellings, & van Leeuwe, 2006).

MoA is a word (or sign) characteristic, just like, for instance, age of acquisition (AoA), concreteness, and imageability (e.g., Brysbaert, 1996; Cortese & Fugett, 2004, all studies being done on spoken words, not signs), which are measured similarly as MoA. These characteristics correlate, but they do not coincide. In an earlier study (Wauters et al., 2003), correlations between MoA of words and imageability, concreteness, and AoA of words were .64, .47, and .59, respectively. Although these relations are significant, they are not perfect. A maximum of only 40% ($r^2$) of the variance is associated with MoA. In three respects, MoA is different from, but related to, these other characteristics.

First, MoA explains at least partly why the aforementioned word characteristics correlate, that is, why many concrete and imageable words are learned early, whereas many abstract and less imageable words are learned late. MoA is concept relative in part. Some word or sign meanings, notably abstract ones, involve concepts that require linguistic information. The meaning of the word or sign “century” simply cannot be explained by or inferred from perceptual information only. Young language learners can utilize linguistic information less well and therefore will acquire abstract word or sign meanings only when they are older. So, MoA has a specific status as an explanatory construct in our hypothetical chain of causality (which, however, will not be tested in this article). Whereas abstractness and imageability are important determinants of MoA, MoA will be a determinant of AoA. These four factors modify the word or sign meaning acquisition of children together with a constellation of other factors, for example, what words or signs are considered to be necessary and appropriate for children of a given calendar age and a given educational level by their educators. But, and this is our second point, MoA also can explain why the correlation with and between the other word characteristics is not perfect. MoA is not only concept relative but also context relative. Children living in the desert most probably will not acquire the meaning of “snow” perceptually, whereas children living in Iceland most probably will. Not just the abstractness or
the imageability (both mainly concept characteristics) determine AoA or MoA or how “hard” a word is, the context also matters. For example, “gas” (i.e., airlike substance) not only has a rather concrete referent but also is rated as having a relatively linguistic MoA. Presumably, the participants who rated this word appreciated the fact that gas, although concrete, is not very imageable because it cannot be seen. Moreover, children under normal circumstances have little contact with gas and, thus, will learn the meaning of “gas” mostly from linguistic information. Apparently, participants who judge the MoA of words or signs take into account several concept and context factors, and in this sense, MoA is more encompassing than each of the other characteristics. Of course, also when estimating AoA, participants probably weigh different factors. But, third, in contrast to the other word characteristics, MoA differentiates between language learners with complete perceptual and linguistic input and learners with incomplete or different perceptual and linguistic input (people who cannot hear or see), and this essentially was the reason for developing the construct of MoA. The majority of deaf children receive incomplete linguistic input.

**Deafness and MoA**

Acquiring word meanings through linguistic information requires access to language (Bloom, 2000). For many young deaf children, language access is scarce. Speech is inaccessible and because 95% of the children have hearing parents (Mitchell & Karchmer, 2004), sign language usually is not available in the early years of life, and in later years it is available mostly in an imperfect form. According to Spencer and Harris (2006, see also Anderson, 2006), there is wide variation in the sign input deaf children get, but most hearing mothers provide insufficient language input to their deaf child, mostly because they are not very experienced using signs or interacting with deaf people. In addition, hearing mothers do not make their sign productions as accessible to their deaf child as deaf mothers do, and they show less consistency in the form of their signs. Given that acquisition of linguistic word meanings is dependent on caregiver explanations, deaf children of hearing parents may experience greater disadvantage in acquiring these word meanings versus perceptual word meanings. Of course, the situation will be different for deaf children of deaf mothers who are known to differ from hearing mothers in making their language more perceptible for their deaf children (Spencer & Harris, 2006). Deaf mothers usually position their signing within the child’s visual field and wait for the child’s gaze before they start the communication. Through this process, the deaf child is in a better position to allocate its gaze appropriately. However, investigating the relatively new construct of MoA, we postpone the study of possible differential effects of the parental hearing status and focus on the more numerous deaf children of hearing parents, who are at a higher risk of an inaccessible and incomplete form of language.

Also, in more “pure-linguistic” situations, deaf children’s input is reduced because they need their eyes both for seeing language and for performing activities. Akhtar, Jipson, and Callanan (2001) showed that hearing toddlers learned novel words equally good from overhearing as from being directly addressed. Whereas hearing children can overhear conversations while going on with their play, deaf children usually cannot.

**This Study**

The differentiation in the input deaf children get, as explained above, is at least partly reflected in the concept of MoA. In this article we investigate the role of MoA in reading comprehension in deaf and hearing participants using a self-paced reading task, in which participants read sentences on a computer screen at their own rate by clicking a button to ask for the next word. We used the moving-window format, in which successive words appear at consecutive places, disappear from the screen after they are read (i.e., after the click that gives the next word), and are replaced by dashes. The reading time for a certain word is defined as the time between the mouse click that leads to its appearing on the screen and the click that brings forth the next word. Just, Carpenter, and Woolley (1982) and Ferreira and Henderson (1990) found similar results in the moving-window condition as in eye fixation studies, indicating that the self-paced reading procedure is a valid measure of sentence processing. Although
this procedure has been used primarily with adults, Beveridge and Edmundson (1989) used it to investigate reading strategies in hearing 8- to 11-year-olds. Reading times were longer than would be expected in normal page reading, but the self-paced reading procedure showed the same differences between good and poor readers as normal page reading did.

In this article, this procedure is used to compare the reading times for words in sentences containing a target word, rated as perceptually acquired or rather as linguistically acquired in a previous study (Wauters et al., 2003). The self-paced reading procedure gives us the opportunity to estimate processing times for the individual words of a reading text and compare the processing times for words of different types. As a consequence, reading times on individual words can tell us whether processing perceptual words when reading for comprehension is different from processing linguistic words. If MoA plays a role in reading comprehension, reading times on linguistically acquired words should be longer than those on perceptually acquired words, assuming that readers use more time to think about “hard” words. More specifically, we investigate whether deaf and hearing participants differ in this respect. If deaf children, indeed, have more difficulty than hearing children in acquiring words through linguistic information, then, on average, they will have less knowledge of these words than hearing children. Longer reading times on the linguistic words would point to difficulty with these words. In order to necessitate reading for meaning, we added a comprehension question after each sentence. This provided us also with a possibility to determine the understanding of a word or sentence. If MoA influences reading comprehension, it will affect both reading times and scores on the comprehension questions (comprehension scores). On the perceptually acquired words, no or only minor differences are expected between deaf and hearing children because linguistic information is not indispensable to learn the meaning of these words.

We expect an age difference because younger children know less words and their word identification skill is not yet fully automatic. Therefore, reading times of the younger participants will be longer and their comprehension scores will be lower than those for the older participants. Some linguistic words will be learned at a higher age because only then do children have enough linguistic knowledge to learn these words. As a consequence, the difference between perceptually and linguistically acquired words (in reading time and in score) will change over age. Reading times on linguistically acquired words will become shorter, and the comprehension scores will increase at a higher age. However, reading times and scores on the perceptually acquired words will not show a considerable change because the meanings of most of these words are already known at a younger age. This change in the difference between perceptually and linguistically acquired words will be stronger for the hearing than for the deaf participants because hearing children have more access to the linguistic information needed to acquire the linguistic words. Although their knowledge of perceptual words is already adequate and cannot improve much, their knowledge of linguistic words will increase, resulting in a smaller difference between the two. Because deaf children have less access to linguistic information, their knowledge of linguistically acquired words will not grow as fast as it will for hearing children. Therefore, the difference between perceptually and linguistically acquired words will not decrease at the same rate as in hearing children or will even stay the same over the years.

Method

Participants

Participants in this study were 72 deaf and 99 hearing children. We selected deaf and hearing children with average word identification performance compared to children of their instructional age, within either of both groups. Because instruction in deaf education does not always start at the same time as in hearing education, the use of instructional age is preferred over chronological age (see Table 1 for corresponding chronological ages for the deaf participants). An instructional age of 1 year means that a child has had 10 months of formal instruction. For hearing children, the instructional age usually corresponds to the grade they are in.

The deaf participants were selected from an initial sample of 229 deaf participants, representing about 90% of the Dutch elementary school population of
deaf children without additional handicaps. The oldest of them also participated in an earlier study by Wauters, van Bon, & Tellings (2006). These 229 participants took a pencil-and-paper lexical decision test. Each item in that test consisted of a pair of letter strings, one a highly frequent existing word and the other a (orthographically and phonologically legal) nonexistent letter string. The participant was asked to cross out the nonexistent letter string. The score was the number of word pairs correctly judged within 1 min (for more information on the task, see Wauters, van Bon, & Tellings, 2006). To select children who were representative of their instructional age group, we used a selection range of 1 standard deviation (SD) below and above the mean for each instructional age group. Table 1 shows the mean scores on the lexical decision test for deaf children. For the instructional age of 2 years, 12 participants scored within the selection range and were selected for participation. For the instructional ages of 3–6 years, 15 children who scored within the selection range were randomly selected for participation.

The deaf children (37 female, 35 male) ranged in age from 7.2 to 14.6 years (mean = 10.3). Instructional ages ranged from 2 to 6 years. The mean ages in the five instructional age groups are included in Table 1. Their mean hearing loss was 100 dB (ranging from 60 to 130). Thirteen of the participants had a cochlear implant. The mean performance IQ (M = 101.24, SD = 13.14; range: 75–126), as reported by the schools and calculated using various instruments, did not significantly deviate from the standardization mean (100). Of the deaf participants, 51 were in schools for the deaf, 13 in schools for hard-of-hearing children, and 8 were in mainstream education. Table 2 provides a list of characteristics of the participants. Participants in the various instructional ages did not differ in IQ (F(4, 36) = .097, p > .05). Chi-square tests pointed out that instructional age groups did not differ in gender, ethnicity, prelingual or postlingual deafness, parental hearing status, cochlear implants, current education (deaf, mainstream, or hard-of-hearing education), educational language, and home language (all p > .05).

The Grade 2–6 (corresponding to instructional ages 2–6) hearing participants came from two elementary schools. In both schools, the selection of the participants was based on their word identification competence. At the time of selection it was not possible to administer the lexical decision task that was used to select the deaf participants. However, in one school we could use the scores of the children on a standardized oral reading test (Drie-Minuten-Toets [Three-Minutes-Test], Verhoeven, 1995) as a selection criterion. For each grade, 10 children scoring in the middle 50% of the norm group on this standardized oral reading test were selected. For Grade 6, 20 children were selected because the second school could not provide children for Grade 6. In that other school, no such test data were available and selection of the participants was based on the teacher’s judgment of word identification competence. The teachers of Grades 2–5 were asked to select 10 children with an average word identification level for their grade. In total, 100 hearing children were selected to participate in the study, 20 for each instructional age. One participant from Grade 5 was ill at both testing times and was excluded from the study, leaving 99 hearing participants (52 female, 47 male). Unfortunately, no IQ data were available for the hearing children.

Materials

The experimental task required participants to read sentences and answer a question after each sentence
they read. The experiment consisted of two testing sessions with a 2-week interval. In each session 43 declarative sentences (in the remainder of the article referred to as “sentences”) and questions were presented. All sentences consisted of seven words in which Word 4 was the target word. The target words differed in their rated MoA.

In a previous study (Wauters et al., 2003), the MoA of a large set of words was determined by asking university students and educational professionals (special educators, speech therapists, teachers, etc.) to rate them on a five-point scale from *acquired through perception alone* (1) to *acquired through linguistic information alone* (5). Ratings by educational professionals were found to strongly agree with ratings by students. For the present experiment we selected 43 words with a mean MoA rating at or below 2 and 43 words with a mean MoA rating at or above 4. In the remainder of this article, the first will be called perceptual words and the latter linguistic words. The mean rating of the 43 perceptual words was 1.68 (*low*). For the linguistic words, the mean rating was 4.34 (*high*). Both the perceptual and the linguistic target words consisted of 28 nouns, 12 verbs, and 3 adjectives (see the Appendix for a list of the words). Table 3 shows length and frequency of the target words in the two conditions.

Each sentence occurred twice: once with a perceptual target word in the one testing session and once with a linguistic target word in the other session. Except for the target word, these sentences were identical. In each testing session, half the items consisted of sentences with a perceptual target word and the other half of sentences with a linguistic target word. If a sentence occurred in the first session with a perceptual target word, it was presented in the second session with a linguistic target word and vice versa. Because the sentence frames are identical in both conditions, reading differences will be determined by the target words as that is the only difference between the sentences. Sentences were presented in a random order. All sentences were written in the active voice, and all, but one, were in the present tense.

After each sentence, a question with a yes-or-no format appeared on the screen. The questions were intended to probe the participant’s knowledge of the meaning of the target word. Of the questions, 28 were

| Table 2 Characteristics of the deaf participants |
|-----------------------------------------------|
| Onset of deafness                             |
| Before the age of 3                           | 55 |
| After the age of 3                            | 5  |
| Missing values                               | 12 |
| Parents                                      |
| Both deaf                                    | 2  |
| Both hearing                                 | 61 |
| Deaf + hard of hearing                       | 1  |
| Missing values                               | 8  |
| Nationality                                  |
| Dutch                                        | 53 |
| Other                                        | 12 |
| Missing values                               | 7  |
| Home language                                |
| Spoken language only                         | 15 |
| Mostly spoken language                       | 18 |
| As much spoken as sign                       | 13 |
| Mostly signs                                 | 10 |
| Sign language only                           | 2  |
| Missing values                               | 14 |
| Educational language                         |
| Spoken language only                         | 13 |
| Mostly spoken language                       | 8  |
| As much spoken as sign                       | 27 |
| Mostly signs                                 | 12 |
| Sign language only                           | 2  |
| Missing values                               | 10 |

Table 3 Mean length and frequency of the target words in each condition

|                           | Perceptually learned words | Linguistically learned words |
|----------------------------|----------------------------|------------------------------|
|                            | N  | M    | SD   | N  | M    | SD   |
| Frequency                  | 43 | 6866.10 | 11535.10 | 42 | 1049.30 | 1468.60 |
| Number of letters          | 43 | 5.00  | 1.83  | 43 | 8.28  | 2.67  |
| Number of syllables        | 43 | 1.67  | 0.61  | 43 | 2.74  | 1.05  |

*Note. Frequency data were derived from CELEX, a lexical database for Dutch words occurring in written texts, with frequencies ranging from 0–852,027 (CELEX Dutch database, 1990).*
directly related to the sentence the participant had read and referred to the meaning of the complete sentence. These questions were exactly the same in both the perceptual and linguistic condition. The other 15 questions referred to more general knowledge of the target word and were not related to the sentence the child read. In these cases, the target word was repeated in the question and, therefore, the questions were not exactly the same in the perceptual and the linguistic condition. All questions had the canonical question format (verb–subject–object) and were in the present tense.

A (translated) example of a sentence in the perceptual condition is “The boy smelled soup in the kitchen.” The linguistic counterpart of this sentence is “The boy smelled gas in the kitchen.” The question that is presented after each of these sentences is read is “Does the boy smell something that can be eaten?” An example of a sentence in the perceptual condition with a question that is not related to the complete sentence is “Simon gave the cat a plate of food”: “Can a cat talk?” The linguistic counterpart of this sentence is “Simon gave the refugee a plate of food” with the question “Can a refugee talk?”

The experiment was conducted on a Macintosh Powerbook G3 with a three-button box connected to it. Each item started with an asterisk at the left side of the screen where the sentence would start. After pushing the middle button of the button box, the first word appeared together with a representation of the sentence with dashes for each letter, spaces between the words, and a period at the end. After pushing the button again, the next word appeared and the first one was replaced by dashes. Sentences were vertically centered and were presented in the Courier font, size 24. By using this nonproportional font, dash patterns and words were at exactly the same position after each button-click. When the last word of a sentence was read, another (middle) button-click revealed the question that had to be answered by pushing the button with the word “ja” [yes] (the left button) or the one with the word “nee” [no] (the right button). The reading time for each word was registered from the moment the child pushed the button to view that word until the child pushed the button again for the next word. Both the answers to the questions and the time it took to read and answer each question were recorded.

Procedure

All participants took part in both testing sessions of the experiment. To control for an order effect, half the participants started with stimulus Set 1 and the other half with Set 2. The two item sets were administered with an interval of 2 weeks.

The test was administered individually by a test instructor who sat next to the child. At the start of the first session, the instruction was given in the modality preferred by the child (Sign Language of the Netherlands, Sign Supported Dutch, or spoken language). Three example sentences were used to show the child how to use the button box and how the sentences would be presented on the screen. The child was instructed that a question would appear after each sentence and that he/she had to answer it by pushing the yes or no button. The correct answers to the questions following the sample sentences were explained to the child. Then, the child started with 10 practice sentences and answered the corresponding questions. To make sure that the child understood the intention of the test, the instructor discussed the answers given to the practice questions with the child. The child started with the test sentences when the instructor was sure the child understood the instructions and no more help was provided.

Results

This article investigated the effect of MoA on the reading time of words in sentences and on understanding questions about these sentences. The analyses that are presented in this section focus on the difference in reading time between items containing a perceptually or a linguistically acquired word. In addition, reading times and comprehension scores of deaf and hearing participants will be compared. The effect of instructional age will also be taken into account in these analyses. When discussing the results, the two levels of MoA will be referred to as the perceptual condition and the linguistic condition.

Before analyzing the data, outliers were eliminated from the reading times data set by excluding all times that deviated more than 2 SDs from both the participant and the item means for a given condition at
a given ordinal position in the sentence. In both conditions, 1.7% of the reading times were removed for the deaf participants. For the hearing participants, 2.1% of the reading times were excluded in both conditions.

Next, the mean reading time was calculated for each participant on all first words, all second words, and so forth until the seventh word, for the perceptual and the linguistic condition separately. An effect of MoA was expected on the target words because these differed in MoA and possibly on the words after the target word. On the words before the target word, no MoA effect was to be expected because the sentences differ only from Word 4 on. Therefore, analyses were performed on the mean reading time for the first three words, on the reading times for the target word (Word 4), and on the mean reading times for the last three words. Other dependent variables in the analyses were the reading times for the questions and the percentage of questions answered correctly.

Analyzing the question data, the average time that it took to answer the questions in each of both conditions was calculated for each child. These means were calculated using the reading-plus-answering times in case of correct responses only. In addition, for the analyses on the answers, the total comprehension score for each condition was used. Two of the deaf participants only completed one item set of the experiment because of absence at the second test administration. For these participants, the reading times for the words were included in the calculation of the mean, but their scores on the questions were not included in the analyses (because their maximum score could only be 43 instead of 86).

We will first present the results on the reading times for the sentences. Subsequently, results on the answering times for the questions and the scores on these questions will be presented.

Figure 1 depicts the reading times of the deaf and hearing participants for each word in the sentences in both MoA conditions. This figure shows that, on average, the reading times for Word 4, which is the target word, are longer in the linguistic condition than in the perceptual condition, whereas there seem to be no such differences for the surrounding words.

Data were analyzed according to a $2 \times 2 \times 5$ multivariate analysis of variance (MANOVA), with reading time or comprehension score as the dependent variable, MoA (perceptual vs. linguistic) as a within-subject factor, and hearing status (deaf vs. hearing) and instructional age (2–6 years) as between-subject factors. Separate analyses were done for each of the three reading times: the mean reading time of the first three words, reading time on Word 4, and the mean reading time of the last three words. The outcome of the MANOVAs is presented in Tables 4, 5, and 6. Analyses of the interaction effects will be reported in the main text.

For the mean reading time of Word 1, 2, and 3, a main effect of hearing status was found with the deaf participants showing longer reading times than the hearing participants. No main effect of or interaction involving MoA was found. The analysis also showed a main effect of instructional age, with a linear decrease in reaction time, and an interaction between hearing status and instructional age. One-way analyses of variance (ANOVAs) to analyze this interaction showed a significant effect of instructional age for the hearing ($F(4, 94) = 27.32, p < .001, \eta^2 = .54$) but not for the deaf participants ($F(4, 67) = 1.39, p > .05, \eta^2 = .08$). Polynomial contrasts (for the hearing participants only) showed a linear decrease in reading time over instructional age ($p < .001$) and a positive quadratic effect ($p < .05$), indicating that the decrease in reading time increased over the instructional ages.
The analysis for Word 4, the target word, showed main effects of MoA and instructional age. Reading times on target words in the linguistic condition (1389 ms) were longer than those in the perceptual condition (853 ms) (see Figure 2), and a linear decrease in reading time was found over instructional age ($p < .001$). Interactions were found between MoA and hearing status, between hearing status and instructional age, and between MoA and instructional age. The effect of MoA was larger for the hearing than for the deaf participants ($F(1, 169) = 56.29, p < .05, \eta^2 = .04$).

The interpretation suggested by Figure 2 is that the deaf and the hearing participants do not or only to a small degree differ in their reading time for the perceptual words, but rather in the reading time for the linguistic words. For neither word type, however, the difference between participant groups is significant (linguistic words: $F(1, 169) = 2.39, p = .12$; perceptual words: $F(1, 169) = .09, p = .76$). The effect of instructional age was found for the hearing participants only ($F(4, 94) = 36.09, p < .001, \eta^2 = .61$). Analyses also showed a three-way interaction of MoA, hearing status, and instructional age. The interaction between MoA and instructional age was only found to be significant for the hearing participants ($F(4, 94) = 28.52, p < .001, \eta^2 = .55$) and not for the deaf participants ($F(4, 67) = 1.11, p > .05, \eta^2 = .06$). The difference between the perceptual and linguistic condition decreased over age for the hearing but not for the deaf participants. Polynomial contrasts over

Table 4  ANOVA for the mean reading times of Words 1, 2, and 3

| Source | df | $F$  | $\eta^2$ | $p$  |
|--------|----|------|----------|------|
| Between subjects |  |  |  |  |
| Hearing status (H) | 1 | 6.06* | .036 | .015 |
| Instructional age (IA) | 4 | 10.36** | .205 | .000 |
| $H \times IA$ | 4 | 3.16* | .073 | .016 |
| Error | 161 (127928.326) |  |  |  |
| Within subjects |  |  |  |  |
| MoA (M) | 1 | 3.30 | .020 | .071 |
| $M \times H$ | 1 | 0.52 | .003 | .47 |
| $M \times IA$ | 4 | 2.16 | .051 | .076 |
| $M \times H \times IA$ | 4 | 1.21 | .029 | .31 |
| Error | 161 (1327.845) |  |  |  |

*Note. Values in parentheses represent mean square errors.  
* $p < .05$; ** $p < .001$.  

Table 5  ANOVA for Word 4 reading time

| Source | df | $F$  | $\eta^2$ | $p$  |
|--------|----|------|----------|------|
| Between subjects |  |  |  |  |
| Hearing status (H) | 1 | 1.46 | .009 | .229 |
| Instructional age (IA) | 4 | 10.46** | .206 | .000 |
| $H \times IA$ | 4 | 8.35** | .172 | .000 |
| Error | 161 (401518.63) |  |  |  |
| Within subjects |  |  |  |  |
| MoA (M) | 1 | 235.29** | .594 | .000 |
| $M \times H$ | 1 | 9.56* | .056 | .002 |
| $M \times IA$ | 4 | 7.70** | .161 | .000 |
| $M \times H \times IA$ | 4 | 10.88** | .213 | .000 |
| Error | 161 (94089.10) |  |  |  |

*Note. Values in parentheses represent mean square errors.  
* $p < .05$; ** $p < .001$.  

184  Journal of Deaf Studies and Deaf Education 13:2 Spring 2008
conditions showed a linear decrease ($p < .001$) and a positive quadratic effect ($p < .01$) of instructional age for the hearing participants, indicating an amplifying decrease of reading time. Figure 2 suggests that the interaction between MoA and instructional age for the hearing participants might be due to the difference in reading time between participants with an instructional age of 2 years and those with an instructional age of 3 years. However, an interaction was still found when participants with an instructional age of 2 and 3 years were excluded from the analysis ($F(2, 56) = 10.52^{**}, p < .001, \eta^2 = .207$).

For the mean reading time on Words 5, 6, and 7, no main effects were found for hearing status or MoA. A main effect of instructional age did occur though, with a linear decrease in reaction time ($p < .01$) and an interaction between hearing status and instructional age. One-way ANOVAs to analyze this interaction showed a significant effect of instructional age for the hearing ($F(4, 94) = 10.52^{**}, p < .001, \eta^2 = .207$) but not for the deaf participants ($F(4, 67) = 1.34, p > .05, \eta^2 = .07$). Analyses also showed an interaction between MoA and instructional age. At the instructional ages of 2 and 6 years, some spurious differences occur between the reading times in both MoA conditions. At the instructional age of 2 years ($F(1, 31) = 4.83, p < .05, \eta^2 = .14$), reading times are somewhat longer on the perceptual words (1105 ms) than on the linguistic words (1076 ms). At the instructional age of 6 years ($F(1, 34) = 7.88, p < .01, \eta^2 = .19$), reading times on the linguistic words (679 ms) are somewhat longer than on the perceptual words (654 ms).

Summarizing the effects of MoA on the reading times of the words in the sentences shows that for Word 4 the effect of MoA proved to be larger for the hearing than for the deaf participants and the effect of instructional age only obtained for the hearing participants. The difference between the perceptual and linguistic condition decreased over age for the hearing but not for the deaf participants. An effect of instructional age was found for all reading times, but interactions between hearing status and instructional age showed that differences in instructional age only pertained to the hearing participants. This effect was characterized by a linear decrease in reading time over the instructional ages. An effect of hearing status was only found for the mean

### Table 6 ANOVA for the mean reading times of Words 5, 6, and 7

| Source           | df  | $F$    | $\eta^2$ | $p$     |
|------------------|-----|--------|----------|---------|
| Between subjects |     |        |          |         |
| Hearing status (H) | 1   | 0.65   | .004     | .422    |
| Instructional age (IA) | 4   | 10.52** | .207     | .000    |
| H $\times$ IA     | 4   | 4.77** | .106     | .001    |
| Error             | 161 |        |          |         |
| Within subjects   |     |        |          |         |
| MoA (M)           | 1   | .39    | .002     | .532    |
| M $\times$ H      | 1   | 2.51   | .015     | .115    |
| M $\times$ IA     | 4   | 3.71*  | .084     | .006    |
| M $\times$ H $\times$ IA | 4   | 0.83   | .020     | .510    |
| Error             | 161 | (1695.108) |          |         |

Note: Values in parentheses represent mean square errors.

* $p < .05; ** p < .001.$
Because the target words in the two conditions differed in length and frequency (see Table 3), it is possible that these factors rather than MoA explain the effects we found. Therefore, we performed a multilevel analysis to study the strength of MoA as predictor of the reading times. Word length and word frequency were included in the analysis as control variables and MoA, hearing status, and instructional age as predictor variables. Reading times and word length were standardized for the analysis. For word frequency the standard score of the logarithm was used. The final model (Table 7), which best fits the data, shows a significant effect of MoA even when controlling for other factors. However, length and frequency of a word also significantly contribute to the reading times. As in the MANOVA, hearing status is not a significant predictor, but interacts with frequency: for hearing children, reading times are lower when word frequency is higher. The random effects show that the intercept and the effects of length, frequency, and MoA vary between participants. Further, as the slope of length increases, the slope of MoA increases but that of frequency decreases. The difference in deviance between the empty model and this final model is significant ($\chi^2(13) = 6482.09, p < .001$), indicating a significant improvement of the fit of the final model.

The outcomes of the MANOVAs for the response latencies of answering the questions and for the comprehension scores are presented in Tables 8 and 9. Figure 3 shows the response latencies for answering the questions. As Table 8 shows, there are main effects of MoA, hearing status, and instructional age and no interactions. Reading times (for reading and answering the questions) were longer in the linguistic condition (5048 ms) than in the perceptual condition (4243 ms), and the reading times of the deaf participants were

### Table 7
Estimates for the final model of the multilevel analysis (Word 4 reading times) with 16 parameters

| Fixed effects of | Coefficient | SE |
|------------------|-------------|----|
| Intercept (I)    | -.020       | .041|
| Hearing status (H) | -.075       | .039|
| Length (L)       | .229        | .015*|
| Frequency (F)    | -.11        | .016*|
| Hearing status $\times$ frequency | -.082 | .021*|
| MoA              | .141        | .026*|

### Random effects

| Variance component | $SE$ |
|-------------------|------|
| Level two random effects |      |
| var(I)            | .196 | .021*|
| var(slope of L)   | .027 | .004*|
| var(slope of F)   | .014 | .002*|
| var(slope of MoA) | .079 | .012*|
| var(slope of L, slope of F) | .096 | .012*|
| var(slope of L, slope of MoA) | .046 | .005*|
| Level one random effect |      |
| var(I)            | .432 | .005*|
| Deviance          | 28628.92 |

*p < .001.

### Table 8
ANOVA for the questions (latency of correct responses)

| Source            | $df$ | $F$     | $\eta^2$ | $p$ |
|-------------------|------|---------|----------|-----|
| Between subjects  |      |         |          |     |
| Hearing status (H)| 1    | 45.92** | .222     | .000|
| Instructional age (IA) | 4   | 10.63** | .209     | .000|
| H $\times$ IA     | 4    | 0.93    | .023     | .448|
| Error             | 161 (4094337.28) |         |          |     |
| Within subjects   |      |         |          |     |
| MoA (M)           | 1    | 114.65** | .416     | .000|
| M $\times$ H      | 1    | 1.58    | .010     | .210|
| M $\times$ IA     | 4    | 1.74    | .041     | .144|
| M $\times$ H $\times$ IA | 4 | 1.88 | .044 | .117|
| Error             | 161 (479290.058) |         |          |     |

*Note. Values in parentheses represent mean square errors.

*p < .05; **p < .001.
longer than those of the hearing participants. Polynomial contrasts showed a linear decrease in reading time over the instructional ages ($p < .001$).

The comprehension scores (percentage of questions answered correctly) are presented in Figure 4. Analyses showed main effects of MoA, hearing status, and instructional age. The scores were lower in the linguistic condition than in the perceptual condition, and the scores of the deaf participants were lower than those of the hearing participants. One-sample $t$ tests showed that, on the linguistic items, the deaf participants do not score significantly above chance level from instructional age 2–5 (all $p > .05$), but at the instructional age of 6 years they do score above that level ($t(13) = 2.61, p < .05$). On the perceptual items they score significantly above chance level at all instructional ages (all $p < .01$; between 60% and 75% correct). The scores showed a linear increase over instructional age. Apart from the main effects, a three-way interaction was found between MoA, hearing status, and instructional age. An interaction between MoA and instructional age was found for the hearing participants ($F(4, 94) = 16.27, p < .001, \eta^2 = .41$) but not for the deaf participants ($F(4, 65) = 1.70, p > .05, \eta^2 = .09$). Evidently, the difference between the perceptual and linguistic condition diminished over instructional age for the hearing but not for the deaf participants. An effect of MoA and instructional age was found for both deaf and hearing participants. For both deaf and hearing participants, polynomial contrasts showed a linear increase in scores over instructional age ($p < .01$ and $p < .001$, respectively).

### Table 9 ANOVA for score (questions: percentage correct)

| Source                  | df | $F$       | $\eta^2$ | $p$  |
|-------------------------|----|-----------|----------|------|
| Between subjects        |    |           |          |      |
| Hearing status (H)      | 1  | 256.34**  | .617     | .000 |
| Instructional age (IA)  | 4  | 12.22**   | .235     | .000 |
| H $\times$ IA           | 4  | .99       | .024     | .412 |
| Error                   | 159| (161.74)  |          |      |
| Within subjects         |    |           |          |      |
| MoA (M)                 | 1  | 380.45**  | .705     | .000 |
| M $\times$ H            | 1  | 3.37      | .021     | .068 |
| M $\times$ IA           | 4  | 1.33      | .032     | .261 |
| M $\times$ H $\times$ IA| 4  | 9.83**    | .198     | .000 |
| Error                   | 159| (55.14)   |          |      |

*Note. Values in parentheses represent mean square errors. 

$p < .05$; **$p < .001$. 

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**Figure 3** Mean reading times for deaf and hearing participants on the questions in both conditions by instructional age.

**Figure 4** Mean comprehension scores (in percentage correct) for deaf and hearing participants in both conditions by instructional age.
However, Figure 4 shows that the hearing participants with an instructional age at or above 4 years scored at ceiling level in the perceptual condition.

In summary, main effects of all factors were found for the reading times on the questions and for the comprehension scores, and all effects were in the expected directions. Reading times were longer and scores were lower in the linguistic condition than in the perceptual condition. Reading times for the deaf participants were longer, and their comprehension scores were lower than those for the hearing participants. Reading times decreased and comprehension scores increased over the instructional ages. For the comprehension scores, analysis on the three-way interaction showed that the difference between the perceptual and the linguistic condition changed over age for the hearing participants but not for the deaf participants.

A multilevel analysis as for the reading times on the target words was not feasible for the comprehension scores because this would require analyzing the scores as a dichotomous variable, but doing this showed nonnormally distributed residuals, which violates the assumptions of multilevel modeling and yields unreliable results (Snijders & Bosker, 1999).2

Discussion

This article investigated the role of MoA in reading comprehension for deaf and hearing students. We expected longer reading times in the self-paced reading task for items with a word that is judged to be learned linguistically than for items with a word that is judged to be learned perceptually and, indeed, found this effect for both deaf and hearing participants. We expected this effect to be larger for the deaf than for the hearing participants, but the difference between both groups was in the opposite direction. Although not supported by statistical testing, we deduce from Figure 2 that this may have resulted mainly from the hearing children taking more time than deaf children to inspect the linguistic target words and less from a difference in the time spent on the perceptual words. In the absence of pertinent data, we prefer not to speculate about the processes in the hearing children that bring about this difference, but stress that it most probably is not caused by differences in decoding, because—as the introduction and the results on the mean reading time for the first three words show—if any differences in decoding skill are found at all, it is the hearing children who are the better and faster decoders. Independent and specific studies are required to explore this remarkable interaction.

We also expected an effect of instructional age, namely, a decrease in reading time and in the difference between perceptually and linguistically acquired words, especially for the hearing participants. We found a decrease in reading time for the hearing participants only. Moreover, as we hypothesized, the difference between perceptually and linguistically acquired words decreases over instructional age for the hearing participants but not for the deaf participants. Wauters (2005) studied deaf participants with instructional ages over 6 years, and even for them, no decrease in reading time on the target word and no decrease in the difference between perceptually and linguistically acquired words were found.

A multilevel analysis confirmed that for both deaf and hearing students, the MoA of words significantly contributes to the word reading times, even after including the contribution of length and frequency. The results further show that the effect of length covaries with MoA and frequency: when the effect of length increases, the effect of MoA also increases and the effect of frequency decreases. For longer words, frequency is less influential in determining the reading time, but the MoA of a word becomes more important: reading time will be longer if the word is more linguistic.

Our hypothesis of lower comprehension scores for linguistic items than for perceptual items was also confirmed. Overall, the deaf participants score lower than the hearing participants on the comprehension questions. A linear increase in comprehension scores is found over instructional age for both deaf and hearing participants. The situation is complicated though because a three-way interaction for the comprehension scores shows a decrease in the difference between the perceptual and the linguistic condition for the hearing participants only. This decrease for the hearing participants may be caused by a ceiling effect for the perceptual items from the instructional age of 4 years.
onward. Apparently, the hearing participants already know the meaning of the perceptual words in this study at this instructional age, although the reading time on the perceptual target words still decreases after that point. For the deaf participants, the comprehension scores also show an increase over instructional age, but they have less knowledge than the hearing participants of both types of words. Whereas for questions involving perceptual words the mean comprehension scores of these participants are above chance at all instructional ages, comparison with chance level responding suggests that the linguistic words are virtually unknown, for all instructional ages, except the highest. For these participants, no significant change occurs over instructional age in the difference between perceptual and linguistic items.

We tested whether the decrease in reading time in the perceptual condition for hearing participants might be caused by improved word identification skill. We used the mean reading time on the three words before the target as a covariate in an ANOVA with instructional age, MoA, and instructional age as the independent variables and target reading time as the dependent variable. This additional analysis showed that the effect of instructional age only remained for the hearing participants in the linguistic condition \((F(4, 94) = 6.09, p < .001, \eta^2 = .21)\). This indicates that the decrease in reading time in the perceptual condition is, indeed, caused by an improvement in reading fluency. However, in the linguistic condition reading times still decrease when instructional age increases. This indicates that reading fluency is not the only explaining factor here, the acquisition of the meaning of the word apparently plays a role as well. If a minimum amount of word meaning knowledge is required for a decrease in reading time, the deaf participants may not have acquired that minimum.

These results show that MoA influences sentence reading time and sentence comprehension for both deaf and hearing participants and that MoA is a relevant factor in explaining the lower performance of deaf children—found in many previous studies as well as in our study—in reading comprehension as compared to the performance of hearing children. Of course, other differences than in the quality of hearing (in IQ, reading ability, memory span, and many other characteristics) may have influenced the results. Deaf and hearing groups equated on such third variables might have shown dissimilar results. Such groups, however, would not have been representative for the relevant populations of deaf and hearing children, and the conclusions would only hold for restricted populations. In studying the role of the relatively new construct of MoA, we chose to compare deaf and hearing children who are representative for their respective populations, the comparison groups being matched for their instructional age, that is, the number of years of formal instruction starting from Grade 1. If MoA would prove to be a fruitful construct in differentiating between the reading behavior of deaf and hearing children (as it did in this article), subsequent studies should test the MoA effect against the explanatory power of such third variables.

Word meaning knowledge is a prerequisite for reading comprehension. In the introduction we discussed the importance of both perceptual and linguistic information, in varying proportions, for word meaning acquisition. Our hypothesis was that deaf children would not differ—or not much—from hearing children on the “perceptual” words, that is, the words which require more perceptual than linguistic information for them to be acquired. It turns out that deaf and hearing children, indeed, do not differ in reading time on these words. Deaf children’s performance with respect to comprehension questions on these words, however, is lower than the performance of hearing children.

We propose a few explanations for this unexpected difference.

The target words in this article were classified as perceptual or linguistic using ratings obtained from adult hearing informants. These hearing raters may have underestimated the linguistic information needed for learning the meaning of (some) perceptual words. Findings by Tellings and Wauters (in press) that words rated as perceptual (for hearing children) by hearing adults were rated more linguistic (for deaf children) by congenitally deaf adults are in support of this suggestion. A difference on “perceptual words” could then be explained as resulting from the need for more linguistic learning than would be expected from the hearing adults’ ratings for these words.
Another finding from the study of Tellings and Wauters (in press) is that only for 64% of the perceptual words (50% of the linguistic words) in that study there is a direct counterpart in the Sign Language of the Netherlands. Although this percentage cannot be readily generalized to the perceptual words used in this study, it points to the probability that for some perceptual words deaf children cannot simply glean the meaning they have learned from their meeting with a matching sign.

Finally, in situations in which, typically, word meanings are acquired by perceptual information, deaf children may be disadvantaged simply because they need their eyes both for seeing accompanying language and for performing practical tasks. Interruption of the ongoing action and explicitly drawing the child’s attention to the speaker or signer will often be necessary to enable deaf children to acquire these action-related perceptual words. If this assumption is correct, the necessity to make such interruptions might discourage adults to give the comments from which the relevant sign or word can be identified or will reduce the perceptual experience from which meaning should be distilled.

This article again shows the importance of a rich vocabulary for deaf as well as hearing children as a prerequisite for reading comprehension. For deaf children, a basis of perceptual words should be built first. Using these perceptual words linguistic word meanings can be built, which because of the linguistic explanation needed are harder to acquire but can be acquired without disruption because the deaf child can focus on the language only. The process of word meaning acquisition may be different, however, for deaf children of deaf parents than it is for deaf children of hearing parents. But, even though most deaf mothers are capable of adequately adapting their signing, differences still exist between them and hearing mothers of hearing children—according to Spencer & Harris (2006)—in the number and length of their utterances, simply because they have to accommodate their signing to the visual attention of their child. In this first examination of the effect of MoA on reading we have focused on deaf children of hearing parents only because language accessibility is a considerable problem in this group. An interesting and important topic for further research is whether critical differences in word meaning acquisition by deaf children of deaf parents and by those of hearing parents can be explained as an effect of MoA, caused by quantitative and qualitative differences in language input.

Appendix  Pairs of perceptual and linguistic target words as they appeared in identical sentences

| Perceptual       | Linguistic                  |
|------------------|-----------------------------|
| cola (coca cola) | basisvoedsel (basic food)   |
| poetsen (to clean) | betrekken (to move into)    |
| oma (grandmother) | herbergier (innkeeper)      |
| man (man)        | wereldnieuws (world news)   |
| zingen (to sing) | overleven (to survive)      |
| hond (dog)       | onderdaan (subject)         |
| blauw (blue)     | apart (unusual)             |
| lachen (to smile) | spijbelen (to skip school)  |
| beer (bear)      | malariaaparasiet (malaria parasite) |
| aiien (to stroke) | jagen (to hunt)             |
| lopen (to walk)  | studeren (to study)         |
| slapen (to sleep)| onderduiken (go into hiding)|
| vallen (to fall) | profiteren (to profit from)|
| koud (cold)      | fiks (firm)                 |
| dier (animal)    | prooi (prey)                |
| moeder (mother)  | slavin (female slave)       |
| eend (duck)      | grassoort (grain)           |
| juf (female teacher) | ambtenaar (public servant) |
| wind (wind)      | orkaankracht (hurricane force)|
| achterdeur (backdoor) | interieur (house interior) |
| nat (wet)        | bar (severe)                |
| opa (grandfather)| vulkaan (volcano)           |
| vlag (flag)      | tijdperk (era)              |
| slaapkamer (bedroom) | zomerverblijf (summer residence) |
| appeltaart (apple pie) | kameraad (comrade) |
| kind (child)     | gas (gas)                   |
| soep (soup)      | omkomen (to perish)         |
| gapen (to yawn)  | lieden (folk)               |
| schapen (sheep)  | grondvlak (base)            |
| dak (roof)       | lijden (to suffer)          |
| gillen (to scream)| afvalstof (waste product)   |
| water (water)    | bezorgen (to deliver)       |
| eten (to eat)    | tipi (tepee)                |
| vogel (bird)     | loodje (het loodje leggen; get the short end of the stick) |
| ei (egg)         | vluchteling (refugee)       |
| poes (cat)       | kazerne (barrack)           |
| bos (forest)     | geluidsbarriër (sound barrier) |
| sloot (ditch)    | beschermen (to protect)     |
| bellen (to call) | slagen (to pass)            |
| huilen (to cry)  | korting (discount)          |
| knikker (marble) | muziek (music)              |
| keuken (kitchen)| culuur (culture)            |
| oppervlakte (surface) | }
Notes

1. Three children (from different instructional age groups) had a hearing loss of less than 80 dB, the boundary used to define profound deafness in the Dutch educational system. Their hearing losses were 60, 65, and 77 dB. The results as discussed in the Results section remain the same when these three children are excluded from the analyses.

2. In an analysis with a subset of 14 items that was matched for length and frequency, Wauters (2005) found the same effects for comprehension score as in the analysis with the complete item set: main effects of MoA, hearing status, and instructional age and an interaction effect of the three. Results for the response latencies for answering the questions were also the same with both sets: main effects of MoA, hearing status, and instructional age.

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