

PDF hosted at the Radboud Repository of the Radboud University Nijmegen

The following full text is a publisher's version.

For additional information about this publication click this link.

<http://hdl.handle.net/2066/25015>

Please be advised that this information was generated on 2018-07-07 and may be subject to change.

The contribution of risk factors to the effect of early otitis media with effusion on later language, reading, and spelling

Sylvia AF Peters

Eefje H Grievink

Wim HJ van Bon

John HJ van den Bercken

Anne GM Schilder

A cohort of 946 children who were screened for otitis media with effusion (OME) from the ages of 2 to 4 were studied for language, reading, and spelling at 7 years of age. The effects of OME in combination with single risk factors and with increasing numbers of risk factors were investigated. An interaction with an additional risk factor was found only for gender and OME, with boys' spelling influenced negatively by a history of OME. OME in combination with preterm birth and low birthweight also appears to put children at risk for later language and educational problems. Although a negative linear relation between the number of risk factors and later functioning was found, it is suggested that OME, even when combined with a number of other risk factors, produces only minor effects on later language, reading, and spelling.

Otitis media with effusion (OME) is one of the most common diseases in early childhood. It is also considered a risk factor for later speech, language, and associated learning problems, because it is accompanied by a loss of conductive hearing (Silva et al. 1986, Friel-Patti and Finitzo 1990, Schilder et al. 1993c). The results of the many studies into the relation of OME to later language and educational problems are nevertheless conflicting. In recent prospective studies, the association of OME with later language and educational problems has been found to be fairly weak (Hubbard et al. 1985; Lous et al. 1988; Friel-Patti 1990; Roberts et al. 1991, 1994; Gravel and Wallace 1992; Grievink et al. 1993; Schilder et al. 1993a; Peters et al. 1994; Paradise et al. 1995). Whenever there are detrimental effects of early OME at school age, they appear to be of little practical importance (Roberts et al. 1991, 1994; Grievink et al. 1993; Peters et al. 1994; Lous 1995). Most children with OME appear to overcome the short-term effects of OME as soon as the disease disappears, even when the OME has been long-lasting. These results also do not change when the frequency of the OME and the pattern of its recurrence are taken into account (Grievink et al. 1993, Peters et al. 1994, Roberts et al. 1994). In other studies, however, a major effect of OME on later language and learning has been found (Silva et al. 1986, Teele et al. 1990). In search of an explanation for these differences, it has been suggested that the effect of OME on later language and learning may be the cumulative effect of a number of risk factors (Rapin 1979, Menyuk 1980, Bishop and Edmundson 1986, Lous et al. 1988, Pearce et al. 1988, Roberts and Schuele 1990, Roberts et al. 1991). Some authors (Roberts and Schuele 1990, Roberts et al. 1991) suggest that it is important to consider those variables that may potentially contribute to the effects of OME as well. In this study, it is assumed that most children can cope with OME and that difficulties may most often arise in the presence of other risk factors. If the negative effects of OME arise from its coincidence with other risk factors, one can expect to find only small effects of OME in a population where the incidence of such risk factors is low. Conversely, one can expect to find a relatively large effect of OME in a population with a high incidence of the risk factors and a history of OME. The data from a specific group of children in the Nijmegen Otitis Media Study (Grievink et al. 1993, Peters et al. 1994) were then analysed to test this hypothesis.

Several factors have been suggested to produce a lower level of language ability and educational attainment in general and in relation to OME in particular. Such variables are socio-economic status, sex, the intelligence level of the children, gestational age and birthweight, and a first language other than Dutch. In a number of studies, the role of a low socio-economic status in placing a child at risk is emphasized (Rapin 1979; Menyuk 1980, 1986; Hopman-Roek et al. 1988; Roberts et al. 1986, 1991, 1994; Lous 1993). Teele et al. (1984) compared a high and low social group and found only a relation between OME and lower language scores for the higher social group. With regard to sex as a risk factor, boys have generally been found to score lower on language-development tests than girls in general and in association with the occurrence of OME in particular (Silva 1980, Hopman-Roek et al. 1988, Allred 1990, Lous 1993). Low intelligence is associated with poor language scores and reading difficulties (Silva et al. 1983). Preterm birth and a low birthweight (LBW) have also been found to be risk factors for later functioning (Largo et al. 1989, Herrgard

et al. 1993, Ross et al. 1992, Levy-Shiff et al. 1994). Bishop and Edmundson (1986) have suggested that OME might interact with a number of perinatal risk factors in the etiology of language disorders. Children born prematurely with chronic OME were found to have relatively poorer verbal-cognitive abilities than children with a preterm delivery and no OME in at least one study (Pearce et al. 1988). Veen et al. (1993) also assessed a population of very preterm and very-low-birth-weight infants and found those children with a history of OME to have a significantly increased risk of language and speech developmental disorders at the age of 5. Children with a first language other than Dutch, the language of the community at large, are assumed to form a specific risk group. Verhoeven (1990) and Verhoeven and Gillijns (1994), for example, found the acquisition of reading and spelling in a second, non-native language to be less efficient than the acquisition of these abilities in a first language.

The purpose of the present study was to investigate whether or not the effects of longstanding, bilateral OME between the ages of 2 and 4 years are accompanied by one or more of the above-mentioned risk factors for later language, reading, and spelling delay at the age of 7. The Nijmegen Otitis Media Study is a large cohort study in which three groups were formed on the basis of the history of OME between the second and fourth birthdays: one group with bilateral OME and no surgical treatment, one group with bilateral OME and treatment with ventilation tubes, and a control group with no OME. The children were then tested at the age of 7 for various aspects of their language, reading, and spelling ability (Grievink et al. 1993, Peters et al. 1994).

In the present study, two specific questions were investigated. The first question is whether or not the OME subjects with an additional risk for later language, reading, and spelling problems produce lower scores at the age of 7 than the OME subjects with no additional risk. Four groups of children were formed: those with and those without a history of OME, and those with and those without an additional risk factor. The second question is whether or not an increased number of risk factors appears to increase the detrimental effects of OME on later language, reading, and spelling ability. In this study, a low educational level for both of the parents, male sex, low non-verbal intelligence, preterm birth and LBW, and Dutch as a second language were considered risk factors.

Method

SUBJECTS

A birth cohort of 1439 children born between September 1 1982 and August 31 1983 in Nijmegen, a town of 145 000 inhabitants in the Netherlands, formed the basis of this study. Of these children, 1328 were screened for OME by tympanometry on nine occasions at 3-month intervals between the ages of 2 and 4 years (Zielhuis et al. 1989b). The reliability and validity of the tympanometer had been tested in pilot studies (Zielhuis et al. 1989b). The tympanograms were classified as type A, C₁, C₂ or B, according to a modification of Jerger's (1970) method. Type A indicates normal compliance of the tympanic membrane. Type C₁ and C₂ indicate various degrees of negative middle ear pressure and reduced compliance of the tympanic membrane. A type B tympanogram (i.e. a flat one) was considered indicative of OME.

On follow-up when the children were 7 to 8 years old, 131 of the 1328 children had moved to another region, and the

parents of 37 children declined to participate after the preschool screening. The remaining 1160 children were invited to participate in this follow-up study between September 1990 and February 1991; 946 attended. All 946 children were examined by otomicroscopy, tympanometry, and audiometry. An ear, nose, and throat history was taken of the period between the last preschool screening and the present study. Audiological and otological characteristics of the whole group are described elsewhere (Schilder et al. 1993b, 1995). Children who had had bilateral B tympanograms on at least two consecutive occasions between the ages of 2 and 4 years (here called 'OME subjects') and children who had never had a bilateral type B or C₂ tympanogram (control subjects) were invited to have their language, reading, and spelling achievement measured: 305 (78%) of the 395 children invited were studied in this way. Three groups of subjects were then formed: untreated OME subjects (N=151), treated OME subjects (N=37) and control subjects without OME (N=82). In addition, 35 children whose first language was other than Dutch ('L2 children') were studied: 20 non-treated OME children, 1 treated child, and 14 control children.

MATERIALS

Various tests of language ability were used to evaluate various aspects of language ability (Baehman et al. 1988, van Bon 1992). Two subtests from the Taaltests voor Kinderen [Language Tests for Children] (van Bon 1982) were used to establish general language ability. The morphological Word Forms Production test was used because it is a good indicator of a general language factor (van Bon 1992), and because morphological competence has been demonstrated to be sensitive for abnormal language development (Morehead and Ingram 1973, Wiig et al. 1973, Johnston and Shery 1976, Vogel 1983). The Concealed Meanings test is receptive in nature, and concerns the child's understanding of the non-explicit content of sentences; there is evidence that children with hearing impairments have problems in recognizing such information (Quigley and Paul 1989). These two tests load on different factors (van Bon 1984).

Each of the 35 items on the Word Forms Production test consists of two sentences. A simple form of the relevant word is used in the first sentence, while the experimenter points at a picture. In the second, open-ended, sentence, the inflected form of the same word has to be provided by the subject while the experimenter points at a second picture. The total number of correct answers is counted.

In the Concealed Meanings test, the child has to match one of two pictures to a sentence that presupposes or implies certain information. This test consists of 33 items, and the total number of correct choices is counted.

Three tests of phonological ability were selected, because phonological ability is assumed to be highly susceptible to the effects of the hearing loss associated with OME, and phonological ability appears to play a crucial role in learning to read and write (Stanovich 1986). Tests for phonemic segmentation, sound blending, and auditory discrimination were used.

The children were asked to divide spoken words into their constituent phonemes in the Phonemic Segmentation test, and to blend separate phonemes into a whole word in the Sound Blending test. Both tests consisted of 30 monosyllabic words: 15 real words, and 15 pseudowords created by changing the vowels of the real words. The pseudowords are pronounceable

but meaningless sequences of speech sounds that obey phonological rules of Dutch word formation. The contrast between real words and pseudowords makes it possible to examine the effect of lexical knowledge on word recognition (Bryant and Bradley 1980). The number of correct answers was counted.

The Auditory Discrimination test was constructed following the procedure of Wepman's test (1973). Children were asked to judge whether or not two monosyllabic spoken words or pseudowords were the same. 'Like' pairs consisted of the same word twice; 'unlike' pairs consisted of minimally contrasting words such as *muis* (mouse) and *huis* (house). The test had 46 items: 23 pairs of real words and 23 pairs of pseudowords: 10 pairs were like words and 36 pairs were unlike. The items were recorded on tape by a speech language pathologist, and the number of correct judgments was counted.

Because of the limited time available for testing, reading tests were restricted to the word and sentence level. Three reading tests were used to test word decoding ability and comprehension of written sentences: the One Minute test, the Word Recognition test and the Sentence Verification test.

The standardized One Minute test (Brus and Voeten 1979) is frequently used to measure decoding ability, and is highly correlated with tests for reading text aloud (Mommers 1987). Words ordered according to difficulty are read aloud as fast and as accurately as possible. The number of words read correctly within one minute constitutes the test score.

The Word Recognition test (adopted from van den Bosch 1991) uses real monosyllabic words and monosyllabic pseudowords consisting of four different orthographical structures. All of the words can be read correctly by applying simple grapheme-phoneme correspondence rules. An Apple-II GS computer with 2 monitors (one for the subjects and one for the experimenter), a voice-key and a microphone were used to present the words and register the response. The real words were all ones frequently used in children's literature according to Staphorsius et al. (1988). The pseudowords were created by changing the vowel graphemes of the real words. The response latency was determined for each trial by measuring the time between the onset of the target stimulus and the verbal response of the subject. Response latency and accuracy were determined for each sentence.

The Sentence Verification test (van den Bosch 1991), which tests sentence comprehension, used short sentences consisting of monosyllabic words appearing with a high frequency in children's literature. Of these sentences, 15 were semantically

correct (for example, 'De lamp is aan' [The lamp is on]) and 10 were semantically incorrect (for example, 'Een kat is een plant' [A cat is a plant]). The child was to indicate whether or not the sentence was correct by pushing the 'yes' or the 'no' button connected to an Apple-II GS computer. Response latency and accuracy were determined for each sentence.

A 'grapheme' test was administered in order to study knowledge of simple rules of spelling-sound correspondence. The children were asked to write down 10 of the most difficult graphemes. The experimenter recited the respective phoneme and a word with that particular phoneme in it.

A spelling test consisted of 15 real monosyllabic words and 15 monosyllabic pseudowords. The real words were used with a high frequency in children's literature (Staphorsius et al. 1988). Pseudowords were created by replacing the vowel graphemes of the real words with others of the same grapheme class. Words were selected that could be written correctly by applying simple phoneme-grapheme correspondence rules. The child was requested to repeat each word correctly and then to write the word.

The Coloured Progressive Matrices test (Raven 1965, van Bon 1986) was administered as a non-verbal test of intelligence.

Parents were asked to complete questionnaires about their own educational level. Information about the first language of children, preterm birth, and birthweight was collected from questionnaires used in the first part of the Nijmegen Otitis Media Study when the children were 3 years of age.

PROCEDURE

The follow-up data were collected between September 1990 and February 1991 at the Department of Otorhinolaryngology of the Nijmegen University Hospital, in order of the subjects' birthdates.

The reading and spelling tests were administered by two of us (SAP and EHG), who were unaware of the OME histories of the subjects. All subjects were tested individually. All tests were administered in the same order. With parents' permission, questionnaires were sent to the children's teachers.

ANALYSES

To study the effects of OME in combination with risk factors on language ability and educational attainment, two approaches were followed. First, it was expected that the performance of OME subjects would be lower if an additional risk

Table I: Tests used in MANOVAs

<i>Language tests</i>	<i>Reading and spelling tests</i>
General language	Grapheme knowledge
Word Forms Production test	Grapheme knowledge test
Concealed Meanings test	Spelling
Phonological ability	Spelling test, using real words and pseudowords
Phonemic Segmentation test, using real words and pseudowords	Reading
Sound Blending test, using real words and pseudowords	One minute test
Auditory Discrimination test,	Word recognition test, using real
using like pairs of real words and pseudowords,	words and pseudowords
and unlike pairs of real words and pseudowords	Sentence verification test,
	using correct and incorrect sentences

factor were present. To test this primary hypothesis, four groups of subjects were considered in a two-by-two design, according to level of subjects' risk (high and low) and the presence of OME (OME subjects compared with controls). The hypothesis was that the effect of OME is greater in subjects with an additional risk than in subjects without one. Thus an interaction effect was defined. The hypothesis assumed that there is indeed a risk factor. This was verified by testing the effect of the risk factor in the control subjects.

Another question was whether OME subjects with an additional risk derive benefit from treatment with ventilation tubes. This was statistically tested by comparing two groups of subjects with an additional risk: a group of untreated OME subjects and a group of treated OME ('OME-VT') subjects. The data of this contrast analysis were only considered when the interaction between OME and the additional risk factor proved to be significant.

A secondary hypothesis was that the more risk factors are present, the larger will be the negative effect of OME on the child's performance, with effects ranging from small (when no additional risk factor is present) to substantial (when more than two risk factors coincide). This question was tested by comparing the trend of each effect at three levels of additional risk (0, 1, or more). The language and educational achievement measures of the variables were similarly grouped for the different MANOVAs as in Grievink et al. (1993) and Peters et al. (1994) (Table I).

Results

In the first part of this section, the effects of OME plus a single risk factor are considered. One-tailed tests were used. In the second part of the section, the effect of a number of risk factors together with OME are considered. The *F*-test outcomes in this part are given only when results were in the predicted direction and were significant.

COMBINED EFFECT OF A SINGLE RISK FACTOR PLUS OME

As revealed by either a χ^2 test or a *t* test, there were no significant differences between the OME (*N*=151) and control subjects (*N*=82) with regard to sex (χ^2 (1, *N*=233)=3.45, *P*=0.06), grade level (χ^2 (3, *N*=233)=1.36, *P*=0.72), age (*t*(231)=0.13, *P*=0.90) or intelligence (*t*(231)=0.40, *P*=0.69).

Educational level of parents

When the data were analyzed with the educational level of the parents as the risk variable, the children of parents with a low educational level constituted the risk group. A low educational level was defined as primary educational level and/or vocational training. The data of some children could not be used because information of the educational level of one or both parents was missing. Of the 151 children in the OME sample, 25 had two parents with a low educational level and 109 had at least one parent with a higher educational level. Of the 37 children with OME who were treated using ventilation tubes, 11 had two parents with a low educational level and 24 did not. Of the 81 subjects without OME, 18 belonged to the high-risk group and 51 belonged to the low-risk group. There were no interaction effects between the educational level of the parents and OME on general language ability, phonological ability, grapheme knowledge, spelling or reading.

There were differences, in the predicted direction, in the educational level of the parents in the non-OME group for

general language ability [*F*(2,235)=4.52, *P*<0.01; univariate effect on Word Forms Production, *F*(5,236)=8.95, *P*<0.01], for spelling [*F*(2,235)=2.28, *P*=0.05; univariate effect on real words, *F*(5,236)=4.48, *P*<0.05, and on pseudowords, *F*(5,236)=2.85, *P*<0.05] or for word reading [One-Minute test, *F*(1,234)=5.17, *P*<0.05; Word Recognition, *F*(4,187)=1.96, *P*=0.05; univariate effect on latency of pseudowords, *F*(5,190)=3.90, *P*<0.05]. No differences were found for phonological ability, grapheme knowledge or sentence verification.

OME apparently had no additional negative effect on language, reading, and spelling ability in subjects of parents with a low educational level. The general language, reading, and spelling abilities of the OME children of parents with a low educational level were relatively poor, but a low educational level of parents did not appear to constitute a risk factor for phonological ability or sentence verification.

SEX

The OME group consisted of 80 boys and 71 girls, the OME-VT group, of 23 boys and 14 girls, and the control groups, of 33 boys and 49 girls. There was no interaction effect of sex and OME for general language ability, phonological ability, grapheme knowledge, or reading. However, there was a multivariate interaction on spelling (*F*(2,263)=3.34, *P*<0.05; pseudowords, *F*(1,264)=5.18, *P*<0.05), as can be seen in Figure 1. The estimate of the parameter of the interaction effect was 0.08. Since the root mean square error was 0.24, the effect was 0.08/0.24 = 0.33. This means that the effect was one-third of the within-group variability.

In the non-OME group, there were differences between the boys and the girls for spelling [*F*(2,263)=2.63, *P*<0.05], but none of the univariate tests proved to be significant. There were no differences in general language ability, phonological ability, grapheme knowledge or reading.

Because an interaction effect between sex and OME for spelling of pseudowords was found, any effect of treatment with ventilation tubes was sought for the boys with OME; none was found.

Early OME appeared to affect the later spelling performance of boys. In the non-OME group, no differences were found between boys and girls with regard to language ability, phonological ability, spelling, or reading. Treatment with

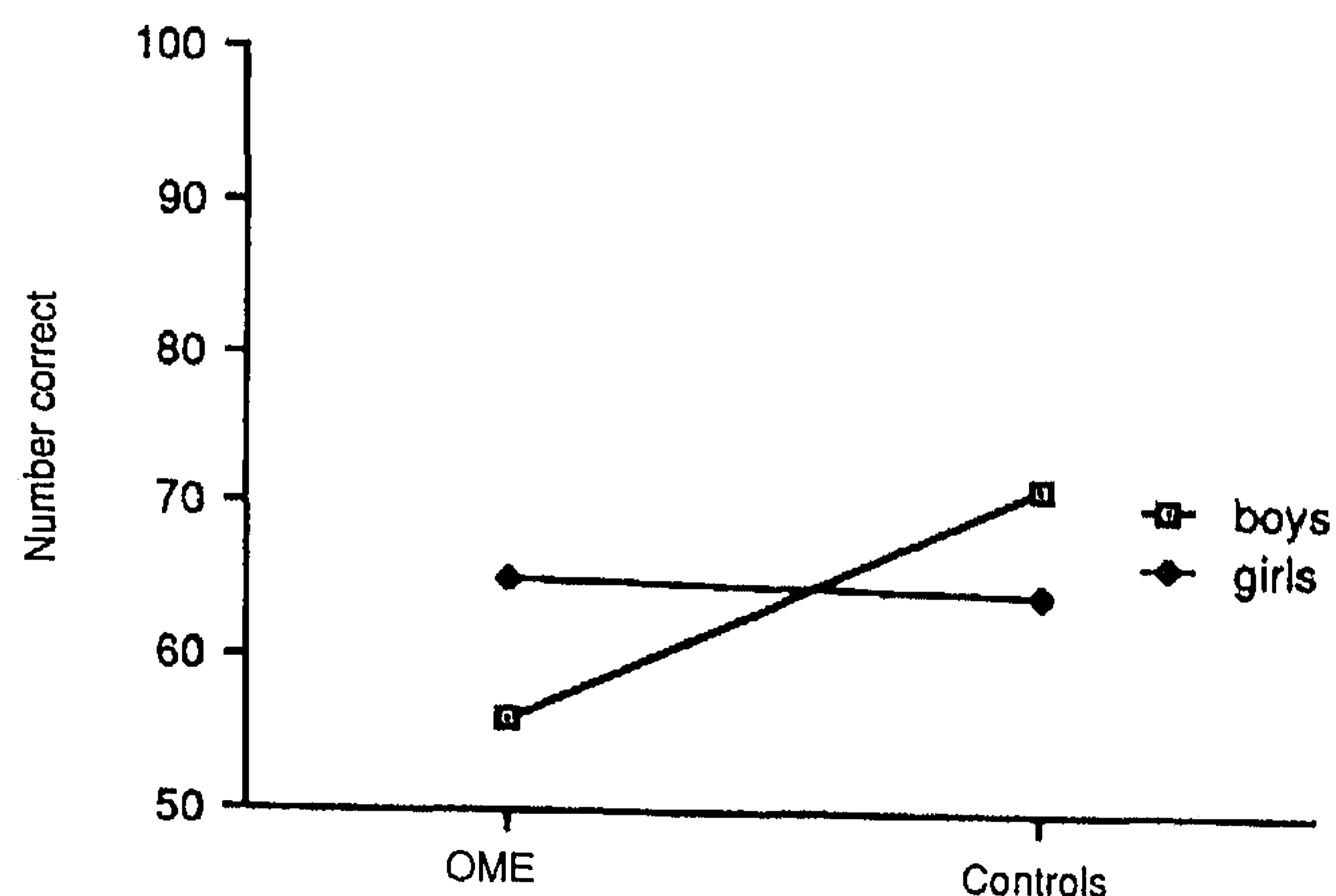


Figure 1: Mean percentages of correctly spelled words for OME and control subjects, according to subjects' sex.

ventilation tubes was not found to affect the spelling performance of the boys with OME.

Non-verbal intelligence

The children were divided into two groups. A risk group, consisting of all the children scoring below the 35th centile on the Raven Coloured Progressive Matrices, was compared with the remaining children. Of the 151 OME subjects, 16 were at risk; of the 37 OME-VT subjects, seven were at risk; of the 82 control subjects, 13 were at risk. There was no interaction between intelligence and OME for general language ability, phonological ability, grapheme knowledge, spelling or reading.

There was an effect of intelligence within the non-OME group on general language ability [$F(2,263)=8.41$, $P<0.001$; both univariate tests: Word Forms Production, $F(5,264)=4.34$, $P<0.05$; Concealed Meanings, $F(5,264)=16.65$, $P<0.0001$], phonological ability [Phonemic Segmentation and Sound Blending, $F(4,261)=1.95$, $P=0.05$; univariate tests for phonemic segmentation: real words, $F(1,264)=2.89$, $P<0.05$, pseudowords $F(1,264)=6.25$, $P<0.05$], grapheme knowledge [$F(1,264)=5.30$, $P<0.05$], spelling [$F(2,263)=3.48$, $P<0.05$; both univariate tests: real words, $F(1,264)=6.53$, $P<0.05$, pseudowords, $F(1,264)=3.32$, $P<0.05$], and reading [One-Minute test, $F(1,262)=3.30$, $P<0.05$; Word Recognition, $F(4,208)=2.79$, $P<0.05$; univariate tests of percentage correct by word type: real words, $F(1,211)=10.01$, $P<0.01$, pseudowords, $F(1,211)=3.16$, $P<0.05$]. There were no effects on auditory discrimination or sentence verification.

The combination of low non-verbal intelligence and OME did not appear to have a detrimental effect on language, reading, or spelling ability. A low non-verbal intelligence alone appeared to decrease a child's general language ability, phonological segmentation skills, grapheme knowledge, and spelling and reading ability but did not appear to influence auditory discrimination or sentence verification.

Preterm birth and/or low birthweight

Children with a gestational age less than 32 weeks and/or LBW children (birthweight less than 2500g) constituted the risk group in these analyses; this group consisted of 13 of the 138 subjects with OME, 4 of the 37 with OME-VT and 2 of the 80 control subjects. There was no interaction of preterm birth and LBW with OME for general language ability, phonologi-

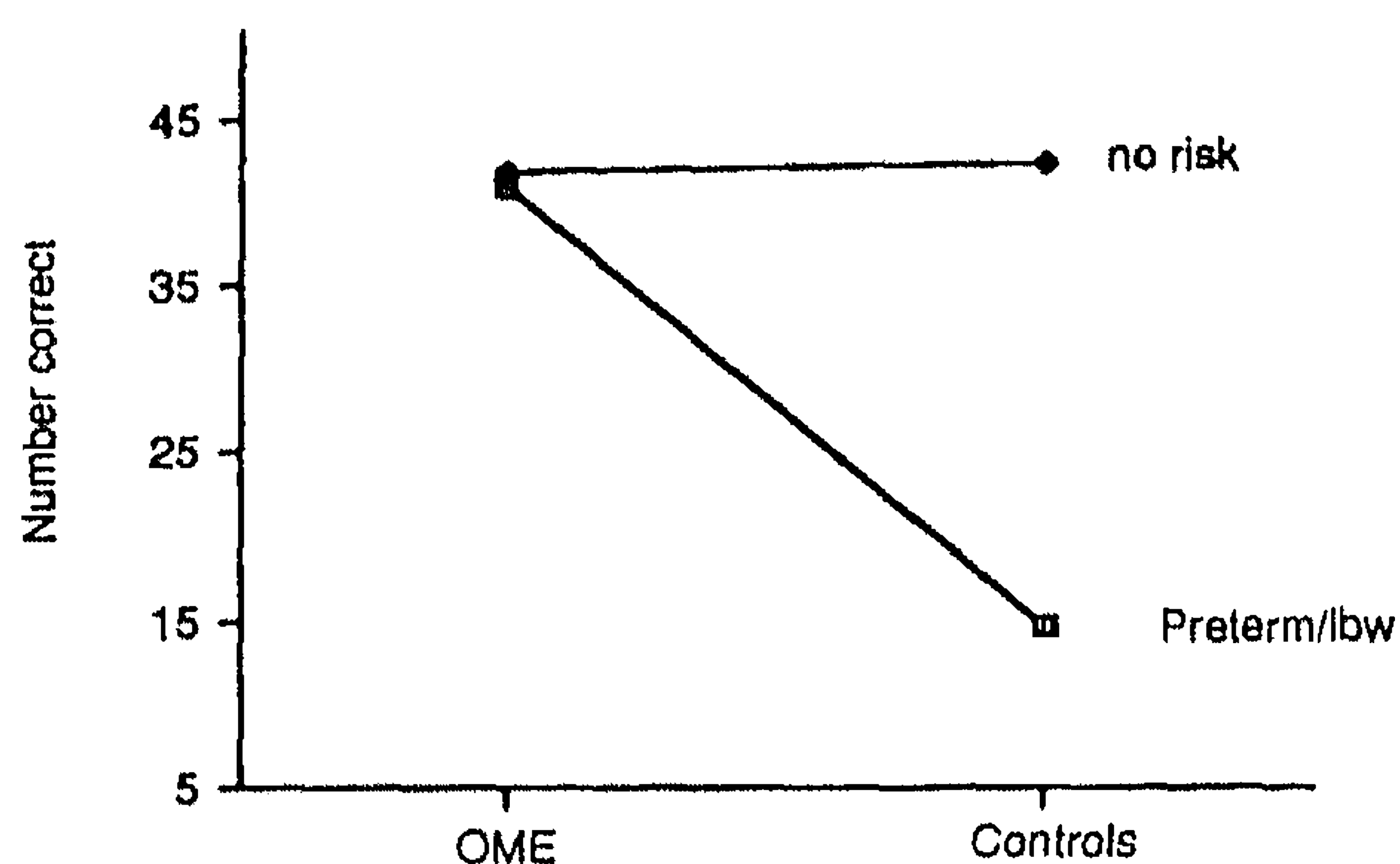


Figure 2: Mean number of correct answers on One-Minute test for OME and control subjects, according to risk factor (gestational age or birthweight, LBW = low birthweight).

cal ability, grapheme knowledge, spelling, or sentence verification. However, there were interactions for reading, but not in the predicted direction (Figs. 2-4).

There was an effect of preterm birth and low birthweight in the control group. Both subjects with the risk factor showed the poorest scores: phonological ability [Auditory Discrimination, like pairs and unlike pairs, both $P<1$; Phonemic Segmentation and Sound Blending [$F(4,246)=3.26$, $P<0.05$]; both univariate tests: real words, $F(1,249)=11.22$, $P<0.001$, and pseudowords, $F(1,249)=11.59$, $P<0.001$], word reading [One-Minute test $F(1,247)=4.28$, $P<0.05$; Word Recognition, $F(4,194)=8.88$, $P<0.001$; univariate tests: percentage correct of real words, $F(1,197)=23.16$, $P<0.001$, and of pseudowords, $F(1,197)=5.37$, $P=0.02$, latency of real words, $F(1,197)=10.64$, $P<0.01$, and of pseudowords, $F(1,197)=5.69$, $P=0.05$]. There was no effect on general language ability, grapheme knowledge, spelling, or sentence verification.

There seemed to be no specific effect of OME when it co-occurs with preterm birth and LBW. Preterm and/or LBW children had lower scores than controls for phonological abili-

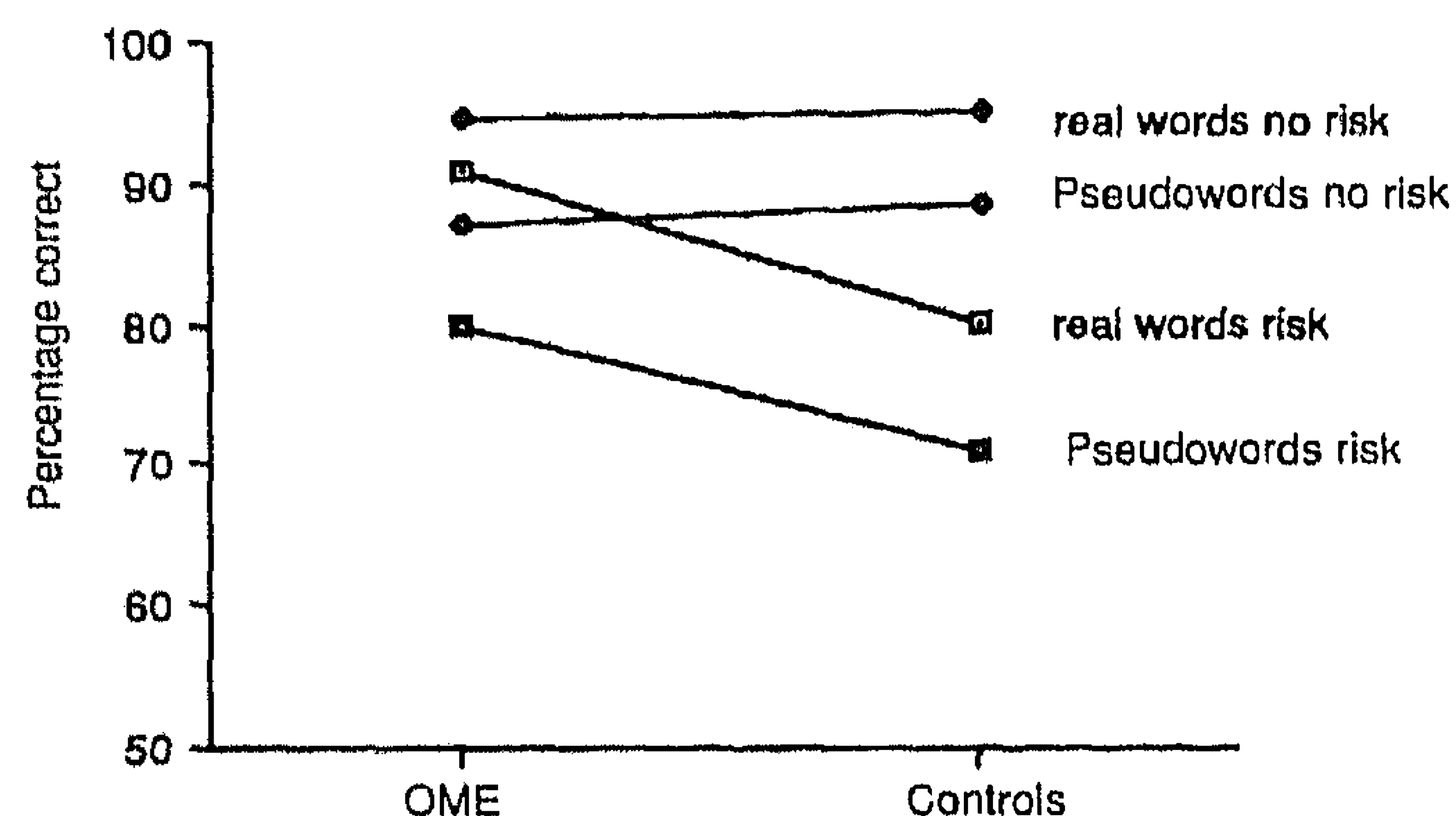


Figure 3: Mean percentage of correct answers on Word Recognition test for OME and control subjects, according to type of word (real or pseudo) and to risk variable (gestational age and birthweight).

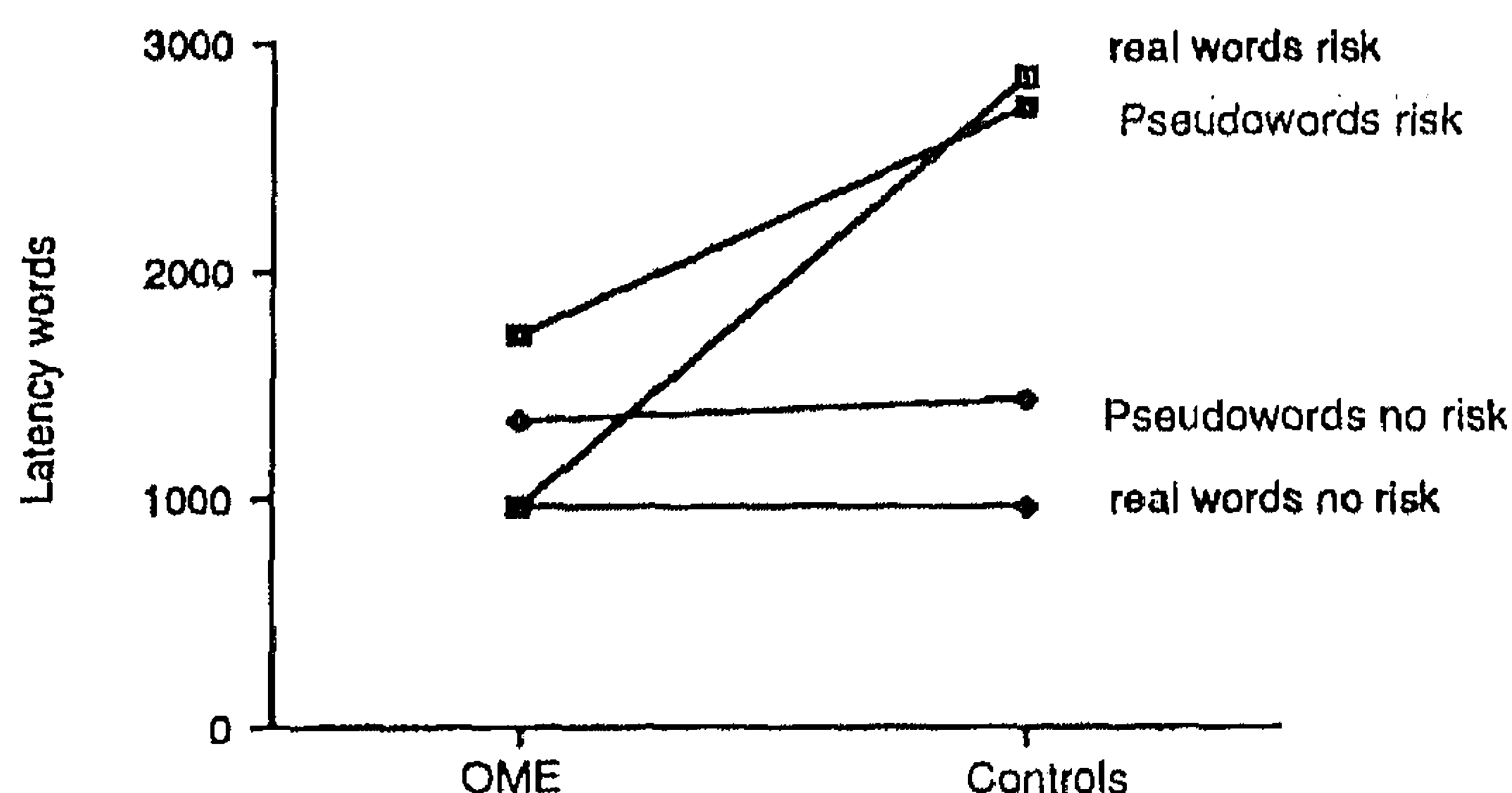


Figure 4: Mean latency of correct answers on Word Recognition test for OME and control subjects, according to type of word (real or pseudo) and to risk variable (gestational age and birthweight).

ty, spelling, and word reading. They did not differ from the controls in general language ability, auditory discrimination, grapheme knowledge, or sentence verification. However, both of the subjects in the risk group without a history of OME produced markedly poorer results than the other subjects.

Additional analyses

Preterm and LBW children nevertheless form a special risk group because they seem to be very susceptible to OME (Pearce et al. 1988, Engel et al. 1996). Because of the high number of preterm and LBW children with a history of OME in our study, only two children could be found with this risk but without a history of OME; this group was compared with control children without this risk or a history of OME in an additional analysis.

There were no significant differences between the preterm and LBW subjects with a history of OME and the control subjects in general language ability, auditory discrimination, reading of real words and sentence verification. However, there were significant differences in phonological ability [Phonemic Segmentation and Sound Blending $F(4,246)=2.63$, $P<0.05$; univariate tests of phoneme segmentation: real words, $F(5,249)=8.58$, $P<0.01$, and pseudowords, $F(5, 249)=3.61$, $P<0.05$; univariate test of sound blending: real words, $F(5, 249)=5.22$, $P<0.05$], grapheme knowledge [$F(1,249)$, $P<0.01$], spelling [$F(2,248)=2.38$, $P<0.05$; univariate tests: real words, $F(5, 249)=4.73$, $P<0.05$, and pseudowords $F(5, 249)=4.00$, $P<0.05$], and word reading [Word Recognition, $F(4,194)=2.06$, $P<0.05$; univariate tests of percentage correct: real words, $F(5, 197)=3.06$, $P<0.05$, and pseudowords, $F(5, 197)=5.15$, $P<0.05$]. Furthermore, the non-verbal intelligence levels of these subjects also appeared to be significantly lower than those of the controls [$F(1,249)=4.36$, $P<0.05$].

Preterm and LBW-children had lower scores than the controls for non-verbal intelligence, phonological ability, grapheme knowledge, spelling, and word reading but not for general language, auditory discrimination, or sentence verification.

First language

There were 35 L2 subjects (children whose first language was other than Dutch), and 270 L1 subjects (children with Dutch as a first language). The distribution among the L2 subjects

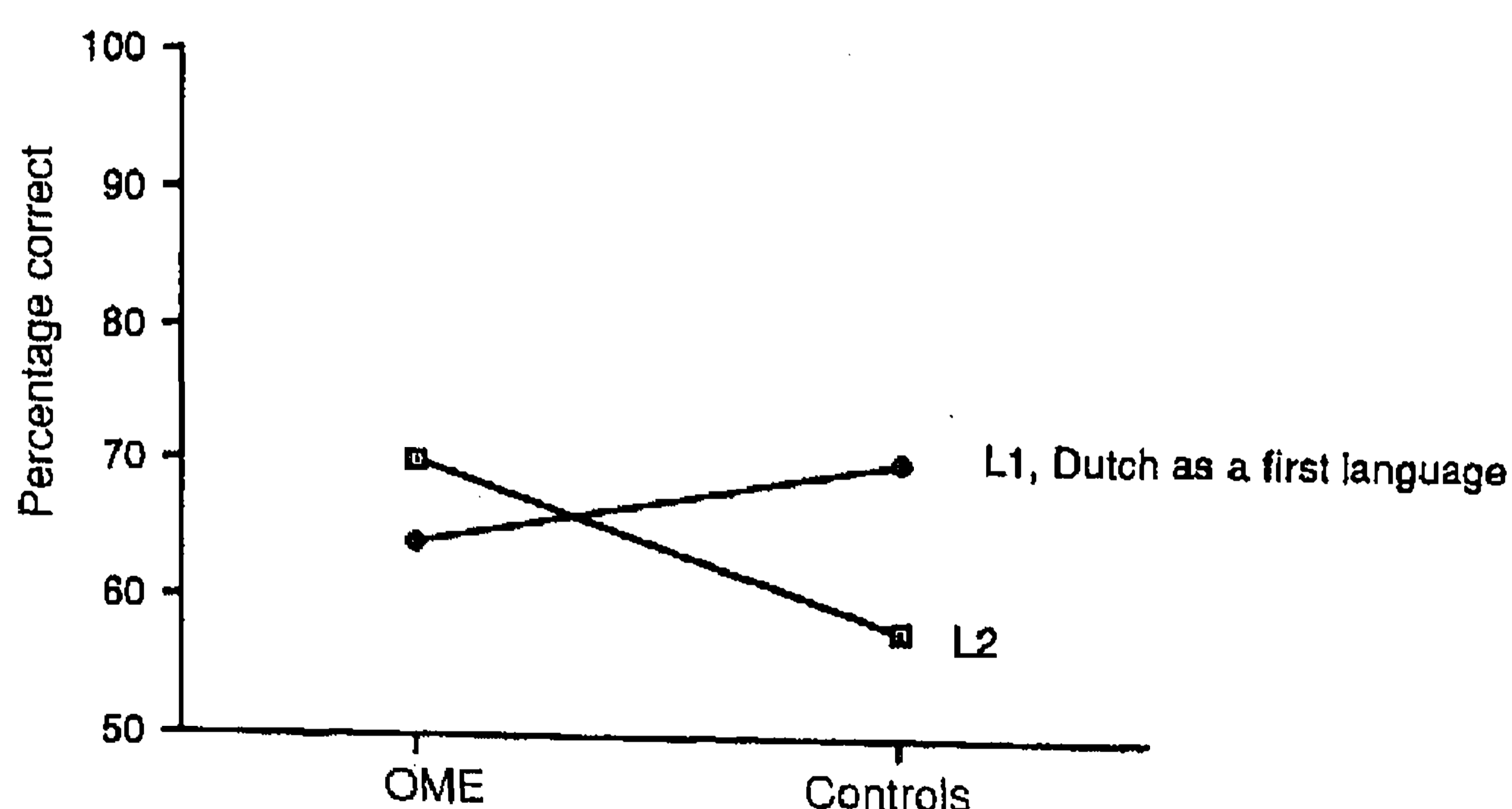


Figure 5: Mean percentage of correctly spelled real words for OME and control subjects, according to subjects' first language (Dutch or non-Dutch).

was: 14 OME subjects, 1 OME-VT subject, and 20 control subjects. No differences were found between the L1 subjects and the L2 subjects in age ($t(267)=1.51$, $P=0.13$), sex ($\chi^2(1, N=267)=0.68$, $P=0.42$) or year at school ($\chi^2(3, N=267)=2.81$, $P=0.42$). There was a difference in the intelligence levels for the two groups ($t(267)=3.78$, $P<0.001$). The L2 subjects had poorer non-verbal intelligence scores than L1 subjects. The educational levels of the parents were not useful because in the L2 group there was no information for 29 of the 34 mothers and 31 of the 34 fathers. There were no interaction effects for first language and OME on general language ability, phonological ability, grapheme knowledge or reading. There was an interaction effect on spelling, not in the predicted direction (Figs. 5, 6).

An effect of having a language other than Dutch as a first language was observed for general language ability [$F(2,298)=75.16$, $P<0.0001$; both univariate tests: Word Forms Production, $F(5,299)=141.08$, $P<0.0001$, and Concealed Meanings, $F(5,299)=8.07$, $P<0.01$], spelling [$F(2,295)=2.65$, $P<0.05$; both univariate tests: real words, $F(5,296)=3.95$, $P<0.05$, and pseudowords, $F(5, 296)=5.31$, $P<0.05$] and reading [Word Recognition, $F(4,239)=2.39$, $P=0.05$; univariate effect on percentage correct of real words, $F(1,246)=4.61$, $P<0.05$; Sentence Verification, $F(4,260)=2.56$, $P<0.05$; univariate effect on percentage correct of correct sentences, $F(4,267)=6.47$, $P<0.05$]. There were no effects of this variable on phonological ability, grapheme knowledge, or reading. The results suggest that having a language other than Dutch as a first language constitutes a risk factor for language, spelling and reading ability. Combined with a history of OME, however, the problems do not become worse.

INTERACTION BETWEEN OME AND THE NUMBER OF RISK FACTORS

If OME in and of itself is not enough to affect language and literacy negatively but might do so in combination with other risk factors, the effect of OME should become larger with an increasing number of risk factors. To consider this issue, trend analyses were performed with the following risk variables: educational level of both parents, sex, gestational age, and birthweight, and non-verbal intelligence. The variable 'number of risk factors' was added and consisted of three levels: no risk factor, one risk factor, or two or more risk factors.

There were no interaction effects for the number of risk fac-

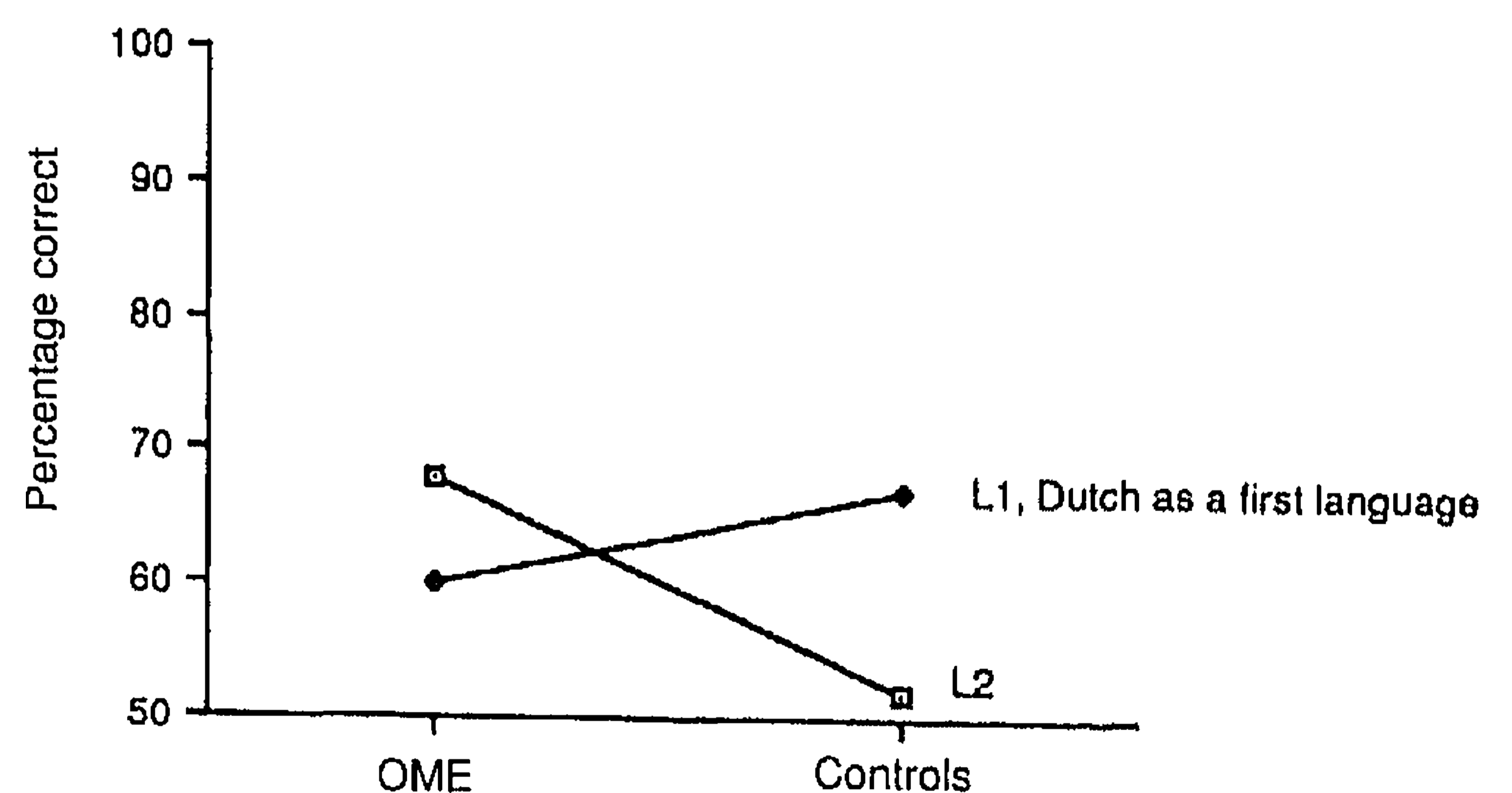


Figure 6: Mean percentage of correctly spelled pseudowords for OME and control subjects, according to subjects' first language (Dutch or non-Dutch).

tors and OME on general language ability, phonological ability, grapheme knowledge, spelling, reading of real words or pseudowords, and sentence verification. There was a significant interaction effect on the reading of real words only [One-Minute test, $F(2,186)=2.91$, $P<0.05$] (Fig. 7). The effect was quadratic, ($t(186)=2.16$, $P<0.05$).

There was a main effect of the number of risk factors on general language ability [$F(4,374)=7.73$, $P<0.001$; univariate tests: Word Forms Production $F(2,187)=7.48$, $P<0.001$, Concealed Meanings, $F(2,187)=14.22$, $P<0.0001$], phonological ability [Phonemic Segmentation and Sound Blending, $F(8,370)=1.95$, $P<0.05$; univariate tests of phonological segmentation: real words, $F(2,187)=5.30$, $P<0.01$, and pseudowords, $F(2,187)=3.17$, $P<0.05$]. There was also an effect on auditory discrimination [Auditory Discrimination (like pairs) and Auditory Discrimination (unlike pairs), $F(8,368)=2.00$, $P<0.05$; univariate test of real words in unlike pairs, $F(2,186)=4.62$, $P<0.01$], spelling [Spelling $F(4,374)=3.81$, $P<0.01$; significant univariate tests: real words, $F(2,187)=7.81$, $P<0.001$, and pseudowords, $F(2,187)=4.94$, $P<0.01$], and reading [One-Minute test, $F(2,186)=3.96$, $P<0.05$; Word Recognition, $F(8,296)=1.75$, $P<0.05$; univariate tests: percentage correct of real words, $F(2,150)=4.36$, $P<0.01$, pseudowords, $F(2,150)=4.22$, $P<0.01$, and latency of real words $F(2,150)=2.99$, $P<0.05$; Sentence Verification, $F(8,324)=1.92$, $P<0.05$; univariate tests: percentage correct of correct sentences, $F(2,164)=5.57$, $P<0.001$, incorrect, $F(2,164)=2.68$, $P<0.05$, and latency of incorrect sentences $F(2,164)=3.10$, $P<0.05$].

The hypothesis that an increased number of risk factors might augment the effects of OME on language, reading, and spelling ability does not appear to be confirmed in this study. There was a significant interaction effect between OME and the number of risk factors on the reading of real words. As no other interaction effects were found, and the one significant interaction showed a quadratic effect, the explanation for this finding remains unclear. However, an increased number of risk factors generally has an increasingly detrimental effect on language, reading, and spelling performance.

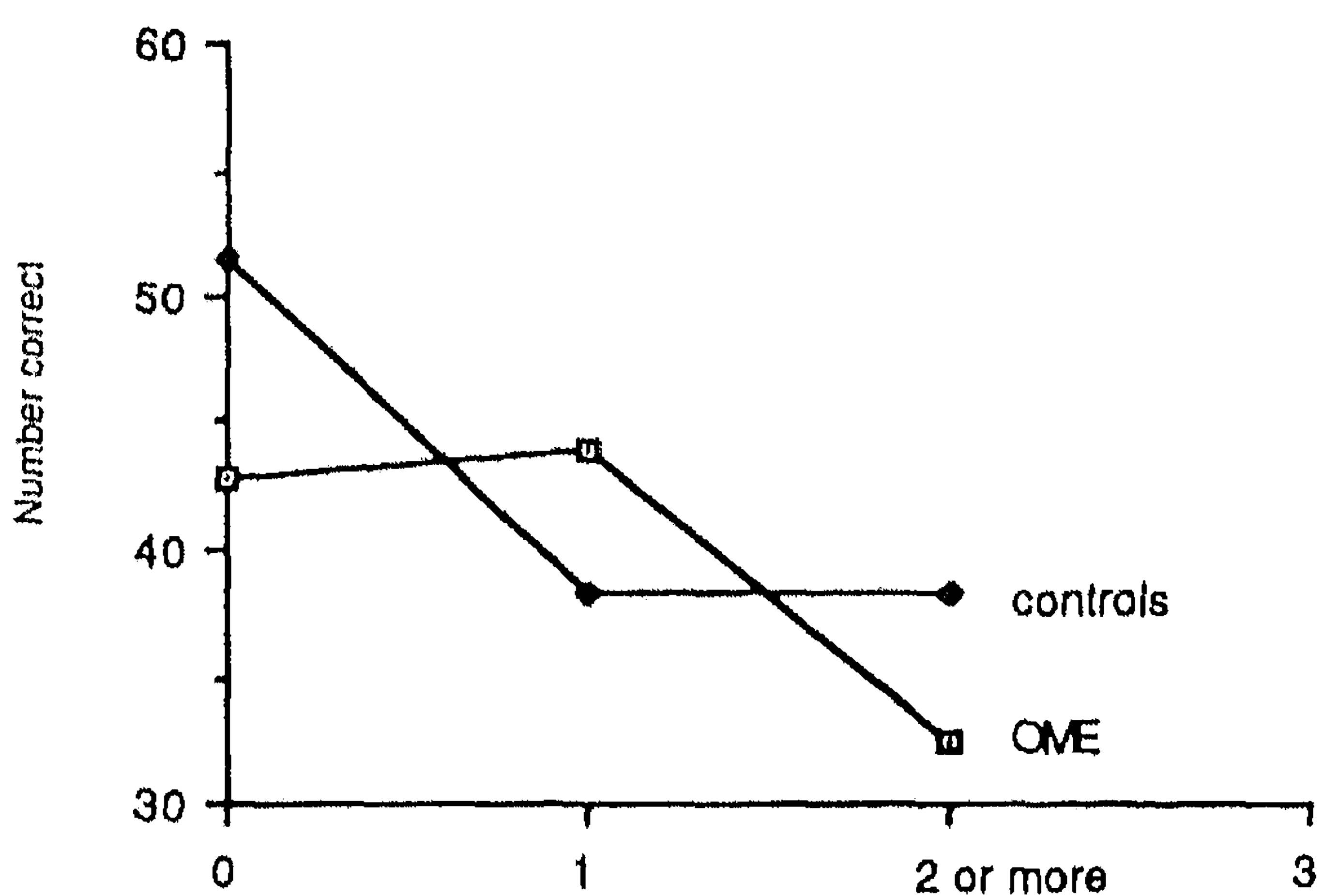


Figure 7: Mean number of correct answers on One-Minute test for subjects with increasing numbers of risk factors, according to type of subject (OME subject or control).

Discussion

The results of the present study indicate that the combined effect of early bilateral OME and other risk factors is only small.

First, the interaction of OME with one additional risk factor was investigated. The results showed OME to produce no effects in combination with the following single risk factors: low educational level of parents, low non-verbal intelligence, preterm birth and/or LBW, and another language than Dutch as a first language. Only one of the predicted interaction effects was found: namely, boys with a history of OME showed a lower spelling ability than boys without a history of OME; there was no such difference for girls. Treatment with ventilation tubes produced no differences.

Second, the possibility that more risk factors would produce a larger effect of OME on language, reading, and spelling performance was investigated. Although a negative linear relation between the number of risk factors and the language, reading, and spelling scores was found (suggesting that the risk factors indeed affect primary and secondary language skills), the results did not confirm the hypothesis of an incremental effect of OME in combination with an increased number of risk factors.

In contrast to suggestions in the literature about possible interactions of OME with risk factors (Bishop and Edmundson 1986, Roberts and Schuele 1990), the present large-scale longitudinal study did not find such interactions. The current study avoided a number of the shortcomings found in previous studies. This study included a large number of children, who were not selected, because a birth cohort was used. The age range of the children was limited. The OME histories of the children were systematically documented using tympanometry, which is a reliable way of measuring OME (Zielhuis et al. 1989b). In addition, the present study is the first prospective study to explicitly analyze the relation between OME and several other risk factors (*i.e.* one risk factor versus an increasing number of risk factors). Comparisons with other studies are difficult, because in most of the recent prospective studies the relation between OME and the risk variables was not studied explicitly. An exception is a handful of studies on the detrimental effects of preterm birth and low birthweight in combination with OME. When risk factors have been included, the ages of the children under study have differed widely, and mostly children in the preschool age have been studied. These differences in the assessment for OME might also account for differences between the present study and others, for example, that of Teele et al. (1990). Our subjects were all at least 2 years of age. It has been suggested that OME is particularly detrimental if it occurs in the first year of life.

In the present study, a significant interaction between OME and sex was found for spelling. Boys with OME performed particularly poorly in spelling. No interaction effects were found for OME and sex on language or reading ability, a finding which is in accord with that of Roberts et al. (1994).

Our finding that there was no interaction between OME and parental background is supported by the results of a few previous prospective studies. Teele et al. (1990) found no significant interactions between socioeconomic status of subjects and OME when later cognitive abilities were considered. Roberts et al. (1991) studied the later language performance of children between 4 and 6 years of age from families with lower or middle socioeconomic status (SES). Those authors specifically investi-

gated the roles of SES and OME but found only minimal differences. In a later study, Roberts et al. (1994) found no associations between OME groups from birth to 8 years of age and their intellectual development and academic performance at age 8, although their sample was rather restricted and was based on economically disadvantaged children.

No interactions between OME and preterm birth or LBW were found in this study. This is in accord with the findings of Gravel and Wallace (1992). In our study, a remarkably high proportion of preterm and LBW children with a history of OME was found (17/19). Zielhuis et al. (1989a) concluded on the basis of the first part of the Nijmegen Otitis Media study that the contribution of birth-related variables to the prediction of OME was low, but they used the internationally accepted definition of preterm birth (gestational age of less than 37 completed weeks). In many studies, as here, the criterion has been a gestational age of less than 32 weeks. Because of the high number of preterm and LBW children with a history of OME and because of the low number of preterm and LBW children without a history of OME (2 subjects), this group was also compared with control subjects without a history of OME. These additional analyses showed that the preterm and LBW children with a history of OME had lower scores on non-verbal intelligence, phonological ability, grapheme knowledge, spelling, and word reading, but not on general language, auditory discrimination, or sentence verification, in comparison with control children without a history of OME. Preterm and LBW children with and without a history of OME can therefore be considered to be particularly at risk for later language and educational problems.

The findings of the Nijmegen Otitis Media Study Group (Peters et al. 1994, and this study) have shown spelling to be particularly sensitive to OME. However, the effect was rather small.

In interpreting the findings of the present study, the question of whether the 'risk factors' really were risk factors must be considered. Neither the fact of being a boy nor having parents with a low educational level was associated with any particular risk, although these factors did appear to affect some aspects of language, reading, and spelling, which may also explain, at least partially, the lack of interactions.

The present study suggests that bilateral, longstanding OME between 2 and 4 years of age does not interact with a low parental educational level or low non-verbal intelligence of the child, and does not affect a child's language, reading, or spelling ability at age 7. However, there seemed to be a relation between sex and OME, with boys' spelling influenced negatively by a history of OME. OME in combination with preterm birth and LBW also appeared to put children at risk for later language and educational problems. The effects of OME seem to be frequently overestimated. The results of the present study and earlier studies (Grievink et al. 1993; Peters et al. 1994) show that OME, even when combined with a number of other risk factors, produces only minor effects on later language, reading, and spelling performance.

Accepted for publication 1st November 1995.

Acknowledgements

This part of the Nijmegen Otitis Media Study was supported by the Stichting Kinderpostzegels Nederland.

Authors' appointments

Sylvia AF Peters, Research Fellow;

Eefje H Grievink, Research Fellow;

*Wim HJ van Bon, PhD, Associate Professor of Special Education;

John HL van den Bercken, PhD, Associate Professor of Special Education;

Department of Special Education, University of Nijmegen, The Netherlands.

Anne GM Schilder, MD, PhD, Department of Otorhino

laryngology, University Hospital Utrecht, Utrecht.

*Correspondence to Wim van Bon at Department of Special Education, University of Nijmegen, Postbus 9104, 6500 HE Nijmegen, The Netherlands.

References

- Allred RA. (1990) Gender differences in spelling achievement in grades 1 through 6. *Journal of Educational Research* **83**: 187-193.
- Bachman LF, Vanniarajan AKS, Lynch B. (1988) Task and ability analysis as a basis for examining content and construct comparability in two EFL proficiency test batteries. *Language Testing* **5**: 128-59.
- Bishop DVM, Edmundson A. (1986) Is otitis media a major cause of specific developmental language disorders? *British Journal of Disorders of Communication* **21**: 321-38.
- Brus BTh, Voeten MJM. (1979) *Een-Minuut-Test. [One-Minute Test]*. Nijmegen: Berkhout.
- Bryant PE, Bradley L. (1980) Why children sometimes write words which they do not read. In: Frith U, editor. *Cognitive Processes in Spelling*. London: Academic Press. p 355-70.
- Engel JAM, Antemuis LJC, Hendriks JJT, Marres EHMA. (1996) Epidemiological aspects of otitis media with effusion in infancy. In: Lim DJ, Bluestone CD, editors. *Proceedings of the Sixth International Symposium on Recent Advances in Otitis Media*. (Forthcoming).
- Friel-Patti S. (1990) Otitis media with effusion and the development of language: a review of the evidence. *Topics in Language Disorders* **11**: 11-22.
- Finitzo T. (1990) Language learning in a prospective study of otitis media with effusion in the first two years of life. *Journal of Speech and Hearing Research* **33**: 188-94.
- Gravel JS, Wallace IE. (1992) Listening and language at 4 years of age: effects of early otitis media. *Journal of Speech and Hearing Research* **35**: 588-95.
- Grievink EH, Peters SAF, van Bon WHJ, Schilder AGM. (1993) The effects of early bilateral otitis media with effusion on language ability: a prospective cohort study. *Journal of Speech and Hearing Research* **36**: 1004-12.
- Herrgård E, Luoma L, Tuppurainen K, Karjalainen S, Martikainen A. (1993) Neurodevelopmental profile at five years of children born at ≤ 32 weeks gestation. *Developmental Medicine and Child Neurology* **35**: 1083-96.
- Hopman-Rock M, Gerritsen FME, Talsma P. (1988) Milieu- en geslachtsverschillen in taalontwikkeling van kinderen van 3 tot 6 jaar. *Pedagogische Studiën* **65**: 437-50.
- Hubbard TW, Paradise JL, McWilliams BJ, Elster BA, Taylor FH. (1985) Consequences of unremitting middle-ear disease in early life. Otologic, audiology, and developmental findings in children with cleft palate. *New England Journal of Medicine* **312**: 1529-35.
- Jerger J. (1970) Clinical experience with impedance audiometry. *Archives of Otolaryngology* **92**: 311-24.
- Johnston J, Shery TK. (1976) The use of grammatical morphemes by children with communication disorders. In: Morehead D, Morehead A, editors. *Normal and Deficient Child Language*. Baltimore: University Park Press. p 239-58.
- Largo RH, Pfister D, Molinari L, Kundu S, Lipp A, Duc G. (1989) Significance of prenatal, perinatal and postnatal factors in the development of AGA preterm infants at five to seven years. *Developmental Medicine and Child Neurology* **31**: 440-56.
- Levy-Shiff R, Einat G, Mogilner MB, Lerman M, Krikler R. (1994) Biological and environmental correlates of developmental outcome of prematurely born infants in early adolescence. *Journal of Pediatric Psychology* **19**: 63-78.

- Louis J. (1993) Silent reading and secretory otitis media in school children. *International Journal of Pediatric Otorhinolaryngology* **25**:25-38.
- (1995) Otitis media and reading achievement: a review. *International Journal of Pediatric Otorhinolaryngology* **32**:105-21.
- , Fiellau-Nikolajsen M., Jeppesen AL. (1988) Secretory otitis media and language development: a six year follow-up study with case-control. *International Journal of Pediatric Otorhinolaryngology* **15**:185-203.
- Menyuk P. (1980) Effect of persistent otitis media on language development. *Annals of Otolaryngology, Rhinology, and Laryngology* **89** (suppl. 68): 257-63.
- (1986) Predicting speech and language problems with persistent otitis media. In: Kavanagh JF, editor. *Otitis Media and Child Development*. Parkton, MD: York Press, p 83-96.
- Mommers MJC. (1987) An investigation into the relation between word recognition skills, reading comprehension and spelling skills in the first two years of primary school. *Journal of Research in Reading* **10**:122-43.
- Morehead D., Ingram D. (1973) The development of base syntax in normal and linguistically deviant children. *Journal of Speech and Hearing Research* **16**:330-52.
- Paradise JL, Haggard MP, Louis J, Roberts JE, Schilder AGM. (1995) Developmental implications of early-life otitis media. *International Journal of Pediatric Otorhinolaryngology* **32** (Suppl.): S37-S44.
- Pearce PS, Saunders MA, Creighton DE, Sauve RS (1988) Hearing and verbal cognitive abilities in high-risk preterm infants prone to otitis media with effusion. *Journal of Developmental and Behavioral Pediatrics* **9**:346-51.
- Peters SAE, Grievink EH, Bon WHJ, van Schilder AGM. (1994) The effects of early bilateral otitis media with effusion on educational attainment: a prospective cohort study. *Journal of Learning Disabilities* **27**:111-21.
- Quigley SP, Paul PV. (1980) English language development. In: Wang MR, Reynolds MC, Walberg HJ, editors. *Handbook of Special Education: Research and Practice, Vol. 3*. Oxford: Pergamon Press, p 3-21.
- Rapin I. (1979) Conductive hearing loss effects on children's language and scholastic skills. *Annals of Otolaryngology, Rhinology and Laryngology* **88** (Suppl. 60):3-12.
- Raven JC. (1965) *Guide to Using the Coloured Progressive Matrices*. Lewis: London.
- Roberts JE, Schuele CM. (1990) Otitis media and later academic performance: the linkage and implications for intervention. *Topics in Language Disorders* **11**:43-62.
- Sanyal MA, Burchinal MR, Collier AM, Ramey CT, Henderson FW. (1986) Otitis media in early childhood and its relationship to later verbal and academic performance. *Pediatrics* **78**:423-30.
- , Burchinal MR, Davis BP, Collier AM, Henderson FW. (1991) Otitis media in early childhood and later language. *Journal of Speech and Hearing Research* **34**:1158-68.
- , Campbell E. (1994) Otitis media in early childhood and patterns of intellectual development and later academic performance. *Journal of Pediatric Psychology* **19**:347-67.
- Ross G, Lipper E, Auld PAM. (1992) Hand preference, prematurity and developmental outcome at school age. *Neuropsychologia* **30**:483-94.
- Schilder Anne GM, van Manen JG, Zielhuis GA, Grievink EH, Peters SAE, van den Broek P. (1993a) Long-term effects of otitis media with effusion on language, reading and spelling. *Clinical Otolaryngology* **18**:234-41.
- , Zielhuis GA, Straatman HS, van den Broek P. (1993b) Long-term effects of otitis media with effusion: auditory findings. Nijmegen: University of Nijmegen. (Thesis).
- , van den Broek P. (1993c) The otological profile of a cohort of Dutch 7.5-8-year olds. *Clinical Otolaryngology* **18**:48-54.
- , Haggard MP, van den Broek P. (1995) Long-term effects of otitis media with effusion: otomicroscopic findings. *American Journal of Otolaryngology* **16**:365-73.
- Silva PA. (1980) The prevalence, stability and significance of developmental language delay in preschool children. *Developmental Medicine and Child Neurology* **22**:768-77.
- , McGee R, Williams SM. (1983) Developmental language delay from three to seven years and its significance for low intelligence and reading difficulties at age seven. *Developmental Medicine and Child Neurology* **25**:783-93.
- , Chalmers D, Stewart J. (1986) Some audiological, psychological, educational, and behavioral characteristics of children with bilateral otitis media with effusion: a longitudinal study. *Journal of Learning Disabilities* **19**:165-9.
- Stanovich KE. (1986) Matthew effects in reading: some consequences of individual differences in the acquisition of literacy. *Reading Research Quarterly* **21**:360-406.
- Staphorsius G, Krom RSH, de Geus K. (1988) *Frequenties van woordvormen en letterposities in jeugdlectuur*. Arnhem: Cito.
- Teele DW, Klein JO, Rosner BA, and the Greater Boston Otitis Media Study Group. (1984) Otitis media with effusion during the first three years of life and development of speech and language. *Pediatrics* **74**:282-7.
- , Chase C, Menyuk P, Rosner BA, and the Greater Boston Otitis Media Study Group. (1990) Otitis media in infancy and intellectual ability, school achievement, speech, and language at age 7 years. *Journal of Infectious Diseases* **162**:685-94.
- van Bon WHJ. (1982) *Taaltests voor Kinderen*. [Language Tests for Children]. Lisse: Swets & Zeitlinger.
- (1984) *Aspekten van taalvaardigheid. Een onderzoek naar de validiteit van de Taaltests voor Kinderen*. Lisse: Swets & Zeitlinger.
- (1986) *Raven's Coloured Progressive Matrices. Nederlandse normen en enige andere uitkomsten van onderzoek*. Lisse: Swets & Zeitlinger.
- (1992) The dimensionality of children's grammatical proficiency in Dutch. In: de Jong J, Verhoeven L, editors. *The Constructs of Language Deficiency*. Amsterdam: Benjamins.
- van den Bosch K. (1991) Poor readers' decoding skills: Effects of training, task, and word characteristics. Nijmegen: University of Nijmegen. (Unpublished doctoral dissertation).
- Veen S, Sassen ML, Schreuder AM, Ems-Dokkum MH, Verloove-Vanhorick SP, Brand R, Grote JJ, Ruys JH. (1993) Hearing loss in very preterm and very low birthweight infants at the age of 5 years in a nationwide cohort. *International Journal of Pediatric Otorhinolaryngology* **26**:11-28.
- Verhoeven LT. (1990) Acquisition of reading in a second language. *Reading Research Quarterly* **15**:90-114.
- , Gillijns P. (1994) Ontwikkeling van beginnende lees- en spellingvaardigheid. *Tijdschrift voor Onderwijsresearch* **19**:259-79.
- Vogel SA. (1983) A qualitative analysis of morphological ability in learning disabled and achieving children. *Journal of Learning Disabilities* **16**:416-20.
- Wepman JM. (1973) Auditory Discrimination Test. Western Psychological Services.
- Wiig EH, Semel EM, Crouse MB. (1973) The use of English morphology by high risk and learning disabled children. *Journal of Learning Disabilities* **6**:457-65.
- Zielhuis GA, Heuvelmans-Heinen EW, Rach GH, van den Broek P. (1989a) Environmental risk factors for otitis media with effusion in preschool children. *Scandinavian Journal of Primary Health Care* **7**:33-8.
- , Rach GH, van den Broek P. (1989b) Screening for otitis media with effusion in preschool children. *Lancet* **i**:311-3.