**Methods for ES/K010425/1**

**Language-specific and language-general influences on reading comprehension development: comparisons between an alphabetic and morphographic script**

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**Methods**

**Participants**

128 6- to 8-year-olds (73 female), 125 9 to 10-year-olds (59 female) and 158 12- to 13-year-olds (85 female) participated. Children were from schools located in the north west of England. All schools acted *in loco parentis.* Signed parental consent was obtained for all children in Years 2 through 6 and, in addition, these participating children gave their assent before each assessment. For children in Year 8, parents were given the option to opt their child out of the study and all of these participating children provided signed consent.

**Materials**

Children completed assessments of literacy skills (decoding, reading comprehension), nonverbal IQ, phonological awareness, vocabulary, and a range of measure of morphological awareness. These are described, in turn, below.

**Decoding ability.** Decoding skills were assessed individually using the Test of Word Reading Efficiency Second Edition (TOWRE-2; Torgesen, Wagner, & Rashotte, 2011). In the Sight Word Efficiency subtest, children are asked to read as many real words as they can within 45 seconds; in the Phonemic Decoding Efficiency the items are pronouncable nonwords. The test-retest reliability reported in the manual is .93 .90, and .84 for children aged 7, 10, and 13 years respectively. The tests were administered and scored according to manual guidelines, using the number of items correctly read within the time limit.

**Reading comprehension.** The reading skills of children aged 7 and 10 years were assessed using the York Assessment of Reading Comprehension (YARC) Passage Reading (Second Edition; Snowling et al., 2009). Children read two passages aloud (corrected for word reading errors) and answered eight comprehension questions after each one. Passages were selected according to the recommended starting level for the age group and the passage above. However, children who made more than the recommended number of word reading errors prescribed by the manual were instead assessed using lower-level passages.

The number of word reading errors, time taken to complete passage, and number of correct comprehension answers were recorded for each passage. Published Cronbach α measures of internal consistency range from .75-.93 for word reading accuracy, .90-.95 for reading rate, and .71-.84 for paired comprehension scores, depending on the passages selected.

The reading fluency and comprehension skills of 13-year-olds were assessed using YARC Secondary (Stothard, Hulme, Clarke, Barmby, & Snowling, 2010), which allows for silent reading of the passages before answering 13 questions after each. Children were assessed using the two Level 1 passages recommended for this age group (Cronbach α = .90 for comprehension). Because of the administration procedure, YARC word reading accuracy scores are not available for this age group. However, children who demonstrated poor word reading skills during the TOWRE were administered the Supplementary Passages (Cronbach α = .76 for comprehension), in which the children read aloud and were corrected for word reading errors.

For all age groups, raw scores were converted to Rasch-based ability scores provided in the manual (see (Cunningham & Carroll, 2015), for similar test usage), which account for both passage difficulty and performance across the two passages administered. Standardised scores were also retrieved from the manual to place our sample in wider context.

**Nonverbal IQ**. Nonverbal IQ was assessed using a matrix reasoning task, a measure of visual pattern matching in which children are asked to select which picture (from a set of 5) is missing from the sequence. Groups of children were trained on three examples, and then individually worked through printed booklets of age-appropriate items at their own pace. There were 22 items for 7 year-olds, 23 items for 10 year-olds, and 21 items for 13 year-olds.

**Phonological awareness.** Phonological awareness was assessed individually using the Phoneme Elision subtask from the Comprehensive Test of Phonological Processing Second Edition (CTOPP-2; Wagner, Torgesen, & Rashotte, 1999). In this task, children hear a word spoken by the assessor and are asked to remove a sound from the beginning/middle/end of each word to produce a different word. The earliest items involve deletion of a syllable from compound words (such as cowgirl) and the subsequent items involve the deletion of a phoneme (e.g., *“*Say *time* without saying /*m*/”). The task was administered and scored according to standard manual procedures, scoring 1 point for each correct answer (maximum = 34) with a discontinuation rule of three incorrect answers in a row. The internal consistency (Cronbach’s α) reported in the manual is .92, .87, and .90 for children aged 7, 10, and 13 years respectively.

**Vocabulary.** Receptive vocabulary was measured using a shortened classroom adaptation of the British Picture Vocabulary Scale Third Edition (Dunn, Dunn, Styles, & Sewell, 2009); for similar modifications see Stanovich & Cunningham (1992). Participating classes were presented with a selection of 36 age-appropriate test items using a projector. Each child was given a score sheet, and asked to circle the number (1-4) corresponding to the picture that best showed the meaning of each word read aloud by the researcher. One point was awarded for each correctly selected answer.

**Morphological awareness tasks.** Children completed two measures to assess each of following aspects of morphological awareness: compounds, derivations, and inflections. Each age group completed the same items, as described below.

**Compounds**

**Stimuli.**Forty-eight novel compounds were created by changing either the modifier or head of existing semantically transparent compound words. These included equal numbers of prototypical and peripheral noun, adjective and verb compound items, e.g., *blue-bug, bear-wave* (Hamawand, 2011). They were constructed to be conceivable but not real concepts (assessed by pilot testing with adults during the development phase). The 48 items were divided into two 24-item lists to create two alternative forms of the tasks, such that any given stimulus appeared in the analogy task for half the participants and in the judgement task for the other half.

**Analogy task.**Children were provided with existing compounds and asked to use these to create new words. For example, “A wand that a fairy has is called a fairy wand. What is the name for a wand that an elf has?” (“elf wand”). Children aged 7 and 10 answered orally in response to the experimenter, but were also presented with key words in written format to minimise demands on memory. The 13-year-old children were presented with the full questions in written format, and provided written answers in booklets at their own pace within class. One point was given for each correctly produced target or semantically identical novel compound (maximum score = 24).

**Judgement task.**This task was based on the (Nagy, Berninger, Abbott, Vaughan, & Vermeulen, 2003) each question, children were asked to choose which of two options best fitted the description. For example, “Which is a better name for a patch you wear over your ear? Ear patch or patch ear?” Children completed the test by circling their answers in individual test booklets in the classroom. Each question was read aloud to the 7- and 10-year-old children. The 13-year-old children were presented with the whole questions in workbooks, which they worked through at their own pace. Each correct answer was awarded 1 point, totalling a maximum test score of 24.

**Morphological awareness: derivations**

**Stimuli***.* We assessed awareness of a broad range of verb-, adjective- and noun-forming suffixes that occurred in the Children’s Printed Word Database (Masterson, Stuart, Dixon, & Lovejoy, 2003). All real word stems had an age of acquisition (AoA) that was less than 6 years and 6 months (Kuperman, Stadthagen-Gonzalez, & Brysbaert, 2012). We also assessed morphological transformations from novel stems that were analogous to real words. Half of the items in each set were phonologically transparent, and half required a phonological change (Carlisle, 2000).

**Analogy task.**In this task, children are presented with a pair of real words and need to decompose the morphological relationship between them to complete the pattern, for example, *drive: driver :: run: \_\_\_\_*. (Nunes, Bryant, & Bindman, 1997). Half of the test items involved the same suffix as the pair provided, and half required a different suffix to be produced.

Three examples and 20 items were included in this assessment. For children aged 7 and 10 years, the examples were presented in both oral and written form and children were asked to give oral responses. The 13-year-olds worked though the items in a booklet at their own pace and provided written responses.

For the real word items, 1 point was awarded for each correct response. For the novel items, 1 point was awarded when the child produced any appropriate suffix that had the same morphological function. This totalled a maximum of 20 points.

**Judgement task***.*This task was based on the Test of Morphological Structure (composition; Carlisle, 2000). Children were presented with the stem of each test item along with an indicator of its word class (i.e., ‘the’, ‘to’, or ‘it is’). They were then asked to choose which word fitted the sentence best from three variations of the stem: the correct answer, an incorrect answer formed by using a syntactically appropriate suffix that was inappropriate for the initial word class, and an inflected form. For example, “To farm. I want to be a *farmer / farmist / farming*.” Three examples and 20 items were presented in workbooks and administered to children in their classrooms. The items were read aloud (and repeated once) to the 7- and 10-year-olds; the 13-year-olds worked through the booklets at their own pace. One point was given per correct answer selected, totalling a maximum score of 20.

**Morphological awareness: inflections**

**Stimuli.**We assessed awareness of three classes of inflections: plural nouns, singular present tense and singular past tense. Target items were created by attaching suffixes to both real (AoA as above) and analogous novel stems. Half of the items were ‘irregular’ forms, although this irregular transformation was not required for singular present tense.

**Analogy task***.* Three training and 24 test items were presented to children as described for the derivation analogy task. One point was awarded for correctly produced real and novel words (maximum score = 24). ‘Irregular’ novel words were scored for both irregular and regularised versions.

**Judgement task.**Three training and 24 test items were presented to children, as in the derivation judgement task. Children had to choose between the correctly inflected and two incorrectly inflected forms. One point was given per correct answer selected (maximum score = 24).

**Procedure**

The 7- and 10-year-olds took part in two group testing sessions in their classroom (lasting approximately 30 minutes each) in which the vocabulary, nonverbal reasoning, and morphological awareness judgement tasks were administered. They also took part in three individual sessions (10-15 minutes each) in a quiet area of their school, in which the decoding, reading comprehension, phonological awareness and analogical morphological awareness tasks were administered. The 13-year-old children took part in two group testing sessions in their classroom (approximately 40 minutes each), in which the vocabulary, nonverbal reasoning and morphological awareness tasks were administered. They also took part in a single individual testing session (30 minutes) in a quiet room in their school, in which the phonological awareness, decoding, and reading comprehension tasks were administered.

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