Prediction of word recognition in the first half of grade 1

Snel, M.J.; Aarnoutse, C.A.J.; Terwel, J.; Van Leeuwe, J.F.J.; Van der Veld, W.M.

published in
European Early Childhood Education Research Journal
2016

DOI (link to publisher)
10.1080/1350293X.2016.1143260

document version
Publisher's PDF, also known as Version of record

European Early Childhood Education Research Journal

ISSN: 1350-293X (Print) 1752-1807 (Online) Journal homepage: http://www.tandfonline.com/loi/recr20

Prediction of word recognition in the first half of grade 1

M.J. Snel, C.A.J. Aarnoutse, J. Terwel, J.F.J. van Leeuwe & W.M. van der Veld

To cite this article: M.J. Snel, C.A.J. Aarnoutse, J. Terwel, J.F.J. van Leeuwe & W.M. van der Veld (2016): Prediction of word recognition in the first half of grade 1, European Early Childhood Education Research Journal

To link to this article: http://dx.doi.org/10.1080/1350293X.2016.1143260

Published online: 22 Feb 2016.

European Early Childhood Education Research Journal, 2016
http://dx.doi.org/10.1080/1350293X.2016.1143260

Prediction of word recognition in the first half of grade 1

M.J. Snel[a], C.A.J. Aarnoutse[b], J. Terwel[c], J.F.J. van Leeuwe[d] and W.M. van der Veld[e]*

[a]*Faculty of Education, Utrecht University of Applied Sciences, The Netherlands;* [b]*Department of Education, Radboud University Nijmegen, The Netherlands;* [c]*Department of Education, VU University Amsterdam, The Netherlands;* [d]*Social Science Faculty, Radboud University Nijmegen, The Netherlands;* [e]*Behavioral Science Institute (BSI), Radboud University Nijmegen, The Netherlands*

Early detection of reading problems is important to prevent an enduring lag in reading skills. We studied the relationship between speed of word recognition (after six months of grade 1 education) and four kindergarten pre-literacy skills: letter knowledge, phonological awareness and naming speed for both digits and letters. Our sample consisted of 178 pupils divided over seven classes. In agreement with the literature, we found that all four kindergarten tests were related to speed of word recognition in grade 1. We also performed a multiple regression analysis with a set of background variables and the four kindergarten tests. The model explained 53% of the variance in speed of word recognition. However, only letter knowledge and naming speed for digits had a significant direct effect. Our conclusion is, nevertheless, that all four kindergarten tests should be used to identify children at risk for reading problems.

Keywords: word recognition; beginning reading; phonological awareness; letter knowledge; naming speed

Introduction

The importance of reading and writing in our time is evident. Someone who does not master these skills cannot function properly in society. One of the main tasks of primary education is therefore to teach all children to read and write or, in other words, to become literate.

Literacy can be defined as the ability to communicate well in writing and thereby read and write effectively and efficiently. *Word recognition* is part of literacy and can be defined as the process of converting a sequence of letters into sounds for the identification of a word. This decoding process can initially be quite slow. As words are encountered more frequently, however, word recognition becomes both faster and more automatic. Specific patterns of letters, morphemes and words are directly linked to their representations in the mental lexicon and therefore recognized with considerable speed (Coltheart 1978).

Extensive research has been conducted on the development of children's word recognition skills and reading instruction (Aarnoutse et al. 2001; Henneman, Kleijnen, and Smits 2004; Verhagen 2009; Verhoeven and van Leeuwe 2003; Wentink and

*Email: mj.snel@live.nl

Verhoeven 2001, 2004). These studies showed that reading instruction should begin early (i.e. in kindergarten) with preparatory word recognition activities. Factors which are known to influence the development of children's word recognition should be targeted as part of these early activities, e.g. phonological awareness, letter knowledge and naming speed (Aarnoutse 2004; Aarnoutse, Van Leeuwe, and Verhoeven 2000, 2005; Beernink 2002; Verhagen, Aarnoutse, and Van Leeuwe 2006, 2008).

Predictors of word recognition

Several studies have shown a small number of kindergarten pre-literacy skills to be related to children's later word recognition (Bowers and Swanson 1991; Hansen and Bowey 1994; Näslund and Schneider 1996; National Early Literacy Panel 2008; Wagner and Torgesen 1987). Among the kindergarten skills are: *phonological awareness* or the ability to detect, manipulate and analyze the auditory aspects of the spoken language including the ability to distinguish or segment words, syllables and phonemes independent of their meaning; *letter knowledge* or familiarity with the names and sounds associated with printed letters; *rapid automatic naming of letters and digits* or the ability to rapidly name a random sequence of otherwise well-known letters or digits; *rapid automatic naming of objects and colours* or the ability to rapidly name random sets of pictures of well-known objects or colours; *writing of letters and name* or the ability to write letters in isolation and write one's own name; and *phonological memory* or the ability to remember spoken information across a short period of time.

In the Netherlands, the most frequently studied predictors of children's early word recognition are: *phonemic awareness*, *naming speed* and *letter knowledge* (e.g. Aarnoutse 2004; Aarnoutse et al. 2000, 2005; Beernink 2002; Verhagen et al. 2006, 2008).

Phonemic awareness

Phonemic awareness is the ability to hear, identify and manipulate phonemes or the smallest units of sounds which differentiate meaning. Separating the spoken word *cat* into the three distinct phonemes */c/, /a/, /t/* requires phonemic awareness, which can be further divided into phonemic analysis and phonemic synthesis (Wagner, Torgesen, and Rashotte 1994). *Phonemic analysis* is the ability to separate spoken words into their respective phonemes; *phonemic synthesis* is the ability to merge a number of phonemes together to produce the spoken word.

According to Aarnoutse and Kapinga (2007), simple phonemic awareness skills develop in Dutch – the language spoken in the Netherlands – before the start of formal reading instruction in grade 1. For example, the analysis of the first or last phoneme of a spoken word and the synthesis of Dutch consonant, vowel, consonant (CVC) words is quite well-developed in kindergarten.

Naming speed

Naming speed is the speed with which children name a continuous series of highly familiar items as rapidly as possible. The stimuli are typically letters, digits, colours or pictures of familiar objects, and it is assumed that the naming responses are highly automatized and overlearned (Wolf, Bally, and Morris 1986). In one of the first studies of the association between serial naming speed and reading ability, Spring

and Capps (1974) compared the naming speeds for digits, colours and the pictures of relatively common objects for dyslexic versus non-dyslexic children. The dyslexic children named the items more slowly than the non-dyslexic children. Many studies have since demonstrated the robustness of the association between serial naming speed and word recognition, even after verbal and nonverbal IQ, prior word reading ability, short-term memory, articulation rate, speed of processing, letter knowledge and phonological awareness were controlled for (van den Bos, Zijlstra, and lutje Spelberg 2002; Scarborough 1998; Wagner et al. 1997; Wolf et al. 1986; Wolf and Bowers 1999). Naming speed further correlates highly with both single-word recognition (e.g. Spring and Davis 1988; Vellutino et al. 1996; Wolf et al. 1986) and textual reading speed (Bowers 1997). According to van den Bos et al. (2002), however, naming speed for letters and digits (i.e. alphanumeric naming speed) predicts word recognition better than naming speed for colours and pictures. Moreover, van den Bos and lutje Spelberg (2010) found naming speed for digits to be a better predictor of word recognition speed than naming speed for letters. They explain this finding in terms of the ambiguity of alphabetic stimuli and the smaller size of the set of digits (i.e. 1 to 10) than the set of letters in the alphabet (i.e. a to z).

Exactly *how* naming speed influences word recognition is still not understood. Cutting and Denckla (2001) outline three, somewhat conflicting, hypotheses regarding the relationship between naming speed and word recognition. First, naming speed can be assumed to be a component of phonological processing (Wagner et al. 1993; Wagner et al. 1994). Second, naming speed can be assumed to be fundamental for the development and, in particular, the start of orthographic knowledge (Bowers 1997; Manis, Doi, and Bhada 2000; Sunseth and Bowers 1997; Wolf and Bowers 1999). Third, naming speed can be assumed to be fundamental to memory span although this hypothesis is less prominent than the other two (see Bowers et al. 1994, for a review).

Letter knowledge

According to Bowey (2005), *letter knowledge* at its most basic level is the ability to represent letters which only differ from others in a few distinct ways (e.g. the ability to distinguish d from b or d from p). At a more developed level, letter knowledge is familiarity with the connections between written or printed letters (i.e. graphemes) and their corresponding phonemes. Many studies have shown letter knowledge in kindergarten to be one of the best predictors of children's later word reading ability (e.g. Bond and Dijkstra 1997; Bowey 2005; Ehri and Sweet 1991; Ehri and Wilce 1987; de Jong and van der Leij 1999; Lonigan, Burgess, and Anthony 2000; Scarborough 1998; Share et al. 1984; Wagner, Torgesen, and Rashotte 1994). Moreover, children who later show reading problems have been found to have *less* knowledge of letters in kindergarten than children without later reading problems (de Jong and van der Leij 2003).

According to Adams (1990) and Bowey (2005), letter knowledge does not *necessarily* imply that the relevant connections can actually be used for the recognition of words and thus contribute to later reading skill. Children may master phoneme-grapheme connections but *still* not understand that these connections must be used to recognize words. Adams (1990) suggests that this is the reason why the learning of isolated graphemes (i.e. letters) in kindergarten does not influence later word recognition while the learning of isolated phonological skills does. The teaching of letter knowledge in *combination* with phonological skills has nevertheless been found to more

strongly affect children's later word recognition than the teaching of just phonological skills, presumably because such learning closely resembles the actual process of decoding and recoding words (Blachman 2000; Bus and van IJzendoorn 1999).

Research question

The present study focused on the prediction of children's word recognition at the end of the first half of grade 1. Based on the reviewed literature we have formulated the following research question: *Is there an effect of phonological awareness, letter knowledge and naming speed in kindergarten on children's word recognition after six month of reading instruction in grade 1*?

Method

Participants

Eight primary schools and a total of nine classes or 178 Dutch students who were all learning to read Dutch participated in this longitudinal study. Prior to the start of the study, the parents of the participating pupils gave their informed consent for the use of the anonymous reading results from their child for purposes of the present research. The average age of the students at the time of initial testing (i.e. the end of kindergarten) was 6 years and 4 months (SD = 5.1 months). Further, 91 were male (51%) and 87 were female (49%); 109 had a non-minority background (61%) and 69 had a minority background (39%). There were 11 non-minority students and 43 minority students who had one or two parents with a lower education; 98 non-minority students and 26 minority students had one or two parents with a higher education.

Measures

Letter Knowledge, Phonemic Synthesis, Phonemic Analysis, Naming Speed Digits and Naming Speed Letters were administered at the end of kindergarten (July). The Word Recognition test was administered in January of grade 1.

All of the measures used in this study were administered by interns in the schools. The interns received special training during several sessions to administer the tests. During these sessions each test, its manual, and its administration were thoroughly discussed and practiced. The tests were administered with individual pupils in a separate and quiet room.

Letter Knowledge. A test developed by Aarnoutse, Beernink, and Verhagen (2010) was used to measure passive letter knowledge. The test consists of 23 lists of 23 letters each with the letters *x*, *y* and *q* excluded and the two letters *s* and *o* serving as practice items. For each list, a single letter is read aloud and the child is asked to circle the letter which has been read aloud. The Cronbach's α in the Aarnoutse, Beernink and Verhagen study was .92.

Phonemic Synthesis. A test developed to measure a child's ability to reconstruct a word from its constituent phonemes was used to measure phoneme synthesis (Aarnoutse and Verhagen 2001). The 20 items range in difficulty from words like *ijs* (ice) to words like *paraplu* (umbrella). The Cronbach's α in the Aarnoutse and Verhagen study was .89.

Phonemic Analysis. A test developed to measure a child's ability to analyze a pseudoword into its constituent phonemes was used to measure phonemic analysis (Verhagen and Aarnoutse 2001). The child is asked to listen to 40 pseudowords and name the first phoneme in words like *buin* and *krontebel* on 20 occasions and the last phoneme in words like *koes* and *draap* on 20 occasions. A Cronbach's α of .94 was reported by Verhagen and Aarnoutse.

Naming Speed for Letters / Digits In each of these tests, as developed by Aarnoutse et al. (2010), five columns of 10 items each are presented; the first column is a practice column. The child is asked to name the items in the columns as quickly and accurately as possible. The child's score is the time required in seconds to name the total of 40 items. *Naming Speed for Letters* uses the letters *o, s, m, p* and *k* because these letters are well known by kindergarten children. The test-retest reliability mentioned in the manual is .88. *Naming Speed for Digits* uses the numbers 1, 2, 3, 4 and 5. The test-retest reliability mentioned in the manual is .86.

Word Recognition. The ability of the child to decode printed words was measured using a task developed by Aarnoutse and Kapinga (2007). The child is presented a card with a list of 100 unrelated words of increasing difficulty and thus ranging from CVC words like *raam* (window) to multi-syllabic words like *handdoek* (towel). The child reads the words aloud as quickly as possible. The test score is the number of words read correctly in 90 seconds. The Word Recognition test was administered after 19 weeks of reading instruction (January).

Analyses

In order to study which kindergarten tests significantly predict later word recognition, we conducted hierarchical regression analyses. OLS regression assumes, among other things, that the residuals are independent of each other. This assumption is possibly violated for our sample, which drew upon children from the same class within a school. The standard errors may thus be underestimated leading to an overstatement of significant effects. In order to counter this problem, we adopted a fixed effects model with class dummies as fixed effects. A drawback of using a fixed effects model is that inferences cannot be made beyond the groups in the sample. This is not an issue for the present study, however, as we do not want to generalize beyond grade 1 to grade 2 or later grades, for example.

Another assumption of OLS regression is that the relationships are linear. Our study involves mostly count variables, which makes linear relationships between variables unlikely. As a consequence of such violation, the estimates and standard errors can be biased. In Table 1, the univariate statistics are presented. It is clear that both

Table 1. Univariate statistics for predictor and outcome variables used in regression analysis.

	Mean	Median	Variance	Skewness	Kurtosis	Min	Max
Phonemic Synthesis	12.07*	12.50	29.713	-.594*	-.366*	0	20
Phonemic Analysis	32.43*	35.00	69.704	-1.595*	2.383*	0	40
Letter Knowledge	12.24*	13.00	38.509	-.210*	-1.309*	0	21
Naming Speed Digits	44.7638*	41.7950	194.810	.873*	.745*	18.18	96.78
Naming Speed Letters	59.2078*	48.4000	1.907.384	5.614*	46.890*	18.00	473.72
Word Recognition	39.52*	38.00	383.641	.801*	.235*	9	99

*$p < .05$.

skewness and kurtosis are significant for almost all of the variables, hence it is unlikely that our relationships are linear. We therefore decided to create dummy variables for some of independent measures and thereby remedy the problem of possibly non-linear relations between the variables. The distribution of phonemic analysis is skewed very much to the right; the distribution of letter knowledge shows two peaks. And the distribution of naming speed letters is extremely skewed to the left. For each of these three variables, a new dummy variable was therefore created. As the cut-off point for each variable, we chose to use the mean. And the dummy variables were coded in such a manner that the 0 category meant poor phonemic analysis, poor letter knowledge, and good (i.e. quick) naming speed for letters.

Finally, we tested the hypothesis implicitly put forth by Adams (1990), namely that not only kindergarten letter knowledge is important for grade 1 word recognition but also the *combination* of kindergarten letter knowledge and phonemic awareness which significantly predicts later word recognition. This was done by adding the following interaction terms to the regression model: letter knowledge * phonemic synthesis; letter knowledge * phonemic analysis; and letter knowledge * phonemic synthesis * phonemic analysis.

Results

In Table 2, the results of the simple regression analysis are summarized. The three background variables of gender, age and ethnicity did not exert an effect on word recognition. The other predictor variables all had significant effects on word recognition with a considerable amount of the variance in word recognition accounted for by naming speed digits and naming speed letters in particular.

The hierarchical regression analysis was next conducted with the addition of dummy class variables and the interaction terms for the predictor variables of letter knowledge, phonemic synthesis and phonemic analysis (see Table 3).

The R^2 changes show phonemic synthesis, phonemic analysis, letter knowledge and the naming speed tests to all make significant contributions to the prediction of word recognition.

In the final model, all predictors explain 53% of the variance in word recognition. However, not all variables showed a significant direct effect. In model 6 (i.e. the final model) after the introduction of naming speed digits and naming speed letters, the effects of letter knowledge and naming speed digits remain significant.

Table 2. Simple regression results with word recognition as outcome variable.

	Intercept	Effect	R	R^2
Gender	38.483*	2.023*	0.052	0.003
Age	27.138*	0.162*	0.042	0.002
Ethnicity	39.188*	0.536*	0.013	0.000
Phonemic Synthesis	20.989*	1.535*	0.427	0.183
Phonemic Analysis[a]	28.639*	16.549*	0.402	0.162
Letter Knowledge[a]	30.345*	17.368*	0.444	0.197
Naming Speed Digits	77.861*	-0.857*	0.610	0.373
Naming Speed Letters[a]	45.648*	-19.487*	0.463	0.216

*$p < .05$.

[a]These variables are not the original variables, but dummy variables we created.

Table 3. Hierarchical regression estimates with word recognition as outcome variable.

Model	1	2	3	4	5	6
(Constant)	42.44*	37.45*	24.64*	30.01*	33.39*	76.56*
Class 1	5.40*	5.32*	4.53*	4.99*	5.32*	7.99*
Class 2	-2.80*	-1.18*	1.32*	1.29*	.41*	3.49*
Class 3	-11.88*	-11.72*	-9.32*	-11.36*	-11.02*	-7.77*
Class 4	-3.15*	-1.44*	2.08*	3.63*	2.75*	3.51*
Class 5	-.68*	.99*	-.43*	-.17*	-.62*	-.28*
Class 6	-1.28*	1.42*	1.77*	3.79*	3.51*	3.38*
Class 7	-10.28*	-10.12*	-7.32*	-6.84*	-7.46*	-1.53*
Class 8	-1.84*	-2.06*	-.46*	1.09*	.81*	4.61*
Boy		2.70*	3.21*	4.40*	3.76*	3.96*
Age		.02*	-.08*	-.16*	-.17*	-.31*
Dutch		1.86*	2.4*	2.83*	2.32*	1.15*
Phonemic synthesis			.82*	.54*	.28*	.26*
Phonemic analysis			13.35*	8.33*	8.90*	3.94*
Letter knowledge				12.69*	11.64*	7.04*
Letter knowledge* Phonemic synthesis					.86*	.23*
Letter knowledge* Phonemic analysis					4.20*	7.33*
Letter knowledge* Phonemic synthesis* Phonemic analysis					1.81*	.72*
Naming speed digits						-.59*
Naming speed letters						-4.48*
R^2	.075*	.080*	.292*	.363	.379*	.533*
R^2 change		0.05*	.212*	.071*	.016*	.155*

*$p < .05$.

Conclusion

The main purpose of this study was to examine the predictive value of kindergarten tests for word recognition after the first half of grade 1. In line with suggestions from the literature (e.g. Verhagen et al. 2006, 2008) we analysed the effects of the following kindergarten tests: *phonological awareness, letter knowledge and naming speed.* We found that all kindergarten tests are significant predictors of word recognition in our separate regression analyses. The results of a subsequent hierarchical regression analysis showed that letter knowledge and naming speed digits are statistically significant predictors of word recognition. The other predictors: phonological awareness, naming speed letters, letter knowledge * phonemic synthesis, letter knowledge * phonemic analysis, and letter knowledge * phonemic synthesis * phonemic analysis were not statistically significant.

Discussion

In a separate regression analysis used in our study we found that kindergarten phonological awareness, letter knowledge and naming speed are significant predictors of word recognition. These results correspond with several Dutch studies of children's early word recognition (e.g. Aarnoutse et al. 2000, 2005; Verhagen et al. 2006, 2008). However, a hierarchical regression analysis, in which we also added the

interaction terms; letter knowledge * phonemic synthesis; letter knowledge * phonemic analysis; and letter knowledge * phonemic synthesis * phonemic analysis, showed that only letter knowledge and naming speed for digits affect children's later word recognition. The other predictors were found not to be statistically significant. Apparently, phonological awareness and naming speed letters are related to word recognition, which we found in the separate regression analyses. However, these kindergarten tests have no direct effect on word recognition. In addition, we could find no evidence for what Adams (1990) claims, namely that letter knowledge alone (i.e. the isolated learning of graphemes in kindergarten) will not predict children's later word recognition, while the combination of letter knowledge with phonological skills (letter knowledge * phonemic synthesis; letter knowledge * phonemic analysis; and letter knowledge * phonemic synthesis * phonemic analysis,) does. The results of our study, however, showed that letter knowledge alone (without the combination with phonological skills) is an important predictor of word recognition.

According to Bond and Dijkstra (1997), Bowey (2005), Ehri and Sweet (1991), Ehri and Wilce (1987), and de Jong and van der Leij (1999), letter knowledge influences word recognition because letter knowledge reflects recognition of the connections between graphemes and their corresponding phonemes (i.e. the link between written and spoken language). Recognition of the grapheme-phoneme link is an important step in the process of converting a sequence of letters into a series of sounds for the identification (i.e. reading) of a word.

The explanation for why naming speed is found to be such a strong predictor of word recognition presumably lies in the central factor: speed. In both the test used to assess naming speed letters and the test used to assess naming speed digits, the students are asked to respond as quickly as possible. However, after introduction of letter knowledge into our regression model, the effect of naming speed for letters became nonsignificant. We suspect that this is due to the overlap between the letter knowledge test and naming speed letters test: In both tests, the children must call upon their letter knowledge to name the presented letters.

On the basis of the present findings, we strongly recommend the measurement of children's letter knowledge and naming speed digits at the end of the kindergarten period. Such information allows us to detect stagnation in the development of children's early word recognition skills and therefore initiate early interventions to prevent further stagnation. Exactly how remedial instruction for students who fall behind on letter knowledge and/or naming speed can improve their skill and facilitate their later word recognition remains to be seen, however, and should therefore be examined in future research.

References

Aarnoutse, C. 2004. *Ontwikkeling van beginnende geletterdheid* [Development of early literacy]. Nijmegen: Katholieke Universiteit Nijmegen.

Aarnoutse, C., J. Beernink, and W. Verhagen. 2010. *Toetspakket Beginnende Geletterdheid* [Beginning Literacy test package]. Amersfoort: CPS.

Aarnoutse, C., and T. Kapinga 2007. *Technisch lezen 3* [Technical reading 3]. Ridderkerk: Onderwijs Advisering.

Aarnoutse, C., J. Van Leeuwe, and L. Verhoeven. 2000. "De ontwikkeling van beginnend geletterdheid [Development of early literacy]." *Pedagogische Studiën* 77: 307–325.

Aarnoutse, C., J. Van Leeuwe, and L. Verhoeven. 2005. "Early Literacy From a Longitudinal Perspective." *Educational Research and Evaluation* 11: 253–275.

Aarnoutse, C., J. Van Leeuwe, M. Voeten, and H. Oud. 2001. "Development of Decoding, Reading Comprehension, Vocabulary and Spelling During the Elementary School Years." *Reading and Writing: An Interdisciplinary Journal* 14: 61–89.
Aarnoutse, C. A. J., and W. Verhagen 2001. *Fonemische synthesetoets* [Phonological synthesis test]. Unpublished manuscript.
Adams, M. J. 1990. *Beginning to Read: Thinking and Learning About Print*. Cambridge, MA: Massachusetts Institute of Technology.
Beernink, J. 2002. "Op weg naar geletterdheid [On the way to literacy]." *Master's thesis Psycholinguistics*., Radboud University Nijmegen, The Netherlands.
Blachman, B. A. 2000. "Phonological Awareness." In *Handbook of Reading Research*, edited by M. L. Kamil, P. B. Mosenthal, P. D. Pearson, and R. Barr, Vol. III, 483–502. Mahwah, NJ: Erlbaum.
Bond, G. L., and R. Dijkstra. 1997. "The Cooperative Research Program in First-Grade Reading Instruction." *Reading Research Quarterly* 32: 342–344.
van den Bos, K. P., and H. C. lutje Spelberg. 2010. *Continu benoemen en woorden lezen* [Continuous naming and word reading]. Groningen: Boom test uitgevers.
van den Bos, K. P., B. J. H. Zijlstra, and H. C. lutje Spelberg. 2002. "Life-Span Data on Continuous Naming Speed of Numbers, Letters, Colors, and Pictured Objects, and Word Reading Speed." *Scientific Studies of Reading* 6: 25–49.
Bowers, P. G. 1997. "*Exploration of the Link between Processes Tapped by Rapid Naming Tests and Orthographic Skill*." Paper presented at the society for the Scientific Study for Reading, Chicago.
Bowers, P. G., J. Golden, A. Kennedy, and A. Young. 1994. "Limits Upon Orthographic Knowledge Due to Processes Indexed by Naming Speed." In *The Varieties of Orthographic Knowledge I: Theoretical and Developmental Issues*, edited by V. W. Berninger, 173–218. Dordrecht/Boston/London: Kluwer Academic Press.
Bowers, P. G., and L. B. Swanson. 1991. "Naming Speed Deficits in Reading Disability: Multiple Measures of a Single Process." *Journal of Experimental Child Psychology* 51: 195–219.
Bowey, J. A. 2005. "Predicting Individual Differences in Learning to Read." In *The Science of Reading*, edited by M. J. Snowling and C. Hulme, 155–173. Oxford: Blackwell.
Bus, A. G., and M. H. van IJzendoorn. 1999. "Phonological Awareness and Early Reading: A Meta-Analysis of Experimental Training Studies." *Journal of Educational Psychology* 91: 403–414.
Coltheart, M. 1978. "Lexical Access in Simple Reading Tasks." In *Strategies of Information Processing*, edited by G. Underwood, 135–155. New York: Academic Press.
Cutting, L. E., and M. B. Denckla. 2001. "The Relationship of Rapid Serial Naming and Word Reading in Normally Developing Readers: An Exploratory Model." *Reading and Writing: An Interdisciplinary Journal* 14: 673–705.
Ehri, L. C., and J. Sweet 1991. "Fingerpoint Research of Memorized Text: What Enables Beginners to Process the Print?" *Reading Research Quarterly* 26: 442–462.
Ehri, L. C., and L. S. Wilce. 1987. "Does Learning to Spell Help Beginners Learn to Read Words?" *Reading Research Quarterly* 22: 47–65.
Hansen, J., and J. A. Bowey. 1994. "Phonological Analysis Skills, Verbal Working Memory, and Reading Ability in Second-Grade Children." *Child development* 65: 938–950.
Henneman, K., M. Kleijnen, and A. E. H. Smits. 2004. *Protocol dyslexie VO. Signalering, diagnose en begeleiding* [Protocol dyslexia secondary education. Signaling, diagnosis and counseling].'s Hertogenbosch: KPC.
de Jong, P. F., and van der Leij, A. 1999. "Specific Contributions of Phonological Abilities to Early Reading Acquisition: Results from a Dutch Latent Variable Longitudinal Study." *Journal of Educational Psychology* 91: 450–476.
de Jong, P. F., and van der Leij, A. 2003. "Developmenal Changes in the Manifestation of a Phonological Deficit in Dyslexic Children Learning to Read a Regular Orthography." *Journal of Educational Psychology* 95: 22–40.
Lonigan, C. J., S. R. Burgess, and J. L. Anthony. 2000. "Development of Emergent Literacy and Early Reading Skills in Preschool Children: Evidence from a Latent Variable Longitudinal Study." *Developmental Psychology* 36: 596–613.
Manis, F. R., L. M. Doi, and B. Bhada. 2000. "Naming Speed, Phonological Awareness, and Orthographic Knowledge in Second Graders." *Journal of Learning Disabilities* 33: 325–333.

Näslund, J. C., and W. Schneider. 1996. "Kindergarten Letter Knowledge, Phonological Skills, and Memory Processes: Relative Effects on Early Literacy." *Journal of experimental Child Psychology* 62: 30–59.
National Early Literacy Panel. 2008. *Developing Early Literacy: Report of the National Early Literacy Panel*. Washington, DC: National Institute for literacy. http://www.nifl.gov/earlychildhood/NELP/NELPreport.html.
Scarborough, H. S. 1998. "Early Identification of Children at Risk for Reading Disabilities: Phonological Awareness and Some other Promising Predictors." In *Specific Reading Disability: A View of the Spectrum*, edited by B. K. Shapiro, A. J. Capute, and B. Shapiro, 243–274. Hillsdale, NJ: Lawrence Erlbaum Associates, Inc.
Share, D., A. Jorm, R. Maclean, and R. Matthews. 1984. "Sources of Individual Differences in Reading Acquisition." *Journal of Educational Psychology* 76: 1309–1324.
Spring, C., and C. Capps. 1974. "Encoding Speed, Rehearsal, and Probed Recall of Dyslexic Boys." *Journal of Educational Psychology* 66: 780–786.
Spring, C., and J. M. Davis. 1988. "Relations of Digit Naming Speed with Three Components of Reading." *Applied Psycholinguistics* 9: 315–334.
Sunseth, K., and Bowers, P. G. 1997. "*The Relationship between Digit Naming Speed and Orthography in Children with and Without Phonological Deficits*." Paper presented at the annual conference for the Society for the Scientific Study of Reading, Chicago.
Vellutino, F. R., D. M. Scanlon, E. R. Sipay, S. G. Small, A. Pratt, R. Chen, and M. B. Denckla. 1996. Cognitive Profiles of Difficult-to-Remediate and Readily Remediated Poor Readers: Early Intervention as a Vehicle for Distinguishing between Cognitive and Experiential Deficits as Basic Causes of Specific Reading Disability. *Journal of Educational Psychology* 88: 601–638.
Verhagen, W. 2009. *Predicting Early Word Recognition and Spelling*. Nijmegen: Radboud University Nijmegen.
Verhagen, W., and C. Aarnoutse. 2001. *Fonemische analyse en synthese van pseudowoorden* [Phonemic analysis and synthesis of pseudowords]. Unpublished manuscript.
Verhagen, W., C. Aarnoutse, and J. Van Leeuwe. 2006. "Predictoren voor beginnende geletterdheid [Predictors of early literacy]." *Pedagogische Studiën* 3: 226–245.
Verhagen, W., C. Aarnoutse, and J. Van Leeuwe. 2008. "Phonological Awareness and Naming Speed in the Prediction of Dutch Children's Word Recognition." *Scientific Studies of Reading* 12: 301–324.
Verhoeven, L., and J. van Leeuwe. 2003. "Ontwikkeling van decodeervaardigheid in het basisonderwijs [Development of decoding skill in primary education]." *Pedagogische Studiën [Pedagogical Studies]* 80: 257–271.
Wagner, R. K., and J. K. Torgesen. 1987. "The Nature of Phonological Processing and its Causal Role in the Acquisition of Reading Skills." *Psychological Bulletin* 101: 192–212.
Wagner, R. K., J. K. Torgesen, P. Laughon, K. Simmons, and C. A. Rashotte. 1993. "Development of Young Readers' Phonological Processing Abilities." *Journal of Educational Psychology* 85: 83–103.
Wagner, R. K., J. K. Torgesen, and C. A. Rashotte. 1994. "The Development of Reading Related Phonological Processing Abilities: New Evidence of Bi-Directional Causality from a Latent Variable Longitudinal Study." *Developmental Psychology* 30: 73–87.
Wagner, R. K., J. K. Torgesen, C. A. Rashotte, S. A. Hecht, T. A. Barker, S. R. Burgess, J. Donahue, and T. Garon 1997. "Changing Relations between Phonological Processing Abilities and Word-Level Reading as Children Develop from Beginning to Skilled Readers: A 5-Year Longitudinal Study." *Developmental Psychology* 33: 468–479.
Wentink, H., and L. Verhoeven 2001. *Protocol leesproblemen en dyslexie* [Protocol reading problems and dyslexia]. Nijmegen: Expertisecentrum, The Netherlands.
Wentink, H., and L. Verhoeven 2004. *Protocol leesproblemen en dyslexie voor groep 5–8* [Protocol reading problems and dyslexia for grade 3–6]. Nijmegen: Expertisecentrum, The Netherlands.
Wolf, M., H. Bally, and R. Morris. 1986. "Automaticity, Retrieval Processes, and Reading: A Longitudinal Study in Average and Impaired Readers." *Child Development* 57: 988–1000.
Wolf, M., and P. G. Bowers. 1999. "The Double-Deficit Hypothesis for the Developmental Dyslexias." *Journal of Educational Psychology* 91: 415–438.