Applied Psycholinguistics (2019), **40**, 743–763
doi:10.1017/S0142716418000826

CAMBRIDGE UNIVERSITY PRESS

ARTICLE

Morphological awareness and reading achievement in university students

Jamie L. Metsala[1,*], Rauno Parrila[2], Nicole J. Conrad[3] and S. Hélène Deacon[4]

[1]Mount Saint Vincent University, [2]Macquarie University, [3]Saint Mary's University and [4]Dalhousie University Life Sciences Centre
*Corresponding author. Email: Jamie. Metsala@msvu.ca

(Received 30 May 2017; revised 29 August 2018; accepted 17 November 2018)

Abstract

We examined morphological awareness and reading achievement in university students in two ways. First, students with and without a self-reported history of reading difficulties were compared on word reading and text reading achievement, and on the reading-related skills of morphological awareness, orthographic processing, and phonological processing. Second, the unique contribution of morphological awareness to reading achievement was examined for a larger sample of first-year university students. Students with a self-reported history of reading difficulties ($n = 54$) showed moderate to large gaps in each area of reading achievement, and timed reading comprehension appeared more severely impaired than word-reading efficiency. These students had a deficit in morphological awareness that persisted even when (a) phonological awareness and orthographic processing skills, or (b) word-reading accuracy were statistically controlled. In the larger first-year sample ($N = 211$), morphological awareness contributed to variance in word reading beyond that accounted for by phonological awareness and orthographic processing. Furthermore, of the reading-related skills, only morphological awareness made a unique contribution to reading comprehension beyond variance accounted for by word reading. Taken together, these results demonstrate that morphological awareness makes unique contributions to university students' reading achievement and is an additional difficulty for students with a self-reported history of reading difficulties.

Keywords: morphological awareness; reading achievement; reading disabilities; university students

Understanding reading achievement in university students is important, given the centrality of reading in academic success (Snow & Strucker, 2000). This study contributes to knowledge of this population through two avenues. First, in studies of English-speaking university students, a group has been identified with undiagnosed, self-reported histories of reading difficulties (e.g., Deacon, Cook, & Parrila, 2012; Parrila, Georgiou, & Corkett, 2007). To better understand the functioning of these students, we explore relative strengths and weaknesses across areas of their reading achievement, and examine their performance on measures of morphological awareness. Second, we examine the contributions of morphological awareness to reading achievement for a larger sample of first-year university students.

Morphological awareness is the ability to recognize and manipulate morphemes, the smallest meaningful units in language (e.g., Carlisle, 1988). Established models of reading development recognize language comprehension as one of two determinants of reading achievement (e.g., Gough & Tunmer, 1986; Scarborough, 2001), and morphology is an important component of oral language (e.g., Wiig, Secord, & Semel, 2013). Few models, however, have specified a role for morphological awareness (Carlisle, 2010). Scarborough (2001) included understanding the structures of language, both the syntactic and the semantic relationships among words, as an important strand of language comprehension. In this model, aspects of language and word reading become more coordinated throughout development, and morphological awareness would be expected to contribute to reading comprehension.

The reading systems framework (Perfetti & Stafura, 2014; Stafura & Perfetti, 2017), although encompassing many aspects of reading not examined in the current study, explicitly incorporates morphology. Subsystems are delineated in this framework, toward integrating word-level processes within a comprehensive model of reading comprehension. The orthographic system, in which internal orthographic representations are mapped onto phonology and morphology, is instrumental to word reading. Morphology is thus important in word reading as it is proposed to be one organizing principle of the lexicon (see Rabin & Deacon, 2008). As one component of a broader linguistic system, morphology is also assigned a role in the integration of word meanings with larger segments of text (for a visual representation see Figure 1, p. 11, in Stafura & Perfetti, 2017). Within the context of the models discussed, the current study examined specific hypotheses concerning independent contributions of morphological awareness to word reading and to reading comprehension.

Reading achievement in students with a self-reported history of reading difficulties

Research with English-speaking university students has identified a group who report a history of reading difficulties, which have gone largely undiagnosed (e.g., Deacon et al., 2012; Jackson & Doellinger, 2002; Parrila et al., 2007). That is, their scores on a self-report questionnaire indicate reading acquisition difficulties in childhood; however, only about 20% have received any type of learning-related diagnosis (Deacon et al., 2012). Academically, students with a self-reported history of reading difficulties had lower first-year grades and completed fewer attempted course credits than their peers without such a history (Bergey, Deacon, & Parrila, 2017; Chevalier, Parrila, Ritchie, & Deacon, 2017). In terms of reading achievement, students with a self-reported history of reading difficulties have been found to show deficits in word reading, reading rate, reading comprehension, and phonological awareness compared to typically achieving peers (Deacon et al., 2012; Deacon, Parrila, & Kirby, 2006; Kemp, Parrila, & Kirby, 2009; Parrila et al., 2007).

Deacon et al. (2012) compared the performance of these students with a group of peers with a diagnosed reading disability, and to a comparison group without a history of reading difficulties. Students with a self-reported history of reading difficulties performed the same as students with diagnosed disabilities, and both groups were poorer than the comparison group on measures of timed reading comprehension, word-reading accuracy and efficiency, and phonological awareness (Deacon et al., 2012; see also Parrila et al., 2007). The diagnosed group performed better than the self-report group on untimed reading comprehension, but the self-report group read texts faster. These group differences may be attributable to different approaches to reading tasks. The authors concluded that students with a self-reported history of reading difficulties most likely represented the same underlying population as those with a diagnosis; that is, high-functioning individuals with reading difficulties. Students with a self-reported history of reading difficulties may face increased risk of academic difficulties in the university setting, as they do not receive the same academic supports as students with a formal diagnosis.

One remaining gap in our knowledge of reading achievement for students with self-reported histories of reading difficulties concerns the relative magnitudes of their impairments across word- and text-reading domains. These students have been found to have the same phonological and word-reading deficits as students with diagnosed reading disabilities (Deacon et al., 2012). It may follow that the largest achievement gaps for students with a self-reported history of reading difficulties will be in isolated word reading, with lower levels of impairment in reading comprehension. The semantic and syntactic contexts provided by connected text may facilitate comprehension for students with a self-reported history of reading difficulties (see Corkett & Parrila, 2008). Alternatively, if processes specific to reading fluency or comprehension are impaired for students with a self-reported history of reading difficulties, text-reading measures may be at least as impaired as isolated word reading. The current study builds on previous research by directly comparing effect sizes for different areas of reading achievement for this group of students.

Reading-related skills in students with a self-reported history of reading difficulties

Another remaining gap in our knowledge concerning students with a self-reported history of reading difficulties is how they read at a level necessary to complete university courses. We turn to another factor that could potentially help to explain reading success in these individuals, morphological awareness. It has been shown that morphology has a role in skilled word reading (e.g., Crepaldi, Rastle, Coltheart, & Nickels, 2010; Taft, 1994). Furthermore, both developmental research (Deacon, Tong, & Mimeau, 2016) and theoretical models support the notion that individual differences in morphological processing are related to reading achievement (Scarborough, 2001; Stafura & Perfetti, 2017). Consistent with some research on university students with dyslexia (e.g., Cavalli, Duncan, Elbro, El Ahmadi, & Colé, 2017; Law, Wouters, & Ghesquière, 2015; Martin, Frauenfelder, & Cole, 2014), morphological awareness may also be a strength for students with a self-reported history of reading difficulties, acting as a compensation for core deficits in the word reading of these students.

There are, however, inconsistencies in the literature addressing the morphological awareness skills of university students with dyslexia. This state of knowledge is in

https://doi.org/10.1017/S0142716418000826 Published online by Cambridge University Press

sharp contrast to the well-established deficits in phonological awareness for university students and adults with reading difficulties, regardless of whether these are diagnosed (Bruck, 1993; Miller-Shaul, 2005) or not (e.g., Deacon et al., 2012). Research findings from several studies support the view that implicit or explicit morphological processing is an additional deficit for university students with dyslexia (e.g., Leikin & Zur Hagit, 2006; Leong, 1999; Schiff & Raveh, 2007). Some researchers have suggested that compensatory mechanisms in university students with dyslexia be sought in skills other than morphological awareness, such as orthographic, semantic, or meta-analytic processes (Cartwright, Bock, Coppage, Hodgkiss, & Nelson, 2017; Leinonen et al., 2001; Welcome, Chiarello, Halderman, & Leonard, 2009).

Morphological processing has not been well studied in university students with a self-reported history of reading difficulties. In one of the few such studies, this group of English-speaking students were not sensitive to morphological complexity in priming tasks involving word reading; typically achieving university students matched on untimed reading comprehension did show these effects (Deacon et al., 2006). These finding are consistent with those of Schiff and Raveh (2007) for Hebrew-speaking university students with dyslexia, and suggest that morphological awareness, which relies on implicit morphological knowledge, may be a deficit rather than a strength for students with self-reported histories of reading difficulties.

When deficits in morphological awareness in university students with dyslexia have been reported, these have been found to extend beyond those explained by phonological deficits (Law et al., 2015; see also Cantiani, Lorusso, Guasti, Sabisch, & Männel, 2013); however, these studies have not frequently included orthographic processing. Orthographic processing has been defined as the ability to "form, store, and access orthographic representations" in the mental lexicon (Cunningham, Nathan, & Rather, 2011, p. 263). These skills are critical to automatic word reading (Ehri, 2005) and have been found to be poorer in adults with diagnosed reading disabilities versus nondisabled peers (e.g., Coleman, Gregg, McLain, & Bellair, 2009; Meyler & Breznitz, 2005; Taft, 2001). For university students with a self-reported history of reading difficulties, one study found that spelling of simple irregular words was poorer than for a comparison group matched on a standardized spelling test (Kemp et al., 2009), suggesting a difficulty memorizing orthographic patterns. Given the central roles accorded to phonological awareness and orthographic processing in word-reading acquisition (Ehri, 2005; Cunningham et al., 2011; Share, 1995, 2008), one goal of our study was to investigate morphological awareness skills within the context of these other two skills in university students with a self-reported history of reading difficulties.

Morphological awareness and its relation to reading achievement in university students

Looking beyond students with a self-reported history of reading difficulties, we examined the contribution of morphological awareness to word reading and reading comprehension for first-year university students more generally. Given that the reading achievement of university students is expected to be higher than the population of all young adults, researchers may argue that individual differences in such are not important to academic achievement (Jackson, 2005). We build on prior research by attempting to explain the individual differences in word reading and reading comprehension achievement that are apparent in university students (e.g., Guo, Roehrig, & Williams, 2011; Jackson & Doellinger, 2002). Given the primacy attributed to phonological and orthographic processing in reading acquisition (e.g., Ehri, 2005), these may account for the overwhelming variance in university students' word reading. Morphological processing, however, is related to word reading in younger samples (Carlisle & Stone, 2005), supports skilled word reading (Crepaldi et al., 2010), and is one factor influencing word recognition in the reading systems framework (Stafura & Perfetti, 2017). Morphological awareness may, therefore, make a unique contribution to individual differences in word reading in university students.

Comprehending text is the ultimate goal of reading and central to successful university studies. There is limited research that simultaneously examines the three reading-related skills included in this study and their relationship to reading comprehension in university students or young adults. Theoretically, morphological awareness is proposed to have a direct influence on reading comprehension (Scarborough, 2001; Stafura & Perfetti, 2017), and this has been found to be the case for elementary and adolescent students (Carlisle, 1995; Deacon et al., 2016; Kirby et al., 2012; Tong, Deacon, Kirby, Cain, & Parrila, 2011). Less is known about the unique contribution of morphological awareness to reading comprehension in university students; however, it has been proposed that over the school years, as words become more structurally complex with increasing text difficulty, the contribution of morphological awareness to reading comprehension should increase (Nagy, 2007). Guo et al. (2011) completed one of very few studies with university students, and did find that morphological awareness contributed to English-language reading comprehension beyond that accounted for by syntactic awareness and vocabulary; however, individual differences in word-reading skills were not accounted for in their analyses. We examined whether morphological awareness contributed to reading comprehension independent of word-reading achievement and other reading-related skills.

The current study

In order to increase current understandings of university students' reading achievement, we examined three research questions:

1. Which areas of reading achievement are most impaired for students with a self-reported history of reading difficulties?
2. Do students with a self-reported history of reading difficulties show deficits in morphological awareness, and if yes, do these persist after controlling for reading-related skills or word reading?
3. Does morphological awareness make a unique contribution to word reading and to reading comprehension in a large sample of first-year university students?

https://doi.org/10.1017/S0142716418000826 Published online by Cambridge University Press

Our predictions for each question in turn were as follows. We expected that word-reading skills would be more impaired than text-reading processes in students with self-reported histories of reading difficulties, as text reading might allow for contextual facilitation for this group of readers. Outcomes for our second research question were not straightforward to predict. That is, morphological awareness may be an additional and persistent deficit in students with a self-reported history of reading difficulties, as found for younger students with diagnosed disabilities (Deacon et al., 2016) and in some studies of university students with dyslexia. Alternatively, morphological awareness may be a strength for students with a history of reading difficulties as reported in other studies with university students with dyslexia, helping them to read university material. Addressing our final research question, we predicted from theoretical models and previous research, largely with younger students, that morphological awareness would make a unique contribution to word reading and to reading comprehension for our larger group of university students.

Method

Participants

Over a 3-year period, each incoming first-year student at a large, research-intensive Canadian university was e-mailed an invitation to participate in an online questionnaire about his or her reading history (Adult Reading History Questionnaire—Revised [ARHQ-R]; Parrila, Corkett, Kirby, & Hein, 2003). The current sample is drawn from 750 students who responded to this invitation. These students had no prior postsecondary experience, had English as a first language, and indicated agreement to being contacted for a follow-up study. Two hundred and thirty-two of these students were recruited and attended an individual testing session at a university laboratory and 220 completed the measures for this study. Students whose performance on the ARHQ-R met criteria for a history of reading difficulties were overrecruited.[1] Of these 220 students (168 females), 58 (26%) had a proportion score on the ARHQ-R that indicated high levels of difficulty learning to read, and 112 had a score that indicated no difficulties in acquiring reading skills (Deacon et al., 2006, 2012; Lefly & Pennington, 2000; Parrila et al., 2003).[2]

In order to create a comparison group and control for gender, age, and nonverbal reasoning, a subset of these 112 students without any indication of difficulties learning to read was individually matched, as closely as possible, with the students with a self-reported history of reading difficulties. A match was judged to be acceptable if the individuals were the same gender, within 1 year of age, and within 4 points on the nonverbal reasoning measure. This matching process resulted in a group of 54 students with a self-reported history of reading difficulties (36 females, *M*age = 18.92; range 17.08–25.5 years; matrix reasoning = 28.65, *SD* = 3.32)[3] and 54 students with no self-reported history of reading difficulties (36 females, *M*age = 18.97; range 17.67–26.33 years; matrix reasoning = 28.63, *SD* = 3.35). Independent-samples *t* tests showed that the groups did not differ on age, $t\ (106) = -0.23$, $p = .82$, or nonverbal reasoning scores, $t\ (106) = 0.03$, $p = .98$.

Table 1. Distribution of ARHQ-R scores for initial and matched samples of first-year students

	First-year students—Initial sample $N = 750$	First-year students—Matched sample $N = 211$
ARHQ-R range	% students	% students
.00–.099	32.81	31.76
.10–.199	19.84	21.33
.20–.299	15.95	12.80
.30–.399	14.14	15.17
.40–.499	8.30	9.00
.50–.599	5.60	5.69
.60–.699	1.95	2.37
.70–.799	1.69	1.9
.80–.899	0.13	0
.90–1.0	0.13	0

Note: Adult Reading History Questionnaire—Revised (ARHQ-R) scores range from 0 (no history of difficulties acquiring reading skills in elementary school) to 1 (extensive difficulties acquiring reading skills in elementary school).

We examined the contribution of morphological awareness to reading achievement in first-year university students more generally. The proportion of students in each decile of the ARHQ-R for the 220 students who completed individual testing was matched with that of the 750 students from whom the sample was drawn. This was done to correct for overrecruiting of students with a history of reading difficulties for individual testing. This resulted in a group of 211 students (161 females) in total, and this group is examined in the regression analyses in this study (see Table 1 for the distribution of ARHQ-R scores for the samples of 750 and 211 students).

Measures

Nonverbal reasoning

A computer-adapted version of the matrix reasoning subtest of the Wechsler Abbreviated Scale of Intelligence (Wechsler, 1999) was administered. Participants chose a computer key to indicate which of five possible responses completed each matrix. The total score was out of 35 items. The split-half reliability for adults is reported in the test manual to be .94 (Wechsler, 1999).

History of reading difficulties

The participants' history of reading difficulties was measured on the Elementary-School Scale on the ARHQ-R (Parrila et al., 2003). The degree of difficulties acquiring literacy skills in elementary school is assessed with an 8-item scale. Participants respond to each item (e.g., "How much difficulty did you have learning to read in elementary school?") on a 5-point Likert-like scale. Responses across the 8 items are

https://doi.org/10.1017/S0142716418000826 Published online by Cambridge University Press

summed and transformed to result in a score that ranges from 0 (*no difficulties*) to 1 (*extensive difficulties*). As in previous research (e.g., Bergey et al., 2017; Deacon et al., 2012; Parrila et al., 2007), students with scores equal to or greater than .37 were identified as having a history of reading difficulties. Students with scores less than .25 were categorized as having no history of reading difficulties. The scale had good reliability in the current sample ($N = 211$; Cronbach's $\alpha = 0.88$). For students with a self-reported history of reading difficulties ($N = 54$), the mean score on this scale was .50 ($SD = .13$) and for the comparison group with no history of reading difficulties ($N = 54$) the mean score was .10 ($SD = .07$). The groups differed significantly on this scale, t (106) = 20.40, $p < .001$.

Phonological awareness

Phonological awareness task 1 (PA1) was the spoonerisms subtest of the York Adult Assessment (Hatcher, Snowling, & Griffiths, 2002). This phonological awareness measure has practice items and 12 test items, for which participants heard a first and last name spoken by the examiner, and were required to switch the initial sounds from the two proper names (e.g., the correct response for "John Lennon" is "Lohn Jennon"). Participants were awarded 2 points for correct items and 0 points for an answer with one or more errors. The Spearman–Brown split-half reliability coefficient for the current sample was .74.

Phonological awareness task 2 (PA2) consisted of a phonological choice task (see Parrila et al., 2007) that combines elements of phonemic judgement or awareness and phonological decoding. Participants were directed to quickly choose one of two written pseudowords "that sounds like a real English word" (e.g., fite-fipe; saip-saif; and doster-dawter). A participant's score was the number correct for the 20 items (17 single-syllable pairs and 3 two-syllable pairs). The Spearman–Brown split-half reliability coefficient for the current sample was .82.

Morphological awareness

Across two tasks, participants read a list of 44 words, with each word consisting of one to four morphemes. Participants were instructed to "draw a line between the smallest meaningful parts of words" in the list, and completed practice items with feedback. Examples of items in the lists include malfunctioning, extrasensory, bilingual, farmer, immobile, and corner (correct parsing: mal | funct | ion | ing; extra | sens | ory; bi | lingu | al; farm |er; im | mobile; and corner). These tasks were previously piloted with university student participants. For morphological awareness task 1 (MA1), participants completed the list at their own pace. For morphological awareness task 2 (MA2), participants were given 45 s to complete a list of 44 different words.

There were 9 and 11 distractor items included in MA1 and MA2, respectively. These were items that consist of only one morpheme, but which have orthographic patterns frequently associated with morphemes (e.g., needle; coral; planet; convey, imitate, earnest). Participants received 1 point for not parsing these words, and 0 points if the word was parsed. Participants using an orthographic strategy, rather than attending to the morphological structure of words, would thus receive lower scores due to these distractor items. Participants' scores were the number of correct parsings, with a maximum score of 56 for each task. The Spearman–Brown coefficient was calculated for odd-even items for the current sample and was .83 for MA1 and .86 for MA2.

Orthographic processing

Orthographic processing was measured using a two-part wordlikeness task similar to previous research (Conrad, Harris, & Williams, 2013) and piloted before inclusion in this study. For orthographic processing task 1 (OP1), participants were instructed to indicate which of the nonwords "looks like it could be a real English word" from two pseudowords. The same instructions were given for the orthographic processing task 2 (OP2), but participants chose from three choices (e.g., *veighk-vayk-vake*; with the correct response *vake*). Stimuli were presented on the computer screen, and reaction times were measured from stimulus presentation to the participant pressing a response key. The setup and task demands of this measure are similar to that of the PA2 task, but responses call for reliance on orthographic rather than phonological information. As expected from pilot work with this task, participants performed at ceiling on OP1 and OP2 ($M = 15.62$, $SD = 1.38$ for 17 items and $M = 9.81$, $SD = 1.19$ for 11 items, respectively); reaction times were used in all the analyses. The Spearman–Brown coefficient for reaction time data for the current sample was .92 for OP1 and .94 for OP2.

Word-reading accuracy

The word identification subtest of the Woodcock Reading Mastery Tests—Revised (Woodcock, 1998) was adapted for computer presentation. Each item was presented one at a time on the screen for the participant to read aloud, and an assistant recorded response accuracy. The test was discontinued after six consecutive errors. Spearman–Brown split-half reliability coefficient is reported in the test manual to be .97 (Woodcock, 1998).

Word-reading efficiency and phonemic decoding efficiency

The two subtests of the Test of Word Reading Efficiency (TOWRE; Torgesen, Wagner, & Rashotte, 1998) were adapted for computer presentation. Presentation of stimuli was identical to the printed test book, but presented on a computer screen. A participant had 45 s to read as many words (or nonwords) aloud as she or he could. The test–retest reliability is reported in the test manual with $r = .91$ for the word reading efficiency scale and .90 for the phonemic decoding efficiency scale (Torgesen et al., 1998).

Reading comprehension and text-reading rate

The Nelson Denny Reading Test (Brown, Fishco, & Hanna, 1993) was used to measure text-reading rate and reading comprehension, and was adapted for computer presentation. The reading comprehension test consisted of seven passages that participants read silently, with a total of 38 multiple-choice questions, and participants were given 20 min to complete the test. Reading rate was determined by recording the amount of time taken to silently read the first passage. The reading comprehension score was the number of accurate responses to the multiple-choice questions. Alternate form reliability for the comprehension scale is reported in the test manual to be .81 (Brown et al., 1993).

Data analytic plan

Data analyses addressed each of our three research questions. We first examined normality for raw scores that were used in analyses, and for reaction time data for the two orthographic tasks. All reaction times (RTs) greater than 2 *SD*s above the participant's mean were recoded to be at the 2 *SD* point (Ratcliff, 1993). Toward determining areas of strength and weakness for students with self-reported histories of reading difficulties, a multivariate analysis of variance (MANOVA) was first conducted comparing the groups ($n = 54$) on the reading achievement measures. We next calculated and examined effect sizes and confidence intervals for these group differences. We judged effect sizes with nonoverlapping confidence intervals to be significantly different (Knezevic, 2008). To address whether morphological awareness skills are a weakness or a strength for students with a self-reported history of reading difficulties, a MANOVA was used to compare the groups on the three reading-related skills. This was followed by two MANCOVAs to determine if morphological awareness differences were explained by the covariates of (a) reading-related skills or (b) word-reading skills. In order to examine our last research question, whether morphological awareness makes a unique contribution to word reading and to reading comprehension in our larger first-year sample, two hierarchical regressions were conducted.

Results

RT distributions for the two orthographic processing tasks, and raw score distributions for all other tasks were examined for normality, and transformations were applied to correct for skewness (Tabachnick & Fidell, 2007). We corrected mild negative skewness for PA1, PA2, and TOWRE phonemic decoding efficiency, and corrected mild positive skewness for OP1 and Nelson Denny reading rate.

Reading achievement in students with a self-reported history of reading difficulties

To examine the relative degree of the impairments for students with a self-reported history of reading difficulties across the reading domains, we first conducted a MANOVA on the five reading achievement measures. This yielded a significant group difference, $F\ (5, 102) = 11.45$, Wilks's $\Lambda = .640$, $p < .001$; follow-up, univariate tests were significant for each reading measure. Table 2 displays these *F* values, as well as effect sizes, 95% confidence intervals, and the group mean standard scores[4] and standard deviations for each reading measure. Effect sizes indicated moderate to large gaps in each area of reading achievement for the students with a self-reported history of reading difficulties. The only indication of differences

https://doi.org/10.1017/S0142716418000826 Published online by Cambridge University Press

Table 2. Mean standard scores and SD for reading achievement measures by reading group

Variable	HRD ($n = 54$) *M*	HRD ($n = 54$) *SD*	NRD ($n = 54$) *M*	NRD ($n = 54$) *SD*	*F* (1,106)	Cohen's *d*	95% CI low ***d***	95% CI high ***d***
Word ID	93.37	8.81	100.51	6.45	31.31*	1.04	0.63	1.4
WRE	91.37	9.72	98.21	12.40	8.14^	0.55	0.16	.93
PDE	91.50	9.77	98.94	9.91	15.97*	0.77	0.38	1.16
ND Comp	203.85	22.76	230.22	14.10	52.87*	1.40	0.98	1.82
ND Rate	199.74	18.52	219.63	28.80	19.95*	0.86	0.46	1.25

Note: HRD, group with self-reported history of reading difficulties. NRD, group with no self-reported history of reading difficulties. Word ID, Woodcock word identification. WRE, TOWRE word-reading efficiency. PDE, TOWRE phonemic decoding efficiency. ND Comp, Nelson Denny reading comprehension. ND Rate, Nelson Denny reading rate. *$p < .001$. ^$p < .005$.

between effect sizes was a more severe deficit for timed reading comprehension compared to that for word-reading efficiency.

In order to better understand the observed reading comprehension deficit, we compared the groups on an untimed reading comprehension score (the number of items the participant got correct / the number of items the participant attempted). An independent-samples *t* test showed a significant difference between the groups on untimed reading comprehension, $t\ (106) = -4.84$, $p < .001$, and $d = 0.957$. The means were .81 ($SD = .13$) and .91 ($SD = .07$), for the group with versus without a self-reported history of reading difficulties, respectively.

Reading-related skills in students with a history of reading difficulties

In order to compare the performance of the groups on the reading-related skills, scores on the six tasks were submitted to a one-way MANOVA (mean raw scores or RTs, and standard deviations for the reading-related skills are presented in Table 3). There was a statistically significant difference between the groups, $F\ (6, 101) = 5.57$, $p < .001$; Wilks's $\Lambda = .751$. Follow-up univariate tests showed a significant group effect for all but one measure; PA1, $F\ (1, 106) = 11.66$, $p < .005$, $d = 0.658$; PA2, $F\ (1, 106) = 7.79$, $p < .01$, $d = 0.537$; OP2, $F\ (1, 106) = 4.89$, $p < .05$, $d = 0.426$; MA1, $F\ (1, 106) = 11.96$, $p < .005$, $d = 0.663$; and MA2, $F\ (1, 106) = 8.72$, $p < .005$, $d = 0.567$. For each of these measures, the students with a self-reported history of reading difficulties performed worse than the comparison group. The effect of group was not significant for OP1, $F\ (1, 106) = 2.31$, $p = .13$.

To examine whether group differences on morphological awareness remained after controlling for individual differences on the two other reading-related skills, a MANCOVA was conducted on the two morphological awareness scores with PA1 and OP2 as covariates.[5] There was a statistically significant difference between the groups, $F\ (2, 103) = 5.91$, Wilks's $\Lambda = .897$, $p < .005$. In order to test whether students with a self-reported history of reading difficulties still manifest a deficit in morphological awareness after controlling for variance in word reading, another

https://doi.org/10.1017/S0142716418000826 Published online by Cambridge University Press

Table 3. Means and SD for reading-related skills by reading group

	HRD ($n = 54$)		NRD ($n = 54$)	
Variable	*M*	*SD*	*M*	*SD*
PA1	21.18	3.15	22.81	1.74
PA2	17.35	2.26	18.38	1.48
OP1 (ms)	1477.06	520.43	1417.10	483.88
OP2 (ms)	2095.83	876.28	1787.46	531.60
MA1	29.91	5.97	33.68	5.34
MA2	20.15	5.92	23.53	5.96

Note: HRD, group with self-reported history of reading difficulties. NRD, group with no self-reported history of reading difficulties. OP1, orthographic processing task 1. OP2, orthographic processing task 2. MA1, morphological awareness task 1. MA2, morphological awareness task 2. PA1, phonological awareness task 1. PA2, phonological awareness task 2.

Table 4. Correlations of variables in regression analyses for first-year students ($N = 211$)

Measure	1	2	3	4	5	6	7	8	9
1. MR									
2. Word ID	−.04								
3. WRE	.02	.31*							
4. PDE	.03	.67*	.38*						
5. ND Comp	.04	.51*	.25*	.32*					
6. ND Rate	.02	.38*	.30*	.22*	.54*				
7. PA1	−.13	.48*	.19*	.48*	.27*	.20*			
8. MA2	−.04	.25*	.11	.14*	.28*	.20*	−.20*		
9. OP2	.29*	.16*	.26*	.14*	.19*	.02	.04	.08	

Note. MR, matrix reasoning. Word ID, Woodcock word identification. WRE, TOWRE word-reading efficiency. PDE, TOWRE phonemic decoding efficiency. ND Comp, Nelson Denny reading comprehension. ND Rate, Nelson Denny reading rate. PA1, phonological awareness task 1. MA2, morphological awareness task 2. OP2, orthographic processing task 2. *$p < .05$.

MANCOVA was conducted with word identification scores as the covariate. A statistically significant difference remained between the groups, $F\ (2, 104) = 3.35$; Wilks's $\Lambda = .940$, $p < .05$.

Reading-related skills and reading achievement in first-year university students

For the sample of 211 first-year university students, zero-order correlations are presented in Table 4.[6] In each of the following regressions, matrix reasoning was included in the first step to control for general ability. In the first regression, we examined whether morphological awareness contributed to word-reading accuracy beyond that accounted for by matrix reasoning, phonological awareness, and orthographic processing. As can be seen in Table 5, Regression 1, Step 1 accounted for

Table 5. Hierarchical regressions predicting reading achievement ($N = 211$)

Predictor	ΔR^2	β	Final β
Reg. 1 Word ID			
Step 1			
MR		−.03	−.03
PA1		−.48**	−.45*
OP2	.25*	−.08	−.08
Step 2			
MA2	.02*		.14*
Reg. 2 ND Reading Comp			
Step 1			
MR		.03	.03
Word ID		.48**	.44**
WRE	.26*	.09	.05
Step 2			
PA1			.02
OP2			−.09
MA2	.03*		.17**

Note: PA1 has a negative β in regression 1 due to the applied transformation to correct for negative skewness. Word ID, Woodcock word identification. MR, matrix reasoning. PA1, phonological awareness task 1. OP2, orthographic processing task 2. MA2, morphological awareness task 2. ND Comp, Nelson Denny reading comprehension. *$p < .05$. **$p \leq .01$.

25.2% of the variance in word-reading accuracy. In Step 2, morphological awareness accounted for an additional and significant 1.8% of the variance in word-reading accuracy.

We next examined the contributions of the reading-related skills to reading comprehension beyond variance accounted for by matrix reasoning, word-reading accuracy, and word-reading efficiency. As can be seen in Regression 2, the first step of the equation predicted 26.3% of the variance in reading comprehension. An additional and significant 3.3% of the variance was accounted for by Step 2, with morphological awareness as the only significant predictor of the three reading-related skills.

Discussion

In the current study, we set out to address three research questions concerning reading achievement and morphological awareness in university students. We first compared the observed effect sizes for group differences across measures of reading achievement, to address which reading skills were relative strengths or weaknesses for students with self-identified histories of reading difficulties. We next compared performance of students with and without a self-reported history of reading

https://doi.org/10.1017/S0142716418000826 Published online by Cambridge University Press

difficulties on reading-related skills. These comparisons addressed whether morphological awareness was a relative strength or an additional deficit for students with a self-reported history of reading difficulties. Previous research has examined this question for students with dyslexia, whereas sample selection in this study was based on a self-report measure of reading acquisition difficulties, rather than on norm-referenced tests. Finally, hierarchical regressions were used to examine whether morphological awareness accounted for unique variance in measures of reading achievement for university students more generally. We discuss our findings for each research question in turn.

We found that students with a self-reported history of reading difficulties showed moderate to large deficits on word-reading accuracy, phonemic decoding efficiency, reading comprehension, and text-reading rate. Upon examination of the effect sizes and associated confidence intervals, timed reading comprehension appeared more severely impaired than word-reading efficiency. This outcome was not expected, but may be related to a number of factors. As is evident in this and related studies (e.g., Deacon et al., 2012), university students with self-reported histories of reading difficulties read text more slowly, and may not have time to answer all the questions on a timed test. Furthermore, university students with reading difficulties, diagnosed or self-reported, have been found to take longer to answer multiple-choice questions (Hebert, 2016; Simmons & Singleton, 2000), and these differences are not fully accounted for by word-reading efficiency or text-reading rate (Hebert, 2016). This may be due to different approaches to reading the text (Simmons & Singleton, 2000); different patterns of metacognitive strategy use have been found between students with a self-reported history of reading difficulties and their peers without such a history (Chevalier et al., 2017). University practices of increasing test taking time may accommodate for more than just differences in reading rate, and such accommodations should likely be extended to students with a history of reading difficulties.

Our second research question addressed morphological awareness for students with a self-reported history of reading difficulties within the context of two other reading-related skills. Our participants with a self-reported history of reading difficulties performed more poorly on measures of phonological awareness and orthographic processing, skills central to theories of reading acquisition (e.g., Cunningham et al., 2011; Ehri, 2005; Share, 1995). We also found deficits on morphological awareness for students with a self-reported history of reading difficulties, and these persisted after statistically accounting for variance in (a) phonological awareness and orthographic processing, or (b) word reading.

Deacon et al. (2012) observed marked similarities between the reading performance of students with a self-reported history of reading difficulties and those with previously diagnosed reading disabilities. They suggested these two groups of students with reading difficulties were likely from the same underlying population. A pervasive morphological awareness deficit in students with self-reported histories of reading difficulties is consistent with some findings on university students with dyslexia. From their findings on a morphological priming task, Schiff and Raveh (2007) concluded that implicit morphological knowledge and the use of such in reading is another area of difficulty for Hebrew-speaking readers with dyslexia. In a second study, students with dyslexia were poorer on Hebrew morphological awareness tasks, even after phonological awareness skills were taken into account (Leikin & Zur Hagit, 2006). Not constrained to studies conducted in Hebrew, an English-language study found that morphological awareness was poorer for university students with versus without dyslexia, and this deficit remained after controlling for phonological awareness and vocabulary (Law et al., 2015). In this light of a shared deficit in morphological awareness, our findings would provide additional evidence for the proposal that students with diagnosed or self-reported histories of reading difficulties may represent the same underlying population (Deacon et al., 2012).

These conclusions are in direct contrast to other research that supports the idea that morphological awareness is a strength for university students with dyslexia, and acts as a compensatory mechanism in their word reading. Although Law et al. (2015) reported that "group analysis demonstrated an MA deficit in dyslexics" (p. 254), they also found that for 15 of 36 participants with dyslexia, defined as "compensated dyslexics" (average word-reading skills), morphological awareness did not differ from peers without reading difficulties. Furthermore, Law et al. found that morphological awareness accounted for unique variance in word reading for university students with dyslexia but not for typical readers (but see Leikin & Zur Hagit, 2006). French-language studies have also found that university students with dyslexia do not differ from their nondyslexic peers on oral-language morphological awareness tasks (Cavalli, Duncan, et al., 2017; Martin et al., 2014). There have even been reports of a larger morphological priming effect for dyslexic versus nondyslexic university students on orthographic tasks and a greater reliance for this dyslexic group on the semantic versus orthographic features of morphemes (Cavalli, Colé, et al., 2017; see Quémart & Casalis, 2015, for similar findings with younger students with dyslexia). Given inconsistencies in the literature concerning morphological awareness as a strength versus weakness for university students with dyslexia, it is unclear at this time if they share this deficit with the population we examined, university students with self-reported histories of reading difficulties.

Given that we found morphological awareness to be an additional area of weakness, the question remains of how students with self-reported histories of reading difficulties complete reading requirements for university courses. The answer may be found in higher level strategic processes. More students with a self-reported history of reading difficulties than peers without such a history reported using study and organizational strategies, as well as greater participation in classroom discussions (Corkett, Parrila, & Hein, 2006, but see Bergey et al., 2017). Furthermore, the extent to which students with self-reported histories of reading difficulties reported using metacognitive reading strategies and study aids predicted their academic success (Chevalier, Parrila, Ritchie, & Deacon, 2017). Although this group of university students has pervasive reading deficits, strategy use may be critical to understanding their approach to university reading requirements.

Our third research question addressed the hypothesis that morphological awareness accounts for unique variance in both word reading and in reading comprehension in our larger sample of first-year students. We found that morphological awareness contributed unique variance to word reading in first-year university students, after controlling for phonological awareness and orthographic processing. This relationship has been demonstrated in samples of school-age children (for reviews, see Deacon, 2012; Kuo & Anderson, 2006), for whom the causal nature of the association was found to be bidirectional (Deacon, Benere, & Pasquarella, 2013; Kruk & Bergman, 2013).

We also found that after controlling for word-reading accuracy and efficiency, morphological awareness was the only reading-related skill examined in our study that accounted for variance in reading comprehension. This finding is consistent with, and extends that of Guo et al. (2011), who found that morphological awareness predicted unique variance in reading comprehension in university students; however, their study did not control for individual differences in word-reading skills. Our findings extend previous research with younger samples that report a unique relationship of morphological awareness to reading comprehension (e.g., Deacon, Kieffer, & Laroche, 2014; Kirby et al., 2012). The small amount of unique variance accounted for by morphological awareness in university students' reading comprehension is comparable to research with children (i.e., accounting for 2%–5% of variance; Deacon & Kirby, 2004; Kirby et al., 2012). Considering our findings with university students compared to studies with younger samples, results do not support the suggestion that the strength of the relationship between morphological awareness and reading gets stronger with increasing grade levels (Nagy, 2007; see also Kuo & Anderson, 2006); however, our findings may be an underestimate of this contribution in adults more generally, as the university student population would be expected to have stronger and less varied reading comprehension than the general adult population. Research is needed to directly compare the contributions of morphological awareness to reading comprehension across age levels.

Our findings lend support to models of reading that propose that morphological awareness exerts a direct influence on each of word reading and reading comprehension (Perfetti & Stafura, 2014). The finding of an independent contribution to reading comprehension is also consistent with models of reading development that emphasize the role of linguistic comprehension to text understanding (Gough & Tunmer, 1986; Scarborough, 2001). Although the amount of unique variance accounted for in reading comprehension by morphological awareness was small, this direct relationship was not found for phonological awareness or orthographic processing. Students with stronger morphological awareness may be better able to figure out the meanings and syntactic roles of unfamiliar words, increasing their comprehension of texts (Elbro & Arnbak, 1996). Consistent with our findings and with theoretical models, an intervention training morphological analysis with Hebrew-speaking university students with dyslexia demonstrated small, positive effects on spelling and text-reading (Bar-Kochva, 2016). Future research is needed to examine if such training can improve the reading achievement of university students with reading difficulties, either diagnosed or self-reported.

The findings of the current study should be viewed within the context of several limitations. First, the models of reading referred to in this paper include many potential sources of individual differences on reading achievement (Scarborough, 2001; Stafura & Perfetti, 2017), and we examined a limited number of these. Including more language measures, such as vocabulary and syntax, would give a fuller picture of contributors to reading in university students, as well as add to our understanding of language strengths and weaknesses in students with self-reported histories of reading difficulties. Second, we did not have the information to determine the number of participants with self-reported histories of reading difficulties who might have had a diagnosed reading disability. We did have access to this information for other cohorts recruited in a similar manner, and can thus only estimate that this would be about 20% of this group of students. Third, we matched the number of participants in each decile of scores on the ARHQ-R with those from our larger sample of first-year students who completed the questionnaire, had English as a first language with no other postsecondary schooling, and agreed to be contacted for follow-up research ($N = 750$). Our goal was to have a representative sample of first-year students in terms of reading acquisition history; however, we do not know what selection biases may influence incoming students to respond to the initial invitation.

In summary, the current study provided evidence concerning the extent of difficulties across all areas of reading achievement for university students with a self-reported history of reading difficulties, and placed a particular focus on timed reading comprehension. Alongside the observed reading achievement deficits, these students earn lower grades and fewer credits (e.g., Bergey et al., 2017; Chevalier et al., 2017). It seems likely that these students would benefit from university supports given to those with a formal diagnosis, including accommodations for timed reading comprehension tasks. The current study also demonstrated the pervasiveness of morphological awareness deficits in university students with self-reported histories of reading difficulties. Finally, we provided evidence that morphological awareness contributes unique variance to word reading and to reading comprehension in university students more generally, extending research with younger readers. Morphological awareness appears similar to phonological awareness insofar as it is an area of impairment for young adults with self-identified histories of reading difficulties and is related to reading in a more normally distributed population of university readers. Taken together, research supports the view that morphological awareness is a foundational skill in reading acquisition and achievement, and contributes to individual differences in the reading of university students.

Author ORCIDs. Hélène Deacon 0000-0002-4792-5137

Notes

1. From the sample of 750 students, 21% met criteria for a self-reported history of reading difficulties. Over 6 years of administering the questionnaire at this university, between 18% and 25% of the students' responses have met criteria for a self-reported history of reading difficulties each year (see Bergey et al., 2017).

2. Previous diagnoses were not collected for these participants. In similar samples at the same university, the rate of previous diagnoses of learning disabilities or reading disabilities has been 19% (e.g., Deacon et al., 2012).

3. Of these participants with a self-reported history of reading difficulties, 38/54 were more than 1 *SD* below the mean of the comparison group on one or both of word identification and word-reading efficiency. This is similar to previously research with this population (Deacon et al., 2012).

4. Standard scores were not used in analyses. These are presented here to further describe the groups; however, to interpret these scores the following caveat should be kept in mind. While standardized tests were administered following most manualized procedures (e.g., basal & discontinue rules, response mode oral or written, practice items, etc.), presentation of these tests were adapted to the computer to more easily standardize presentation of tests across experimenters.

5. To provide a conservative test of group differences on morphological awareness, the phonological awareness and orthographic processing measures that were significant and had the largest effect size on the group comparisons were used as covariates.
6. For each of the three reading-related skills, the measure most strongly related to reading achievement was included in the regressions; these were MA2, OP2, and PA1 (spoonerisms).

References

Bar-Kochva, I. (2016). An examination of an intervention program designed to enhance reading and spelling through the training of morphological decomposition in word recognition. *Scientific Studies of Reading*, **20**, 163–172. doi: 10.1080/10888438.2015.1108321

Bergey, B., Deacon, S., & Parrila, R. (2017). Metacognitive reading and study strategies and academic achievement of university students with and without a history of reading difficulties. *Journal of Learning Disabilities*, **50**, 81–94. doi: 10.1177/0022219415597020

Brown, J. I., Fishco, V. V., & Hanna, G. (1993). *The Nelson-Denny Reading Test*. Itasca, IL: Riverside.

Bruck, M. (1993). Word recognition and component phonological processing skills of adults with childhood diagnosis of dyslexia. *Developmental Review*, **13**, 258–268. doi: 10.1006/drev.1993.1012

Cantiani, C., Lorusso, M., Guasti, M., Sabisch, B., & Männel, C. (2013). Characterizing the morphosyntactic processing deficit and its relationship to phonology in developmental dyslexia. *Neuropsychologia*, **51**, 1595–1607. doi: 10.1016/j.neuropsychologia.2013.04.009

Carlisle, J. F. (1988). Knowledge of derivational morphology and spelling ability in fourth, sixth, and eighth graders. *Applied Psycholinguistics*, **9**, 247–266. doi: 10.1017/S0142716400007839

Carlisle, J. F. (1995). Morphological awareness and early reading achievement. In L. B. Feldman (Ed.), *Morphological aspects of language processing* (pp. 189–209). Hillsdale, NJ: Erlbaum.

Carlisle, J. F., & Stone, C. (2005). Exploring the role of morphemes in word reading. *Reading Research Quarterly*, **40**, 428–449. doi: 10.1598/RRQ.40.4.3

Carlisle, J. F. (2010). Effects of instruction in morphological awareness on literacy achievement: An integrative review. *Reading Research Quarterly*, **45**, 464–487. doi: 10.1598/RRQ.45.4.5

Cartwright, K. B., Bock, A. M., Coppage, E. A., Hodgkiss, M. D., & Nelson, M. I. (2017). A comparison of cognitive flexibility and metalinguistic skills in adult good and poor comprehenders. *Journal of Research in Reading*, **40**, 139–152. doi: 10.1111/1467-9817.12101

Cavalli, E., Colé, P., Pattamadilok, C., Badier, J. M., Zielinski, C., Chanoine, V., & Ziegler, J. C. (2017). Spatiotemporal reorganization of the reading network in adult dyslexia. *Cortex*, **92**, 204–221. doi: 10.1016/j.cortex.2017.04.012

Cavalli, E., Duncan, L., Elbro, G., El Ahmadi, C., & Colé, A. (2017). Phonemic—Morphemic dissociation in university students with dyslexia: An index of reading compensation? *Annals of Dyslexia*, **67**, 63–84. doi: 10.1007/s11881-016-0138-y

Chevalier, T. M., Parrila, R., Ritchie, K. C., & Deacon, S. H. (2017). The role of metacognitive reading strategies, metacognitive study and learning strategies, and behavioral study and learning strategies in predicting academic success in students with and without a history of reading difficulties. *Journal of Learning Disabilities*, **50**, 34–48. doi: 10.1177/0022219415588850

Coleman, C., Gregg, N., McLain, L., & Bellair, L. W. (2009). A comparison of spelling performance across young adults with and without dyslexia. *Assessment for Effective Intervention*, **34**, 94–105. doi: 10.1177/1534508408318808

Conrad, N. J., Harris, N., & Williams, J. (2013). Individual differences in children's literacy development: The contribution of orthographic knowledge. *Reading and Writing*, **26**, 1223–1239. doi: 10.1007/s1114501294152

Corkett, J. K., & Parrila, R. (2008). Use of context in the word recognition process by adults with a significant history of reading difficulties. *Annals of Dyslexia*, **58**, 139–161. doi: 10.1007/s11881-008-0018-1

Corkett, J. K., Parrila, R., & Hein, S. F. (2006). Learning and study strategies of university students who report a significant history of reading difficulties. *Developmental Disabilities Bulletin*, **34**, 57–79.

Crepaldi, D., Rastle, K., Coltheart, M., & Nickels, L. (2010). "Fell" primes "fall," but does "bell" prime "ball"? Masked priming with irregularly-inflected primes. *Journal of Memory and Language*, **63**, 83–99. doi: 10.1016/j.jml.2010.03.002

Cunningham, A., Nathan, R., & Raher, K. (2011). Orthographic processing in models of word recognition. In M. Kamil, P. Pearson, E. Moje, and P. Afflerbach (Eds.), *Handbook of reading research* (Vol. 4). New York: Routledge.

Deacon, S. H. (2012). Sounds, letters and meanings: The independent influences of phonological, morphological and orthographic skills on early word reading accuracy. *Journal of Research in Reading*, **35**, 456–475. doi: 10.1111/j.1467-9817.2010.01496.x

Deacon, S. H., Benere, J., & Pasquarella, A. (2013). Reciprocal relationship: Children's morphological awareness and their reading accuracy across grades 2 to 3. *Developmental Psychology*, **49**, 1113–1126. doi: 10.1037/a0029474

Deacon, S. H., Cook, K., & Parrila, R. (2012). Identifying high-functioning dyslexics: Is self-report of early reading problems enough? *Annals of Dyslexia*, **62**, 120–134. doi: 10.1007/s11881-012-0068-2

Deacon, S. H., Kieffer, M. J., & Laroche, A. (2014). The relation between morphological awareness and reading comprehension: Evidence from mediation and longitudinal models. *Scientific Studies of Reading*, **18**, 432–451. doi: 10.1080/10888438.2014.926907

Deacon, S. H., & Kirby, J. R. (2004). Morphological awareness: Just "more phonological"? The roles of morphological and phonological awareness in reading development. *Applied Psycholinguistics*, **25**, 223–238. doi: 10.1017/S0142716404001110

Deacon, S. H., Parrila, R., & Kirby, J. R. (2006). Processing of derived forms in high-functioning dyslexics. *Annals of Dyslexia*, **56**, 103–128. doi: 10.1007/s11881-006-0005-3

Deacon, S. H., Tong, X., & Mimeau, C. (2016). Morphological and semantic processing in developmental dyslexia across languages: A theoretical and empirical review. In C. Perfetti, and L. Verhoeven (Eds.), *Dyslexia across languages and writing systems: A handbook*. Cambridge: Cambridge University Press.

Ehri, L. (2005). Learning to read words: Theory, findings, and issues. *Scientific Studies of Reading*, **9**, 167–188. doi: 10.1207/s1532799xssr0902_4

Elbro, C., & Arnbak, E. (1996). The role of morpheme recognition and morphological awareness in dyslexia. *Annals of Dyslexia*, **46**, 209–240. doi: 10.1007/BF02648177

Gough, P. B., & Tunmer, W. E. (1986). Decoding, reading, and reading disability. *Remedial and Special Education*, **7**, 6–10. doi: 10.1177/074193258600700104

Guo, Y., Roehrig, A. D., & Williams, R. S. (2011). The relation of morphological awareness and syntactic awareness to adults' reading comprehension: Is vocabulary knowledge a mediating variable? *Journal of Literacy Research*, **43**, 159–183. doi: 10.1177/1086296X11403086

Hatcher, J., Snowling, M., & Griffiths, Y. (2002). Cognitive assessment of dyslexic students in higher education. *British Journal of Educational Psychology*, **72**, 119–133. doi: 10.1348/000709902158801

Hebert, M. (2016). *An examination of reading comprehension and reading rate in university students* (Unpublished doctoral dissertation, University of Alberta, Canada).

Jackson, N. E. (2005). Are university students' component reading skills related to their text comprehension and academic achievement? *Learning and Individual Differences*, **15**, 113–139. doi: 10.1016/j.lindif.2004.11.001

Jackson, N. E., & Doellinger, H. (2002). Resilient readers? University students who are poor recoders but sometimes good text comprehenders. *Journal of Educational Psychology*, **94**, 64–78. doi: 10.1037/0022-0663.94.1.64

Kemp, N., Parrila, R., & Kirby, J. (2009). Phonological and orthographic spelling in high-functioning adult dyslexics. *Dyslexia*, **15**, 105–128. doi: 10.1002/dys.364

Kirby, J. R., Deacon, S. H., Bowers, P. N., Izenberg, L., Wade-Woolley, L., & Parrila, R. (2012). Children's morphological awareness and reading ability. *Reading and Writing*, **25**, 389–410. doi: 10.1007/s11145-010-9276-5

Knezevic, A. (2008). Overlapping confidence intervals and statistical significance. StatNews: Cornell University Statistical Consulting Unit, 73. Retrieved from http://www.cscu.cornell.edu/news/statnews/stnews73.pdf.

Kruk, R. S., & Bergman, K. (2013). The reciprocal relations between morphological processes and reading. *Journal of Experimental Child Psychology*, **114**, 10–34. doi: 10.1016/j.jecp.2012.09.014

Kuo, L. J., & Anderson, R. C. (2006). Morphological awareness and learning to read: A cross-language perspective. *Educational Psychologist*, **41**, 161–180. doi: 10.1207/s15326985ep4103_3

Law, J. M., Wouters, J., & Ghesquière, P. (2015). Morphological awareness and its role in compensation in adults with dyslexia. *Dyslexia*, **21**, 254–272. doi: 10.1002/dys.1495

Lefly, D. L., & Pennington, B. F. (2000). Reliability and validity of the adult reading history questionnaire. *Journal of Learning Disabilities*, **33**, 286–296. doi: 10.1177/002221940003300306

Leikin, M., & Zur Hagit, E. (2006). Morphological processing in adult dyslexia. *Journal of Psycholinguistic Research*, **35**, 471–490. doi: 10.1007/s10936-006-9025-8

Leinonen, S., Müller, K., Leppänen, P., Aro, H., Ahonen, M., & Lyytinen, T. (2001). Heterogeneity in adult dyslexic readers: Relating processing skills to the speed and accuracy of oral text reading. *Reading and Writing*, **14**, 265–296. doi: 10.1023/A:1011117620895

Leong, C. K. (1999). Phonological and morphological processing in adult students with learning/reading disabilities. *Journal of Learning Disabilities*, **32**, 224–238.

Martin, J., Frauenfelder, U. H., & Cole, P. (2014). Morphological awareness in dyslexic university students. *Applied Psycholinguistics*, **35**, 1213–1233. doi: 10.1017/S0142716413000167

Meyler, A., & Breznitz, Z. (2005). Impaired phonological and orthographic word representations among adult dyslexic readers: Evidence from event-related potentials. *Journal of Genetic Psychology*, **166**, 215–240. doi: 10.3200/GNTP.166.2.215-240

Miller-Shaul, S. (2005). The characteristics of young and adult dyslexics readers on reading and reading related cognitive tasks as compared to normal readers. *Dyslexia*, **11**, 132–151. doi: 10.1002/dys.290

Nagy, W. E. (2007). Metalinguistic awareness and the vocabulary-comprehension connection. In R. K. Wagner, A. E Muse, and K. R. Tannenbaum (Eds.), *Vocabulary acquisition: Implications for reading comprehension* (pp. 52–77). New York: Guilford Press.

Parrila, R., Corkett, J., Kirby, J., & Hein, S. (2003). *Adult Reading History Questionnaire—Revised* (Unpublished questionnaire, University of Alberta).

Parrila, R., Georgiou, G., & Corkett, J. (2007). University students with a significant history of reading difficulties: What is and is not compensated? *Exceptionality Education Canada*, **17**, 195–220. doi: 10.1037/t52486-00

Perfetti, C., & Stafura, J. (2014). Word knowledge in a theory of reading comprehension. *Scientific Studies of Reading*, **18**, 22–37. doi: 10.1080/10888438.2013.827687

Quémart, P., & Casalis, S. (2015). Visual processing of derivational morphology in children with developmental dyslexia: Insights from masked priming. *Applied Psycholinguistics*, **36**, 345–376. doi: 10.1017/S014271641300026X

Rabin, J., & Deacon, H. (2008). The representation of morphologically complex words in the developing lexicon. *Journal of Child Language*, **35**, 453–465. doi: 10.1017/S0305000907008525

Ratcliff, R. (1993). Methods for dealing with reaction time outliers. *Psychological Bulletin*, **114**, 510. doi: 10.1037/0033-2909.114.3.510

Scarborough, H. (2001). Connecting early language and literacy to later reading (dis)abilities: Evidence, theory, and practice. In S. B. Neuman, and D. K. Dickinson (Eds.), *Handbook of early literacy research* (pp. 97–110). New York: Guilford Press.

Schiff, R., & Raveh, M. (2007). Deficient morphological processing in adults with developmental dyslexia: Another barrier to efficient word recognition? *Dyslexia*, **13**, 110–129. doi: 10.1002/dys.322

Share, D. L. (1995). Phonological recoding and self-teaching: Sine qua non of reading acquisition. *Cognition*, **55**, 151–218. doi: 10.1016/0010-0277(94)00645-2

Share, D. L. (2008). Orthographic learning, phonological recoding, and self-teaching. *Advances in Child Development and Behavior*, **36**, 31–82. doi: o10.1016/ S0065-2407(08)00002-5

Simmons, F., & Singleton, C. (2000). The reading comprehension abilities of dyslexic students in higher education. *Dyslexia*, **6**, 178–192. doi: 10.1002/1099-0909(200007/09

Snow, C., & Strucker, J. (2000). Lessons from preventing reading difficulties in young children for adult learning and literacy. In J. Comings, B. Garner, and C. Smith (Eds.), *Annual review of adult learning and literacy: A project of the National Center for the Study of Adult Learning and Literacy* (Vol. **1**, pp. 25–73). San Francisco: Jossey-Bass.

Stafura, J., & Perfetti, C. (2017). Integrating word processing with text comprehension: Theoretical frameworks and empirical examples. In K. Cain, D. L. Compton, and R. K. Parrila (Eds.), *Theories of reading development* (Vol. **15**, pp. 9–32). Amsterdam: Benjamins.

Tabachnick, B. G., & Fidell, L. S. (2007). *Using multivariate statistics* (5th ed.). Boston: Pearson Education.

Taft, M. (1994). Interactive-activation as a framework for understanding morphological processing. *Language and Cognitive Processes*, **9**, 271–294. doi:10.1080/01690969408402120

Taft, M. (2001). Processing of orthographic structure by adults of different reading ability. *Language and Speech*, **44**, 351–376. doi:10.1177/00238309010440030301

Tong, X., Deacon, S. H., Kirby, J. R., Cain, K., & Parrila, R. (2011). Morphological awareness: A key to understanding poor reading comprehension in English. *Journal of Educational Psychology*, **103**, 523. doi: 10.1037/a0023495

Torgesen, J. K., Wagner, R. K., & Rashotte, C. A. (1998). Phonological processing and reading: Contributions from longitudinal research. *Thalamus*, **16**, 30–39.

Wechsler, D. (1999). *Wechsler Abbreviated Scale of Intelligence*. New York: Psychological Corporation.

Welcome, S. E., Chiarello, C., Halderman, L. K., & Leonard, C. M. (2009). Lexical processing skill in college-age resilient readers. *Reading and Writing*, **22**, 353–371. doi: 10.1007/s11145-008-9120-3

Wiig, E. H., Secord, W. A., & Semel, E. (2013). *Clinical evaluation of language fundamentals: CELF-5*. Bloomington, MN: Pearson.

Woodcock, R. (1998). *Woodcock Reading Mastery Tests—Revised [kit]: Normative update*. Minneapolis, MN: Pearson Assessments.

Cite this article: Metsala JL, Parrila R, Conrad NJ, and Deacon SH (2019). Morphological awareness and reading achievement in university students. *Applied Psycholinguistics* **40**, 743–763. https://doi.org/10.1017/S0142716418000826