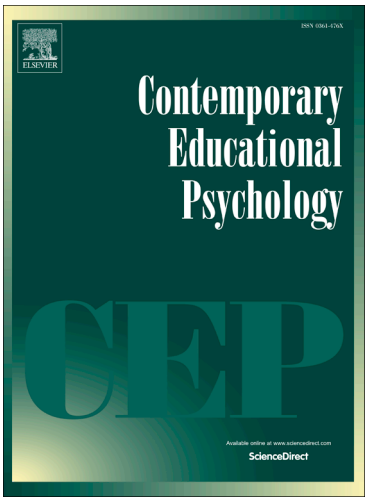

How Reading and Writing Support Each Other Across a School Year in Primary School Children

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PII: S0361-476X(18)30156-5
DOI: https://doi.org/10.1016/j.cedpsych.2018.09.005
Reference: YCEPS 1716

To appear in: *Contemporary Educational Psychology*

Received Date: 12 April 2018
Revised Date: 15 June 2018
Accepted Date: 18 September 2018

Please cite this article as: Calmar Andersen, S., Vedsgaard Christensen, M., Skyt Nielsen, H., Kjærgaard Thomsen, M., Østerbye, T., Rowe, M.L., How Reading and Writing Support Each Other Across a School Year in Primary School Children, *Contemporary Educational Psychology* (2018), doi: https://doi.org/10.1016/j.cedpsych.2018.09.005

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Keywords: writing; language development; elementary school; reading

Acknowledgements: This project was financially supported by TrygFonden.

How Reading and Writing Support Each Other Across a School Year in Primary School Children

Abstract

There is general agreement of the broad notion that reading and writing skills complement one another. However, when it comes to the more detailed interplay between skills at the word, sentence and text levels within and across reading and writing domains, there is much less evidence. In a study of 1,160 6-9 year-old children in second and third grade in Denmark we measured at the beginning and end of a school year both reading and writing skills at the word level (decoding and spelling), sentence level (sentence reading and writing), and text level (text comprehension and narrative). Results show generally that over the course of one school year word-level skills in both reading and writing predict the development of higher-level skills in the opposite domain. The results hold important implications for the teaching of reading and writing in primary school.

Introduction

Traditionally in literacy research, reading has received much more attention than writing (Miller & McCardle, 2011; Dockrell et al., 2015). The general well-documented association between good reading and writing skills at a given point in time (e.g., Graham & Hebert, 2011; Shanahan, 1984), has lead researchers to hypothesize a so-called "Matthew-effect" (Stanovich, 1986; Wollscheid et al., 2016): Students who read often improve their literacy skills accordingly, as the developing automation of one skill underpins the other. However, the growing body of research on links between reading and writing skills development suggests that the relationship is much more nuanced and deserving of continued research attention. Especially, a small but growing body of research highlights that the relation between reading and writing skills seems to differ at the word-, sentence- and text-level (Ahmed, Wagner & Lopez, 2014). The overall aim of this study is to examine both lower- and higher-level reading and writing skills at the beginning of a school year in relation to higher-level skills at the end of a school year for a large number of children in second and third grade in Denmark. This investigation has implications for theories of literacy development and future development of instruction during these primary grades.

Much research that aims to understand the links between reading and writing is grounded in the theoretical perspective that both types of skills rely on shared knowledge and cognitive processes. Fitzgerald & Shanahan (2000) summarize this knowledge as consisting of pragmatic knowledge (e.g., knowledge of the functions and purposes of reading and writing), domain knowledge about content (including vocabulary), knowledge about text attributes including graphophonics, syntax and text format, and procedural knowledge necessary to negotiate reading and writing. However, it is likely that more specific aspects of reading and writing skills will play more or less of a role at different levels of literacy development across the primary school years (Fitzgerald & Shanahan, 2000). Indeed, the development of reading and writing skills improve dramatically between the ages of 6 and 10. Chall (1983) framed the reading accomplishments across this period as the transition from 'learning to read'

to 'reading to learn'. Specifically, in her Stage 1 or 'initial reading or decoding' stage (Grades 1-2, ages 6-7) children are gaining knowledge of the grapheme system and how reading works, whereas during Stage 2 (grades 2-3, ages 7-8) fluency and processing of larger words and sentences is enhanced, and typically by Stage 3, or the 'reading for learning the new' stage (Grades 4+, ages 9-13) knowledge of the grapheme system is complete and other types of knowledge such as semantics or domain knowledge play a larger role for text comprehension (Chall, 1983). Similarly, in writing research, grounded in the early studies on invented spelling conducted by Carol Chomsky (1971) and Charles Read (1971), it is now widely accepted that children pass through stages of spelling development with 6-9 year olds transitioning from a semiphonetic stage where children begin to use print letters to represent sounds, to a phonetic stage where sounds are more systematically represented, to a transitional stage that displays a better understanding of spelling conventions, to the correct spelling stage. In addition to relying on their grapheme knowledge during this process of spelling development, children are also actively learning specific spelling rules for the particular language in question (Bryant, 2002). Once the challenges of spelling are primarily mastered, other sources of knowledge may play a larger role in writing development. For example, Fitzgerald & Shanahan (2000) suggest that during Chall's Stage 3 of 'reading for learning the new', both reading and writing rely on learning of more complex text and syntactic structures (at the sentence level), and on self-monitoring of comprehension or meta-comprehension (at the text level) and on domain or background knowledge. Thus, there is theoretical evidence that at different stages of literacy development during the primary grades, children build higher-level sentence and text skills in both reading and writing on a foundation of more basic word-level skills.

Initial empirical evidence on relations between reading and writing skills supported the general theoretical perspective in that reading and writing skills are often significantly associated at any given point in time, with the skills in one domain explaining up to 45% of the variance of skills in the other domain (e.g., Juel, Griffith & Gough, 1986; Shanahan, 1984). An early study of the reading-writing

relation found that relations were reciprocal with reading having an effect on writing and writing having an effect on reading for both 2nd and 5th graders, however the reading-to-writing effects were stronger (e.g., Shanahan & Lomax, 1986). More recently, longitudinal studies have added to the body of evidence by examining relations between reading and writing across different stages of literacy development. The longitudinal approach has enabled researchers to try and determine the directionality of relationships – that is do reading skills predict writing skills to a greater, lesser or equal extent as writing skills predict reading skills? And to start to uncover the specific skills in each domain that best predict skills in the other domain over time. Regarding the direction of effects, the results of these studies have been mixed. Some studies find stronger writing effects on reading than vice-versa (e.g., Berninger, Abbott, Abbott et al., 2002). However, other studies find more reciprocal effects. For example, a study in Finland that measured first graders reading and writing skills across the school year (Lerkkanen et al., 2004), found very reciprocal effects for the first half of the school year, yet in the second half, reading predicted spelling more than vice-versa and writing productivity predicted reading performance. Thus, the direction of effects may depend on the age of the children and the specific level of reading and writing skills examined.

This interpretation is supported by a recent longitudinal study that examined reading-writing relations from 1st to 4th grade (Ahmed, Wagner & Lopez, 2014; Ahmed, Kim & Wagner, 2014) and measured skills in each domain at the word (decoding and encoding), sentence (sentence reading and writing) and text (comprehension) level. The results indicate that a reading-to-writing model fits better for the word and text levels. At the word level, decoding predicted growth in spelling. And, at the text level reading comprehension facilitated growth in writing composition fluency. But, for the sentence reading and writing level, results were more reciprocal with growth in each domain predicting growth in the other, potentially because both draw upon similar knowledge of syntactic structures. Further, in this particular study the relations between reading and writing at the word level were stronger than the relations at the other levels (Ahmed, Wagner & Lopez, 2014). These findings raise the question of

whether and how reading and writing skills affect each other across these levels. It is not obvious whether word-level skills in one domain will be relevant for higher-level skills in another. Writing a coherent and well-formed narrative involves skills beyond decoding and spelling and includes capabilities in setting the context in which the events of the story unfold, providing enough information about the events and those involved for the reader to follow, and to apply an academic written-like (as opposed to oral-like) language style in a communicative situation, where the printed word has to do all the work (Kaderavek et al., 2009). Yet, mastering decoding at the word-level may still free up mental capacity to focus on the sentence and text levels, when writing. Thus, during this key developmental period of transitioning from learning to read to reading to learn, cross-level and cross-domain relations are worthy of investigation.

Intervention studies can also provide evidence of directions of effects by examining whether reading interventions improve writing skills and vice-versa. A recent meta-analysis on the effects of reading interventions on writing (Graham et al., 2017) found that reading instruction strengthened writing skills and that effects were maintained over time. The effects of reading interventions on writing were seen in many areas of writing including spelling, words written, writing quality as well as an overall measure of writing. Effect sizes ranged from 0.35 to 0.57 depending on the writing outcome of interest. Similarly, a meta-analysis on the effects of writing interventions on reading finds similar results (Graham & Hebert, 2011). Specifically, writing instruction focused on the sentence level, text structure, and process writing resulted in an increase in reading comprehension and fluency, with much larger effect sizes for fluency (0.66) than comprehension (0.22). In addition, the meta-analysis found that in 1st – 6th grade classrooms increasing student writing by 15-minutes a day resulted in positive effects on reading comprehension with an effect size around 0.35. These meta-analyses provide some support for the argument that reading and writing draw upon some of the same cognitive processes, as teaching one skill helps build skills in the other domain. They also indicate that while reading and writing are related there is reason to teach both skills separately, as teaching one skill cannot completely enhance

another as evidenced by the medium effect sizes. Yet, they provide less evidence on whether word-level skills (decoding and spelling) continue to be important to practice when children are at Chall's Stage 3 of 'reading for learning the new'.

It is therefore clear that more research is necessary, particularly research with large sample sizes that can speak to the issue of the types of reading and writing skills that predict one another at certain points in development. Especially, based on existing research it is unclear whether more basic skills at the word level (decoding and spelling) are also important for the development of skills at the sentence and text levels during this developmental period. Examining these cross-level relationships may add to our understanding of the reading and writing relations and have important implications for both reading and writing instruction in primary school. The current study aims to fill some of these gaps and add to this body of research. In this study we measured both reading and writing skills at the word level (decoding and spelling), sentence level (sentence reading and writing), and text level (text comprehension and narrative) in 1,160 second and third graders in Denmark at the beginning and end of their school year. Our specific research questions are as follows: (1) How strongly are different reading and writing skills correlated with each other in the beginning of a school year in this sample of Danish students? (2) Do reading and writing skills predict the development of skills in the opposite domain later in the school year – even after controlling for the initial level of reading/writing skills themselves? (3) Are the more basic, word-level skills (decoding and spelling) more predictive of higher-level skills at the sentence and text levels than higher-level skills?

Methods

Participants

The sample for our study was collected as part of a larger randomized field experiment with a control and treatment group (author identifying reference). The current study was limited to analyzing

the writing and reading skills of students in the control group[1]. To participate, classes had to sign up for the project. 242 classrooms including 5,405 students enrolled in 2nd and 3rd grade in the public schools in the City of Aarhus, Denmark, were invited to participate. 2,895 students from 133 classrooms from 28 public schools signed up. (Thus, 109 classrooms containing 2,510 students did not sign up for the project.) The control group reported on here included 1,421 students. Writing data for the study were collected twice: in August-December 2013 and in March-June 2014. The two data collections included responses from 81.6 percent of the students in the fall (n = 1,160) and 74.0 percent of the students in the spring (n = 1,052 students). Reading data were collected for 2nd grade students in both fall and spring. Third grade students could only take the reading test in the fall, so they are left out of the analyses predicting reading skills.

In our sample of 1,160 students, 49 percent were boys, 79 percent were of Danish origin[2] and the children were, on average, 8.61 years of age at the time of the first assessment (range 6-9 years). The participating classes were all mainstream classes, and they reflect the overall socio-economic and linguistic diversity in public schools in the City of Aarhus. All information about child and family background characteristics are administrative records hosted by Statistics Denmark and are linked to the sample via the civil register system. The education level of the mothers and fathers were coded categorically; 51 percent of the mothers and 47 percent of the fathers had completed a higher education (short-, medium or long-cycle higher education). The average disposable income for mothers was 247.70 (1000 DKK) and for fathers was 280.14 (1000 DKK). The employment rate for mothers was 71 percent and 78 percent for fathers. The students in our study come from families with slightly higher maternal education (23 versus 20 percent with long-cycle higher education, p-value 0.04), slightly lower maternal income (247.70 versus 255.76 1000 DKK, p-value 0.05), and are more likely to be descendants of immigrants compared to non-included students (19 versus 15 percent, p-value <0.00). There are no

[1] In this study, we only include the control group since the results from the experiment revealed an effect on writing skills in the treatment group.

[2] The remaining 21 percent were first or second generation immigrants (mainly from non-Western countries). We do not have information about whether a child was bilingual or not.

significant differences in mean paternal education and income or paternal and maternal employment rate between the two groups.[3] The observed differences between included and non-included students are sufficiently small not to cause concerns about bias in the final sample.

Procedure and measures

Writing Skills

Children's writing skills were elicited using two different writing prompts similar in structure and layout. The first was used in the fall 2013 and the second in the spring 2014. Both writing prompts consisted of four pictures, representing steps in a narrative structure (Martin & Rose, 2008) with blank lines below the pictures for the student to fill in. One of the pictures was replaced with a question mark allowing the student to make up his or her own twist of the plot at a pivotal place in the story (see Figure 1). The task was set to last no more than 45 minutes (one lesson) and the teachers were instructed to hand out extra paper to the students if needed.

FIGURE 1 ABOUT HERE

The writing prompt was developed specifically for this study, but was motivated by activities widely used in writing instruction, as this type of writing task (writing a narrative from picture prompts) is well-known in early years' literacy classes in Denmark. The writing prompts included a step-by-step and easy to follow instruction to the teachers. Both the writing prompt and the task were purposely designed to resemble a year 2 or 3 writing task as much as possible, hence the instructions also allowed the teachers to introduce the writing task and to scaffold students' progress when needed as they would do in their everyday practice. The aim of the prompt was to elicit as many and as elaborate narratives as possible from the participating students. The writing prompt and the instructions were not pilot tested, as the task itself is very familiar to both teachers and students.

[3] Differences in means are tested by a two-tailed t-test. Reported p-values reflect the outcome of these tests.

To measure the young writers' skills from their narratives, we conceptualized and applied a number of measures of writing including word-, sentence- and text-level skills. Two research assistants were trained to code the written data. The coding procedure – to secure a higher degree a reliability – involved scoring the texts, not according to often rather subjective notions of appropriateness or function of linguistic traits (spelling being the exception, see below), but instead the measures were identified and the number of different examples were counted in the following areas specified below (see appendices for details on the coding procedure and reliability analysis).

Word-level: Spelling. We measure the students' spelling on a 4-point scale. The lowest score (0) is assigned to text that show no or little phonological awareness. Text written by students who master phonological strategies and hence are able to spell out words "as they sound" receive score 1. Score 2 was used if the spelling strategies are rooted in morphological knowledge. If the students to some extent master not only morphological but also orthographic features of Danish, the texts are awarded the highest scores (3). The variable is standardized with a mean of 0 and a SD of 1 (Cronbach's alpha .87 in both the fall and the spring).

Sentence-level: Microstructure. The microstructural features at the sentence level are measured applying the Narrative Assessment Protocol (NAP) coding procedure (Justice et al., 2010), which is a validated and reliable assessment tool used to evaluate the microstructure of oral narratives. For this study, we have adapted the NAP to written narratives in a score we call wNAP. We used the short NAP score sheet including 12 items. The NAP evaluates five aspects of narrative language: sentence structure (use of complex sentences), phrase structure (use of elaborated noun or prepositional phrases, verb phrases), use of modifiers and tier-two verbs and nouns. For each of the 12 items research assistants coded how frequently a given NAP item occurred in the narrative with instances of three occurrences or above counting as "3" as in Justice et al. (2010). Only few children scored maximum on all 12 items. The wNAP total score was created by summing the child's score on the 12 items, with a possible range from 0-36. The mean and standard deviations for each of the NAP indicators and the

total wNAP score are presented in the Appendix in Table A2. Similar to Justice et al. (2010) each item weights equally. The variables applied in our analysis are standardized with a mean of 0 and a SD of 1.

Text-level (I): Narrative discourse. We include two measures of writing at the text level. The first is the narrative discourse. For a text to function as a narrative, writers must master linguistic skills that go beyond handwriting, spelling and syntax, they must also be able to organize meaning in a coherent way for readers to recognize the text as a narrative. Narratives can essentially be defined as texts (written or spoken) that recount past events (real or fictitious) unfolding in a series of steps recounting at least two events linked in time (Labov & Waletsky, 1967; Martin & Rose, 2008). This means that narrative discourse organizes meaning using language that represent the past events, links them in time and/or cause and organizes them in the form of a narrative. We measure narrative discourse using four different items measured on 2 or 3 point scales. Mastering language forms that represents a series of past events involves establishing temporal distance between the here and now of the events in the narrative and the communicative event itself, hence we examine whether a coherent and consistent use of verb tenses create temporal distance and cohesion in the narrative (item 1). Linguistic features that create cohesion and establish temporal and causal relations within text are important traits of written discourse. We examine how the writers use pronouns (item 2) and conjunctions (item 3) in order to create and maintain cohesion between phrases and sentences and whether the events depicted in the pictures in the writing prompt are represented in the texts (item 4). We ran an exploratory factor analysis including the four items (see Table A4 in the Appendix). All four items load on one factor. In the fall 2013, the factor loadings are all positive ranging from .41 to .63 (Cronbach's alpha is .61). We construct an additive index with all four items weighted equally. The index is standardized with a mean of 0 and a SD of 1.

Text-level (II): Narrative genre. The second measure at the text-level is narrative genre, which uses four items to assess to what extent the students can compose a text in the shape of a narrative. As stated above, narratives are traditionally described as texts unfolding in steps (Labov & Waletsky, 1967;

Martin & Rose 2008). A narrator often needs to "set the scene", meaning to tell the who, the where and the when of the story for readers or listeners to follow and understand (item 1, orientation). The narrator can choose to suspend the action and instead focus on how characters in the story react to or evaluate the events, e.g. through showing or telling about their thoughts and feelings before the action continues (item 2, evaluation). The different steps of the narrative can be more or less elaborated and they can appear in different order or multiple times, but in order for a text to be recognizable as a narrative, it must contain at least two events linked in time (item 3, complication), and often a well-formed narrative features a solution to the complication (item 4). These items are measured on 2- or 3-point scale. Again we ran an explanatory factor analysis (see Table A5). In the fall 2013, the factor loadings range from .41 to .58 (Cronbach's alpha is .58). We construct an additive index with all four items weighted equally that is standardized with a mean of 0 and a SD of 1.

Reading skills

We include measurements of reading skills which are measured by IT-based, self-scoring, adaptive, standardized reading tests used by all public schools in Denmark. Each individual student performs the tests by use of a tablet or a computer. He or she views the exercises (pictures and brief questions) on the screen and uses mouse or touch screen for the response (tick a box, move cursor, insert dividing line).[4] Since the tests are scored automatically and validated in other studies (Beuchert & Nandrup, 2018), we present these measures more briefly than the writing skill measures, which we scored and validated ourselves. The tests measure reading at the three levels: decoding at the word-level, language comprehension at the sentence-level and text comprehension at the text-level (Beuchert & Nandrup, 2018; Pøhler & Sørensen, 2010). *Decoding* measures pupils' proficiency at identifying written words and letters. For instance, they have to identify the words and divide a word chain correctly (three words were written without separation, such as "informedilluminatedinvaded"). *Language comprehension* tests

[4] For examples, see http://demo.evaluering.uvm.dk. Students with special needs may request a version of the test without mouse or touch screen or a read-aloud application. Under rare circumstances, students may be exempted from the test.

pupils' knowledge of foreign words, idioms and proverbs. For instance, they read the question: What does "A bird in the hand is worth two in the bush" mean? And then they have to select one out of four possible explanations. *Text comprehension* tests pupils' understanding of written texts in different genres. Exercises consist of a combination of multiple choice exercises and objective cloze tests (Pøhler & Sørensen, 2010; Andreasen et al., 2015, Kelly et al., 2017). A total score and a score for each domain is calculated. The tests are compulsory in 2nd, 4th, 6th and 8th[h] grade. The students in our study completed the national test in reading in 2nd grade in October-December 2013 and in March-June 2014. The measures are standardized with a mean of 0 and SD of 1.

Estimation Strategy

We estimate the following model:

$$Y_t = \beta_0 + \beta_1 X_{t-1} + \beta_2 Y_{t-1} + \boldsymbol{C\beta_3} + \epsilon$$

where Y_t is the skill we predict at time t, which we define as the spring of 2014, whereas *t-1* is the fall of 2013. X_{t-1} is the skills that we use to predict Y_t, while controlling for Y_{t-1} as well as controlling for $\boldsymbol{C}$, which is a vector of covariates including child's gender, age, ethnicity, grade level, as well as family status (single parent family) and mother's and father's age, ethnicity, education, income and employment status. So, for instance, to predict writing skills microstructure (wNAP) measured in the spring 2014 by decoding skills measured in the fall 2013, we control for the same writing skill measured in the fall:

$$wNAP_{spring\ 2014} = \beta_0 + \beta_1 Decoding_{fall\ 2013} + \beta_2 wNAP_{fall\ 2013} + \boldsymbol{C\beta_3} + \epsilon.$$

Results

Table 1 presents the bivariate correlations between all reading and writing skills measured in the fall 2013. We note that all the skills are fairly highly correlated and all correlations are statistically significant. We also note that the four writing skills are more strongly correlated with each other than

with the three reading skills dimensions and vice versa – as expected. The only exception is a relatively high correlation between spelling and decoding (r = .54). Despite these higher correlations within the groups of reading and writing skills, it is clear there are associations across the literacy domains. Especially we see that decoding (word level) is more strongly correlated with all of the writing skills than are the other reading skills, language understanding (sentence level) and text comprehension (text level). Similarly, spelling (word level) is more strongly correlated with all of the reading skills than are any of the other writing skills at the sentence and text levels.

Our next analysis focused on whether reading skills in the fall predict writing skills in the spring (even after controlling for previous writing skills) – and if so, which of the reading skills are most predictive. By controlling for the previous writing skills, we are in essence asking whether the reading skills in the fall predict improvement in writing skills over a school year. As mentioned, we also control for child's gender, age, ethnicity, grade level, as well as family status (single parent family), and mother's and father's age, ethnicity, education, income and employment status.

TABLE 1 ABOUT HERE

Tables 2-5 present these analyses for each of the four writing skills: spelling, wNAP, Narrative discourse, and Narrative genre. The results are very consistent: All four writing skills are predicted by each of the three reading skills when entered separately in the models. When all three reading skills are included in the same model (model 4 in tables 2-5), the word-level decoding skill is the strongest predictor, in all cases except one. The only exception is that text comprehension is a slightly stronger predictor of narrative discourse skills than is decoding. However, decoding also has a separate predictive power of narrative discourse skills (Table 4, model 4). Across the models, a one standard deviation increase in decoding is related to a positive change between .13 and .26 of a standard deviation in the writing skills – after controlling for previous writing skills.

TABLES 2-5 ABOUT HERE

The next main question is whether writing skills predict reading skills. This is analyzed in tables 6-8 where we predict the three reading skills (Decoding, Language Comprehension, and Text Comprehension) in the spring based on fall writing skills, controlling for fall reading skills and the covariates: child's gender, age, ethnicity, grade level, family status (single parent family) and mother's and father's age, ethnicity, education, income and employment status. The results for decoding and for text comprehension resemble the analyses of writing skills discussed above in the sense that (a) all four writing skills predict these two reading skills when entered separately in the model but (b) when all writing skills are included in the same model (model 5 in tables 6-8), the word-level skill, spelling, is the strongest predictor of both decoding and text comprehension. One standard deviation change in spelling skills predicts a positive change of approximately .12 of a standard deviation in the two reading skills – after controlling for prior reading skills. Results for language comprehension are different, as only fall narrative discourse skills significantly predicts language comprehension, even when the other writing skills are entered in the model.

TABLES 6-8 ABOUT HERE

Discussion

It is well-established in literacy research that skills build upon skills (e.g., Stanovich, 1986), yet more research is needed to identify the specific relations between reading and writing skills across word, sentence and text levels at different points in development. The current study adds to the literature in this area by focusing on the developmental period when children are transitioning from learning to read to reading to learn (Chall, 1983). Our results not only confirm previous research by showing that reading and writing skills are closely linked, but that at this developmental period, the

most basic word level literacy skills in each domain (decoding and spelling) are strong predictors of each other and of gains in more advanced sentence and text level reading and writing competences across domains. Thus, our findings are consistent with prior research, but also extend previous findings by examining reading and writing relations across word and text levels.

It is especially worth highlighting the finding that fall decoding skills play a consistent role in predicting spring writing skills at all levels (spelling, microstructure, discourse), even with the fall writing skill in question controlled. The finding that word level reading skills predict spelling and microstructure is not surprising and is consistent with previous work (e.g., Ahmed, Wagner & Lopez, 2014), yet the fact that decoding along with higher level reading comprehension skills predict the development of higher level written discourse, suggests a continued role for the basic reading skills at this developmental period and in relation to these more complex skills. We speculate that effective decoding skills may facilitate spelling and thereby speed up the writing process and free cognitive resources which can be reinvested in formulating sentences and structuring the narrative.

Similarly, we found that students' fall spelling skills predicted not only changes in spring decoding skills, but also spring text comprehension skills. Thus, better spelling skills may facilitate decoding which again may increase reading fluency, which is likely to improve understanding and text comprehension. Of course, alternative explanations cannot be ruled out. It is possible that both the basic and the more advanced literacy skills measured in this study all depend on or are driven by more general underlying skills or factors not measured in this study, e.g. domain or background knowledge (Fitzgerald & Shanahan, 2000). For example, significant differences in young children's oral language skills can be identified before schooling begins, and these differences when children arrive at school are very predictive of literacy skills measured later in school (Durham et al., 2007; Snow et al., 1998; Uccelli et al., 2018;). One limitation of the study is that we do not examine previous domain knowledge, oral language abilities or home reading experiences. Therefore, we cannot rule out effects of these potential underlying factors driving the progress. However, whereas such underlying skills and experiences may

explain overall correlations between reading and writing skills, they are less likely to explain why specifically word-level skills seem to be so important for progress in higher-level skills. Furthermore, our results do hold after controlling for a large variety of parent characteristics.

Another limitation of the study is the generalizability to other languages and other groups of students. Yet, we replicate the general finding in previous studies—namely that reading and writing skills correlate internally—in a large sample of students with various socioeconomic status. This general result suggests that the more specific results of this study may also generalize to other countries and languages, and that the results therefore have implications for future development of early literacy instruction and especially for the discussion of the role and importance of training the basic skills.

The learners in this study are from second and third grade, hence in the crucial transition from "learning to read" to "reading to learn" (Chall, 1983) meaning that a significant portion of them will no longer be receiving instruction that places heavy emphasis on decoding skills. Especially third grade students will receive reading instruction that aims at preparing them for the more independent reading they will need to master in the middle years. The current results point to the importance of a continued focus on the development of basic skills also beyond early literacy instruction. For example, consistent with the literature showing that in this same developmental period oral reading fluency is a strong predictor of later reading comprehension (e.g., Kim, Petscher, Schatschneider & Foorman, 2010), our results suggest that a continued focus on reading fluency may also promote written discourse skills. Even though the present analysis does not show whether progress in higher order skills in one literacy domain can be directly affected by explicit teaching of lower level skills in another at this stage of literacy development, the empirical findings suggest this might be the case and that it is an area worthy of future investigation.

Writing plays an important role for reading development, and even though recent studies emphasize the reading-to-writing model as an overall explanation for the relationship between reading and writing skills (e.g., Ahmed, Wagner & Lopez, 2014), studies have also shown that an explicit focus

on writing in literacy instruction fosters reading skills (Graham & Hebert, 2011); especially for older students, writing to learn from texts and writing to learn to master the writing process itself has a positive impact on reading skills. In the current study we found that spelling skills in the fall of 2nd grade predicted decoding and text comprehension in the spring. Therefore, while we replicated previous research showing that the reading-to-writing relations appeared stronger, the importance of the more basic word level skills in writing (e.g., spelling) also predicted higher text level skills in reading.

Even though literacy teaching in Denmark (like in comparable education systems, e.g. Ahmed, Wagner & Lopez, 2014) focusses heavily on reading skills, writing does play a significant role; students write a lot and across school subjects, but writing is often used as a supportive tool not a topic of study in and of itself: students copy from the blackboard, take notes and write answers to questions in textbooks etc. (Brok, Bjerregaard & Korsgaard, 2015). A recent study found similar practices in a Norwegian context (Blikstad-Balas, Roe & Klette, 2018). The results from this study show that basic writing skills likely support reading skills in young learners, hence it underscores the importance of explicit teaching of all aspects of writing as an important part of literacy instruction.

Conclusion

Studying the development of reading and writing skills at both the word, sentence and text level in a large sample of 2nd and 3rd graders in Denmark, we find that both reading and writing skills predict the development of each other – even after controlling for prior levels of the predicted skills. In models including multiple skills we generally find that the more basic skills at the word level are the most predictive. Especially, strong decoding skills are important predictors for the development of all writing skills. Spelling predicts decoding and text comprehension, but not language comprehension.

Even though more research is needed to confirm the causal relationships between these skills, the results here clearly suggest that a continued focus on mastery of word-level skills in reading and writing in primary schooling is beneficial not just for these lower-level skills themselves, but also for

strengthening the development of higher-level skills related to reading sentences and inferring meaning from full texts.

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Figures & Tables

Figure 1: The wordless strip used for generating written narratives

Note: The word in the speech balloon, "MOR", is Danish for "MOM".

Table 1: Correlation fall 2013

	Writing skills				Reading skills		
	Spelling	wNAP	Narrative discourse	Narrative genre	Decoding	Language understanding	Text comprehension
Writing							
Spelling							
wNAP	0.555***						
Narrative discourse	0.501***	0.749***					
Narrative genre	0.418***	0.675***	0.636***				
Reading							
Decoding	0.542***	0.476***	0.434***	0.382***			
Language understanding	0.366***	0.352***	0.314***	0.280***	0.640***		
Text comprehension	0.476***	0.431***	0.390***	0.351***	0.804***	0.622***	
Reading, total	0.521***	0.474***	0.429***	0.381***	0.917***	0.844***	0.910***

N = 889-1160, depending on measurement. All variables are standardized mean=0 and SD=1.
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 2. Predicting Spelling, Spring 2014

	(1)	(2)	(3)	(4)
Spelling fall 2013	0.286***	0.427***	0.341***	0.278***
	(0.044)	(0.038)	(0.045)	(0.044)
Decoding fall 2013	0.338***			0.262***
	(0.038)			(0.064)
Language understanding fall 2013		0.159***		-0.032
		(0.040)		(0.051)
Text comprehension fall 2013			0.278***	0.126+
			(0.038)	(0.064)
Constant	0.217	-0.043	0.046	0.199
	(0.368)	(0.374)	(0.364)	(0.367)
Observations	754	754	754	754
Adjusted R-squared	0.407	0.351	0.391	0.411
Covariates	Yes	Yes	Yes	Yes

Robust standard errors in parentheses
*** p<0.001, ** p<0.01, * p<0.05, + p<0.10
SEs in parentheses are clustered at the classroom level. All variables are standardized mean=0 and SD=1.

Table 3. Predicting wNAP, Spring 2014.

	(1)	(2)	(3)	(4)
wNAP fall 2013	0.443***	0.510***	0.472***	0.441***
	(0.052)	(0.048)	(0.047)	(0.051)
Decoding fall 2013	0.218***			0.180**
	(0.044)			(0.053)
Language understanding fall 2013		0.115**		-0.020
		(0.041)		(0.049)
Text comprehension fall 2013			0.178***	0.064
			(0.040)	(0.048)
Constant	0.130	-0.017	0.027	0.120
	(0.294)	(0.287)	(0.285)	(0.296)
Observations	754	754	754	754
Adjusted R-squared	0.483	0.460	0.475	0.483
Covariates	Yes	Yes	Yes	Yes

Robust standard errors in parentheses
*** p<0.001, ** p<0.01, * p<0.05, + p<0.10
SEs in parentheses are clustered at the classroom level. All variables are standardized mean=0 and SD=1.

Table 4. Predicting Narrative discourse, Spring 2014.

	(1)	(2)	(3)	(4)
Narrative discourse, fall 2013	0.318***	0.379***	0.326***	0.310***
	(0.043)	(0.038)	(0.039)	(0.042)
Decoding fall 2013	0.246***			0.128*
	(0.048)			(0.060)
Language understanding fall 2013		0.146**		-0.030
		(0.048)		(0.050)
Text comprehension fall 2013			0.252***	0.176**
			(0.043)	(0.059)
Constant	0.391	0.253	0.292	0.352
	(0.277)	(0.267)	(0.260)	(0.270)
Observations	754	754	754	754
Adjusted R-squared	0.322	0.294	0.327	0.330
Covariates	Yes	Yes	Yes	Yes

Robust standard errors in parentheses
*** p<0.001, ** p<0.01, * p<0.05, + p<0.10
SEs in parentheses are clustered at the classroom level. All variables are standardized mean=0 and SD=1.

Table 5. Predicting Narrative Genre, Spring 2014

	(1)	(2)	(3)	(4)
Narrative genre fall 2013	0.324***	0.360***	0.344***	0.324***
	(0.064)	(0.066)	(0.063)	(0.064)
Decoding fall 2013	0.180***			0.177*
	(0.050)			(0.072)
Language understanding fall 2013		0.106*		0.002
		(0.052)		(0.065)
Text comprehension fall 2013			0.130**	0.002
			(0.044)	(0.063)
Constant	-0.231	-0.326	-0.306	-0.233
	(0.444)	(0.457)	(0.454)	(0.445)
Observations	754	754	754	754
Adjusted R-squared	0.214	0.200	0.205	0.212
Covariates	Yes	Yes	Yes	Yes

Robust standard errors in parentheses
*** p<0.001, ** p<0.01, * p<0.05, + p<0.10
SEs in parentheses are clustered at the classroom level. All variables are standardized mean=0 and SD=1.

Table 6. Predicting Decoding, Spring 2014

	(1)	(2)	(3)	(4)	(5)
Decoding fall 2013	0.664***	0.693***	0.687***	0.704***	0.633***
	(0.049)	(0.043)	(0.041)	(0.041)	(0.049)
Spelling fall 2013	0.143**				0.116*
	(0.048)				(0.048)
wNAP fall 2013		0.117**			0.001
		(0.042)			(0.036)
Narrative discourse fall 2013			0.136**		0.086+
			(0.040)		(0.048)
Narrative genre fall 2013				0.088*	0.037
				(0.041)	(0.047)
Constant	0.571*	0.380	0.529*	0.395	0.617*
	(0.260)	(0.237)	(0.250)	(0.246)	(0.251)
Observations	500	500	500	500	500
Adjusted R-squared	0.607	0.603	0.607	0.602	0.614
Covariates	Yes	Yes	Yes	Yes	Yes

Robust standard errors in parentheses
*** p<0.001, ** p<0.01, * p<0.05, + p<0.10
SEs in parentheses are clustered at the classroom level. All variables are standardized mean=0 and SD=1.

Table 7. Predicting Language Comprehension, Spring 2014

	(1)	(2)	(3)	(4)	(5)
Language comprehension fall 2013	0.451***	0.460***	0.450***	0.457***	0.442***
	(0.058)	(0.061)	(0.059)	(0.058)	(0.057)
Spelling fall 2013	0.069				0.044
	(0.044)				(0.047)
wNAP fall 2013		0.062			-0.067
		(0.039)			(0.048)
Narrative discourse fall 2013			0.120**		0.124*
			(0.041)		(0.054)
Narrative genre fall 2013				0.071	0.034
				(0.044)	(0.050)
Constant	0.092	-0.017	0.124	-0.006	0.204
	(0.386)	(0.402)	(0.409)	(0.400)	(0.390)
Observations	500	500	500	500	500
Adjusted R-squared	0.466	0.465	0.473	0.468	0.472
Covariates	Yes	Yes	Yes	Yes	Yes

Robust standard errors in parentheses
*** p<0.001, ** p<0.01, * p<0.05, + p<0.10
SEs in parentheses are clustered at the classroom level. All variables are standardized mean=0 and SD=1.

Table 8. Predicting Text Comprehension. Spring 2014.

	(1)	(2)	(3)	(4)	(5)
Text comprehension fall 2013	0.543***	0.568***	0.567***	0.593***	0.514***
	(0.079)	(0.073)	(0.072)	(0.073)	(0.077)
Spelling fall 2013	0.188**				0.131*
	(0.052)				(0.051)
wNAP fall 2013		0.194***			0.067
		(0.053)			(0.049)
Narrative discourse fall 2013			0.197***		0.118+
			(0.052)		(0.061)
Narrative genre fall 2013				0.106*	0.003
				(0.042)	(0.047)
Constant	0.039	-0.218	0.003	-0.189	0.070
	(0.292)	(0.260)	(0.279)	(0.258)	(0.272)
Observations	500	500	500	500	500
Adjusted R-squared	0.521	0.522	0.525	0.509	0.536
Covariates	Yes	Yes	Yes	Yes	Yes

Robust standard errors in parentheses
*** p<0.001, ** p<0.01, * p<0.05, + p<0.10
SEs in parentheses are clustered at the classroom level. All variables are standardized mean=0 and SD=1.

Appendix

Measuring Micro Structure of written narratives (wNAP)

To assess the validity of the measure of the micro structure of written narratives, wNAP, we present analyses of reliability and construct validity, and we examine potential ceiling and floor effects.

Reliability

To ensure inter-rater reliability of coding by two research assistants, we randomly selected 113 written narratives to be double coded by the research assistants. The 113 selected narratives constitute approximately ten percent of the 1160 children in our sample and approximately five percent of the full sample of narratives (since most children wrote two narratives, one in the autumn test and one in the spring test). For a given variation in the full sample, the uncertainty of the reliability statistics depends only on the actual number of randomly selected narratives, not their relative share of the full sample. The 113 narratives in our reliability subsample are more than the total number of participants in many other studies of the microstructure of reading (e.g., Hall-Mills & Apel., 2015; Sun & Nippold, 2012). Thus, our 113 selected narratives constitute a more certain reliability estimate than for instance 20 percent of 90 narratives (for a given variability in the sample).

Following reliability procedures used for the validation of the spoken NAP measure in prior studies (see Justice et al. 2010) agreement on each of the 12 items occurred when the two coders were within one scale point of one another. We computed an agreement percentage for each of the 12 items by dividing the number of disagreements (where coders had more than a one point difference) with the total number of narratives coded. Agreement ranged from 84 percent (Advanced modifiers) to 100 percent (Negative sentences) with an average of 94 percent. These results are as good if not better than those obtained by Justice et al. (2010) and suggests that the wNAP can be coded reliably once coders

have been trained. The two research assistants then each coded half of the remaining written narratives and coding of each narrative took no more than 20 minutes.

Construct Validity of the wNAP

To assess the construct validity of the wNAP we study the factor structure of the wNAP items. We ran an exploratory factor analysis and found – as expected – a single, dominant factor for the wNAP in both fall and spring. Moreover, the results for fall and spring are similar: The first factor has an eigenvalue much larger than the second factor. The factor loadings for the first factor are all weighted positively with weightings ranging from .51 to .74 with the exception of tier-two verbs that load .32 in the fall assessment—but .51 in the spring assessment. In addition, screeplots (not presented) show a bend at the second factor, with much larger eigenvalues for Factor 1 than factor 2.

Table A1: Factor analysis, wNAP-items, fall 2013 & spring 2014

	Fall 2013 (n = 1,160)		Spring 2014 (n = 1,052)	
	Factor 1	Factor 2	Factor 1	Factor 2
Complex sentence	0.74	-0.04	0.69	-0.02
Negative sentence	0.63	0.23	0.54	0.20
Elaborated noun phrase	0.55	0.22	0.51	0.16
Prepositional phrase	0.63	-0.06	0.56	0.02
Advanced modifier	0.68	0.17	0.72	0.16
Pluralized noun	0.60	0.18	0.59	0.19
Tier-two noun	0.56	0.18	0.61	0.17
Auxiliary verb + main verb	0.62	0.24	0.62	0.24
Copula verb	0.57	-0.12	0.67	0.07
Irregular past tense verb	0.60	-0.57	0.59	-0.65
Regular past tense verb	0.73	-0.41	0.60	-0.63
Tier-two verb	0.32	0.08	0.51	0.10
Eigenvalues	4.46	0.77	4.39	1.05

Note: Principal factor analysis.

The total NAP score is computed as a sum score of the twelve items (Justice et al. 2010). The reliability estimates of sum scored wNAP measured by Cronbach's alpha are high (0.87 in both the fall and the spring). These statistics support the notion that the wNAP items combine to consistently

measure a single factor of written narrative microstructure skills. The mean and standard deviations for each of the NAP indicators and the total score for written narratives, wNAP are presented in Table A2.

Table A2: Descriptive statistics, wNAP, fall 2013 and spring 2014

	Fall 2013 (n = 1,160)				Spring 2014 (n = 1,052)			
	mean	sd	min	max	mean	sd	min	Max
NAP total score (12 items)	15.07	8.21	0.00	35.00	19.56	8.21	0.00	36.00
Sentence structure (2 items)	2.48	1.93	0.00	6.00	3.07	1.59	0.00	6.00
-Complex sentence	1.56	1.20	0.00	3.00	2.34	0.97	0.00	3.00
-Negative sentence	0.93	1.06	0.00	3.00	0.73	0.98	0.00	3.00
Phrase structure (2 items)	2.96	1.52	0.00	6.00	3.54	1.36	0.00	6.00
-Elaborated noun phrase	0.56	0.92	0.00	3.00	0.82	1.01	0.00	3.00
-Prepositional phrase	2.40	0.97	0.00	3.00	2.72	0.70	0.00	3.00
Modifier (1 item)	0.99	1.13	0.00	3.00	1.50	1.22	0.00	3.00
-Advanced Modifier	0.99	1.13	0.00	3.00	1.50	1.22	0.00	3.00
Nouns (2 items)	1.51	1.69	0.00	6.00	2.95	1.80	0.00	6.00
-Pluralized noun	0.66	0.97	0.00	3.00	1.09	1.10	0.00	3.00
-Tier-two noun	0.84	1.03	0.00	3.00	1.87	1.01	0.00	3.00
Verbs (5 items)	7.13	3.72	0.00	15.00	8.50	4.07	0.00	15.00
-Auxiliary verb + main verb	1.55	1.19	0.00	3.00	1.68	1.20	0.00	3.00
-Copula verb	2.21	0.96	0.00	3.00	2.16	1.09	0.00	3.00
-Irregular past tense verb	1.78	1.31	0.00	3.00	1.91	1.27	0.00	3.00
-Regular past tense verb	1.48	1.35	0.00	3.00	1.90	1.33	0.00	3.00
-Tier-two verb	0.11	0.39	0.00	3.00	0.85	0.92	0.00	3.00

Floor and Ceiling Effects

Another important criterion for the usefulness of wNAP is whether it has ceiling or floor effects. We examine this through visual inspection of histograms plotting the distribution of the wNAP total scores by grade level and by fall and spring tests (see Figure A1 and A2). Figure A1 shows the distribution of the wNAP for children in grade 2 by fall and spring test. The relative high frequency of scores at 0 or just above in the fall indicates a floor effect, meaning that the assessment cannot differentiate between students with low and very low abilities. However, in the spring, wNAP scores clearly have increased and the floor effect seems to be minimal.

Figure A1: Distribution of wNAP for children in grade 2, fall 2013 and spring 2014

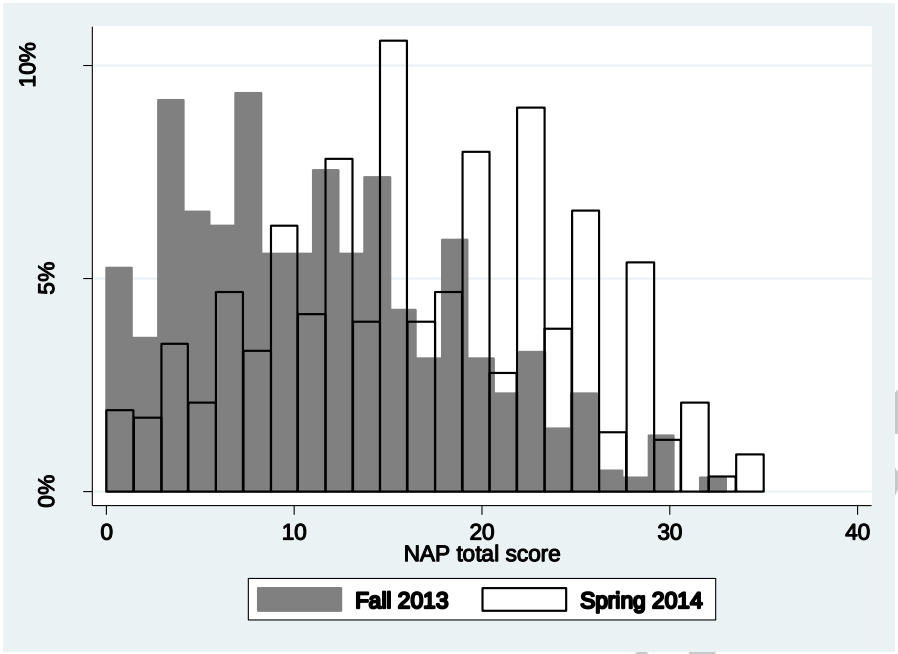
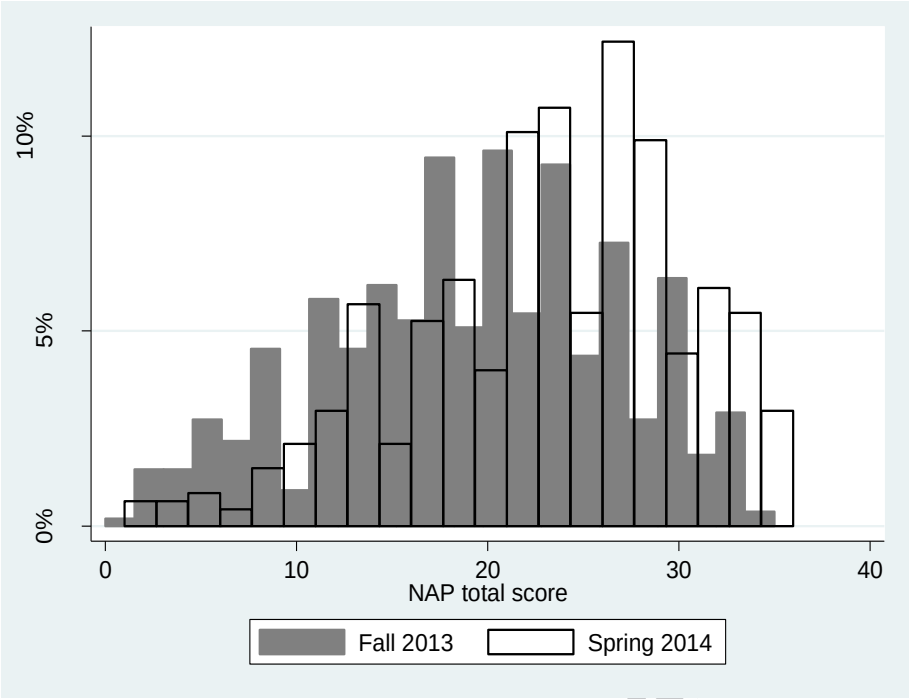


Figure A2 shows the same distribution of wNAP scores by spring and fall, but for grade 3 students. Here there seem to be no floor effect in either fall or spring. This indicates that the floor effect found for children in grade 2 may be because the task is hard for children in the beginning of 2nd grade. For grade 3 students there may be some tendency of a ceiling effect in the spring test (by the end of grade 3). This is seen from the relatively high frequency of students scoring the maximum of 36 points or close to that. Taken together, Figure A1 and Figure A2 suggest that the wNAP score is able to measure the progression that we would expect to see from grade 2, fall through grade 3, spring. This is also confirmed by Table A2 above showing and increase in mean score between fall and spring from 15.1 to 19.6.

Figure A2: Distribution of wNAP for children in grade 3, fall 2013 and spring 2014



Measuring Narrative Discourse and Genre

Tables A4 and A5 show factor analyses of the measures of Narrative Discourse and Genre. See main text for discussion of the results.

Table A4: Narrative Discourse, fall 2013 & spring 2014

	Fall 2013 (n = 1,160)		Spring 2014 (n= 1,052)	
	Factor 1	Factor 2	Factor 1	Factor 2
Item 1	0.44		0.37	
Item 2	0.63		0.46	
Item 3	0.53		0.53	
Item 4	0.61		0.55	
Eigenvalues	1.23		0.94	

Note: Principal factor analysis.

Table A5: Narrative Genre, fall 2013 & spring 2014

	Fall 2013 (n = 1,160)		Spring 2014 (n= 1,052)	
	Factor 1	Factor 2	Factor 1	Factor 2
Item 5	0.48		0.39	
Item 6	0.58		0.58	
Item 7	0.52		0.63	
Item 8	0.41		0.53	
Eigenvalue	1.01		1.16	

Note: Principal factor analysis.

Highlights:

- This study examines relations between reading and writing skills across a school year in 1,160 2nd and 3rd graders in Denmark
- Word-level, sentence-level and text-level reading and writing skills were assessed in fall and spring
- Fall reading skills (particularly at the word level -- decoding) predicted spring writing skills across levels, with fall writing skills controlled
- Fall writing skills (particularly at the word level – spelling) predicted spring reading skills, with fall reading skills controlled