The Relationship between Morphological Awareness and Literacy Skills in German

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Abstract

The objective of this dissertation was to explore relations between morphological awareness and literacy skills in German, i.e. in an orthography that is more transparent for reading than for spelling. To represent the particularly rich German morphology in the measure of morphological awareness, items covering inflection, derivation and compounding were gathered. This dissertation pursued three research questions. First, it was explored how different facets of morphological awareness relate to different literacy competencies. Because of the asymmetric orthography of German, a stronger relationship with spelling than with reading was expected. Second, it was investigated whether morphological awareness is a unique predictor of literacy skills in German after accounting for other language-related skills. Third, it was tested whether the relationship of morphological awareness with literacy skills increases with increasing literacy proficiency. Studies were conducted in different age groups. Adapted morphological awareness tasks were tested and optimised with the help of two pilot studies. Based on the findings of these two pilot studies, the cross-sectional main-study was conducted with 351 primary school children. Additionally, two exploratory studies comprising 187 university students were conducted assessing relations between morphological awareness and literacy skills in literacy competent adults. Results indicated that different facets of morphological awareness are related to literacy skills both in primary school children and in adults. Morphological awareness proved to be closer related to spelling skills than to reading skills in university students, but not in primary school children. In primary school children, phonological awareness was the key predictor of literacy skills, while morphological awareness did not have any additional predictive power. In university students, morphological awareness explained unique variance in spelling skills, but not in reading skills. In the main study with primary school children, comparisons between grade levels suggested that the relationship between morphological awareness and literacy skills does not increase with increasing literacy proficiency. However, the relative importance of morphological awareness for literacy competencies in comparison with that of phonological awareness was identified to be higher in literacy competent adults than in primary school children. Results implicate that morphological awareness is an important correlate of literacy skills in German, and that it continues to unfold its relevance beyond primary school years.

Zusammenfassung

In dieser Dissertation wurden Zusammenhänge zwischen der morphologischen Bewusstheit und schriftsprachlichen Fähigkeiten im Deutschen untersucht, das heißt in einer Orthographie, die für das Lesen transparenter ist als für das Schreiben. Um die morphologische Vielfalt des Deutschen bei der Messung der morphologischen Bewusstheit abbilden zu können, wurden Aufgaben zu Flexionen, Derivationen und Komposita zusammengestellt. Diese Dissertation verfolgte drei Forschungsfragen. Erstens wurde erforscht, inwiefern verschiedene Facetten der morphologischen Bewusstheit mit verschiedenen schriftsprachlichen Leistungen im Zusammenhang stehen. Aufgrund der asymmetrischen Orthographie des Deutschen wurde erwartet, dass die morphologische Bewusstheit einen engeren Zusammenhang mit Rechtschreibleistungen als mit Leseleistungen hat. Zweitens wurde getestet, ob die morphologische Bewusstheit ein zusätzlicher Prädiktor für schriftsprachliche Leistungen ist, wenn für weitere kognitive Grundlagenfertigkeiten des Schriftspracherwerbs kontrolliert wird. Drittens wurde untersucht, ob der Zusammenhang zwischen der morphologischen Bewusstheit und schriftsprachlichen Leistungen mit zunehmenden schriftsprachlichen Fähigkeiten steigt. Die Studien wurden in verschiedenen Altersgruppen durchgeführt. Aufbauend auf den Erkenntnissen aus zwei Pilotstudien erfolgte die querschnittliche Untersuchung von 351 Grundschulkindern in der Hauptstudie. In den zwei zusätzlich durchgeführten, explorativen Studien mit insgesamt 187 Studierenden wurden Relationen zwischen der morphologischen Bewusstheit und schriftsprachlichen Leistungen bei schriftsprachlich kompetenten Erwachsenen untersucht. Die Ergebnisse zeigten, dass verschiedene Facetten der morphologischen Bewusstheit sowohl bei Grundschulkindern als auch bei Erwachsenen mit schriftsprachlichen Fähigkeiten in Beziehung stehen. Ein engerer Zusammenhang von morphologischer Bewusstheit mit Rechtschreibfähigkeiten als mit Lesefähigkeiten konnte nur bei Erwachsenen, nicht jedoch bei Kindern festgestellt werden. In der Hauptstudie mit Grundschulkindern war die phonologische Bewusstheit der wichtigste Prädiktor für schriftsprachliche Leistungen, wobei die morphologische Bewusstheit keine zusätzliche Varianz aufklären konnte. In den Erwachsenenstudien konnte die morphologische Bewusstheit signifikant zur Varianzaufklärung von Rechtschreibleistungen, nicht jedoch von Leseleistungen beitragen. Die Ergebnisse der Hauptuntersuchung mit Schulkindern deuteten darauf hin, dass es keinen enger werdenden Zusammenhang zwischen der morphologischen Bewusstheit und schriftsprachlichen Leistungen mit zunehmender schriftsprachlicher Kompetenz gibt. Jedoch schien die relative Relevanz der morphologischen Bewusstheit für schriftsprachliche Leistungen im Vergleich zur Relevanz der phonologischen Bewusstheit bei Studierenden höher zu sein als bei Grundschulkindern. Die

Ergebnisse sprechen dafür, dass die morphologische Bewusstheit eine wichtige kognitive Variable ist, die im Zusammenhang mit schriftsprachlichen Leistungen im Deutschen steht und die ihre Relevanz auch nach der Grundschulzeit weiter entfaltet.

Table of contents

List of tables

List of figures

1 General introduction

1.1 Introductory notes

Literacy has been described as "the key survival skill for the 21st century" (Snow, 2017, p. 6); and the UNESCO names it as a "basic human right" (Carr-Hill, 2008, p. 11). Ensuring universal access to literacy is a matter of social justice (Snow, 2017). However, even in western society, many students and adults struggle with basic reading and spelling tasks. For example, although in the most recent PISA study 15-year-old German adolescents had on average reading skills above the OECD mean, one fifth were barely able to comprehend text passages and to reflect on them (Reiss, Weis, Klieme, & Köller, 2019).

Thus, an increase in our knowledge about the factors that stand in relation to literacy skills is fundamentally necessary. This dissertation wants to shed light on morphological awareness, which is a cognitive competency that receives increasing attention from researchers around the world. Its relation with literacy skills has been detected in various languages, which differ for example in writing system, transparency and morphological structures. For German, however, few studies have analysed the relation between morphological awareness and literacy skills so far. The aim of this dissertation was to explore this relationship in German with attention to developmental aspects. For this, the role of morphological awareness was analysed with respect to its different facets and in contrast to other cognitive variables in different age groups to enhance our knowledge on cognitive skills and their relation to literacy skills in German.

This dissertation consists of two parts: Part I focuses on the relationship between morphological awareness and literacy skills in German primary school children. Part II is more exploratory in nature and focuses on the relationship between morphological awareness and literacy skills in German adults. An overview of the empirical studies that were conducted for this dissertation can be viewed in Table 1.

Parts I and II are prefaced with a general introduction presenting theoretical aspects that are crucial for both parts of this dissertation. Thus, definitions of morphological awareness and orthographic consistency, and theoretical considerations on the relationship between morphological awareness and literacy skills are given in the following. More specific theoretical background information relevant for the studies conducted in parts I and II is presented in the respective parts.

Table 1

Overview of the empirical studies conducted for this dissertation

	Part I			Part II	
	Pilot Study 1 for Main Study	Pilot Study 2 for Main Study	Main Study with primary school children	Adult Study 1 with university students	Adult Study 2 with university students
Characteristics	Nov. - Dec. 2015	Nov. - Dec. 2017	Apr. - Jun. 2018	Nov. - Dec. 2018	May - Jun. 2019
Sample (before exclusion)	*N* = 71 adult students (18 – 40 y.)	Grade 2: *n* = 24 Grade 4: *n* = 15	Grade 2: *n* = 135 Grade 3: *n* = 109 Grade 4: *n* = 107	*N* = 102 adult students (18 – 36 y.)	*N* = 85 adult students (18 – 29 y.)
Final sample	*N* = 61 adult students (18 – 40 y.)	Grade 2: *n* = 20 Grade 4: *n* = 11	Grade 2: *n* = 119 Grade 3: *n* = 87 Grade 4: *n* = 85	*N* = 96 adult students (18 – 36 y.)	*N* = 73 adult students (18 – 29 y.)
Purpose	Test of adapted morphological awareness tasks for study with school children	Test of adapted morphological awareness tasks and of testing procedure for study with school children	Cross-sectional investigation of relations between morphological awareness and literacy skills	Review of morphological awareness tasks, Analysing relations of morphological awareness with literacy skills	Review of morphological awareness tasks, Analysing relations of morphological awareness with literacy skills
Literacy Skills	Spelling, Reading: - Fluency	Spelling, Reading: - Fluency - Comprehension	Spelling, Reading: - Fluency - Comprehension	Spelling, Reading: - Fluency	Spelling, Reading: - Fluency - Comprehension
Cognitive Variables	Morphological Awareness	Morphological Awareness, Phonological Awareness, Rapid Naming, Verbal Memory, Vocabulary	Morphological Awareness, Phonological Awareness, Rapid Naming, Verbal Memory, Vocabulary	Morphological Awareness, Vocabulary, Fluid intelligence	Morphological Awareness, Phonological Awareness, Rapid Naming, Vocabulary
Further Variables	Age, Mother tongue	Age, Mother tongue	Age, Mother tongue	Age, Mother tongue, Final school exam grade	Age, Mother tongue, Final school exam grade
Analyses	Item characteristics, Correlations	Item characteristics, Correlations	Factor Analyses, Correlations, Multiple linear Regressions, Group Comparisons	Correlations, Multiple linear Regressions	Item characteristics, Correlations, Multiple linear Regressions, Group Comparisons
Section	4.1	4.2	4.3	7.1	7.2

1.2 Definition of morphological awareness

Morphological awareness is a linguistic awareness skill (Apel, 2014). Within the course of research on morphological awareness, different definitions for this construct have been accumulated (for an overview see Apel, 2014). One definition that has been widely used was formulated by Carlisle (1995) describing morphological awareness as the ability to recognize, reflect on, and manipulate morphological structures in a language. Many subsequent works on morphological awareness were based on this definition (e.g. Deacon & Kirby, 2004; Kirby et al., 2012; Lee, 2011; McBride-Chang, Shu, Zhou, Wat, & Wagner, 2003). Whereas the abilities to recognize and to manipulate morphological structures in a language are usually included in definitions on morphological awareness, the ability to reflect on morphological structures is not always specified (e.g. Casalis, Colé, & Sopo, 2004; Fink, Pucher, Reicher, Purgstaller, & Kargl, 2012; Guo, Roehrig, & Williams, 2011). Apel (2014) pointed out that including this specification helps differentiate morphological awareness from other concepts such as morphological production. Morphological production, also sometimes referred to as morphological knowledge, describes the unconscious use of morphemes, for example in spontaneous spoken language (Apel, 2014). On the other hand, when referring to morphological awareness, most researchers refer to an ability that includes active thinking about morphological structures.

The proposed definition by Carlisle (1995) also helps differentiating the concept of morphological awareness from morphological processing abilities. According to Deacon, Parrila, and Kirby (2008) morphological processing describes the mental representations of morphological structures and the manipulation and usage of these structures. They differentiate morphological awareness from morphological processing insofar that for morphological awareness an explicit awareness of morphemes is required. Usually, the term morphological awareness is used to describe tasks that require the production of correct morphological forms, whereas the term morphological processing is used for more implicit tasks, for example lexical decision tasks that measure how quick individuals classify stimuli as words or pseudowords (Deacon et al., 2008). The measurement of morphological awareness is further described in section 2.1.2.

It is important to note that reflection on morphological structures does not necessarily include the ability to verbalise the underlying grammatical rules. In this sense, morphological awareness does not refer to verbalisable knowledge of morphological rules in a given language. Indeed, it has been shown that children can form plurals for pseudowords based on gut feeling (i.e. what sounds right) without explicit, verbalisable knowledge of inflectional morphology

(Berko, 1958). Further support for this view comes from experimental tasks, in which participants report awareness of inflectional rules of an artificial language to which they have been relatively briefly exposed. In subsequent testing, they showed the ability to apply some of the inflectional rules correctly, but were not able to verbalise them (Rogers, 2017; Rogers, Révés, & Rebuschat, 2015). This means that it is possible to apply morphological rules without the knowledge as to why their formation is correct.

As the definition proposed by Carlisle (1995) is widely accepted and useful for differentiating morphological awareness from other concepts, further considerations on morphological awareness in this dissertation are based on this definition.

1.3 Morphological awareness and its relation to literacy skills

This dissertation focuses on the relationship between morphological awareness and literacy skills in German. Theoretical implications and empirical findings are summarized in this section.

Morphemes are at the core of morphology (Anderson, 2015) and refer to the smallest units of meaning in a language (Elsen, 2014). Several theoretical models specify the importance of morphemes and morphological processes for reading and spelling, for example, in orthographic and morphological reading and spelling strategies (Frith, 1985, 1986; Varnhagen, 1995), as connectors between phonology, orthography and semantics (Kirby & Bowers, 2017), in morpho-semantic and morpho-orthographic processes in the dual route approach to word reading comprehension (Grainger & Ziegler, 2011) and in the sublexical pathway in a dual route approach to spelling (Sheriston, Critten, & Jones, 2016). It is probable that morphological awareness, i.e. the ability to recognize, reflect on and change morphological structures in a language (Carlisle, 1995) helps using morphemes in these processes. The mentioned theories and their importance with regard to morphological awareness are explained in section 2.2.4.

There are studies examining the relationship between morphological awareness and literacy skills for many different languages, for example for English (Lee, 2011), French (Fejzo, 2016), German (Fink et al., 2012), Greek (Pittas & Nunes, 2014), Portuguese (Freitas, Mota, & Deacon, 2018), Italian (Vernice & Pagliarini, 2018), Finnish (Müller & Brady, 2001), Hebrew (Vaknin-Nusbaum, Sarid, & Shimron, 2016), and Chinese (McBride-Chang et al., 2003). Across all of these languages, a relationship between morphological awareness and literacy skills was found. Although some studies on this relationship are available for German, the German research base is scarce, so far. Therefore, this dissertation reports not only German studies but also English ones to give a broader overview of findings regarding morphological awareness and its relation to literacy skills. For English, two meta-analyses have been

conducted on this relationship so far (Lee, 2011; Ruan, Georgiou, Song, Li, & Shu, 2018). Empirical evidence is presented in more detail in sections 2.2.5 for schoolchildren and 6.2 for adults.

1.4 Orthographic transparency

Orthographic transparency is a concept that appears at several points throughout this dissertation. Therefore, an introduction of orthographic transparency is given here.

Orthographic transparency of a langue accounts for cross-language variation in reading abilities (Goswami, Ziegler, & Richardson, 2005; J. C. Ziegler & Goswami, 2006). It can be determined by the ambiguity of grapheme-to-phoneme-mappings and phoneme-to-grapheme mappings of a language (Borgwaldt, Hellwig, & Groot, 2005). Transparent mappings are completely predictable, i.e. a given grapheme is always represented by a specific phoneme or vice versa (Borleffs, Maassen, Lyytinen, & Zwarts, 2017). Mappings become the less predictable, and by this less transparent, the more alternative representations there are, i.e. the more alternative pronunciations there are for a grapheme and the more alternative spellings there are for a phoneme (Borgwaldt et al., 2005; Borleffs et al., 2017). The more similarly likely pronunciations or spellings there are for a certain grapheme or phoneme, the more difficult it is for the reader or speller to pick the correct one (Borleffs et al., 2017). The German letter “b” /b/ is an example for an ambiguous grapheme-phoneme-mapping: It can be pronounced /b/ as in “Bach” /bax/ (Eng. “stream”) or due to terminal devoicing /p/ as in “ab” /ap/ (Eng. “off”) (Kleiner, Knöbl, & Mangold, 2015). Knowledge of such grapheme-phoneme mappings is related to literacy abilities. For example, Wimmer and Hummer (1990) found that both reading performance and spelling performance of German-speaking first graders was predicted by their knowledge of grapheme-phoneme mappings.

Alphabetic orthographies differ in their orthographic depth (J. C. Ziegler et al., 2010). Transparent languages are also called shallow orthographies (Borgwaldt et al., 2005), whereas languages with low orthographic transparency are also called opaque orthographies (Borgwaldt et al., 2005) or deep orthographies (Schmalz, Marinus, Coltheart, & Castles, 2015). To name some examples, Finnish has been described as a shallow orthography, German, Greek, Italian and Spanish as rather shallow, Portuguese and Dutch are of medium transparency, French has a rather deep orthography and English is best described as a deep orthography (Seymour, Aro, & Erskine, 2003).

Orthographic transparency can be asymmetric for reading (i.e. grapheme-phoneme mappings) as compared to spelling (i.e. phoneme-grapheme mappings). For example, both German (Landerl, 2017) and Greek (Protopapas & Vlahou, 2009) have been labelled as rather

shallow orthographies for reading but as more opaque orthographies for spelling. Thus, the writer has to choose between different phonologically acceptable phoneme-grapheme correspondences for spelling, whereas for reading there is mostly one dominant pronunciation for a given grapheme (Kargl & Landerl, 2018). To put it simply, these two languages are easier to read than to write (cf. Protopapas & Vlahou, 2009).

The impact of orthographic transparency on reading and spelling is discussed further in sections 2.4 with respect to schoolchildren and 6.4 with respect to adults.

Part I

2 Theoretical Background

2.1 Introduction of morphological awareness

In the following, the construct morphological awareness is introduced further. First, the morphological categories inflection and word formation are described and differences between German and English morphology are summarized (section 2.1.1). Then, means of measuring morphological awareness (section 2.1.2) and aspects on the development of morphological awareness (section 2.1.3) are presented.

2.1.1 Morphological categories: Inflection and Word formation

As stated in section 1.3, morphemes are the smallest units of meaning in a language (Elsen, 2014). Words can consist of one or more morphemes, which build the internal structure of words (Spencer, 2002). For instance, the word "rabbits" consists of the root morpheme "rabbit" and the suffix morpheme "-s" indicating plural. Together, both morphemes signify: several rodents of the type rabbit.

Morphology can be subdivided into inflectional morphology and word formation (Elsen, 2014; Trips, 2017). Important for the differentiation between inflection and word formation is the understanding of the term lexeme. A lexeme is a more abstract notion for a word (Booij, 2006) and conventionally written in small capitals (Spencer, 2002). A lexeme can have different word forms (Spencer, 2002). For example, the English words "write", "writes", "wrote" and "writing" are viewed as different word forms of the lexeme WRITE. On the other hand, the noun "writer" has a different lexical meaning and belongs to a different lexical category than the lexeme WRITE (Booij, 2006; Cruse, 2002). Therefore, WRITE and WRITER are seen as distinct lexemes (Booij, 2006). Different lexemes usually have their own lexicon entries, whereas different forms of a word do not (Cruse, 2002).

2.1.1.1 Inflection

Inflection refers to morphological processes that create different forms of lexemes (Booij, 2006; Lieber, 2017). This means inflection changes the word form, but not the word class (Elsen, 2014). From the examples from above, the words "write", "writes", "wrote" and "writing" are all inflections of the lexeme WRITE. Inflectional morphology refers to relations such as number (e.g. singular, plural), gender (e.g. male, female, neuter), person (e.g. first person, second person, third person), tense (e.g. past, present, future), case (e.g. nominative, dative, accusative), possession (e.g. internal, external), aspect (e.g. progressive, non-

progressive), and grammatical mood (e.g. indicative, subjunctive, imperative) (Brandt, Dietrich, & Schön, 2006; Janda, 2010; König & Gast, 2012). In inflectional morphology, the relation between form and meaning can be rather complex (Booij, 2006) for which there are two main reasons: The first reason is the variety of classes for the relational paradigms described above (Booij, 2006). In German, for instance, there are five different plural categories (König & Gast, 2012). The plural suffix is, for example, determined by the gender and the phonological properties of the noun (Gallmann, 2016). However, there is a wide range of exceptions to the rules (Dudenredaktion, 2016; Gallmann, 2016). Combined with another paradigm such as case, there is a great variety of inflectional possibilities (Booij, 2006). The second reason for the complex relation between form and meaning in inflectional morphology is that the same marker can have different meanings (Booij, 2006, 2010). For instance, in English "-s" can be both a plural morpheme and a marker for third person singular. Morphemes with multiple meanings also exist in German. For instance, the suffix "-er" can have several morphological meanings like indicating plural, signifying the comparative of an adjective or signalling that a noun refers to a male person (Dudenredaktion, 2016).

2.1.1.2 Word formation

Means of word formation are *derivation* and *compounding* (Booij, 2006; Elsen, 2014). In *derivation*, new lexemes are created by a change of the syntactic category and/or by adding substantial new meaning to a lexeme (Lieber, 2017; Spencer, 2002). There is a variety of different ways by which new lexemes may be derived, including affixation, conversion and subtraction (Lieber, 2017). Affixation is the dominant mode for derivation (Lieber, 2017). There are three types of affixes (Fleischer & Barz, 2012): First, there are prefixes, which are added in front of the lexeme (English: "un|true"; German: "un|wahr"). Second, there are suffixes, which are added at the end of the lexeme (English: "driv|er"; German: "der Fahr|er"). Third, there are circumfixes, which are added "around" the lexeme, i.e. both in front and at the end (English: "en|large|ment"; German: "die Er|weiter|ung").

Conversion is another subtype of derivation and refers to a change in word class while the word from remains unchanged (Elsen, 2014; Lieber, 2017). For example, the English noun "post" becomes the verb "(to) post". In German, a conversion is typically accompanied with a change in the capitalization of the first letter as German nouns always begin with an uppercase letter (Elsen, 2014). The stem is nonetheless unchanged. For example, the German adjective "blau" (Eng. "blue") becomes a noun "(das) Blau" (Eng. "blue").

Subtraction describes a change from one word form to another while an affix is eliminated (Fleischer & Barz, 2012). In English and German, nicknames are a form of

derivational subtraction like Ben from Benjamin (Lieber, 2017). In German, subtracted verbs can be formed out of compounds (Dudenredaktion, 2016). An example given by the Duden Grammar (Dudenredaktion, 2016) is the verb "mähdreschen" (Eng. "[to] harvest"), that is a subtraction of the compound "Mähdrescher" (Eng. "harvester").

Compounding describes a morphological process in which two or more lexemes are linked together to form a new morphologically complex word (Booij, 2006). The meaning of the whole compound is most often derived from the meaning of its components, although some meanings can be quite metaphorical like in the word "head-hunter" (cf. Spencer, 2002). The right-hand member of the compound determines the syntactic category and the general meaning (Spencer, 2002). The left-hand member is the so-called modifier of the compound (Spencer, 2002). For example, the word "handball" is a compound consisting of the lexemes HAND and BALL. The right-hand member BALL refers to the sporting equipment or alternatively the game in which that sporting equipment is used. Context would determine which meaning of the two is addressed. The left-hand member HAND determines which kind of ball is meant. Thus, it is the modifier of "ball".

2.1.1.3 Differences between German and English morphology

German and English morphology differ from each other (König & Gast, 2012). Therefore, findings on the relationship of morphological awareness with literacy skills from one language cannot be transferred to the other one. This is demonstrated in the following with the help of some examples.

The division of morphology in inflection and word formation is found both in English and in German. In general it can be said that in contrast to English, German has a particularly rich morphology, especially with regard to inflection and compounding (for a comprehensive comparison see König & Gast, 2012).

With regard to inflection, an obvious example is the plural system. As mentioned above, German has five regular types of plural formation that are based, for example, on gender and on phonological properties of the noun (Gallmann, 2016; König & Gast, 2012). In English, on the other hand, only the suffixes "-s" (pronounced as /s/, /z/ or /ɪz/) and "-es" (if the noun ends on a s-sound) are the regular plural markers (König & Gast, 2012). Therefore, learners of German have to pay attention to more subtle differences between nouns to apply the correct plural affix.

Another example for the difference between the two languages is the relevance of compounds. In German, compounds play a greater role in word formation and are a very productive morphological category (König & Gast, 2012; cf. section 2.1.1.2). A distinction

between English and German is that English compounds are mostly binary, whereas in German, compounds with more than two elements are quite common (König & Gast, 2012). For example, the German compound "Trainingszeitraum" consists of the lexemes TRAINING, ZEIT and RAUM. The English translation would be "training period". In contrast to English, nominal compounds often contain linkers in German (König & Gast, 2012) such as the –s- in "Trainingszeitraum". Compounding is seldom assessed in English studies on morphological awareness (McBride-Chang, 2004). However, in German, tasks on compounding could be very informative due to the influential role compounding has for word formation.

The examples illustrate that morphological categories differ in their importance and are of different complexity in English and German. Accordingly, studies on morphological awareness in English allow only for limited conclusions concerning German. The differences in the morphological systems make it reasonable to focus on different morphological categories in the measurement of morphological awareness.

2.1.2 Measurement of morphological awareness

Researchers have used a range of different tasks for measuring morphological awareness so far (Apel, 2014). The presentation of different morphological awareness tasks in the following two sections is structured with regard to the categories oral or written measurement and real word or pseudoword items.

2.1.2.1 Oral or written measurement

According to Apel (2014, p. 200), definitions of morphological awareness should include a reference to "awareness of spoken and written forms of morphemes". Apel (2014) argues that morphological awareness comprises the understanding of what morphemes sound like in speech, look like in writing, and how affixes attach to base words in speech and in writing because morphemes occur both in oral and in written language. However, while some studies use a combined measure in which the morphological awareness task is read to the participant while the participant can read along (Fracasso, Bangs, & Binder, 2016; Nagy, Berninger, & Abbott, 2006; Nagy, Berninger, Abbott, Vaughan, & Vermeulen, 2003; Singson, Mahony, & Mann, 2000; Wilson-Fowler & Apel, 2015), measuring morphological awareness both orally and in writing is rare (Apel, Diehm, & Apel, 2013). Written morphological awareness measures are typically used in studies with adult participants (Guo et al., 2011; Mahony, 1994; Metsala, Parrila, Conrad, & Deacon, 2019), although there are some German studies with fourth to seventh graders that also rely on written assessment only (Fink et al., 2012; Kargl & Landerl, 2018; Kargl, Wendtner, Purgstaller, & Fink, 2018).

Although the theory behind the comprehensive definition of morphological awareness covering oral and written aspects is justified, some researchers decide deliberately to use oral measures only because it cannot be ensured that the performance in written measures of morphological awareness is not confounded with literacy skills. The written measurement of morphological awareness systematically disadvantages less skilled readers and writers (Deacon et al., 2008). However, oral only presentations in turn cannot measure the recognition and use of written morphemes. A combined task in which the items are read aloud while the participant can read along could help solve this problem. However, due to differences in reading speed between participants, it cannot be ensured that everyone has the same conditions. In addition, when using a combined measure it cannot be distinguished whether participants used oral, written or both morphological cues for their response.

These considerations illustrate that with different measurement modes different aspects of morphological awareness are measured. When comparing results between studies, divergent measurement modes of morphological awareness should be taken into account.

2.1.2.2 Pseudowords and real words

Morphological awareness has been measured both with real word tasks (e.g. Desrochers, Manolitsis, Gaudreau, & Georgiou, 2018; Kirby et al., 2012; Metsala et al., 2019), with pseudoword tasks (e.g. Guo et al., 2011; Kargl et al., 2018) and with a combination of both (e.g. Apel et al., 2013; Berko, 1958; Fink et al., 2012; McBride-Chang, Wagner, Muse, Chow, & Shu, 2005). There are arguments in favour of all three approaches, which are presented in the following.

Morphological awareness can be measured with pseudoword tasks in which a grammatical change is required for the pseudoword. For solving such a tasks, one has to make use of morphological knowledge to recognize the morphological structure of the test word, to reflect on possible morphological adaptions and finally, to change the word form or word class in line with morphological rules. For example, if a person is presented with a pseudoword in its plural form (e.g. “wugs”)[1] and is asked to change this word into its singular form, that person has to recognize which part of the tests word comprises the stem (“wug”) and which part makes it plural (“-s”). Then the individual can more or less consciously reflect on what to do to change a plural into a singular (omit the plural suffix). Finally, the test word has to be manipulated by omitting the plural suffix (response: “wug”). Usually, morphological awareness task do not use technical terms such as singular or plural but rather ask how a thing is called when there are

[1] Example taken and adapted from Berko(1958)

many of them or just one of them (e.g. Berko, 1958; Fink et al., 2012). The advantage of pseudoword tasks is that the participant cannot have memorised the form that is being asked for, but has to actively apply an inflection or word formation to the test word by making use of morphological rules (Berko, 1958).

In contrast, when working with real words, one could solve the task based on semantic knowledge (cf. Fink et al., 2012). For example, when asking for the singular of a familiar word like “hands”, one could solve this task with semantic knowledge based on the memory that several of these things are called “hands” and one is called “hand”. While this would certainly be a correct solution, it does not necessarily mean that the person is aware of how plural inflections are turned into singulars, and she or he might fail to form a correct singular for unfamiliar words. Therefore, measuring morphological awareness with real words cannot be completely disentangled from semantic knowledge. Yet, when measuring morphological awareness it is the aim to find out whether the person understands the underlying morphological structures of the language. Pseudoword tasks offer a measure of morphological awareness that is separate from semantics.

Yet, pseudoword tasks do not come without disadvantages. One disadvantage is that participants could assume that pseudowords are exceptions from the normal language as they are obviously not part of that language. Thus, participants could assume that grammatical rules of their mother tongue do not apply to pseudowords. Two approaches are usually pursued as countermeasures. First, pseudowords are created in a way that their phonology is typical for the language in which the test is designed. For example, Berko (1958) formed pseudowords based on typical sound combinations of English, Kemp (2006) built pseudowords in sound analogy to real words and McBride-Chang et al. (2005) let participants form compounds not used in Standard English but based on real words like “pigshoes” as a compound of “pig” and “shoe” and in analogy to “horseshoes”. Second, pseudowords are usually included in mini stories where they already function according to the morphological rules of the language in which the test is conducted (e.g. Berko, 1958; Fink et al., 2012; McBride-Chang et al., 2005). This framing should encourage participants to work with this pseudoword as if it were part of their normal language.

A second problem with pseudoword tasks is that some facets cannot be observed using invented words. For example, measuring a person’s knowledge on word families is usually implemented using real words (Casalis et al., 2004; Fink et al., 2012; Leikin & Zur Hagit, 2006). Such tasks have the advantage that they can disclose the individual’s knowledge on how words are related to each other. Participants who have greater knowledge on word families should

have advantages in reading and spelling situations where they can deduce the pronunciation or spelling of an unknown word from a familiar one belonging to the same word family. For example, knowing the word "drive" can help to pronounce or spell the words "driver", "drive-in" or "driveway", even if having never read or spelled them before.

Knowledge of word families are measured, for example, in morphological fluency tasks (cf. Casalis et al., 2004; Fink et al., 2012; Leikin & Zur Hagit, 2006). In such tasks, participants are asked to name as many words as possible that belong to the same word family as the test word. Answers are rated whether they are morphologically correct word formations from the test word. Inflections, synonyms or phonologically similar words are rated as incorrect solutions. German has a rich morphology with regard to compounds (König & Gast, 2012). As compounding is a correct response strategy, such a task could be especially informative on an individual's morphological awareness in German.

It can be concluded that real word and pseudoword tasks both are valuable approaches to measure morphological awareness. The usage of both seems to be necessary to obtain a comprehensive picture of morphological awareness.

2.1.3 The development of morphological awareness

Across languages, inflectional morphology is mastered between ages two and six. (McBride-Chang, 2004). Typically developing children with German mother tongue start using grammatical markers (plural and gender) when aged between 18 and 30 months (Szagun, 2013), which is a first sign of using inflectional morphology. From the very beginning, they use different plural and gender markers for different words (Szagun, 2013). However, at this early age, children do not yet think about morphemes actively (Apel, 2017). Young children are engaged in morphological production, however morphological awareness, i.e. recognition and intentional usage of morphemes, first occurs at about five years of age (Apel, 2017). This means, children show morphological awareness even before they learn to read and write. Empirical studies demonstrated this for English (Berko, 1958; Carlisle, 1995; Kirby et al., 2012) and for German (Kaus, 2013). One of the starting points in assessing morphological skills was set by Berko (1958). In Berko's so-called "Wug test", English-speaking pre-schoolers and first graders had to inflect and derivate pseudowords so that they fitted into a given test sentence, such as in "This is a wug /wʌg/. Now there is another one. There are two of them. There are two ____." (Berko, 1958, p. 165). In another task, children had to explain the meaning of real-word compounds such as "blackboard" and "Friday". Berko found no sex differences in morphological skills, but age differences between pre-schoolers and first graders, i.e. first graders reached higher scores in the administered test then pre-schoolers. This study showed

that various morphological skills were present in preschool children, and skills increased when children were getting older. In addition, the results indicated that children are creative and productive with morphological knowledge and that they regard language as meaning-based (Berko, 1958).

There is evidence that morphological awareness continues to grow as children get older. English studies showed that morphological awareness increases from pre-school until second grade in both real word and pseudoword tasks (Apel, 2014; Kirby et al., 2012) and for written and orally administered morphological awareness tasks (Apel, 2014). Further, Singson et al. (2000) could show that knowledge on derivational morphology grew from third grade through sixth grade. A study by Nagy, Diakidoy, and Anderson (1993) suggested that the strongest increase in students' knowledge on derivational suffixes occurred between fourth and seventh grade. After that, no significant increase in morphological knowledge was observed by the authors. Although no further increase was detected, morphological knowledge was reported to be incomplete for most participants even in 12th grade, as students still made errors in tasks on simple English suffixes.

For German, Kargl et al. (2018) showed that morphological awareness increased from fourth until sixth grade, but not beyond sixth grade, in a task that comprised both inflectional and derivational items. This could indicate that children reach their personal maximum in morphological awareness skills around that time. It is noteworthy that although morphological awareness did not seem to grow from sixth until seventh grade, no obvious ceiling effect was reached in the morphological awareness task: Seventh graders reached a mean of M = 27.2 (SD = 5.5) in a task where 39 points could be obtained. This result is in line with that of Nagy et al. (1993) for the English language and suggests that morphological awareness is a skill that might not be fully mastered by every individual.

To summarize, the presented research suggests that children develop their first morphological awareness skills before learning to read and write. When children enter primary school, morphological awareness keeps growing. Studies by Kargl et al. (2018) and Nagy et al. (1993) indicate that morphological awareness might not continue to grow at some point in secondary school, but evidence on this topic is still limited.

2.2 The role of morphological awareness for literacy skills

Literacy comprises the facets reading and spelling. Both are inseparably intertwined with our everyday lives. Sections 2.2.1 and 2.2.2 explain reading and spelling skills. Section 2.2.3 offers notions on developmental aspects of literacy skills. Section 2.2.4 brings morphological awareness and literacy skills together by providing theoretical considerations on

the relationship between literacy skills and morphological awareness. Finally, section 2.2.5 summarizes empirical evidence on the relationship between morphological awareness and literacy skills.

2.2.1 Reading

2.2.1.1 Concept

Reading is a multidimensional construct that includes various skills. It is beyond the scope of this dissertation to discuss all facets of reading and their relations with each other. Rather, one basic and one higher-level reading skill are introduced, which are important for diagnosing reading skills in German: *Reading fluency* and *reading comprehension* (Landerl & Wimmer, 2008; Schulte-Körne, 2010). Reading comprehension is selected because it is most often the actual goal of reading (McBride-Chang, 2004). Reading fluency is selected because it is an accurate measure for basal reading skills and because it is also a basis for reading comprehension (Klauda & Guthrie, 2008; Moll & Landerl, 2014).

Reading fluency is a basal reading skill that refers to accurately reading aloud with appropriate prosody and adequate speed (Hudson, Pullen, Lane, & Torgesen, 2008; Snow, 2017). It is the product of several underlying sub-processes like decoding fluency, rapid naming and general processing speed, and relies on knowledge domains like orthographic knowledge and vocabulary (Hudson et al., 2008). The measurement of oral reading fluency is widely used for estimating the progress toward success in reading (Snow, 2017). In German, reading fluency is a better measure for basal reading competencies than reading accuracy (Landerl, 2017; Moll & Landerl, 2014) because the high grapheme-phoneme consistency in German leads even for beginning readers to relatively high reading accuracy rates compared to readers from less consistent orthographies like English (Landerl, 2017). Reading fluency can therefore better differentiate between struggling and competent readers in German than reading accuracy (Landerl, 2017; Moll & Landerl, 2014).

Reading comprehension is a higher-level reading skill that describes the understanding of read words, sentences and/or texts. To be able to understand print, vocabulary knowledge and the ability to retrieve meaning from written words are necessary (Verhoeven & Perfetti, 2017). More technically, reading comprehension has been described as an interactive process between information in a printed text and a reader's contextual and general knowledge (Frankel, Becker, Rowe, & Pearson, 2016). This means, it is necessary to integrate information from the text with one's own background knowledge to construct meaning. Reading comprehension as a higher-level reading skill builds on basal reading skills such as reading fluency (Hoover & Gough, 1990; Verhoeven & Perfetti, 2017). Therefore, an adequate level of reading fluency is

necessary to master reading comprehension (August & Shanahan, 2006). Consequently, reading comprehension is obstructed when the reader has deficits in basal reading competencies (Snow, 2017).

Reading fluency and reading comprehension stand in close relation to each other (Klauda & Guthrie, 2008) because some of the underlying sub-processes of reading fluency and reading comprehension (e.g. decoding and vocabulary skills) are relevant for both reading skills (Hudson et al., 2008; Klauda & Guthrie, 2008).

2.2.1.2 Reading strategies

Frith (1985, 1986) described three strategies that are central for reading. Descriptions of these strategies were based on empirical studies with English-speaking children. Whether all three strategies are used to a similar extend by German readers has been the focus of discussion (cf. Schründer-Lenzen, 2013). This aspect is regarded in section 2.2.3 after the strategies have been introduced. Nevertheless, reading strategies as described by Frith (1985, 1986) are still useful to explain which cues children use for reading in German because Frith's strategies provide a parsimonious model of reading acquisition, which is appropriate for this introduction. In addition, research on reading in German was heavily influenced by Frith's assumptions (cf. Steinbrink & Lachmann, 2014). The following descriptions of the strategies are based on explanations by Frith (1985, 1986) and illustrated with own examples.

The logographic reading strategy: This strategy allows instant word recognition based on salient graphic features (Frith, 1986). Typical salient graphic features are the first letter of a written word or the special design of a logo with which the recipient is familiar (Frith, 1986). For example, a five-year old pre-schooler could recognize her own name based on the first letter and optionally on further salient letters and the approximate length of the word: The name "Alexandra" might be recognized as the own name even when some of the letters are incorrectly ordered or left out, e.g. "Alexradna" or "Alexanda". However, leaving out the salient "A" (e.g. "lexandra") or the salient "x" (e.g. "Aleandra") might change the appearance enough that the child does not link the written word with her own name. Logos that can be recognized by its special features and perhaps single letters could be for example "kinder Schokolade" with its distinctive colouring and two typefaces or "Milka" with its unique purple coloration and italic type.

The alphabetic reading strategy: Readers who apply this strategy use grapheme-phoneme-correspondence rules to blend sounds to words (Frith, 1986). This is achieved by a strict sequential translation of graphemes into sounds (Frith, 1986). This strategy allows the

reader to pronounce novel and nonsense words (Frith, 1985). For instance, a child using this strategy would sequentially blend the letters /h/, /æ/, /n/ and /d/ to the word /hænd/.

The orthographic reading strategy: A reader using an orthographic strategy recognizes and makes use of orthographic and morphological units in words while reading (Frith, 1986). The ordering of letters is crucial when this strategy is used (Frith, 1986). Instead of grapheme-phoneme correspondences as with the alphabetic strategy, sounds that refer to orthographic entities and morphemes are activated (Frith, 1986). For example, the reader recognizes the words "hand" and "ball" in the compound "handball", activates the corresponding equivalents in sounds (/hænd/ and /bɔːl/) and puts them together for the correct pronunciation of the compound (/ˈhændˌbɔːl/).

2.2.2 Spelling

2.2.2.1 Concept

For spelling, phonemes have to be translated into graphemes. Input entities for writing can be either spoken utterances as in spelling to dictation, or visual prompts as in picture naming (Tainturier & Rapp, 2001). However, spelling does not necessarily need an input entity, as it is possible to decide without external input or cues what to write, for example when writing creatively. Spelling output can be either written, typed or spelled aloud (Tainturier & Rapp, 2001).

2.2.2.2 Spelling strategies

Like for reading, a range of different spelling strategies, i.e. procedures to optimise spelling outcome, have been described. Three central strategies are described in the following:

Alphabetic spelling strategy (also sometimes referred to as "phonological spelling strategy"): This spelling strategy is based on the phonological principle, meaning that a word is deconstructed into its phonemes which in turn are translated into graphemes with the help of phoneme-grapheme-correspondence rules (Schründer-Lenzen, 2013; Varnhagen, 1995). Basic characteristics of this strategy are sound segmentation and sequential ordering of sounds to graphemes (Frith, 1986). Thus, the speller would sequentially segment the sounds in, for instance, /nest/ as /n/, /e/, /s/ and /t/ and represent each of the sounds with the corresponding grapheme ("n", "e", "s" and "t"). These graphemes then add up to the written word "nest". For German, this strategy is quite efficient because many words that are spelled phonetically accurate are also orthographically correct (Schründer-Lenzen, 2013).

Orthographic spelling strategy: Spellers use this strategy when applying orthographical rules to their writing (Varnhagen, 1995). For this, spellers make use of word analogies to deduce the correct spelling (Goswami, 1988; Varnhagen, 1995). Goswami (1988) could show that

children were able to make use of word analogies between a known word (e.g. “beak”) and previously incorrectly spelled words such as “bean” or “peak”.

Morphological spelling strategy: For this spelling strategy, morphological knowledge of the structure and the meaning of words is used for spelling decisions (Varnhagen, 1995). An illustration for the use of this strategy in German is the spelling of the word “Fahrrad” (Eng. “bicycle”). Spellers who apply a morphological spelling strategy would spell the word “Fahrrad” correctly with two “r” in the middle, although only one “r”-sound can be heard because there are two meaningful parts in this word (“fahr” [Engl. “drive”] and “rad” [Eng. “wheel”]) that have been compounded into one word (cf. May & Malitzky, 1999). An example for the English language is the spelling of the affixed word “magician” for which the speller can deduce the correct spelling when identifying the root word “magic” and the suffix “-ian” (cf. Varnhagen, 1995).

It should not remain unmentioned that some researchers view the orthographic and the morphological spelling strategy as one strategy and have used either label for it (Frith, 1985, 1986; Nunes, Bryant, & Bindman, 1997). The reason for this is that orthographic rules often have a morphological base as, for instance, the spelling of past regular verbs that end on “-ed” in English (Nunes et al., 1997). However, a finer discrimination between spelling strategies was necessary for this dissertation because the administered spelling test in the main study differentiates between the three spelling strategies introduced here. As the administered reading tests include no differentiations between reading strategies, the classic categorization for reading strategies as presented by Frith (1985, 1986) was explained.

2.2.3 Developmental aspects of literacy acquisition

Literacy acquisition is considered to develop stepwise, corresponding to the reading and spelling strategies introduced above (Frith, 1985, 1986). It is evident that some strategies must precede others as it is, for example, highly unlikely to make morphological decisions in reading and spelling before the alphabetic principle is understood. To acquire phonological, orthographical and/or morphological strategies most developing readers and spellers need teaching instruction (Frith, 1986). Frith (1985, 1986) argues that different strategies are merged within the literacy acquisition process and that characteristics from earlier stages are still part of later strategies. Moreover, reading and spelling skills influence each other (Frith, 1985, 1986). This means, knowledge in either domain can aid processing in the other domain.

There is evidence that different strategies are used already in early phases of literacy acquisition (Verhoeven & Perfetti, 2017). For example, it has been shown that beginning spellers of English at the age of 7 already used orthographic spelling strategies (Goswami,

1988). Advanced readers and spellers have been shown to apply all of the strategies – depending on the words that need to be processed (Donovan & Marshall, 2016; Goswami, 1988; Sénéchal, Basque, & Leclaire, 2006; Sprenger-Charolles, Siegel, Béchennec, & Serniclaes, 2003; Varnhagen, 1995). However, there is also evidence that primary school children, secondary school children and even adults have difficulties with applying morphological strategies when presented with novel words (Kemp & Bryant, 2003; Kemp, Mitchell, & Bryant, 2017). Kemp et al. (2017) argue that individuals who have difficulties with applying morphological spelling strategies might rather rely on memorised word-specific spellings and statistical patterns of letter co-occurrences. The evidence suggests that using morphological spelling strategies is especially demanding and not all individuals reliably make use of these strategies.

For German, the organisation and development of strategies could differ from findings for English because German has a rather consistent orthography, whereas English has an inconsistent orthography (cf. section 2.4). This means that German readers and spellers can rely more on grapheme-phoneme and phoneme-grapheme correspondence rules and, therefore, more on alphabetic strategies than English readers and spellers. Indeed, studies indicate that logographic reading and spelling strategies have less importance in German than in English (Wimmer & Goswami, 1994; Wimmer & Hummer, 1990), which has been attributed to the higher orthographic consistency in German (Wimmer & Goswami, 1994) and different didactic approaches to literacy acquisition (Schründer-Lenzen, 2013; Wimmer & Hummer, 1990). In addition, Valtin (2011) summarized evidence showing that German first graders started using orthographic rules in spelling already a few months after school entry. However, when under pressure, children tended to regress to simpler spelling strategies.

Summarizing the theoretical considerations and empirical findings, there are different reading and spelling strategies that have a sequential order in development but are already present to some extent in early stages of literacy acquisition. The relative importance of the different reading and spelling strategies seems to vary between languages and changes with increasing literacy proficiency.

2.2.4 Theoretical considerations on the relationship of morphological awareness with literacy skills

As stated above, morphemes are the smallest units of meaning in a language (Elsen, 2014). As comprehension of the meaning of print, i.e. reading comprehension, is most often the main goal of reading (McBride-Chang, 2004), morphemes are of decisive importance (Henry, 2017). In the following, the relationship between morphological awareness and literacy skills is illuminated. The theoretical relationship between these skills can be studied from different

points of view. From the wide range of theoretical approaches to reading and writing, three are discussed in more detail. First, morphological awareness is set in relation to the reading and spelling strategies that were introduced above. Second, morphological knowledge is discussed as a binding operator between phonology, orthography and semantics. Third, the role of morphological units and processes is discussed in dual route approaches to reading and spelling. Each of these three approaches can contribute to the understanding why morphological awareness and literacy should be related. It is not the aim of this section to favour one approach over the other, but to demonstrate that from different viewpoints a relation between morphological awareness and literacy skills is to be expected.

2.2.4.1 Reading and spelling strategies

As described in section 2.2.3, there are different reading and spelling strategies that are most likely acquired consecutively (Frith, 1985, 1986; Varnhagen, 1995). Being able to recognize morphemes and to operate with them is fundamental to using orthographic and/or morphological reading and spelling strategies because they are based on morphological units as processing entities. Therefore, morphological awareness can be associated with orthographic and morphological strategies. Goswami (1988) showed that children as young as seven years of age already use different reading and spelling strategies. This could indicate that morphological awareness is related to literacy abilities already very early in literacy acquisition.

In many scripts, there is more than one way to spell phonemes or sequences of phonemes (Nunes et al., 1997). This is the case for German with its rather inconsistent orthography and even more so for English. Therefore, relying only on phoneme-grapheme-correspondence rules leads to misspellings in opaque words. Morphological spelling skills can help to choose the correct spelling based on the meaning structure of the word at hand (McCutchen & Stull, 2015; Nunes et al., 1997). If one is familiar with the spelling of a certain morpheme, one can transfer that knowledge to deduce the correct spelling of words that contain this specific morpheme. Thus, a morphological spelling strategy helps to make correct spelling decisions.

With regard to reading, the ability to recognize morphemes could aid children in understanding written language, including cases in which they try to deduce the meaning of unknown words (Kirby, Desrochers, Roth, & Lai, 2008). Moreover, knowing some of the morphemes of a word or recognizing a word as a whole based on its morphemes can help the reader to choose the correct pronunciation, especially in inconsistent orthographies such as English. For German, retrieving pronunciation from morphological cues is not as important because grapheme-phoneme-correspondence rules already lead to correct pronunciation in many cases (cf. Valtin, 2011). Yet, morphological awareness is important because of the

productivity of morphological systems, which means that new words can be constructed based on morphological rules (McBride-Chang, 2004). Meaning and pronunciation of these new words can then be deduced based on their morphological structure.

Thus, from a theoretical point of view, orthographic and morphological strategies are closely intertwined with the concept of morphological awareness. As these strategies are not optional but necessary for skilled reading and writing (Frith, 1985, 1986; Nunes et al., 1997; Varnhagen, 1995), a relation between morphological awareness and literacy skills should be found.

2.2.4.2 The binding agent theory of morphological knowledge

Kirby and Bowers (2017) proposed in their binding agent theory of morphological knowledge that morphology is a "binding agent" between semantics, orthography and phonology (Kirby & Bowers, 2017, p. 438). Through connecting these three components, morphology is crucial for comprehension, spelling and pronunciation. The authors state that morphology gives clues to the meaning of written words by integrating phonological and orthographic information. Morphology also connects semantic and orthographic information and by this gives clues to pronunciation. Clues to spelling can be obtained from morphology when it integrates semantic and phonological information. In addition, morphology contributes to syntax, i.e. sentence structure, by helping to specify the role a given word has in the sentences it is embedded in. Kirby and Bowers conclude that morphology contributes to word reading, reading comprehension and spelling. It is to be expected that the ability to recognize, reflect on and manipulate morphemes, i.e. morphological awareness, is necessary in these processes. Thus, higher levels in morphological awareness should be associated with higher literacy skills.

2.2.4.3 Dual-route approaches to reading and spelling

Dual route approaches to reading

Many models on word reading assume that two different procedures are involved in reading processes (Coltheart, Curtis, Atkins, & Haller, 1993). These different procedures are commonly described as "routes". In dual route approaches for reading aloud, usually a direct lexical route and an indirect non-lexical route are distinguished (Coltheart et al., 1993; Coltheart, 2006; Coltheart, Rastle, Perry, Langdon, & Ziegler, 2001). In the lexical route, letter clusters activate whole word representations in the orthographic lexicon. The pronunciation stored in the phonological lexicon is generated through a calibration with the phoneme system. This lexical route works with and without an activation of the semantic system, which means the meaning of the processed word can but does not have to be retrieved for successfully reading aloud. The non-lexical (or phonological) route makes use of grapheme-phoneme-

correspondence rules to generate word pronunciation. Coltheart et al. (2001) specify that within the non-lexical route also context information, letter position and morphological units are used for the translation of graphemes into phonemes. Readers with higher morphological awareness skills could have advantages in recognising morphological units and in making use of morphemes for pronunciation. The lexical route is associated with processing familiar words and the non-lexical route is associated with processing unfamiliar words. However, both routes are interdependent and can be activated simultaneously when abstract grapheme clusters need to be decoded.

The above model explains how single words are read aloud. This is a type of reading in which the comprehension of the processed word is not necessarily involved. A model explaining reading comprehension can shed more light on the role of morphology in reading as morphemes are the smallest units of meaning in a language. Therefore, the dual route approach to word reading comprehension for silent reading by Grainger and Ziegler (2011) is introduced in the following. This model distinguishes between a coarse-grained and a fine-grained route. Both routes make use of frequencies of letter occurrences, but in different ways.

The coarse-grained route optimises rapid access to semantics. Combinations of the most informative letters are coded and used to maximise information on word identity and corresponding semantic information. This gives the opportunity for a fast bottom-up activation of whole-word representations. These, combined with contextual information, are used for reading comprehension. Morphology plays insofar a role in this route, as letter co-occurrences activate not simply one word but rather a set of related words. For instance, the letter “f” somewhere before the letter “r” in a single word would be a good indicator that the processed word is something like “farm” or “farmer”. If combined with information from the fine-grained route, the corresponding morpho-semantic representation (e.g. the word “farmer”) is activated, which results in a in a top-down process that increases the activation of the whole word family (e.g. the words “farm”, “farming”, “farmhouse”) through the shared morpho-semantic representation, which is “something to do with farms”.

The fined-grained route makes use of the precise ordering of letters and their exact position within the word (e.g. beginning or end of the word). Contiguous letter combinations that are frequently co-occurring activate corresponding phonemes. These in turn facilitate the activation of fitting phonological whole-word representations and their corresponding semantic representations. The authors emphasize that this route capitalizes not only on graphemes (e.g. “a”, “b”, “th”) but also on morphemes, especially affixes (e.g. “re-”, “-ed”, “-s”). Stored morphological and phonological representations are used in these morpho-orthographic

processes. That is, morphological information is used in both routes in this dual-route approach by Grainger and Ziegler (2011).

Grainger and Ziegler (2011) constructed their model for the English language. A study conducted by Hasenäcker, Schröter, and Schroeder (2017) showed that some adaptions might be necessary for explaining reading processes in German beginning readers. The authors found sequential facilitation in lexical decisions tasks from compounds around grade two, from suffixes around Grade 3 and from prefixes even slightly later. Word stems proved to be the most important units of morphological analysis in German in initial phases of reading development and in adulthood. The results indicate further that stems and different types of affixes are involved in different processing mechanisms in beginning readers. The authors suggest that an adaption of the dual-route approach by Grainger and Ziegler (2011) that includes the differential processing of stems, prefixes and suffixes is needed for explaining reading comprehension in German. However, in line with the dual route approach by Grainger and Ziegler (2011), the results underline the important role of morphological information for reading.

In another study, Hasenäcker and Schroeder (2017b) found that children in second and fourth grade relied more on fine-grained processing whereas adults make more use of the coarse-grained route. This indicates that beginning readers might use morphological information differently than skilled readers because the coarse-grained route is associated with morpho-semantic processing and the fine-grained-route with morpho-orthographic processing with a special focus on affixes. Nonetheless, all readers rely on morphological information and therefore, morphological awareness could be important in all reading proficiency levels.

Dual route approaches to spelling

Dual route approaches to spelling differentiate a lexical route and a sublexical route. Researchers vary in the exact specifications on how these routes operate (Houghton & Zorzi, 2003). Houghton and Zorzi (2003) summarize that most researchers would agree that the lexical route relies on memorised spellings that are stored in and retrieved from the mental lexicon, and the sublexical route relies on phoneme-grapheme-correspondence rules. Analogous to dual route approaches to reading, both routes can be used concurrently during spelling, and the routes can interact with each other (Treiman, 2017).

There are different assumptions concerning the role of morphology in this dual route approach. Sheriston et al. (2016) postulated that the sublexical route not only capitalizes on phonological but also on orthographic and morphological units for sublexical translations from sound to writing. Results of their study with 8 to 10 year old British schoolchildren implicated

that students mainly reported two different approaches to the spelling of regular words. These two approaches were on the one hand pure lexical retrieval and on the other hand the use of elaborate strategies that comprised both orthographic and morphological strategies. The authors assigned these two approaches to the two routes in the framework of the dual route approach. Therefore, pure lexical retrieval was associated with the lexical route and elaborate strategy use was associated with the sublexical route.

Schründer-Lenzen (2013) on the other hand, postulated that the inner lexicon is a mental network that comprises knowledge on the formations and the structure, especially the morphological structure, of words. For example, children use their knowledge on word families for spelling decisions. That is, Schründer-Lenzen (2013) associates morphological processes with the lexical rather than with the sublexical route. According to her, the sublexical route relies on phoneme-grapheme-correspondence rules and leads to a loud-orientated spelling. She postulates that beginning spellers rather rely on the sublexical route, whereas competent spellers rather use the lexical route for spelling, and that both routes can interact with each other.

The positions of Sheriston et al. (2016) and Schründer-Lenzen (2013) vary with respect to the role of morphology for the two routes. However, it is evident that morphology has an important role in spelling – be it in the lexical or in the sublexical route. Therefore, it can be assumed that one can profit from morphological awareness skills during spelling.

2.2.4.4 Conclusion

All approaches to reading and spelling that were introduced above illustrated that morphological processes are important for literacy skills both in beginning and in skilled readers and spellers. Thus, morphological awareness, which indicates how an individual can recognize morphemes and operate with them, should be related to reading and spelling skills across reading proficiency levels.

2.2.5 Empirical evidence on the relationship between morphological awareness and literacy skills

Empirical findings on the relationship between morphological awareness and literacy skills in German are limited. In contrast, in English research, output on this topic is growing rapidly, and two meta-analyses have already been conducted summarizing the findings from different studies. Section 2.2.5.1 gives an overview of English research and section 2.2.5.2 summarizes evidence for German.

2.2.5.1 Morphological awareness and literacy skills in English

For the English language, there is evidence for a relationship between morphological awareness and literacy skills from primary school years (e.g. Deacon, Benere, & Pasquarella,

2013; Kirby et al., 2012), across later school years (e.g. Mahony, 1994; Nagy et al., 2006) and into adulthood (e.g. Mahony, 1994; Metsala et al., 2019; Wilson-Fowler & Apel, 2015). Researchers have measured morphological awareness with a variety of tasks covering real word and pseudoword tasks (section 2.1.2) and with judgement and production tasks. For an overview on different tasks with which morphological awareness has been measured see Apel (2014).

Relations between morphological awareness and literacy skills in English have been summarized in two meta-analyses. Lee (2011) conducted a meta-analysis on 42 empirical studies on the relationship between morphological awareness and literacy competencies. Participants in the included studies were children from preschool age until sixth grade. Both studies on native speakers of English and on English-language learners were included in this meta-analysis. Measures on reading accuracy and reading fluency were combined to word reading (n = 38). Additionally, 31 measures of reading comprehension and 20 measures on spelling were collected. The mean correlation of morphological awareness was high with reading comprehension (M = .55), and medium with word reading (M = .45) and spelling (M = .46). Morphological awareness tasks on inflectional morphology explained similar amounts of variance of outcome measures as did morphological awareness tasks on derivational morphology.

Ruan et al. (2018) conducted a meta-analysis including 32 English studies and 32 Chinese studies on relations between morphological awareness, reading accuracy, reading fluency and reading comprehension. All participants in the included studies were native speakers of their language. This meta-analysis comprised studies with participants from preschool age until high-school age. Morphological awareness and outcome measures were significantly related in both languages. This implies that morphological awareness is related to reading skills in different scripts because an alphabetic script is used in English and a logographic script in Chinese. In English, morphological awareness and reading comprehension correlated highly (M = .53), which corresponds with the results by Lee (2011). The mean correlation between morphological awareness and basal reading skills were of medium height: M = .46 with reading accuracy and M = .37 with reading fluency for the English studies, which is also in line with the findings by Lee. All correlations between morphological awareness and reading measures for the Chinese studies were of medium height ($.36 \leq M \leq .39$). The results show that morphological awareness is associated with reading skills in different scripts. However, English is an atypical alphabetic script because of its low orthographic transparency (cf. section 1.4). Consequently, only limited conclusions for other alphabetic scripts can be drawn from these findings. In addition, German morphology is richer than the English one (cf.

section 2.1.1.3), which adds to the need for original studies on the relationship between morphological awareness and literacy skills in German. Results of German studies are presented in the next section.

2.2.5.2 Morphological awareness measures and their relationship with literacy skills in German

This section describes how morphological awareness has been measured in German studies so far and gives an overview of findings on relationships between morphological awareness and literacy skills.

Several studies looked into the relation between morphological awareness and literacy skills in German. Taking their evidence together, a relationship between morphological awareness and literacy skills has been found for children between second and seventh grade (Fink et al., 2012; Kargl et al., 2018; Kargl & Landerl, 2018; Klassert, Bormann, Festman, & Gerth, 2018; Volkmer, Schulte-Körne, & Galuschka, 2019).

Fink et al. (2012) used several measures of morphological awareness. One task was a pseudoword cloze task in which children had to derive or inflect pseudowords so that they fitted into a presented sentence. This task was administered in a written presentation and response format. Performance in this task was significantly correlated with spelling (r = .59**) and with basal reading ability (r = .49**) in fifth and sixth graders. Two further studies used the same pseudoword test. They found significant relations with spelling skills (Kargl et al., 2018; Kargl & Landerl, 2018) and with proficiency in orthographic and morphological spelling strategies (Kargl et al., 2018) in children from fourth to seventh grade.

Another measure for morphological awareness used by Fink et al. (2012) was a morphological fluency task. This task was also administered in a written presentation and response format. In this task, children were given four verbs that were all real words. Children had to write down as many words belonging to the word families of the test words as they could find in a limited time. Morphological fluency correlated with spelling (r = .22**) and with basal reading ability (r = .23**) in fifth and sixth graders.

Volkmer et al. (2019) assessed morphological awareness with an oral+written real word cloze task in a study with second graders (Volkmer et al., 2019). In this task, children had to derive real words so that they fitted into a given sentence. The test items were presented in a written form and concurrently read to the children to minimise disadvantages for children with lower reading skills. Morphological awareness reached medium correlations with reading speed (r = .45**), real word reading fluency (r = .36**), pseudoword reading fluency (r = .29**) and spelling (r = .34**).

A fourth type of task was used by Klassert et al. (2018). They used a judgement task, in which children listened first to a test word and afterwards to three alternatives of which only one was morphologically related to the test word (Klassert et al., 2018). Children were asked to identify the morphologically related word by ticking the box on a sheet of paper that corresponded with the position in which the alternative had been presented (first, second or third position). All of the test words were real words. This task had a low correlation with spelling errors of consonant clusters in third graders (r = -.23*), and none in first and second graders (-.41 ≤ r ≤ .17, all p > .05). The authors argue that children in early primary school years, although showing well developed morphological awareness, cannot yet use it to their advantage in spelling situations. This result could imply that morphological awareness gains in importance with increasing spelling proficiency.

The results signify that morphological awareness is related to literacy skills in German at least from later primary school years and until the middle of secondary school. This result is strengthened by the fact that different morphological awareness measures have been applied so far. A next step would be to inspect whether morphological awareness proves to be a unique predictor when accounting for other variables that stand in relation to literacy skills. This aspect is considered in the next sections.

2.3 Morphological awareness in relation to other cognitive variables

A huge range of variables is associated with literacy skills. Such variables concern, for example, the school environment, the home environment and personal factors. Even when focusing on a specific set of variables, like on cognitive variables in this dissertation, other variables have to be taken into consideration because environmental and personal variables interact with each other (McBride-Chang, 2004). In the following, some of the environmental and personal variables related to reading and spelling are highlighted. Due to the focus of this dissertation, cognitive variables are discussed in more detail in the subsequent sections.

The school environment is fundamental for literacy development and achievement. While access to schooling is usually secured in western society, it remains a huge obstacle in less privileged countries (McBride-Chang, 2004). Within school, the type of literacy instruction is to be considered (Graham & Santangelo, 2014; Kuhl & Röhr-Sendlmeier, 2018). For example, Graham and Santangelo (2014) reported in a meta-analytic review that a formalised spelling instruction was associated with better spelling performances by students compared to an informal spelling instruction. Formalised spelling instructions were characterized by direct spelling practise of specific words, and by teaching skills, rules, and strategies for spelling unknown words. Informal spelling instructions were characterized by the teacher modelling

correct spelling when writing and by the teacher providing opportunities for students to find out about correct spelling by themselves. This result underlines that the approach to literacy instruction influences children's literacy performances.

Variables concerning the home environment are, for instance, cultural beliefs (August & Shanahan, 2006; McBride-Chang, 2004) and socioeconomic status of the parents (McBride-Chang, 2004). Low socio-economic status, immigrant status, and having several siblings have been associated with lower literacy achievement in Finland and Sweden, which are two OECD countries that were among the best in the Programme for International Student Assessment, PISA for short (Linnakylä, Malin, & Taube, 2004). For example, if parents do not speak the language their children learn at school, they can provide less support and learning opportunities in that language than parents who speak that language. Having a low income restricts parents' opportunities to pay for private lessons or additional learning material. These examples illustrate that variables concerning home environment can directly and indirectly influence children's literacy acquisition.

Literacy development is also determined by personal factors. These are for example learning motivation (Oldfather & Dahl, 1994), cognitive skills (Kirby et al., 2008) and mother tongue (August & Shanahan, 2006). For instance, it makes a difference whether literacy skills are learned in one's mother tongue or in a secondary langue (August & Shanahan, 2006). If the learner is still in the process of acquiring the secondary language, learning to read and spell will be harder (Perfetti & Dunlap, 2008). It is therefore beneficial for children who learn to read and spell in a secondary language to receive explicit training in phonemes that belong to the secondary language, but do not occur in their mother tongue (August & Shanahan, 2006).

As mentioned above, environmental and personal variables interact with each other (McBride-Chang, 2004). For example, children learning to read and spell in a secondary language accomplish better results when they receive specific support by parents and teachers than when no additional support is provided (August & Shanahan, 2006).

This dissertation concentrates on cognitive variables with a special focus on morphological awareness. Accordingly, further cognitive variables related to literacy skills are introduced in more detail in the following. Many studies on the roles of morphological awareness and other cognitive variables for literacy skills have been conducted in English and in Chinese (for a meta-analysis for these two languages see Ruan et al., 2018). For other languages, like German, studies on the relationship between morphological awareness and literacy skills are still scarce. Few German studies have explored whether morphological awareness uniquely explains literacy skills when accounting for other cognitive variables. As

results from one language cannot be transferred to another one because of, for example, differences in writing systems, morphological systems (section 2.1.1.3) and orthographic transparency (section 1.4), insights into morphological awareness as a unique predictor of literacy skills in German are still limited.

2.3.1 Phonological processing

Phonological processing describes mental operations that make use of speech-sounds when dealing with spoken or written language (Steinbrink & Lachmann, 2014; Torgesen, Wagner, & Rashotte, 1994). Phonological processing is important for reading and spelling across languages (Moll et al., 2014; Verhoeven & Perfetti, 2017). In the following subsections, three subdomains of phonological processing skills are described. Phonological awareness is introduced in section 2.3.1.1, rapid naming in section 2.3.1.2 and verbal memory in section 2.3.1.3. All three skills are defined, empirical evidence on their relevance for literacy skills is summarized, and their role for literacy skills in comparison to that of morphological awareness is considered.

2.3.1.1 Phonological awareness

Definition

Phonological awareness is defined as "one's sensitivity to, or explicit awareness of, the phonological structure of the words in one's language" (Torgesen et al., 1994, p. 276). In German literature, it is common to differentiate between phonological awareness in the broader sense and phonological awareness in the narrower sense (Skowronek & Marx, 1989). Phonological awareness in the broader sense refers to greater chunks of sounds and describes the ability to detect or produce alliterations and rhymes and the ability to segment words into syllables or to put syllables together to words (Näslund & Schneider, 1996; Steinbrink & Lachmann, 2014). For example, the word "alphabet" (/ˈælfəˌbet/) can be segmented into its syllables /ˈæl/, /fə/ and /bet/ and, the other way around, the syllables /ˈæl/, / fə / and /bet/ can be blended together to form the word /ˈælfəˌbet/. Phonological awareness in the narrower sense, also sometimes called phoneme awareness, requires more explicit segmentation skills (Näslund & Schneider, 1996). It describes the ability to segment words into individual phonemic units and to put individual phonemic units together to words (Näslund & Schneider, 1996; Steinbrink & Lachmann, 2014). For example, the word "post" (/pəʊst /) can be segmented into the phonemes /p/, /əʊ/, /s/ and /t/ and, the other way around, the phonemes /p/, /əʊ/, /s/ and /t/ can be blended together to the word /pəʊst/.

Phonological awareness develops as children grow older (Anthony & Francis, 2005). Children are able to detect or manipulate syllables before they detect and manipulate onsets and

rhymes and in turn, they are able to detect onsets and rhymes before they detect and manipulate phonemes within words (Anthony & Francis, 2005). As such, tasks that tap phonological awareness skills acquired later are more difficult than tasks that tap phonological awareness skills mastered relatively early.

The role of phonological awareness for literacy skills

Phonological awareness is necessary to make use of alphabetic reading and spelling strategies because in these strategies phonemes have to be recognized and assigned to the corresponding graphemes, or vice versa. Without some degree of awareness of the phonological structure of the language, an alphabetic script is hardly understandable (Torgesen et al., 1994). In the case of reading aloud, being aware of the phonological structure of words is necessary to understand how to come from print to pronunciation (Torgesen et al., 1994). Furthermore, phonological awareness helps to efficiently store orthographic patterns, a process which depends on the repeated experience on how phonological and orthographic word parts correspond to each other (Perfetti, 1992). The more irregularities and inconsistencies there are in a language, the more stress is put on the phonological systems and, by this, the more important become phonological awareness skills for literacy competencies (Moll et al., 2014).

Phonological awareness is a unique predictor of reading and spelling abilities in schoolchildren in both English (Hulme et al., 2002; Hulme, 2002; Mann & Liberman, 1984; Torgesen et al., 1994) and German (Berendes, Schnitzler, Willmes, & Huber, 2010; Ennemoser, Marx, Weber, & Schneider, 2012; Landerl & Wimmer, 2008; Moll, Wallner, & Landerl, 2012). Longitudinal studies with German-speaking children tested at school entry and in third grade imply that earlier deficits in phonological awareness do not affect later pseudoword reading skills, but have an effect on orthographic spelling skills (Wimmer, Mayringer, & Landerl, 2000). That is, in German, phonological awareness could be more important for spelling than for alphabetic reading skills. The authors discuss this result, which is in contrast to findings for the English language, with regard to orthographic transparency, implying that in transparent languages reading accuracy is less affected by phonological awareness deficits than reading fluency and spelling abilities. This might be explained by the importance of phonological awareness for building up word-specific orthographic representations in the mental lexicon (Moll et al., 2014). Word-specific orthographic representations are important for direct word recognition during reading and for orthographically correct spelling during writing (Moll et al., 2014). That is, the more inconsistencies and irregularities there are in an orthography, the more phonological awareness abilities are important when building up orthographic representations in the mental lexicon (Moll et al., 2014). This reasoning can explain Wimmer et al.'s (2000)

result because orthographic representations would be necessary for orthographic spelling skills and also for real word reading skills. In contrast, pseudoword-reading skills rely on grapheme-phoneme correspondence rules, but not on direct word recognition. As there are less exceptions and irregularities in grapheme-phoneme correspondence rules in more transparent orthographies, phonological awareness could be less important in German than in English for pseudoword reading.

Furthermore, Gorecki and Landerl (2015) found in a longitudinal study with German-speaking first graders that phonological awareness measured at the beginning of first grade did not predict real word and pseudoword reading fluency skills at the end of grade one when reading skills from the beginning of first grade were added to the model. The authors suggest that the predictive power of phonological awareness is overestimated when prior reading skills are not accounted for. Nonetheless, phonological awareness and reading fluency were substantially correlated both at the beginning and at the end of first grade.

Some studies suggest that phoneme awareness is the better predictor for literacy skills than phonological awareness skills in the broader sense (Hulme et al., 2002; Hulme, 2002). Correspondingly, Pfost (2015) found in a meta-analysis on 21 independent German studies that the mean relationship of literacy skills with phonological awareness in the narrower sense was stronger (M = .34) than that with phonological awareness in the broader sense (M = .22). All included studies were longitudinal and had measured phonological awareness in kindergarten or in early primary school prior to the assessment of literacy skills.

A meta-analysis conducted with mostly English studies suggests that throughout the primary school years the relationship between phonological awareness and reading skills is of moderate height (r = .48) and relatively stable (Swanson, Trainin, Necoechea, & Hammill, 2003). In another meta-analysis on English studies, it was suggested that phonological awareness plays a greater role when reading occurs without context such as in the reading of word lists in reading fluency or reading accuracy tasks than when reading occurs with context such as in reading comprehension tasks (Ruan et al., 2018).

The empirical evidence demonstrates that phonological awareness is associated with literacy skills both in English and in German.

The relative importance of phonological awareness and morphological awareness for literacy skills

In a meta-analysis on English studies, Ruan et al. (2018) found that both morphological awareness and phonological awareness uniquely predicted reading accuracy, reading fluency and reading comprehension. Phonological awareness was the stronger predictor for the basal

reading skills reading accuracy and reading fluency, whereas for reading comprehension no significant difference in the predictive power of the two cognitive skills was found.

In a longitudinal study, phonological and morphological awareness skills in second grade proved to be predictive of pseudoword reading and reading comprehension skills in fourth and fifth grade (Deacon & Kirby, 2004). Phonological awareness, but not morphological awareness, was additionally a predictor of pseudoword reading and reading comprehension in third grade and of single word reading in third, fourth and fifth grade.

Evidence with respect to spelling is limited and inconclusive, so far. In a study conducted by Desrochers et al. (2018), both phonological and morphological awareness measured at the beginning of second grade were unique predictors of spelling abilities at the end of second grade in English-speaking second graders. In contrast, only morphological awareness, but not phonological awareness, was a unique predictor of word spelling in a study with American third graders (Zhao, Joshi, Dixon, & Chen, 2017).

Volkmer et al. (2019) found both morphological awareness and phonological awareness to be unique predictors of reading speed, reading fluency and spelling abilities in German second graders (Volkmer et al., 2019). Additionally, phonological awareness, but not morphological awareness, uniquely predicted pseudoword reading fluency.

To summarize, there is evidence for both morphological and phonological awareness to be unique predictors of literacy skills in English. The available evidence suggests that phonological awareness might be more important than morphological awareness for basal reading skills. Yet, there is both evidence for and against phonological awareness being a unique predictor of spelling in English-speaking primary school children. So far, only one study showed that both language awareness skills were predictors of reading and spelling skills in German schoolchildren.

2.3.1.2 Rapid naming

Definition

Rapid naming, also rapid automatized naming or RAN, describes the ability to retrieve easily and rapidly phonological information from long-term memory (Torgesen et al., 1994). Rapid naming tasks assess the speed at which children can name a continuous series of overlearned objects, such as letters, numbers, colours or highly familiar pictures (Bowey, 2005). Performance in a rapid naming task is associated with how well and fast children can make use of phonological information when decoding print into syllables and words (Torgesen et al., 1994).

The role of rapid naming for literacy skills

A meta-analysis comprising mostly English studies with 49 independent samples suggests that throughout the primary school years, the relationship between rapid naming and reading skills is of moderate height (M = .46) and relatively stable (Swanson et al., 2003). In the same meta-analysis, a mean relationship of moderate height between rapid naming and spelling was found (M = .45).

Another meta-analysis comprising 137 studies with children from pre-reading age (kindergarteners) to advanced reading age (fifth grade and higher) showed that the correlation of rapid naming with reading fluency is slightly stronger (M = .49) than that with reading accuracy (M = .42), which can be explained by the speed component in the fluency task (Araújo, Reis, Petersson, & Faísca, 2015). In this meta-analysis, studies from different languages were analysed. Subgroup analyses suggested the relationship between rapid naming and reading skills to be closer in opaque orthographies than in transparent ones. Additionally, it was found that rapid naming tasks using letters or numbers as stimuli had higher correlations with reading skills than rapid naming tasks with colours or pictures, which was explained with the similarity of the stimuli in those tasks. Rapid naming tasks using letters as stimuli are in part influenced by the child's letter knowledge that by itself is related to reading abilities (Araújo et al., 2015).

Two German longitudinal studies by Wimmer et al. (2000) implied that rapid naming deficits in grade one predict deficits in reading fluency and orthographic spelling in grade three. Further, German studies suggest that rapid naming is closer associated with basal reading skills than with spelling skills (Landerl & Wimmer, 2008; Moll et al., 2012).

Taking the evidence together, rapid naming is associated with literacy skills both in English and in German. Whereas German studies suggested that rapid naming is closer associated with basal reading skills than with spelling skills (Landerl & Wimmer, 2008; Moll et al., 2012), such a differential relationship was not observed for English (Swanson et al., 2003).

The relative importance of rapid naming and morphological awareness for literacy skills

To the best of the author's knowledge, evidence on morphological awareness and rapid naming as unique predictors for literacy skills is scarce for English and non-existent for German. Both, morphological awareness and rapid naming were unique predictors of reading fluency, reading accuracy, reading comprehension and spelling in English-speaking second graders (Desrochers et al., 2018). In this study, rapid naming was measured with rapid colour naming and rapid digit naming.

2.3.1.3 Verbal memory

Definition

Verbal memory, also sometimes called phonological memory or verbal/phonological short-term memory, refers to the ability to mentally represent the phonological features of a language (Torgesen et al., 1994). For that, phonological representations are kept present in working memory for an ongoing task. Verbal memory should help beginning readers to maintain an accurate representation of the phonemes during reading (Wagner et al., 1997). Tasks assessing verbal memory require, for example, the accurate repetition of pseudowords (Torgesen et al., 1994), of series of digits (Waters & Caplan, 1996), or of the final words of sets of sentences that participants had read aloud (Waters & Caplan, 1996).

The role of verbal memory for literacy skills

Verbal memory is related to literacy skills as found both in English (Mann & Liberman, 1984; Torgesen et al., 1994; Wagner et al., 1997) and in German studies (Ennemoser et al., 2012; Landerl & Wimmer, 2008). However, the empirical evidence reported by Landerl and Wimmer (2008) indicated that verbal memory measured in first grade was only associated with later spelling skills in fourth and eighth grade, but not with spelling skills in first grade and neither with reading skills in first, fourth and eighth grade. This observation indicates that earlier verbal memory abilities might not affect concurrent but later spelling abilities.

Although some researchers find that verbal memory uniquely predicts reading variables when accounting for other phonological processing variables (Mann & Liberman, 1984), other researchers do not find verbal memory to have any additive predictive power both in English (Torgesen et al., 1994) and in German (Landerl & Wimmer, 2008). Studies with German children by Ennemoser et al. (2012) indicated that verbal memory measured at the end of kindergarten is a unique predictor of spelling at the end of first grade, but not later, when accounting for other phonological processing variables, intelligence and linguistic competencies measured at the end of kindergarten or at the beginning of first grade. In addition, verbal memory uniquely predicted sentence comprehension in first and third grade, but not in second and fourth grade. In this study, verbal memory was no unique predictor of reading speed and text reading comprehension from first to fourth grade.

The findings of these studies indicate that verbal memory is associated with literacy skills, but it is a less stable unique predictor of reading and spelling skills compared to other cognitive variables.

The relative importance of verbal memory and morphological awareness for literacy skills

Results of English studies that assessed both verbal memory and morphological awareness do not give a clear picture on the relative importance of these two variables.

Singson et al. (2000) found in their study with children from third to sixth grade that both morphological awareness and verbal memory were unique predictors of reading accuracy.

Nagy et al. (2006) explored the relative importance of morphological awareness and verbal memory for reading and spelling in three age groups from fourth to eighth grade. Morphological awareness was a unique predictor of spelling and reading comprehension in all three age groups, whereas verbal memory only uniquely predicted spelling in the group of fourth to fifth graders and reading comprehension in the group of eight to ninth graders.

Robertson and Deacon (2019) found that morphological awareness, but not verbal memory, was a unique predictor of word reading in first to second graders when accounting for phonological awareness and nonverbal cognitive ability. For third to fourth graders, results were the other way around: Verbal memory, but not morphological awareness, was a unique predictor of word reading. Aside from that, morphological awareness, but not verbal memory, was a unique predictor of pseudoword reading across the whole primary school sample.

To the best of the author's knowledge, no studies assessing both verbal memory and morphological awareness in German have been made available so far. That is, studies that could clarify the relative importance of verbal memory and morphological awareness for literacy skills are needed both for English and for German.

2.3.2 Vocabulary

2.3.2.1 Definition

Vocabulary refers to the words a person has in his or her language repertoire (Burger & Chong, 2011). Researchers distinguish receptive vocabulary from expressive vocabulary.

Receptive vocabulary refers to the words a person can comprehend in listening or reading (Burger & Chong, 2011), whereas expressive vocabulary refers to words a person can express or produce in speaking or writing (Burger & Chong, 2011).

Children's vocabulary is growing rapidly during primary school years with some children acquiring 2000 and more words per year (for an overview see Nagy & Scott, 2000). Most of these new words are learned through exposure to spoken and written language and only to a small degree through direct instruction (Nagy & Scott, 2000). That is, children have appropriate skills to acquire many new words for their language repertoire by themselves.

2.3.2.2 The role of vocabulary for literacy skills

Vocabulary is crucial for reading, for example for the recognition of familiar words in a text (Kirby et al., 2008; Ouellette & Beers, 2010), and for the recognition of less familiar words when they are sounded out (Kirby et al., 2008). Furthermore, being familiar with the meaning of the words encountered in a text is a requirement for reading comprehension (Freebody & Anderson, 1981; Ouellette & Beers, 2010; Quinn, Wagner, Petscher, & Lopez, 2015).

In a study with English-speaking fourth graders, receptive vocabulary uniquely predicted pseudoword reading skills after accounting for age and nonverbal intelligence, whereas expressive vocabulary predicted word recognition and reading comprehension (Ouellette, 2006).

A study with German second graders implied that vocabulary was moderately correlated with basal reading abilities, but was no unique predictor of reading abilities when controlling for phonological awareness (Juska-Bacher, Beckert, Stalder, & Schneider, 2016). In another study with slightly older children, receptive vocabulary was significantly associated with reading abilities in third grade when controlling for phonological awareness and nonverbal intelligence, but such a result was not found in fourth grade (Berendes et al., 2010).

In an English study with second and third graders, vocabulary was moderately associated with spelling abilities (Apel, Wilson-Fowler, Brimo, & Perrin, 2012). In a German study, vocabulary was positively associated with spelling in third grade but, surprisingly, negatively associated with spelling in fourth grade (Berendes et al., 2010). The authors speculated that overgeneralisations caused the negative relationship in fourth graders. Further research is needed to see if this result is replicable.

The research evidence suggests that vocabulary is associated with reading skills in English. The evidence for German is inconclusive so far because positive, negative and non-significant relationships between vocabulary and literacy variables have been found for primary school children. That is, more research is needed to understand the role of vocabulary for literacy in German.

2.3.2.3 The relative importance of vocabulary and morphological awareness for literacy skills

Singson et al. (2000) found that morphological awareness, vocabulary and phonological awareness were all unique contributors to reading accuracy in children between third and sixth grade. In a study by Zhao et al. (2017), both morphological awareness and vocabulary, but not phonological awareness, were unique predictors of spelling abilities in third graders. In contrast,

in another study with second and third graders, vocabulary and morphological awareness had no unique predictive power for reading comprehension when accounting for age (Apel et al., 2012). It is possible that the low number of participants (N = 56) prevented the detection of significant regression coefficients for vocabulary and morphological awareness.

In a longitudinal study, Kirby et al. (2012) found that vocabulary measured in kindergarten was predictive of reading accuracy, reading speed and reading comprehension in third grade. Morphological awareness measures of second and third grade, but not of first grade were also unique predictors of these reading skills.

To summarize, several English studies suggest that both morphological awareness and vocabulary are unique predictors of literacy skills in primary school years. To the best of the author's knowledge, morphological awareness and vocabulary have not yet been studied together in a German study on literacy skills in primary school children.

2.3.3 Conclusion

Many English studies investigated whether morphological awareness uniquely predicts literacy skills when accounting for further cognitive variables. To summarize, morphological awareness is a unique predictor of literacy competencies in schoolchildren above and beyond phonological awareness (Desrochers et al., 2018; Ruan et al., 2018; Zhao et al., 2017), rapid naming (e.g. Desrochers et al., 2018), verbal memory (e.g. Nagy et al., 2006; Robertson & Deacon, 2019) and vocabulary (e.g. Singson et al., 2000). Yet, there were some studies in which morphological awareness did not reach significance as a unique predictor, for example beyond verbal memory in third to fourth graders word reading abilities (Robertson & Deacon, 2019), and beyond phonological awareness in third grader's reading accuracy and reading comprehension abilities (Deacon & Kirby, 2004). Despite these exceptions, many studies showed that morphological awareness is a relevant variable in explaining current literacy skills and future literacy development in English-speaking children.

Some German studies also controlled for further cognitive variables to find out whether morphological awareness uniquely predicts reading and spelling abilities in German. Volkmer et al. (2019) found morphological awareness to be a unique predictor of reading and spelling abilities in second graders when accounting for phonological awareness. Furthermore, morphological awareness uniquely explained spelling abilities when fluid intelligence was controlled for in children between fourth and seventh grade, (Kargl & Landerl, 2018). These two studies gathered important evidence that morphological awareness uniquely predicts literacy skills in German. Nevertheless, knowledge is limited so far because, in comparison to English, evidence of morphological awareness as a unique predictor of literacy skills beyond

rapid naming, verbal memory and vocabulary is still missing. Moreover, so far, phonological awareness was only used as a control variable in one study with second graders (Volkmer et al., 2019). To control for phonological processing variables in more grade levels would be a valuable expansion of our knowledge on the role of morphological awareness for literacy skills in German.

2.4 Orthographic transparency as a moderator between cognitive variables and literacy skills

It has been suggested that orthographic transparency (cf. section 1.4) might be a moderating factor in the relationship between different cognitive variables and literacy competencies (Moll et al., 2014; J. C. Ziegler et al., 2010). Moll et al. (2014) argue that this is because consistent mappings of phonological and orthographic information of word parts facilitate efficient storage of orthographic patters (cf. Perfetti, 1992). The phonological system is the more challenged with regard to building up word specific representations in the mental lexicon, the more inconsistencies and irregularities there are due to less consistent grapheme-phoneme and phoneme-grapheme correspondences. Word specific orthographic representations facilitate direct word recognition during reading and orthographically correct spelling during writing. Therefore, the authors conclude, the relevance of phonological processing variables for literacy skills should be the higher, the lower the orthographic consistency of the language. In a study with 1062 children between second and seventh grade, Moll et al. compared the literacy competencies of participants from five European orthographies with ascending degrees of orthographic consistency (English, French, German, Hungarian and Finnish). Phonological awareness, rapid naming and verbal memory were the assessed cognitive variables. Across languages, rapid naming was the best predictor of reading speed, whereas phonological awareness was the best predictor of reading accuracy and spelling. In line with their argumentation, the predictive power of the cognitive variables was considerably higher for English, which is the deepest of the five orthographies.

Findings by J. C. Ziegler et al. (2010) are also in line with this. They found that phonological awareness was an important factor in explaining reading competencies of second graders across languages varying in orthographic consistency (Finnish, Hungarian, Portuguese, Dutch and French). As in the study by Moll et al. (2014), phonological awareness proved to be a stronger predictor in less transparent orthographies. The only language in which phonological awareness was not the strongest predictor for reading competencies was Finnish, which has the shallowest orthography of the five languages. For Finnish, vocabulary was the best predictor for reading competencies in second graders. The authors argued that Finnish second graders

already reached a proficiency level in reading that enabled them to considerably boost their vocabulary through reading activities. Children from other languages were not as advanced in reading as their Finnish counterparts were.

With respect to morphological awareness, Desrochers et al. (2018) argued that morphological awareness is more important in less transparent orthographies (e.g. English) than in rather transparent ones (e.g. Greek). The authors explain that morphological awareness might provide a special advantage for reading and spelling in less transparent orthographies because morphemes can disambiguate inconsistencies in grapheme-phoneme and phoneme-grapheme correspondence rules (Desrochers et al., 2018). In contrast, in transparent languages, additional information from morphemes is less important for reading and spelling because readers and spellers can rely on grapheme-phoneme and phoneme-grapheme correspondences. The authors tested their assumption with second graders in three languages with descending degrees of orthographic transparency: Greek, French and English. In this study, morphological awareness was measured with a set of inflection and derivation tasks on real words. It uniquely predicted reading comprehension and spelling after controlling for phonological awareness and rapid naming in all three languages. In English and French, morphological awareness was also a predictor of reading fluency, while only in English, it was additionally a predictor of reading accuracy. This supports the view that morphological awareness is a cognitive variable related to literacy skills across languages, but with stronger associations with literacy skills in less transparent orthographies.

It should be noted that even in rather transparent orthographies, morphological awareness is still a unique predictor of literacy skills as has been shown for Greek (Desrochers et al., 2018), for Finnish (Müller & Brady, 2001), for Italian (Vernice & Pagliarini, 2018) and for Portuguese (Freitas et al., 2018). That is, even in rather transparent languages, readers and spellers seem to make use of morphological information. Therefore, morphological awareness is a predictor of literacy skills across languages with varying degrees of orthographic depth, but with greater importance in inconsistent orthographies than in consistent ones.

With respect to the asymmetric orthography of German, it is to be expected that relations between morphological awareness and literacy skills are stronger for spelling than for reading variables. Yet, the studies that investigated spelling and reading abilities did not report differential effects in their relationships with morphological awareness (Fink et al., 2012; Volkmer et al., 2019). Possibly, this might be explained by an emphasis on phonological approaches to literacy in primary school literacy instruction (cf. Bremerich-Vos & Wendt, 2019; Hagemann, 2018). As only two German studies reported relations of morphological

awareness with both reading and spelling skills so far, more research is needed on this topic to see whether the results can be replicated.

2.5 Developmental aspects of the relationship between morphological awareness and literacy skills

Kuo and Anderson (2006) suggested that the relationship between morphological awareness and literacy skills is most likely a bi-directional one. They argued that morphological awareness contributes to literacy abilities and in turn, growing proficiency with literacy enhances morphological awareness. Results from a longitudinal study by Deacon et al. (2013) are in line with this assumption. In this study, the authors found a bi-directional relationship between reading accuracy and morphological awareness in children assessed in second and third grade after accounting for age, vocabulary and nonverbal intelligence.

The question has been raised whether the relationship between morphological awareness and literacy skills increases with literacy competency. Models on reading by Frith (1985, 1986) and spelling by Varnhagen (1995) state that beginning readers predominantly use alphabetic reading and spelling strategies in which they make use of grapheme-phoneme and phoneme-grapheme correspondences. Later in their reading and spelling acquisition, they also capitalize on longer units in written and spoken language when applying orthographic and/or morphological reading and spelling strategies. Using orthographic and morphological units contributes to becoming a competent reader and/or speller because it boosts processing speed and reduces error rates (see sections 2.2.1.2 and 2.2.2.2). The changes in strategy use suggest that the importance of morphological awareness could increase with higher literacy competency.

In addition, it has been shown that morphological awareness increases over the primary school years (Carlisle & Fleming, 2003; Kirby et al., 2012; Pittas & Nunes, 2014). By this, it could increasingly aid children's reading and spelling processes as described above. However, it has been argued that relations between two variables are unlikely to be stable when either of them is undergoing growth (Kirby et al., 2012; Parrila, Aunola, Leskinen, Nurmi, & Kirby, 2005). Therefore, the strength of the relationship could vary over time.

Grade level has been used as a rough measure for literacy development (e.g. Kirby et al., 2012; Klassert et al., 2018; Ruan et al., 2018). In the English literature, there has been evidence in favour of an increase in the relationship between morphological awareness and reading accuracy (Kirby et al., 2012; Singson et al., 2000), reading speed (Kirby et al., 2012) and reading comprehension (Carlisle, 1995; Kirby et al., 2012) with increasing grade level. Yet, in a meta-analysis on English studies, an increasing relationship was only found between

morphological awareness and reading fluency, but neither with reading accuracy nor with reading comprehension (Ruan et al., 2018). In addition, another meta-analysis for English studies by Lee (2011) did not find systematic increases in the strength of the relationship between morphological awareness and word reading, reading comprehension and spelling in higher grades. Both meta-analysis were conducted with a relatively low number of studies for moderator analyses (Ruan et al.: $N = 32$; Lee: $N = 42$) and therefore lacked testing power in sub analyses. That is, possibly existing increases in the analysed relationships might not have been detected. A difference between the two meta-analyses were the grade level categories that were compared. While Ruan et al. (2018) compared pre-schoolers, beginning readers (Grades 1 and 2), intermediate readers (Grades 3 and 4) and advanced readers (Grades 5 to 12), Lee (2011) concentrated on primary school only (lower vs. upper primary school). It is possible that increases in the relationship of morphological awareness with literacy skills become more evident in later school years. However, such an increase was only found for reading fluency by Ruan et al. (2018).

Results of German studies that addressed the same question are inconclusive, too. It has been found that morphological awareness was related to spelling skills of third graders, but not of first and second graders (Klassert et al., 2018). The authors of this study argue that younger schoolchildren, although already having well-developed morphological awareness skills, cannot yet use them for spelling decisions in a reliable way. In contrast, Volkmer et al. (2019) found that morphological awareness uniquely predicted literacy skills already in second graders. The differences in results could be due to different ways of assessing morphological awareness (Klassert et al.: judgement vs. Volkmer et al.: cloze task; see section 2.2.5.2) and to the different outcome variables (Klassert et al.: consonant clusters vs. Volkmer et al.: more general reading and spelling abilities).

For somewhat older schoolchildren, morphological awareness has been found to be significantly correlated with spelling, although the relation for sixth graders was slightly lower than for children in Grades 4, 5 and 7 (Kargl et al., 2018). In contrast, Kargl and Landerl (2018) found no differences in the relationship between morphological awareness and spelling skills between Grades 4 and 7. That is, also for older students, it remains unclear whether the relationship between morphological awareness and reading variables changes with increasing literacy proficiency in German.

The presented English and German studies give first insights into the development of the relationship between morphological awareness and literacy skills. Their findings are inconclusive, though. For English, there is some evidence that the relationship between

morphological awareness and reading fluency, but not between morphological awareness and other literacy variables, increases. It is possible that changes for other variables could not be detected due to testing power issues. For German, there are too few studies to come to a conclusion about changes in the strength of the inspected relationships. That is, more studies are needed that compare the relationship of morphological awareness with literacy skills between grade levels.

3 Aim and research questions of part I of this dissertation

The aim of this dissertation was to explore the construct morphological awareness and its relations with literacy competencies in German. Part I focuses on schoolchildren.

International studies show that morphological awareness is related to literacy skills (sections 1.3 and 2.2.5) and that it is a unique predictor of both reading and spelling skills (section 2.3). However, studies on this topic for German are scarce. Although the international research base on relations between morphological awareness and literacy skills is growing steadily, findings from one language cannot be transferred to the other one because languages differ in their characteristics. For example, English and German differ in their morphological systems (section 2.1.1.3) and in their orthographic transparency (sections 1.4 and 2.4).

The available German studies suggest a relationship between morphological awareness and literacy skills in German-speaking schoolchildren, too (section 2.2.5.2). However, limited evidence is available with regard to several further questions. For instance, little is known on differential relationships between morphological awareness and different reading and spelling variables. Furthermore, there is scarce evidence on the role of morphological awareness for literacy skills compared to those of other language-related variables. In addition, the role of literacy proficiency for the relationships between morphological awareness and literacy variables is still unclear. The first part of this dissertation was designed to answer three research questions based on these open questions. These three research questions are introduced in the following accompanied with the deduction of corresponding hypotheses.

3.1 How are different facets of morphological awareness related to different literacy competencies?

International studies with schoolchildren imply a stronger relationship between morphological awareness and literacy skills in opaque orthographies than in transparent ones (section 2.4). German is a language with a rather transparent orthography, but with higher orthographic consistency for reading than for spelling (section 1.4). Thus, German is an interesting test case as to whether morphological awareness is more relevant for spelling than for reading in a language with a rather transparent, but asymmetric orthography.

The following two hypotheses were tested:

H1. There is a relationship between morphological awareness and literacy skills in German schoolchildren.

H2. There is a stronger relationship of morphological awareness with spelling skills than with reading skills in German schoolchildren.

3.2 Does morphological awareness uniquely predict literacy skills above and beyond other cognitive skills?

Besides morphological awareness, other language-related skills such as phonological processing skills (section 2.3.1) and vocabulary (section 2.3.2) are associated with literacy competencies. In English, morphological awareness uniquely contributes to literacy competencies in schoolchildren (section 2.3). For German, only one study tested the unique contribution of morphological awareness on literacy skills when accounting for phonological awareness (Volkmer et al., 2019). Its results suggest a unique contribution of morphological awareness on reading and spelling in second grade. A control for further cognitive variables and the consideration of further grade levels can broaden our understanding of the role of morphological awareness for literacy competencies in German.

The following hypothesis was derived:

H3. Morphological awareness uniquely predicts literacy skills in German schoolchildren when accounting for phonological processing skills and vocabulary.

3.3 Is there an increase in the relationship between morphological awareness and literacy skills with increasing literacy proficiency?

Models of reading and writing suggest that children primarily make use of alphabetic reading and spelling strategies at the beginning of their literacy acquisition process. Later they increasingly make use of orthographic and morphological strategies by taking into account larger orthographic and morphological entities (section 2.2.3). This could imply that morphological awareness increases in its importance with increasing literacy proficiency. Moreover, as morphological awareness skills increase across primary school years (section 2.1.3), children could increasingly benefit from their morphological awareness skills when reading or writing. At present, empirical evidence is inconclusive as to whether relations between morphological awareness and literacy skills strengthen with increasing grade level, i.e. with increasing reading and spelling experience (section 2.5). A further cross-sectional study with comparable tests between grade levels would add to our knowledge on this issue.

The following hypothesis was derived from this research question:

H4. The relationship between morphological awareness and literacy skills becomes stronger with increasing literacy proficiency, i.e. with increasing grade level.

The following chapter presents two preparatory pilot studies and the main study that was designed to answer the three research questions and make decisions on the formulated hypotheses.

4 Empirical Studies Part I

For part I of this dissertation, three studies were conducted. Two of these studies were pilot studies that prepared the subsequent main study. The pilot studies were necessary to compile a set of morphological awareness tasks that covered different morphological categories and were suitable for schoolchildren in different grades. The first pilot study tested the adaption of two morphological awareness tasks into an oral presentation and response format with an adult sample (section 4.1). Based on the first pilot study, morphological awareness items were chosen that were expected to be suitable for schoolchildren and they were complemented with further tasks to cover more morphological categories. These tasks, together with all other tests that were to be used in the main study, were included in the second pilot study that was conducted with second and fourth graders (section 4.2). The second pilot study gave further valuable information on the suitability of the morphological awareness tasks for schoolchildren and the feasibility of the planned test sessions. Based on the findings of the two pilot studies, the main study was conducted with primary school children in second, third and fourth grade (section 4.3). In the main study, morphological awareness skills with tasks on different morphological categories, phonological processing skills, vocabulary and different reading and spelling measures were used to be able to test the hypotheses and answer the research questions.

4.1 Pilot Study 1

The aim of this pilot study was to test an adaptation of two tasks of the *Test zur Erfassung der morphematischen Bewusstheit* (TMB, Eng. "*Test for the assessment of morphematic awareness*") by Fink et al., 2012 that were modified into an oral presentation and response format. University students were assessed in this pilot study to determine if such an adaptation is generally practicable.

4.1.1 Preliminary considerations

First, considerations were directed at the measurement of morphological awareness. An inspection of German morphological awareness tasks for schoolchildren was executed to find out what kinds of morphological awareness tasks were available. At this point, the aim was to later work with children in third, fifth and seventh grade in the main analysis. For this reason, a focus was taken on tasks that were suitable for the respective grades. The inspection of tests revealed that no published test existed that was designed for the assessment of morphological awareness in schoolchildren in third to seventh grade. In fact, the only available morphological awareness test for German was the TMB by Fink et al. (2012) which was originally conducted with fifth and sixth graders. It included, for example, a pseudoword cloze task and a

morphological fluency task. It was noticed, though, that some of the other inspected tests included items that were analogous to tasks used in international studies measuring morphological awareness, albeit the German test authors did not give them this label. The search was expanded to take unpublished and published tests into account that included such tasks. Two more tests were identified that included a pseudoword cloze task and that were designed for groups that included schoolchildren (for an overview see Table 2).

Table 2

German tests which were designed and/or standardised for schoolchildren and included items analogous to internationally used morphological awareness tasks

Name of the test	Authors	Age group	Morphological categories in cloze task	Morphological fluency task
Heidelberger Sprachentwicklungs-test (HSET)	Grimm and Schöler (1991)	3-to-9-year-olds (approximately until 3rd grade)	Inflections, Derivations; (real words and pseudowords)	No
Sprachstands-erhebungstest für Kinder im Alter zwischen 5 und 10 Jahren (SET 5-10)	Petermann (2012)	5;0 - 10;11 (approximately until 4th grade)	Inflections (real words and pseudowords)	No
Test zur Erfassung der morphematischen Bewusstheit (TMB)	Fink et al. (2012)	10 - 14 years (conducted in 5th and 6th grade)	Inflections, Derivations; (pseudowords)	Yes (real words)

Note. Tests are listed in the order of the maximal age for which they are designed or the maximal age of participants they had been conducted with, respectively. The TMB is the only test that referred to its tasks as "morphological awareness tasks". The other tests included tasks analogous to tasks used in English studies to assess morphological awareness.

The HSET by Grimm and Schöler (1991) is standardised and offers norms for children aged 3 to 9 years. It includes three subscales with oral cloze tasks, in which real words and pseudowords have to be inflected (plural and singular inflections), derivated (noun derivations to describe a male person, a female person, a place or a diminutive) or both inflected and derivated (inflection and derivation of adjectives). All items are imbedded in mini-stories. The conductor of the test tells the mini-story with the target word to the child. In these mini-stories, the last word of the final sentence is missing. The child is asked to complete the sentence with the inflected or derivated target word.

The SET 5-10 by Petermann (2012), which is standardised and offers norms for children aged 5;0 to 10;11 years, includes oral cloze tasks with plural inflections of pseudowords. The task type equals that of the HSET. Children hear a mini-story from the conductor of the test and they are then asked to inflect the presented target word to finish the last sentence of the mini-story.

The TMB, for which no norms are available so far, had been conducted with children in fifth and sixth grade when the first pilot study for this dissertation was prepared (Fink et al., 2012). The TMB includes a cloze task in in which pseudowords have to be inflected (e.g. plurals, comparatives, and superlatives) and derivated (e.g. diminutives, and nominalisations). Additionally, it includes a morphological fluency task on word families of real words. The TMB uses a written presentation and response format for all tasks.

Of these three tests, only the TMB by Fink et al. (2012) uses the terminus "morphological awareness" to describe the construct that is measured. The pseudoword cloze task of the SET 5-10 is described as measuring knowledge on morphological rules (Petermann, 2012), and the three subscales of the HSET with pseudoword cloze tasks are assigned to the block "morphological structure" (Grimm & Schöler, 1991). However, all three pseudoword cloze tasks are analogous to tasks used in international studies to assess morphological awareness (cf. Berko, 1958; Casalis & Louis-Alexandre, 2000; McBride-Chang et al., 2005). The morphological fluency task is not typical for measurement of morphological awareness in English studies, but has been used in French (Casalis et al., 2004) and in Hebrew (Leikin & Zur Hagit, 2006).

As the SET 5-10 offers norms for children until age 10 (which they reach approximately in fourth grade) and the HSET offers norms for children until age 9 (which they reach approximately in third grade), ceiling effects were anticipated when conducting these tests with older schoolchildren. The TMB had been conducted with children attending fifth and sixth grade. Therefore, the chance of ceiling effects was considered lower for the TMB than for the other two tests when working in different grade levels. Moreover, as it was an aim to cover different morphological categories, the SET 5-10 was not selected because it only covered the category plural inflections. Overall, the TMB was deemed as the most appropriate test of the three for the planned research direction.

As it was an aim to analyse the relationship of morphological awareness with literacy skills, it was decided that an oral assessment of morphological awareness was necessary to avoid confounding with literacy skills (cf. section 2.1.2). Yet, the TMB uses a written presentation and response format. Thus, an adaption of the morphological awareness tasks of

the TMB into an oral presentation and response format was necessary. Permission was granted by the tests authors to work with the TMB for this dissertation. Moreover, they kindly provided additional unpublished test material of the TMB (R. Kargl, personal communication, November 9, 2015). Of the available materials, items were selected for and adapted into an oral presentation and answer format for this dissertation.

The oral presentation and answer format was tested with a university student population. Schoolchildren were deliberately not chosen for this pilot study because an impression on whether the adaption of the test items was feasible could be answered with a university student population. Recruiting and testing schoolchildren is challenging because it needs additional time and logistic resources compared to testing university students. In addition, for teachers and schoolchildren, tests are an intrusion into school life and need both the benevolence and the logistic assistance on the part of headmasters, teachers, parents and children. It was decided that for a first testing of the adaption, these resources should not be exploited.

4.1.2 Research questions

The purpose of this pilot study was to test whether an adaption of the pseudoword cloze task and the morphological fluency task of the TMB into an oral presentation and response format for assessing oral morphological awareness was comprehensible for adult participants and feasible in implementation. Three research questions were formulated.

4.1.2.1 Is the applied adaption of the pseudoword cloze task and the morphological fluency task into an oral presentation and response format comprehensible for participants and feasible in implementation?

University students with German mother tongue have been exposed to German for at least 18 years and attended German classes in school for at least 12 years. Therefore, university students were expected not to have problems with the given tasks in terms of difficulty as the items were originally conducted with fifth and sixth graders. If students were struggling with certain items, this could be attributed to ambiguity in the items, for example, due to the adaption into an auditory format. If such items were identified, they could be excluded from further studies. As the items had been originally conducted with fifth and sixth graders, ceiling effects were expected for all items of the pseudoword cloze task. In contrast, the speed component of the morphological fluency task made ceiling effects much less likely for this task type.

4.1.2.2 Which testing time frame is suitable for the morphological fluency task?

The adaptation of the morphological fluency task into an auditory format required the selection of a testing time frame for the individual items. The TMB provided six minutes testing time for five items, during which participants can freely distribute the time on the five items

(R. Kargl, personal communication, November 9, 2015). As even skilled spellers usually speak faster than they write, it was deemed appropriate to assign a bit less time to each item than the average of 1 minute and 12 seconds provided by the TMB. For this study, a testing period of one minute per item was chosen. The number of responses within 15-seconds intervals over the course of one minute would be analysed for each item to identify a suitable testing time frame for future studies.

4.1.3 Methods

4.1.3.1 Sample

Seventy-one university students were recruited for participation (60 female/11 male; M_{age} = 20.11 years, *SD* = 3.3 years, Range = 18 – 40 years). Students were invited to this study during lectures and seminars. Participants received course credit equivalent to their testing time and chocolates for participation. Participants affirmed that their mother tongue or one of their mother tongues was German. Participants were required to have normal or corrected-to-normal seeing and hearing abilities to be included into the data analyses. These requirements led to the exclusion of four participants. Another six datasets were excluded because the corresponding audio recordings had not been saved properly. The final sample consisted of N = 61 participants (52 female/9 male; M_{age} = 20.9 years, *SD* = 3.3 years, Range = 18 – 40 years).

4.1.3.2 Instruments

Morphological awareness

To measure morphological awareness, two tasks of the TMB by Fink et al. (2012) were adapted. The adaptation was based on the A-version of the TMB as presented in a journal article in 2012 and utilised with fifth and sixth graders and also on additional material that was kindly provided by the authors: The B-version of the TMB and supplementary information on the rating of answers (R. Kargl, personal communication, November 9, 2015). The TMB has since been applied in studies with children from fourth to seventh grade (Kargl et al., 2018; Kargl & Landerl, 2018) and is still under development.

Please note that because the applied tasks were not developed by the author of this work but adapted from other researchers' work, some of it unpublished, test protocols and items are not included in the appendix of this dissertation due to test protection requirements (Diagnostik- und Testkuratorium der Föderation Deutscher Psychologenvereinigungen, 2019).

The two selected tasks, *Pseudowörter* (Eng. pseudowords) and *Morphematische Flüssigkeit* (Eng. morphological fluency), and the applied adaptations are explained in the following.

Pseudoword cloze task

Version A of the task *pseudowords* of the TMB was used, which is a cloze task that requires the manipulation of morphological structures. Participants are asked to manipulate a given pseudoword, which is introduced within a mini-story, in a way that it fits into a subsequent gap. In the following example, a verb has to be derivated into a noun: “Peter grellt schnell. Er ist ein schneller… .” (Eng. “Peter grells quickly. He is a quick… .”).

The pseudoword cloze task includes items measuring inflectional and derivational morphology. All target words are pseudowords, which have the advantage to measure morphological awareness independently from knowledge of orthography and semantics, because the pseudowords are unknown to participants (cf. Fink et al., 2012; see section 2.1.3.2).

To avoid confounding with reading and spelling skills, the pseudoword cloze task was converted into an oral presentation and response format. For this, several adaptions of the tasks were necessary. These adaptations are described in the following.

Oral presentation and response format: The TMB-items of version A of the task *pseudowords* were read to the participants. In the original mini-stories, empty lines indicated were target words should be inflected or derivated. This task was transferred into a verbal presentation as follows: If the gap occurred at the end of the sentence, participants were asked to finish the sentence with their response. For in-sentence-gaps, the expression “hm-hm-hm” was used to indicate that a word was missing there. After the whole mini-story was read to the participants, they were asked to give an inflection or derivation of the target word that would have fitted the in-sentence gap. Participants gave their responses verbally.

Adapted instruction and additional exemplary items: The instruction had to be rewritten so that it explained the auditory presentation and response format. To make sure that all participants fully understood the task, the first three test items of version A and two items of version B were used as exemplary items for the adaptation. By this, all different kinds of stimuli like mid- and end-sentence-gaps were practised.

Reordering of sentences: In the TMB, some of the test sentences are grouped together. In some mini-stories, there were two different sources from which an inflection could be formed. This was the case in mini-stories in which participants had to form first a diminutive and second a plural of the target word: “Hier steht ein Lug. Wie heißt ein winziger Lug? … Das ist eine Gruppe von … .” (Eng. “This is a Lug. How is a tiny Lug called? … . This is a group of … .”). The second item in this group could be answered in two ways: with a) the plural of the diminutive that was formed for the first gap (correct response: Lugchen) or b) the plural of the original word (correct response: Lugs). For the present study, it was decided to reorder the

sentences so that only one type of response would be correct, namely the plural of the original test word. Therefore, the sentences were restructured asking for the plural first and for the diminutive second: “Hier steht ein Lug. Das ist eine Gruppe von … . Wie heißt ein winziger Lug? … .” (Eng. “This is a Lug. This is a group of … . How is a tiny Lug called? … .”). Five groups of sentences were restructured in this way.

Adding pictures: It was decided to complement some tasks with pictures to make them easier to comprehend. This was the case when the wording of the item suggested that there should be something to look at. Six groups of sentences were identified that needed complementary pictures. This applied for all restructured sentences described above and one additional mini-story. The pictures were designed in a way that they followed the logic of the sentences. The pictures were adaptions from the *Heidelberger Sprachentwicklungstest* (HSET by Grimm and Schöler, 1991)[2]. Pictures from the singular-plural test were used and adapted in a way that they additionally showed a smaller version of the presented being or object to represent the test item asking for a diminutive.

Rewording of items: For some items, rewording was necessary to enhance comprehensibility in the auditory presentation. All changes that were conducted are minor, as they did not affect the expected answers to an item.

Rating of Responses: Rating criteria provided by the authors of the TMB recommended considering all responses as correct ones that had appropriate affixes. This guideline was extended to obtain a finer discrimination between responses. All responses with the correct affix and no additional changes in the stem of the test word were awarded with 1 point. From the diminutive example from above, a response awarded with 1 point would be “Lugchen”. Responses that had a correct affix, but made a change in the stem of the word, were awarded with 0.5 points because the correct affix was acknowledged although the transformation of the target word was not completely correct, e.g. “Luginchen”. Additionally, “-i”-suffixes for a diminutive were awarded with 0.5 points, although according to the TMB guideline, zero points would be awarded. In German, the “-i”-suffix is usually used to create a diminutive form of a person (Fleischer & Barz, 2012). As all diminutive items were accompanied by pictures and no picture showed a person, but fantasy animals or objects, a rating of 0.5 points was chosen to acknowledge the diminutive form that was, however, not completely correct in the given context. That is, the response “Lugi” was awarded with 0.5 points. Zero points were assigned

[2] Kindly, the publishing house Hogrefe retrospectively granted permission to use the adapted pictures of the HSET in the described way in this pilot study (J. Niedung, personal communication, September 4, 2019).

to false responses, i.e. responses without the correct affix. False responses were, for example, “Lugling” or “Lukius”.

Morphological fluency

Versions A and B of the morphological fluency task of the TMB were used. Participants were asked to find as many new word formations to a given test word as possible. For this test, several adaptions were applied, which are described in the following.

Auditory presentation: All test items were read to the participants, and participants responded verbally.

Adapted instruction: The instruction was adapted for an auditory presentation and response format. First, an exemplary item was explained and possible correct solutions were presented. Then, participants were asked to find own responses to a second exemplary item. False responses were corrected in the practise phase. Feedback to the practise items was erroneously adapted in a way that it suggested that not only new word formations counted as correct answers but also inflections of the test words. Therefore, both new word formations and inflections of the test words were rated as correct answers in this study. In line with the original guidelines of the TMB, all responses that were not etymologically related to the test word (e.g. rhymes and synonyms) were counted as false responses.

Test items used: All test items of versions A and B of the morphological fluency task of the TMB were used. The exemplary item of version A was also used as an exemplary item in the present study. Yet, this word was not only an exemplary item for version A, but also a test item in version B. Therefore, four test items of version A and only three test items of version B were used in the present study. Five more items were added to test further word categories. Decisions were based on morpheme frequencies in the *linguistics and automatic language processing corpus* (LIMAS) that had been analysed by Hausser (1998). The two nouns “Zeit” (Eng. “time”) and “Jahr” (Eng. “year”), the adjective “groß” (Eng. “great”/ “big”) and the verbs “sein” (Eng. “(to) be”) and “arbeiten” (Eng. “(to) work”) were included into the morphological fluency task as these words had relatively high morpheme frequencies compared to other words of their respective word classes. Randomised lists of the 12 items were produced to balance out sequence effects during testing.

Testing time frame: For this task, a testing time frame of one minute per test item was set for the participants. For the analyses, the number of correct responses within this minute was counted. Additionally, the number of correct answers was analysed in 15 seconds intervals to find out an adequate testing time frame for future studies.

Questionnaire about demographic information

This questionnaire included items on mother tongue, age, gender, educational background, visual and/or auditory impairments, reading and/or spelling disorders and socio-economic status. The questionnaire can be looked up in Appendix A. Some of the questions in this questionnaire were relevant for further research questions that were not related to this dissertation.

4.1.3.3 Procedure

Data for this study was collected as part of course work by students in their third semester and formed part of an empirical training for students. The course work was supervised by the author of this dissertation. There were twelve different student conductors of the tests. Data were re-analysed for this dissertation. The context of the empirical training made it necessary to formulate and pursue research questions that surpassed the methodical questions pursued for this dissertation. Therefore, reading skills, spelling skills and the participants' reading history were additionally measured. These variables were not part of this pilot study. Therefore, they are not regarded in data analyses and discussions.

For this study, both a group and an individual session were administered. The group session always preceded the individual session. In the group session, the questionnaire on demographic information, a spelling test, and a questionnaire about the participants' reading history were applied. The three components of the group session were conducted in a randomised order. Up to four participants took part in a group session. In the individual session, the morphological fluency task, the pseudoword cloze task and a reading test were conducted. The order of the tests in the individual session was again randomised. In addition, the order of morphological fluency items was randomised between participants.

The conduction of the test was practised until all conductors of the test pronounced the items and especially the pseudowords in the same way. Responses to both morphological awareness tasks were audio recorded. Data collection took place in the laboratories of the University of Erfurt in December 2015.

4.1.3.4 Design

This study used a within-subjects, nonexperimental design. The order of applied tests within the two sessions and the order of items of the morphological fluency task were randomised to avoid sequence effects, but not to create different experimental conditions that would be compared.

4.1.3.5 Data analytic method

To analyse whether the adaption into an oral presentation and response format was feasible, means and standard deviations of the morphological awareness tasks were inspected. The pseudoword items were grouped according to the different grammatical categories they represent. The inflectional categories were *Plurals*, *Past participles from verbs*, *Comparatives*/*Superlatives* and *Third person singular*. Derivational categories were *Nominalisations*, *Adjectives*, *Diminutives* and *Past Participles from nouns*. For all categories, ceiling effects were expected, as the participants of the study were all university students. Ceiling effects are reached when 15% of the participants achieve the highest possible score (McHorney & Tarlov, 1995; Terwee et al., 2007).

For the morphological fluency task, means and standard deviations of correct responses for all four 15-seconds intervals were calculated. This information was used to define an optimal testing time frame for future applications of this task.

Finally, correlation analyses between morphological awareness variables were conducted to analyse the relationship between these variables. These correlations were used to determine whether the additional morphological fluency items improved the measure of morphological fluency compared to morphological fluency measured with the TMB items only.

4.1.4 Results

The descriptive statistics are displayed in Table 3. In the pseudoword task, participants reached on average 30 out of 35 points. Taking all 12 items of the morphological fluency task together, on average 87.6 correct responses were made.

Table 3

Descriptive statistics of variables of Pilot Study 1

Variable	Max	*M*	*SD*	Range
Age		20.11	3.4	18 - 40
MA: Pseudoword cloze task (points)	35	30.0	2.8	22 - 34.5
MA: Morphological fluency (points)		87.6	25.9	36 - 174

Note. *N* = 61. MA: Morphological awareness.

For the pseudoword task, descriptive statistics were obtained to examine the data for ceiling effects for each individual item and for the morphological categories. The results are displayed in Table 4. It shows that the percentage of participants with the highest possible score in the respective categories exceeded 15% in all categories except *Adjectives*. In addition, although the 15%-threshold was exceeded for *Comparatives/Superlatives* and *Diminutives*, correct response rates were nonetheless considerably lower than for the other categories.

Table 4

Descriptive statistics for points gained in the pseudoword cloze task

	Points				% of participants with the
Morphological category	Max	*M*	*SD*	Range	highest possible score
Plurals	6	5.6	0.5	4.0 - 6.0	68.9
Plural 1	1	1.0	0.0	1.0 - 1.0	100.0
Plural 2	1	0.9	0.2	0.0 - 1.0	93.4
Plural 3	1	0.9	0.3	0.0 - 1.0	88.5
Plural 4	1	1.0	0.2	0.0 - 1.0	95.1
Plural 5	1	0.9	0.2	0.0 - 1.0	90.2
Plural 6	1	1.0	0.2	0.0 - 1.0	93.4
Comparatives/Superlatives	6	4.9	1.0	2.5 - 6.0	27.9
Comparative 1	1	0.5	0.5	0.0 - 1.0	44.3
Comparative 2	1	0.6	0.5	0.0 - 1.0	60.7
Comparative 3	1	1.0	0.1	0.0 - 1.0	96.7
Comparative 4	1	.93	0.2	0.0 - 1.0	88.5
Superlative 1	1	1.0	0.2	0.0 - 1.0	91.8
Superlative 2	1	0.8	0.3	0.0 - 1.0	82.0
Past participle from verb	2	1.9	0.3	1.0 - 2.0	85.2
Past Participle from verb 1	1	1.0	0.2	0.0 - 1.0	91.8
Past Participle from verb 2	1	0.9	0.2	0.0 - 1.0	91.8
3rd person singular	1	0.93	0.2	0.0 - 1.0	93.4
Nominalisations	4	3.8	0.5	2.0 - 4.0	80.3
Nominalisation 1	1	1.0	0.5	0.5 - 1.0	96.7
Nominalisation 2	1	1.0	0.2	0.0 - 1.0	95.1
Nominalisation 3	1	0.9	0.2	0.0 - 1.0	93.4
Nominalisation 4	1	0.9	0.3	0.0 - 1.0	90.2
Adjectives	6	4.3	0.9	2.0 - 6.0	4.9
Adjective 1	1	0.8	0.4	0.0 - 1.0	80.3
Adjective 2	1	0.6	0.5	0.0 - 1.0	62.3
Adjective 3	1	0.3	0.4	0.0 - 1.0	26.2
Adjective 4	1	0.8	0.4	0.0 - 1.0	82.0
Adjective 5	1	0.9	0.3	0.0 - 1.0	86.9
Adjective 6	1	0.9	0.3	0.0 - 1.0	88.5
Diminutives	6	4.5	0.9	0.0 - 6.0	36.1
Diminutive 1	1	0.7	0.5	0.0 - 1.0	60.7
Diminutive 2	1	0.7	0.4	0.0 - 1.0	68.9
Diminutive 3	1	0.8	0.3	0.0 - 1.0	72.1
Diminutive 4	1	0.7	0.4	0.0 - 1.0	65.6
Diminutive 5	1	0.8	0.4	0.0 - 1.0	70.5
Diminutive 6	1	0.8	0.3	0.0 - 1.0	67.2
Past participle from noun	4	4.0	0.2	3.0 - 4.0	95.1
Past Participle from noun 1	1	1.0	0.1	0.5 - 1.0	96.7
Past Participle from noun 2	1	1.0	0.1	0.5 - 1.0	98.4
Past Participle from noun 3	1	1.0	0.1	0.5 - 1.0	98.4
Past Participle from noun 4	1	1.0	0.1	0.5 - 1.0	98.4

Compared to the other categories, the categories *Adjectives*, *Comparatives*/*Superlatives* and *Diminutives* had also the greatest variability in terms of standard deviations and ranges. All individual items surpassed the threshold criterion on 15%.

The morphological fluency task was analysed with respect to the 15-seconds intervals and the different items. For the testing-time analysis, correct responses of the participants were summarized within each 15-seconds interval. Table 5 shows that the interval of the first 15 seconds had the highest mean (M = 3.7) of correct responses. For the subsequent interval, the mean dropped sharply to (M = 1.6). The mean for the last interval (M = 0.8) indicated that on average participants found less than one correct response per item within the last 15 seconds.

Table 5

Descriptive statistics for correct responses within each 15-seconds interval of the morphological fluency task averaged across the 12 items

	Average per item		
Interval	*M*	*SD*	Range
1 – 15 seconds	3.7	0.9	2.3 - 5.9
16 – 30 seconds	1.6	0.6	0.3 - 3.1
31 – 45 seconds	1.1	0.5	0.2 - 3.0
46 – 60 seconds	0.8	0.5	0.1 - 3.0

Note. Means were calculated across all 12 items and divided by the number of items.

Descriptive statistics for the morphological fluency items are displayed in Table 6. Information on the TMB items was grouped together due to test protection requirements because not all TMB items are publicly accessible (cf. Diagnostik- und Testkuratorium der Föderation Deutscher Psychologenvereinigungen, 2019). Table 6 shows that the verb "(to) work" was the easiest item and the verb "(to) be" was the most difficult item. Of the TMB items, none reached a mean value that was above or below that of "(to) work" and "(to) be", respectively.

Table 6

Descriptive statistics for morphological fluency items

Items	Items	*M* (per item)	*SD*	Range
TMB items	7	7.7	2.5	0 - 26
(to) work	1	10.6	3.5	5 - 23
(to) be	1	3.4	2.6	0 - 9
time	1	7.0	3.2	1 - 14
year	1	6.7	3.3	0 - 19
great	1	5.6	2.7	1 -13

Note. As not all of the TMB items are publicly accessible, the individual items are not displayed here.

Correlation analyses were run for the morphological awareness variables and age (Table 7). No significant correlations were observed between the pseudoword cloze task and any set of morphological fluency tasks (only TMB items, no TMB item or all 12 items). The sets of morphological fluency items correlated highly with each other. Correlations with age were not significant, except for the one with the pseudoword cloze task. The negative value indicates that younger participants tended to produce more correct responses than older participants did.

Table 7

Correlations between different morphological awareness variables and age

Variable	1	2	3	4
1 Age	-			
2 Pseudoword cloze task	.32*	-		
3 Morph. Fluency (only TMB items)	.16	.03	-	
4 Morph. Fluency (no TMB items)	.24	.07	.64**	-
5 MA: Morph. Fluency (all 12 items)	.21	.05	.95**	.85**

*$p < .05$ **$p < .01$.

4.1.5 Discussion

In this pilot study, written morphological awareness items of the TMB were adapted into an oral presentation and response format and tested with university students. Answers to the two research questions of this pilot study are given in the following.

4.1.5.1 Is the applied adaption of the pseudoword cloze task and the morphological fluency task into an oral presentation and response format comprehensible for participants and feasible in implementation?

Overall, the adaption of the two morphological awareness tasks into an oral presentation and response format proved to be comprehensible for participants and feasible in implementation. However, a closer investigation of the tasks and items revealed that some further adaptations would enhance practicability and interpretability when working with schoolchildren.

Some difficulties were observed with some of the morphological categories covered in the pseudoword cloze task. Only six of the seven categories showed the expected ceiling effects, i.e. 15% or more of participants reached the maximal score (cf. McHorney & Tarlov, 1995; Terwee et al., 2007). *Adjectives* was the only category without an observable ceiling effect. In addition, the categories *Comparatives/Superlatives* and *Diminutives* had considerably lower frequency scores for the portion of participants who reached the highest possible score in that category compared to the other morphological categories. The most difficult item was an

adjective, which only 26.2% of participants solved correctly. In addition, the categories *Adjectives*, *Comparatives/Superlatives* and *Diminutives* showed the highest variability in the data. Based on the descriptive statistics, the categories *Adjectives*, *Diminutives*, and *Comparatives/Superlatives* were assessed as possibly problematic.

Several explanations were considered why participants reached lower scores than expected in some of the pseudoword cloze task categories. It is possible that the adaption into an oral presentation and response format put additional load on verbal memory. Therefore, verbal memory was controlled for in the subsequent studies.

Another explanation for this finding is that variance in morphological awareness tasks is still to be expected even for adults. For example, Nagy et al. (1993) observed that morphological knowledge was still incomplete in 12th-graders. Furthermore, Kargl et al. (2018) found in their study with fourth to seventh graders that morphological awareness did not increase beyond sixth grade, but still did not reach ceiling effects in the highest observed grade, which was seventh grade. In a task comparable to the pseudoword cloze task applied here, seventh graders reached a mean of $M = 27.2$ points out of $Max = 39$ points. For comparison, the sample of the present study reached a mean of $M = 30.0$ points out of $Max = 35$ points. That is, the current sample showed a clearer tendency for a ceiling effect than the seventh graders of Kargl et al.'s study did, but still showed variation especially for some of the subcategories. As this university sample experienced at least five more years of schooling and everyday-contact with German, it was assumed that some of the items do not work well with adults when presented in the adapted version.

The unexpected finding of difficulties with some of the pseudoword cloze task items was shared with the authors of the TMB. They reported that they also had observed participants responding with unexpected diminutive forms in the pseudoword cloze task, which is why they had excluded diminutive items from the TMB in more recent versions (R. Kargl, personal communication, June 6, 2016). They also suggested that the diminutive is less common in Germany than in Austria, where their study was conducted, which could have made this task even more difficult for German participants.

As the next studies were planned with German schoolchildren, some of them even younger than the fifth and sixth graders with which the items were originally conducted, it was decided to omit the categories *Adjectives*, *Diminutives*, and *Comparative/Superlatives* from subsequent studies.

Inspections of the instructions and items of the morphological fluency task revealed that some adaptations were necessary for the application of the task with schoolchildren.

Instructions had to be corrected and clarified because in this pilot study, contrary to the original morphological awareness test of the TMB, the instructions falsely suggested that inflections were a possible correct solution because an example for an inflection was given during the instruction. This led to some participants gaining many points with inflecting the words for different grammatical persons (e.g. “Ich arbeite, du arbeitest, er arbeitet…”; Eng. “I work, you work, he works…”). This was not in line with the original purpose of this task. Therefore, instructions were revised for subsequent studies insofar as to explicitly state that only new word formations are requested, i.e. derivations and compounds.

In addition, during testing it was observed that the morphological fluency task was exhausting for some of the participants. Therefore, the number of items had to be reduced for the subsequent studies. All sets of items of the morphological fluency task (TMB items only, no TMB items, all 12 items combined) correlated highly with each other (.64** $\leq r \leq$ .95**), i.e. they were similar measures of the same. In addition, item characteristics of the additional items were similar to those of the TMB items. Therefore, the additional items were left out of the subsequent studies. The further selection procedure for items chosen for the work with schoolchildren is explained in the instruments section of the second pilot study (section 4.2.3.2).

No correlation was observed between the pseudoword cloze task and any set of items of the morphological fluency task (.03 $\leq r \leq$ .07), although they measure different facets of the same construct (c.f. Fink et al., 2012). The observed ceiling effects in the pseudoword cloze task could be an explanation for this finding. Ceiling effects are a marker of skewness in a distribution, i.e. of non-normality. Pearson’s correlation is affected by skewed data and can lead to both inflations and deflations of type I error rates (Bishara & Hittner, 2012), i.e. the likelihood of falsely rejecting a null-hypothesis. This means, the items of the pseudoword cloze task were presumably too easy to adequately measure morphological awareness in adults and to find relationships with morphological fluency. In addition, the erroneous instruction of the morphological fluency task, which suggested that not only word formations but also inflections would be correct solutions, could be a reason why no relationship between the morphological fluency tasks was observed, despite the fact that the morphological fluency task showed considerable variance. Because some participants used the strategy to produce many inflections and others did not, this might have created unwanted noise. In the second pilot study, instructions were revised and clarified.

It was detected that performance in the pseudoword cloze task correlated negatively with age, meaning that younger participants gave more correct responses than older participants did. This is a surprising finding as it was expected that longer exposure to German could

increase morphological awareness. As morphological fluency was uncorrelated with age, it could not be derived that older university students were per se performing lower on morphological awareness variables. Possibly, younger adults were better able to adapt to the pseudoword task. The pseudoword cloze task was presumably more unusual for participants than searching for words of a word family, an exercise they might have had contact with in German lessons. However, in a study by Guo et al. (2011), who observed morphological awareness in American university students with a revised version of Berko's (1958) cloze task that was originally designed for children aged 4 to 7, no relationship between age and morphological awareness was observed. This evidence contradicts the assumption that younger university students can per se adapt to unusual tasks better. Therefore, at this point, it cannot be determined what led to the negative correlation between the pseudoword cloze task and age in the present study.

4.1.5.2 Which testing time frame is suitable for the morphological fluency task?

In the morphological fluency task, participants had a testing time frame of 60 seconds per item to find inflections and word formations of a given test word. All answers were recorded. Recordings were partitioned in four 15-seconds segments to get an impression of the distribution of responses over time. Within the first 15-seconds segment, most correct responses were generated. In subsequent intervals, the mean of correct responses dropped steadily. As the conductors of the test observed that participants who failed to find a correct response for one or more whole 15-seconds-intervals showed signs of discomfort because of this and because it was anticipated that children might produce even less words, it was decided to halve the testing-time for each item to 30 seconds in subsequent studies. Whether 30 seconds were suitable for children was tested in the second pilot study.

4.1.5.3 Conclusion

To summarize the findings, this pilot study gave valuable information for the subsequent studies with children. It could be confirmed that the pseudoword cloze task and the morphological fluency task could be adapted into an oral presentation and response format. However, some categories of the pseudoword cloze task did not reach the expected ceiling effects, which is why these categories were excluded from the studies with children. For the morphological fluency task, a testing time of 30 seconds per item was expected to be suitable for studies with schoolchildren. Moreover, a need to shorten the morphological fluency task was observed. As the additionally added items were no obvious improvement of the morphological fluency measure, they were excluded from the next studies. Moreover, instructions were clarified to stay in line with the original scope of the morphological fluency

task of the TMB. The fact that no correlations between the pseudoword cloze task and the morphological fluency task could be observed can be attributed to ceiling effects, and, in the case of the morphological fluency task, an error in the instructions. Nonetheless, important conclusions could be drawn for the subsequent studies with schoolchildren in terms of the implementation of the morphological awareness tasks.

4.2 Pilot Study 2

Results of the first pilot study were encouraging with respect to the feasibility of an oral measurement of morphological awareness. However, not all item groups that had been applied in the first pilot study functioned as expected, and it had been decided to drop some of them. To be able to cover a wider range of morphological categories again, the assessment of morphological awareness was reconsidered and expanded. Moreover, it was an aim of this dissertation to compare the relationship between morphological awareness and literacy skills at different literacy proficiency levels. Therefore, this second pilot study was conducted to test the revised and expanded set of morphological awareness tasks in a sample of primary school children. Thereby it should be assessed whether the morphological awareness tasks were suitable to measure morphological awareness in second and fourth grade, because the main study would be conducted with primary school children. In addition, the feasibility of the planned testing procedure for the upcoming main study was tested.

4.2.1 Preliminary considerations

As outlined in section 2.1, it was an aim of this dissertation to assess morphological awareness comprehensively covering the categories *inflections*, *word formations*, *real words* and *pseudowords* with an oral presentation and response format. In the first pilot study, these categories had already been covered by the two adapted morphological awareness tasks of the TMB. After analysing the results, pseudoword cloze items covering the inflectional categories *plurals*, *past participle from verb* and *third person singular* and the derivational categories *nominalisations* and *past participle from noun* were expected to be suitable for the application with children. Alternatives were sought for the categories that did not function well in the first pilot study. Items covering these categories were found in the HSET (Grimm & Schöler, 1991), which is a test designed for 3- to 9-year-old children (cf. section 4.1.1). A third set of tasks for measuring skills in compound morphology (Hasenäcker & Schroeder, 2017a) was included. This measure had previously been applied with first and fourth graders (S. Schroeder, personal communication, September 18, 2017) and it used both real words and pseudowords. The second morphological awareness task using real words and covering the morphological category *word formation* was the morphological fluency task that had been tested in the first pilot study. Based on the findings of that pilot study, the task was improved.

Another aim of this dissertation was to observe morphological awareness and its relations to different literacy skills (cf. section 2.2.4) at different proficiency levels of reading and spelling (cf. section 2.5) while controlling for further cognitive variables (cf. section 2.3). Thus, comparable testing material in different grades was needed. Available tests for measuring

reading, spelling, and the cognitive skills phonological awareness, rapid naming, verbal memory, vocabulary, and morphological awareness for German schoolchildren were carefully examined and inspected whether they fulfilled the following three requirements:

1. Established test with good psychometric properties.
2. Including standardisation and normative data for at least three different school grades between grades two and seven.
3. Testing time of all the tests had to add up to not more than two school hours of group testing (which is 90 minutes in total) and not more than one school hour of individual testing (which equals 45 minutes). This criterion was necessary for the feasibility of the study in the participating schools.

Tests measuring literacy skills and the cognitive control variables that fulfilled all our requirements were identified for the primary school grades two, three, and four.

In addition, the comparability between school types was considered. In Germany, all schoolchildren attend primary school from first to fourth grade. Afterwards they go to secondary school. There are different types of secondary schools that differ, not only in their curricula (Thüringer Ministerium für Bildung, Wissenschaft und Kultur, 2011, 2016) and in their academic levels (Weis et al., 2019) but also in the average socio-economic levels of their pupils (Lenz, Holtmann, Rjosk, & Stanat, 2019). In contrast, in German primary schools, all children learn together in one classroom regardless of their academic capacity. Although didactic approaches can differ between classrooms (Hagemann, 2018), the curricula are the same for all primary schools within one federal state. Therefore, conducting all tests within the same school type was favourable because it enhanced comparability between classrooms. By this, it could be avoided to additionally having to control for school type in subsequent analyses, which would have made a greater sample necessary.

Based on these considerations, literacy competency levels were not operationalised, as initially planned, with third, fifth and seventh grade (cf. section 4.1.1) but with second, third and fourth grade. Therefore, this pilot study prepared the main study by testing the suitability of morphological awareness measures and the feasibility of the testing procedure in German primary school children. To test for bottom and ceiling effects in the lowest and highest grade level that would be part of the main study respectively, this pilot study was conducted with second and fourth graders.

4.2.2 Research Questions

The purpose of this study was to test whether adapted and revised morphological awareness items were suitable for second and fourth graders. Furthermore, the feasibility of the testing procedure for the main study was assessed. Two research questions were formulated.

4.2.2.1 Are the adapted and revised morphological awareness tasks suitable for second and fourth graders?

As some of the selected morphological awareness tasks were originally used for an older (TMB) or younger (HSET) population than second- to-fourth graders, ceiling or bottom effects could occur in the respective grade levels. Therefore, this pilot study was conducted with children in the middle of second and fourth grade to test whether the selected tasks were suitable for children in these grade levels.

Additionally, relationships between morphological awareness and the other cognitive and literacy variables could be inspected to determine whether correlation coefficients showed the expected directions. Positive relationships between morphological awareness and other study variables could be a first indicator of appropriate convergent validity of the morphological awareness tasks.

4.2.2.2 Is the testing procedure feasible for school settings?

The second aim of this pilot study was to test whether the planned tests could be conducted within a time frame of 2x45 minutes in group sessions and 45 minutes in individual sessions. Moreover, it had to be assessed whether the number of tests was appropriate for primary school children.

4.2.3 Methods

4.2.3.1 Sample

Participants were 24 second graders and 15 fourth graders from three different primary schools in Erfurt, Thuringia. Four second graders and three fourth graders were excluded from further analyses because they did not participate in the individual session. Analyses were carried out with children whose predominant home language was German, which was checked with a questionnaire for parents. Because of this criterion, one further fourth grader was excluded from analyses. The final sample was 20 second graders (10 male/10 female; M_{age} = 7;9 years, *SD* = 0;4 years, Range = 7;1 - 8;5 years) and 11 fourth graders (4 male/7 female; M_{age} = 9;10 years, *SD* = 0;4 years, Range = 9;4 - 10;8 years). The study was conducted in November and December 2017 during the after-school care club. All participants had written permissions for participation from their parents.

4.2.3.2 Instruments

Spelling

The test *Hamburger Schreib-Probe* (HSP) by May (2013) is a spelling test that requires the child to write down words or sentences that are read aloud by the experimenter. The words and sentences are filled in blanks next to pictures representing the word or sentence. In line with the guidelines of the HSP-manual, test book *HSP 1-M2* was used for second graders and test book *HSP 4-5* was used for fourth graders. Specific norms for the testing period within the school year (mid of second and fourth grade, respectively) were used. In this pilot study, the raw scores for correctly written graphemes were used in analyses because children who attended the same grade also belonged to the same norm group. The test also offers scores for proficiency in alphabetic, orthographic and morphematic spelling strategies. These three variables were not analysed for this pilot study. Internal consistency for the number of correct graphemes is $r = .97$ for the second-grade version and $r = .98$ for the fourth-grade version.

Reading Fluency

Reading fluency skills were measured with *version A* for real words and pseudowords of the subtest *Ein-Minuten-Leseflüssigkeitstest* (Eng. One minute reading fluency test) of the *Salzburger Lese- und Rechtschreibtest II* (SLRT-II) by Moll and Landerl (2014). The SLRT-II reading subtests measure word reading fluency and pseudoword reading fluency. According to the test manual, word reading fluency is a measure for automatic, direct word identification. Pseudoword reading fluency measures synthetic reading based on grapheme-phoneme-correspondence rules, i.e. proficiency in the alphabetic reading strategy.

For each reading subtest, there is a card containing 156 words or pseudowords, respectively. For each of the two cards, the participant is given one minute to read aloud the displayed words as fast and as accurately as possible. All reading sessions were audio recorded. Based on the recordings, the numbers of correctly read words and non-words were identified. Raw scores were used in the analyses as all children belonged to the same norm group within their respective grades. The manual reports reliability indices for second to sixth grade. Parallel-form reliabilities are between $.93 \leq r \leq .98$ for word reading and between $.90 \leq r \leq .96$ for pseudoword reading.

Reading comprehension

Reading comprehension was measured with the paper-pencil version of the *Ein Leseverständnistest für Erst- bis Siebtklässler – Version II* (ELFE-II) by Lenhard, Lenhard, and Schneider (2017). This test includes subscales for word-reading comprehension, sentence-reading comprehension and text-reading comprehension. The test also gives a mean *t*-value for

reading comprehension across all three subscales. This value was used in analyses. The usage of the mean *t*-value was necessary because the subscales differed in their respective number of items and item difficulties. To weight the three scales equally, *t*-values were identified for each subscale and then averaged across the scales. There are specific norms for all six two-month periods within each school year. Thus, specific norms for the time of testing could be applied. Overall split-half reliability across all subscales for the paper-pencil version is $r_{tt} = .96$. Re-test reliability after 30 days for the paper-pencil version is $r_{tt} = .93$.

Phonological awareness

Phonological awareness was assessed with subtest 5 of the *Potsdam-Illinois Test für Psycholinguistische Fähigkeiten* (P-ITPA) by Esser, Wyschkon, and Ballaschk (2008). Subtest 5 consists of three different tasks, two of which measuring phonological awareness in the narrower sense and one measuring phonological awareness in the broader sense. In the vowel-change task, which measures phonological awareness in the narrower sense, participants have to exchange a vowel in a given word with another one. If the threshold criterion in the vowel-change task is not reached, the rhyme task is administered. In the rhyme task, the child is asked to choose from three to four options the one that rhymes with the presented test word. This task measures phonological awareness in the broader sense. If the threshold criterion of the vowel-change task was met, children are by default credited with the maximum of points that is reachable in the rhyme task. For all children, the final task is the consonant-elision task, which again measures phonological awareness in the narrower sense. In this task, the child is asked to leave out a certain consonant of a given word. All children work on two tasks measuring phonological awareness in the narrower sense, but only children struggling with the vowel-change task are presented with a task measuring phonological awareness in the broader sense. For analyses, raw scores of correctly answered items were used because all children belonged to the same norm group within their grades. Norms are given in half-year intervals. Cronbach's α is α = .96 for the rhyme task, α = .94 for the vowel-change task and α = .95 for the consonant-elision task.

Verbal memory

Verbal memory was assessed with the subscale "*Pseudowörter nachsprechen*" (Eng. "repeating pseudowords") of the *Züricher Lesetest II* (ZLT-II) by Petermann and Daseking (2015). For this test, orally presented pseudowords of increasing length had to be repeated by the child. The raw score of the number of mistakes made by the child was used in later analyses. The ZLT-II manual advises to speak slowly and clearly when presenting the words, speaking one syllable per second. During preparations for the present study it was realised that one

second per syllable is an extremely slow presentation of a word and untypical for normal spoken language. Therefore, it was decided to diverge from the instructions by presenting the words slowly, but in a relatively normal articulation speed. All conductors of this test practised the presentation until equal pronunciation and length of articulation was reached. Cronbach's α for the respective grade levels is α = .70 for mid of second grade and α = .76 for fourth grade. Re-test reliability across all grade levels is *r* = .79.

Rapid naming

Rapid naming was assessed by using the subscale "*Schnelles Benennen*" (Eng. "rapid naming") of the ZLT-II (Petermann & Daseking, 2015). Both versions of the subtest were applied. In both versions, objects have to be named as fast as possible. In version 1, the five different objects are practised with the child before testing starts. In version 2, 30 different objects have to be named without prior practising. Due to the lack of practicing in version 2, children sometimes were unsure what some of the objects represented, by what their naming speed was slowed down. Therefore, only the raw score of version 1 was used in analyses. Re-test reliability across all grade levels for version 1 is *r* = .94.

Vocabulary

Vocabulary was assessed through the vocabulary subtest of the KEKS-test-battery *Kompetenzerfassung in Kindergarten und Schule* (KEKS) by May and Bennöhr (2013). Second graders worked with the KEKS Deutsch 2M (Mitte Kl. 2) version A and fourth graders worked with the KEKS Deutsch 4M (Mitte Kl. 4) version A. With this subtest, receptive vocabulary was measured in a group setting. Manual guidelines say that children shall work through the test on their own, i.e. they read the instructions and items themselves. Yet, this would put struggling readers at a disadvantage. As reading competency was a dependent variable in this study, it was decided to reduce confounding between the variables reading and vocabulary by adapting the procedure of the test. The conductor of the tests explained the task to all children and worked through the exemplary items together with the children making sure everyone understood the task. After that, each test item was read aloud separately by the conductor of the test. Children were asked to read silently along and then mark their response in the test book. Each item consisted of a sentence with a gap and a list of four words from which the child was asked to tick the word that fitted in the sentence. The sum of correct responses was used for analyses as all children belonged to the same norm groups within their grades. Values for Cronbach's α are α = .88 for the version used with second graders and α = .78 for the version used with fourth graders.

Morphological awareness

Morphological awareness was measured with a pseudoword cloze task and a morphological fluency task. As mentioned above, morphological awareness items were taken and adapted from published and unpublished tests that had been developed by other authors. Due to test protection requirements (cf. Diagnostik- und Testkuratorium der Föderation Deutscher Psychologenvereinigungen, 2019), only few exemplary items can be given for the explanation of the tasks as administered in this study.

Pseudoword cloze task

The pseudoword cloze task as applied in the first pilot study was revised and extended. Due to unexpected difficulties adults had with items on diminutives, adjectives and comparatives/superlatives, the respective categories were excluded. As items on diminutives were always grouped together with plural items, and because other plural items from another test would be used (see below), the plural items from the TMB were also omitted from the pseudoword cloze task. The TMB items that were kept were those on past participles, 3rd person singular, and nominalisations. As all items for which pictures had been added in the first pilot study (plurals and diminutives) were excluded, no pictures from the HSET were used for this part of the pseudoword cloze task anymore. Adaptions concerning the oral presentation and response format and the re-wording of specific items remained.

To replace the omitted categories of the TMB, and because participants would be younger than originally anticipated, pseudoword tasks from three subtests of the HSET that were designed for children up to 9 years of age were used[3]. The applied subscales were *Plural-Singular-Bildungen* (Eng. plural-singular formations), *Adjektivderivationen* (Eng. adjective derivations) and *Ableitungsmorpheme* (Eng. derivational morphemes). Of the *plural-singular formations*, all 13 items with pseudowords were applied. One item with a real word as the target word was used as an exemplary item for the instruction of this task. In this task, 7 pseudowords that were presented in a singular form had to be turned into plurals and 6 pseudowords that were presented as plurals had to be turned into a singular form. Of the subscale *adjective derivations*, the tripartite exemplary item and the 4 tripartite test items with pseudowords of the 5 tripartite test items this subtest comprises were used. In these tasks, first, a noun had to be derivated into an adjective, and then this adjective had to be inflected in its comparative and superlative forms. Of the subscale *derivational morphemes*, the 2 quadripartite test items with

[3]Kindly, the publishing house Hogrefe retrospectively granted permission to use the adapted items of the HSET in the described way in this pilot study (J. Niedung, personal communication, September 4, 2019).

pseudowords of the 4 quadripartite test items this subtest comprises were used. In these tasks, items describing male persons, female persons, places and diminutives had to be derivated.

For the final part of the pseudoword cloze task, 10 items assessing the ability to form and decompose compounds were used. This task was practised with two exemplary items. These items were provided by Hasenäcker and Schroeder (2017a) and had previously been applied with first graders and fourth graders (S. Schroeder, personal communication, September 18, 2017). In 8 items, a compound had to be formed out of two base words, and in 2 items, a compound had to be decomposed into two base words. Compounds had to be formed with either two real words (5 items), a real word and a pseudoword (2 items) or two pseudowords (1 item). An item for the formation of a compound with a real word and a pseudoword is displayed in Table 8. Of the compounds that had to be formed with two real words, two resulted in an existing word and three resulted in non-existing words. The two compounds that had to be decomposed were non-existing words that consisted of two real words. An instruction explaining this task was added.

Table 8

Exemplary items for the pseudoword cloze task

Category (Test)	Stimulus[a]	Task	Exemplary answer[b]	Response rated
Inflection: Past participle (TMB)	Sie kann jederzeit *ankuben*.[1]	Repetition of the pseudoword.	ankuben	No[c]
	Vorgestern hat sie uns … .[2]	Inflection of the pseudoword so that it fits into the gap.	angekubt	Yes
Derivation: Create a noun describing a male person (TMB)	Peter *grellt* schnell.[3]	Repetition of pseudoword.	grellt	No[c]
	Er ist ein schneller… .[4]	Derivation of the pseudoword so that it fits into the gap.	Greller	Yes
Compound: Forming a compound (Hasenäcker & Schroeder, 2017a)	Eine Decke zum *Manken* ist eine … .[5]	Repetition of the phrase.	Decke zum Manken	No[c]
		Combining the two test words to one compound.	Mankdecke	Yes

Note. [a]Presented via audio recording. [b]Responses were rated based on the rating criteria of the TMB, the manual guidelines of the HSET and rating guidelines provided by the authors of the compound items (Hasenäcker & Schroeder, 2017a). [c]Not included in the pseudoword cloze task score, but the rating of the subsequent response was based on this answer.

English translations: [1]She can *ankub* anytime. [2]The day before yesterday she has … us. [3]Peter *grells* quickly. [4]He is a quick… .[5]A blanket for *manking* is a…

For all items, the following adaptions applied: Audio recordings of all test items were made with the help of a trained speaker. In the test session, the audio recordings of the items were presented to the child from a laptop. Furthermore, to verify that participants understood the pseudowords correctly, they had to repeat the pseudowords before they applied the morphological change (cf. Table 8). If a child failed to repeat the presented pseudoword correctly, the rating of the subsequent morphological change that was applied to the pseudoword in the second part of the item was based on how the child had repeated the pseudoword and not on the original pseudoword. This should ensure that a child did not lose points in the pseudoword cloze task due to mishearings.

For the pseudoword cloze task, a protocol sheet was designed that listed the items in the order in which they were presented to the participants along with the numbers of the audio recordings and, where necessary, miniatures of the pictures that had to be presented with the items. Conductors of the test made notes of the responses of the participants in the protocol sheet. Due to test protection requirements, the protocol sheet cannot be included in this dissertation as the original items were developed by other authors (cf. Diagnostik- und Testkuratorium der Föderation Deutscher Psychologenvereinigungen, 2019).

Of the final set of items of the pseudoword cloze task, 24 items required an inflection, 21 items required a derivation and 10 items concerned compounding.

Responses were rated based on the rating criteria of the TMB, the manual guidelines of the HSET and the rating guidelines provided by the authors of the compound task (Hasenäcker & Schroeder, 2017a). In all tasks, two points could be gained for completely correct answers, one point for partly correct answers and zero points were given for false or no answers. According to the HSET, partly correct responses show that the child understood the semantic relations in the item and based his or her answer on a grammatical rule that is not exactly concordant with the actual rule that had to be applied. For instance, a child could use the suffix "-lig" instead of the correct "-ig" to mark an adjective. In this case, the applied suffix is very similar to the correct suffix. Using a dichotomous false/correct rating would underestimate the child's ability because the response indicates that a grammatical rule was applied based on the semantic relations in the test item (Grimm & Schöler, 1991). The differentiation between correct, partly correct and false responses had already been applied on the adapted TMB items in the first pilot study, but was an adaptation for the rating of the original TMB items and the compound items, as these two sources did not specify points for partly correct answers in their guidelines. For analyses, raw scores of points gained in the pseudoword cloze task were used.

Morphological Fluency

The morphological fluency task was based on the adapted version of the morphological fluency task of the TMB that was tested in the first pilot study. Findings from that first pilot study induced several revisions, which concerned the instruction, the number of items and the testing-time participants had for each item. The instruction was revised to explain clearly with the help of exemplary items that only word formations (derivations and compounds) were correct answers but not inflections. As the sample in the present study was younger than the fifth and sixth graders with which the TMB was originally conducted, an effort was made to choose the easiest items for this task from the items provided by the TMB to minimise the risk of bottom effects for younger schoolchildren. For this, the respective type frequencies of the morphological family sizes of all practice and test items of versions A and B of the TMB were identified with the help of the *German Children's Book Corpus* (ChildLex). ChildLex contains over ten million words from 500 books that are written for children between 6 to 12 years (Schroeder, Würzner, Heister, Geyken, & Kliegl, 2015). The type frequency of the morphological family size indicates in how many different words in the ChildLex corpus the stem of the word is used. The four items with the highest respective type frequencies of the morphological family sizes were chosen as test items because participants should be familiar with more derivations and compounds of these items than with derivations and compounds of items with lower type frequencies. Being familiar with more derivations and compounds should make the morphological fluency task easier. Four items were chosen which corresponds to the number of test items used in the TMB. Based on the findings of the first pilot study, 30-seconds intervals were chosen as testing time frames for each item (cf. section 4.1.5). For each correct response, one point was awarded.

Questionnaire for parents

In the letter that explained the implementation and aim of this study, parents were asked to fill in a short questionnaire. The questionnaire consisted of questions on the language(s) that were spoken at home, the parents' educational background, the number of books at home, how often their participating child read books or magazines, and how often parents read to their participating child. The questionnaire can be viewed in Appendix B. The questions of this questionnaire were self-generated, except for the task on the number of books at home, which was an adaption from a question used in PISA 2000 (Haider & Böck, 2001). The number of books has widely been used as an indicator for parental socio-economic status (e.g. Bos, 2003; Bos et al., 2003; Gustafsson, Nilsen, & Hansen, 2018; Petrova & Alexandrov, 2015). In this pilot study, this questionnaire was mainly used to determine the child's home language. In the

main study, the other questions would be used to analyse whether the subsamples from the different grades were comparable in terms of socio-economic status and literacy exposure. Questions on these variables were already included in this pilot study to get an impression of whether parents filled in this questionnaire completely and whether their responses suggested that the wording of one or more questions could be improved (cf. section 4.3.1.2).

4.2.3.3 Design

This cross-sectional study used a correlational design. The between-subjects variable was grade level. Literacy variables were spelling, reading fluency, pseudoword reading fluency, and reading comprehension. Morphological awareness was measured with the morphological fluency and the pseudoword cloze task, which contained the categories inflections, derivations and compounds. Further, phonological awareness, rapid naming, verbal memory, vocabulary and age were measured.

4.2.3.4 Procedure

Testing order was the same for all participants. First, spelling, reading comprehension and vocabulary were measured in a group session. Second, morphological awareness, rapid naming, phonological awareness, verbal memory, word reading fluency, and pseudoword reading fluency were measured in an individual session.

Data for this study was collected as part of course work by students in their third semester and by the author of this dissertation. The course work was supervised by the author of this dissertation. Data were re-analysed for this dissertation.

4.2.3.5 Data analytic method

As the sample sizes of second and fourth graders are small, differences between the two groups should be interpreted with caution. Nevertheless, it was deemed important to compare means of descriptive variables between second and fourth grade, especially for the morphological awareness tasks, to assess the plausibility of the data. For morphological awareness tasks and for further variables on which fourth graders unexpectedly performed worse than second graders, *t*-tests of independent samples were calculated to have an indication whether the observed differences were significant.

Item characteristics of the morphological awareness items were inspected for bottom and ceiling effects. For that, discriminatory power and difficulty of the items of the pseudoword cloze task were identified. Because the testing time of the individual session exceeded 45 minutes, item characteristics were used to select the most suitable items for the main study.

Item difficulty (P) is calculated with the item mean (Moosbrugger, 2012). In this analysis, item difficulty could take values between $P = 0$ (no participant solved that item) and

P = 2 (all participants replied with a fully correct answer). That is, item difficulty actually indicates how easy an item is (Moosbrugger, 2012). Item difficulties of P = 0 or P = 2 signify bottom or ceiling effect, respectively, because no or all participants solved that item. The threshold criterion of 15% of participants with the highest or lowest possible score (cf. McHorney & Tarlov, 1995; Terwee et al., 2007) was inspected for the overall points gained in the pseudoword cloze task and its subcategories inflections, derivations and compounds.

The discriminatory power (r_{it}) of an item is calculated by the correlation of the item with its scale (Moosbrugger, 2012). The higher the discriminatory index, the better an item can differentiate between participants. A threshold criterion for acceptable item difficulty is $r_{it} \geq .30$ (Wentura & Pospeschill, 2015). Items of lower discriminatory power can still be useful to differentiate between very high- or low-achieving participants if the item is of very high or low difficulty, but discriminatory power should not be close to zero because that would indicate that the item cannot differentiate between any participants (Moosbrugger, 2012). Negative discriminatory power is problematic because it indicates that this item is solved rather by lower-performing participants than by higher-achieving participants (Pospeschill, 2010). As no item in the pseudoword cloze task is reversely coded, negative discriminatory power should not occur.

Correlations of morphological awareness variables with other study variables were inspected for plausibility to obtain a further indicator for the validity of the morphological awareness tasks. All variables were expected to correlate positively with morphological awareness tasks, except for correlations with rapid naming and verbal memory. Rapid naming is represented by the time needed for that task, i.e. the more time needed, the lower the performance. Verbal memory should show negative correlations with the other tasks because errors were counted for this variable. For all other variables, correct responses were counted.

Post-hoc power analyses were conducted for correlation analyses using the programme GPower (Faul, Erdfelder, Buchner, & Lang, 2009). They were executed with the parameters corresponding to the analyses reported in the results section. These were two-tailed testing, an α-error probability of α = .05, and the sample sizes of n_{second_grade} = 20 and n_{fourth_grade} = 11. For second graders, a small correlation of r = .1 reached a power of 1-β = .11, a medium correlation of r = .3 reached a power of 1-β = .39, and a large correlation of r = .5 reached a power of 1-β = .80. For fourth graders, a small correlation of r = .1 reached a power of 1-β = .09, a medium correlation of r = .3 reached a power of 1-β = .25, and a large correlation of r = .5 reached a power of 1-β = .55. According to Cohen (1992), the power should be 1-β ≥ .80, because otherwise there is too great a risk of making a type II error, i.e. falsely not-rejecting the null-

hypothesis. In this correlation analysis, this would mean falsely assuming that there is no correlation between the variables. In the correlation analyses, only for a large effect in the sample of second graders the threshold-criterion of $1\text{-}\beta \geq .80$ was reached. That means the risk of making a type II error was high for all correlations for fourth graders and for small and medium correlations for second graders. Accordingly, results should be interpreted with caution. Therefore, correlations between observed variables were only inspected as to whether correlation coefficients showed the right directions and not with regard to significance values.

4.2.4 Results

Descriptive statistics are presented in Table 9. Descriptively minimal differences in the overall points gained in the pseudoword cloze task were observed between second- and fourth graders. In the subcategories inflections and compounds, descriptively second graders reached on average higher scores than fourth graders, while fourth graders reached on average higher scores for items on derivations than second graders. Yet, *t*-tests of independent samples revealed that all differences were not significant ($-.47 \leq t \leq 1.15$, all $p > .05$). The overall means for the pseudoword cloze task did not show bottom or ceiling effects because no child in either second or fourth grade received zero or the maximal score of points. The same applies for the subcategories inflections, derivations and compounds.

For the morphological fluency task, a descriptive difference between second- and fourth graders was evident. While second graders received on average 3.9 points, fourth graders received on average 11.9 for this task. A *t*-test of independent samples confirmed that this difference was significant: $t(15.92) = -4.63$, $p < .01$**. The descriptive statistics of the other study variables were in the expected ranges with the exception of those of verbal memory, in which fourth graders descriptively made on average more errors than second graders. However, this difference was non-significant in a *t*-test of independent samples: $t(16.30) = -0.40$, $p = .691$. Spelling, reading comprehension and vocabulary cannot be compared directly as different maxima existed for second and fourth graders (for spelling and vocabulary) or *t*-values had to be used (reading comprehension).

Table 9

Descriptive statistics of the second pilot study

		Second Grade			Fourth Grade		
Variable	Max	*M*	*SD*	Range	*M*	*SD*	Range
Age (years;months)		7;9	0;4	7;1 - 8;5	9;10	0;4	9;4 - 10;8
Correctly spelled graphemes (raw score)	2: 63 4: 277	56.0	4.4	45 - 62	252.8	20.5	212 - 276
Reading comprehension (mean *t*-value)		54.9	11.8	29 - 76	54.3	11.1	38 - 70
Word reading fluency (raw score)	156	43.0	19.4	4 - 102	67.6	22.1	27 - 94
Pseudoword reading fluency (raw score)	156	30.1	9.4	9 - 54	38.4	14.8	21 - 61
Phonological awareness (raw score)	64	54.0	6.0	41 - 62	55.3	7.4	40 - 63
Rapid naming (time in seconds)		23.0	3.4	17.7 - 29.0	22.4	5.0	16.5 - 31.0
Verbal memory (errors)	25	5.6	3.4	1 - 13	6.2	4.5	1 - 14
Vocabulary (raw score)	2: 22 4: 15	20.6	1.4	18 - 22	10.5	2.8	7 - 15
MA: Pseudoword cloze task (points)	110	62.2	12.4	34 - 86	63.4	12.9	46 - 80
Inflections	48	37.1	6.7	24 - 47	36.9	7.2	22 - 45
Derivations	42	25.2	8.4	10 - 40	26.5	6.9	18 - 38
Compounds	20	11.9	4.1	1 - 17	10.3	3.3	5 - 15
MA: Morphological fluency (points)		3.9	3.7	0 - 11	11.9	5.1	4 - 19

Note. Second grade: n = 20. Fourth grade: n = 11. MA: Morphological awareness.

Each item was analysed for discriminatory power and difficulty. Item difficulty varied between $.4 \leq P \leq 2.0$ for both second graders and fourth graders (Table 10). One plural-to-singular item was solved by all participants. No more ceiling effects were observed for second graders. For fourth graders, three more items were solved by all participants: one plural item, one comparative and one compound. No bottom effects were identified.

Discrimination indices varied between $-.26 \leq r_{it} \leq .63$ for second graders and between $-.38 \leq r_{it} \leq .92$ for fourth graders. For second graders, they were lowest for inflections and highest for compounds. The reverse was observed for fourth graders. Some items had negative discriminatory power. In the case of second graders, this concerned 3 items, and in the case of fourth graders, this concerned 10 items.

Table 10

Summarized item characteristics of the pseudoword cloze task

	Second Grade						Fourth Grade					
	P			r_{it}			*P*			r_{it}		
Category	*M*	*SD*	Range	*M*	*SD*	Range	*M*	*SD*	Range	*M*	*SD*	Range
Pseudowords	1.3	0.4	0.4 - 2.0	.29	.22	-.26 - .63	1.3	0.5	0.4 - 2.0	.28	.32	-.38 - .92
Inflections	1.5	0.4	0.6 - 2.0	.22	.25	-.26 - .58	1.5	0.4	0.8 - 2.0	.30	.37	-.38 - .92
Derivations	1.2	0.4	0.4 - 1.9	.35	.15	.04 - .61	1.3	0.4	0.5 - 1.8	.28	.29	-.26 - .70
Compounds	1.2	0.4	0.6 - 1.9	.36	.23	.03 - .63	1.0	0.6	0.4 - 2.0	.23	.30	-.09 - .74

Note. Second grade: $n = 20$. Fourth grade: $n = 11$. P = Item difficulty; r_{it} = Discriminatory power.

Cronbach's α for the pseudoword-cloze task was α = .87 for second graders and α = .86 for fourth graders. Taking all participants together, it was α = .86.

During data collection, it was noticed that the instruction of the morphological fluency task was confusing for the children. Although it was clearly explained with the help of exemplary items that inflections did not count as correct answers, children tended to form inflections of the test words. After the observation of six children, the instructions of the morphological fluency task were revised. In the revised version, only correct solutions were explained, i.e. mentioning incorrect examples was omitted. Only if the child produced incorrect solutions in the practise trial, he or she was informed that this type of answer was not correct. The revision significantly improved the performance in the morphological fluency task, $t(17.73) = -2.81$, $p = .012$*. All fourth graders received the revised instructions. Table 9 shows descriptive statistics averaged across the morphological fluency task both before and after revision. Table 11 gives more details on the morphological fluency tasks by differentiating descriptive statistics before and after the revision of the instruction.

Table 11

Descriptive statistics of the morphological fluency task before and after the instructions were revised

	Second Grade			Fourth Grade		
Morphological fluency	*M*	*SD*	Range	*M*	*SD*	Range
Before revision (points)	1.5	1.4	0 - 3	-	-	-
After revision (points)	4.9	3.9	0 - 11	11.9	5.1	4 - 19

Note. Second grade: $n = 6$ before revision; $n = 14$ after revision. Fourth grade: $n = 11$ (all after revision).

Discrimination indices for the morphological fluency items were $.07 \leq r_{it} \leq .79$ for second graders and $.22 \leq r_{it} \leq .80$ for fourth graders for the revised version of the morphological

fluency task. Each item reached a discrimination index of $r_{it} \geq .30$ in at least one grade. Cronbach's α for the revised morphological fluency tasks was α = .61 for second graders and α = .76 for fourth graders. Taking all participants together, it was α = .82.

Table 12 displays correlations between morphological awareness and other study variables. In second and fourth grade, correlations showed the expected directions or were close to zero with the exception of some correlations with age. Age correlated negatively with the pseudoword cloze task (r = -.57**) and with the subcategory inflections (r = -.59**) in second grade. Additionally, the correlations between both morphological awareness tasks were inspected. The correlations between the pseudoword cloze task and the revised version of the morphological fluency task was r = .46 in second grade and r = .67* in fourth grade. Correlations of the subcategories of the pseudoword cloze task were between $.33 \leq r \leq .68$** in second grade and between $.48 \leq r \leq .67$* in fourth grade.

Table 12

Correlations of morphological awareness variables with other study variables in second and fourth grade

Variable	Age	Correctly spelled graphemes	Reading comprehension	Word reading fluency	Pseudoword reading fluency	Phonological awareness	Rapid naming	Verbal memory	Vocabulary
Second grade									
Pseudoword cloze task	-.57**	.49*	.62**	.48*	.25	.55*	-.07	-.45*	.51*
- Inflections	-.59**	.34	.36	.36	.33	.30	-.31	-.42	.56
- Derivations	-.37	.44	.63**	.42	.10	.57*	.15	-.33	.30
- Compounds	-.35	.39	.58*	.29	.09	.35	.05	-.35	.34
Morphological fluency	.01	.52*	.54*	.57**	.52*	.30	-.13	-.55*	.46*
Morphological fluency-revised	-.13	.69*	.53	.58*	.55*	.29	-.22	-.71**	.45
Fourth grade									
Pseudoword cloze task	-.09	.67*	.75**	.79**	.87**	.88**	-.30	-.82**	.54
- Inflections	-.36	.50	.67*	.72*	.74**	.82**	-.30	-.87**	.36
- Derivations	.21	.73*	.69*	.72*	.86**	.79**	-.24	-.64*	.63*
- Compounds	-.08	-.00	.56	.59	.49	.65*	-.03	-.65*	.18
Morphological fluency-revised	.32	.73*	.26	.38	.45	.50	-.13	-.61*	.11

Note. Second grade: $n = 20$. Fourth grade: $n = 11$. Morphological Fluency revised ($n_{second\_grade} = 14$). Pairwise exclusion. Two-tailed testing.
*$p < .05$ **$p < .01$.

4.2.5 Discussion

The aim of this second pilot study was to test the suitability of the adapted morphological awareness tasks in a sample of primary school students. Furthermore, the whole test battery that was prepared for the main study was tested to evaluate the feasibility and length of testing time. The two research questions are answered in the following.

4.2.5.1 Are the adapted and revised morphological awareness tasks suitable for second and fourth graders?

The morphological awareness tasks covered different morphological categories and comprised two task types: the pseudoword cloze task and the morphological fluency task. Both are analysed in terms of suitability for primary school children based on the results of descriptive statistics, item characteristics and correlations.

Pseudoword cloze task

Descriptive statistics did not indicate any obvious bottom or ceiling effects for the pseudoword cloze task and its subcategories *inflections*, *derivations* and *compounds* in both grades, which is a first indicator that the applied items discriminate between different morphological awareness skills in primary school children. Studies showed that morphological awareness is undergoing growth during primary school years (Apel, 2014; Kirby et al., 2012; Singson et al., 2000). Therefore, fourth graders should reach significantly higher scores in morphological awareness tasks than second graders. Yet, *t*-tests of independent samples did not detect a difference in points gained in the pseudoword cloze task and any of its subcategories between second and fourth grade. In fact, descriptively even the reverse was observed for the subcategories inflections and compounds, indicating that second graders performed better in these subcategories than fourth graders. What is more, inspections of item characteristics revealed that three items in second grade and ten items in fourth grade had negative discriminatory power, indicating a reversed probability for correct responses in comparison with the other items in the test. As a reverse coding of items was not applicable, the negative discriminatory power signifies that these items did not function well in the tested sample. The mean discriminatory power of all items combined was $M_{rit} = .29$ in second grade and $M_{rit} = .28$ in fourth grade. These values are close to the threshold criterion of $r_{it} \geq .3$ (cf. Wentura & Pospeschill, 2015), indicating that despite the negative discriminatory power of some items, others could discriminate well between participants ($r_{it\_max} = .63$ in second grade and $r_{it\_max} = .92$ in fourth grade). Besides, discriminatory power can be lower for very difficult or very easy items (section 4.2.3.5), which are important to differentiate between participants that have very low or very high morphological awareness skills. In addition, Cronbach's α for the

pseudoword cloze task was $\alpha \geq .80$ for both grades. According to threshold guidelines (cf. Field, 2018), reliability of this task can therefore be rated as good.

As this pilot study was conducted with a small and presumably not representative sample in the respective grades, decisions on the omission of items should not be based solely on items characteristics and descriptive statistics. Yet, the findings motivated another careful inspection of the pseudoword cloze task items and the instructions for the different subtasks.

For items on compounding, two areas that could be improved were identified. One such area was that the exemplary items only covered the task type in which a compound had to be formed but not the task type in which a compound had to be decomposed. Clarity of the task could be improved if both task types were explained with an exemplary item. The second area of improvement concerned the items themselves. Compounds could be formed of two real words, a real word and a pseudoword or two pseudowords. The "real word + real word"-compounds resulted in two instances in an uncommon but existing word and in three instances in a non-existing word. If the correct solution of an item was an uncommon but existing word, there could be a confounding with vocabulary. Therefore, these two items would be excluded from future studies.

In addition, the findings were discussed with a group of experts in the field of speech-related sciences in a colloquium at the University of Erfurt. Experts suggested that the structure of some items seemed atypical for the German language. For example, some items contained a structure that could be interpreted as a prefix based on the sound structure of the pseudoword, although there is no such prefix in the German language ("wo-", "ko-"). Such an unusual structure might have affected participants' responses. If the test item seems unusual for the German language, the participants could assume that other morphological rules than the typical ones might be adequate to change the test item to a new meaning (cf. section 2.1.2.2). Three items were identified that were unusual for the structure of the German language. These three items were two items for inflections and one item for derivations of the TMB tasks. It was decided to omit these items in future studies.

Power analyses revealed that correlations have to be interpreted with caution. Moreover, it has to be acknowledged that the number of computed correlations (58 in second grade; 49 in fourth grade) was very high, especially in light of the small sample sizes. This can lead to an α-error accumulation (Field, 2018), an obstacle that was further addressed in the main study in which relationships between study variables were analysed in detail. Therefore, not the actual correlation coefficients were interpreted but rather the directions of the relationships were

inspected. Overall, correlation coefficients were showing the expected directions. This was encouraging with respect to the criterion validity of the pseudoword cloze task.

Correlations of the subcategories inflections, derivations and compounds of the pseudoword cloze task were inspected to further assess the plausibility of the data and have another indicator for the validity of the pseudoword cloze task. Correlations were between $.33 \leq r \leq .68^{**}$ in second grade and between $.48 \leq r \leq .67^{*}$ in fourth grade. That is, all correlations showed the expected directions which was interpreted as an indicator of concurrent validity.

Morphological fluency task

The instructions of the morphological fluency task had to be revised during data collection for this study because participants confused the exemplary items for correct and incorrect solutions with each other. Subsequently, only if the participants produced incorrect solutions in the practise items, differences between correct and incorrect solutions were clarified. This revision significantly increased the mean of correct solutions from $M = 1.5$ to $M = 4.9$ for second graders. Fourth graders were presented only with the revised version of the task. Their mean for correct solutions was $M = 11.9$. A *t*-test for independent samples revealed that fourth graders performed significantly better on this task than second graders. This observation is in line with findings for the English language that suggest that morphological awareness is still developing in schoolchildren (Apel, 2014; Kirby et al., 2012; Nagy et al., 2003).

For the revised version of the morphological fluency task, each item reached a discrimination index of $r_{it} \geq .30$ in at least one grade. Therefore, no item should be omitted from this task as each item proved to be important to discriminate between participants' abilities. Cronbach's α for the revised morphological fluency tasks was questionable for second graders ($\alpha = .61$), but acceptable for fourth graders ($\alpha = .76$). The reliability for the overall sample was good ($\alpha = .82$). At this early stage of research with this morphological fluency task and in light of the small sample sizes for both second graders ($n = 14$) and fourth graders ($n = 11$), the reliability can be rated as appropriate for further applications of this task (cf. Field, 2018). In the main study, reliability was evaluated again.

Correlations of the morphological fluency task with the other study variables showed the expected directions, which can be interpreted as an indicator for suitable criterion validity of the morphological fluency task. In addition, it was checked whether both morphological awareness tasks correlated with each other because both tasks are assumed to measure different facets of the same construct, namely morphological awareness (cf. Fink et al., 2012). Again,

both the correlation in second grade (r = .46) and the one in fourth grade (r = .67*) showed the right direction, which can be interpreted as an indicator for concurrent validity.

Conclusion

Taking the evidence on the two morphological awareness tasks together, it can be concluded that both tasks are suitable measures of morphological awareness in primary school children. Evidence on the validity and the reliability were encouraging for both measures. However, it has to be noted that some items should be omitted from future applications of these tasks because item characteristics and expert opinions suggested that these items were problematic. An exclusion of these items could improve the morphological awareness measure further. The exact selection procedure is described in the instruments section of the main study (section 4.3.1.2).

4.2.5.2 Is the testing procedure feasible for school settings?

Observations concerning the reasonableness and length of testing time disclosed that testing time and number of tests in the group sessions were suitable for the application during school lessons. However, testing time in the individual session exceeded 45 minutes for struggling participants by about 5 minutes, and testing was sometimes tedious for participants. For the main study, this meant that the individual session would have to be shortened. Item analyses already revealed some morphological awareness items that could or should be omitted in future studies. Yet, these items would not be equivalent to a testing time of 5 minutes. Therefore, further items had to be selected that could be omitted from future morphological awareness assessment. As mentioned above, the selection procedure is described in the instruments section of the main study (section 4.3.1.2).

4.2.5.3 Conclusion

Taken together, this pilot study provided important information for the improvement of the measurement of morphological awareness in German primary school children and about the reasonableness and test length of the whole test battery. The testing procedure and instruments of the main study were adjusted based on this information.

4.3 Main Study

The two pilot studies gave insights into how different morphological awareness tasks can be applied verbally and which morphological awareness items are suitable for primary school children from second grade onwards. Based on these findings, the main study was conducted to give answers to the three main research questions as specified in section 3:

Research question 1: How are different facets of morphological awareness related to different literacy competencies?

H1. There is a relationship between morphological awareness and literacy skills in German schoolchildren.

H2. There is a stronger relationship of morphological awareness with spelling skills than with reading skills in German schoolchildren.

Research question 2: Does morphological awareness uniquely predict literacy skills above and beyond other cognitive skills?

H3. Morphological awareness uniquely predicts literacy skills in German schoolchildren when accounting for phonological processing skills and vocabulary.

Research question 3: Is there an increase in the relationship between morphological awareness and literacy skills with increasing literacy proficiency?

H4. The relationship between morphological awareness and literacy skills becomes stronger with increasing literacy proficiency, i.e. with increasing grade level.

4.3.1 Methods

4.3.1.1 Sample

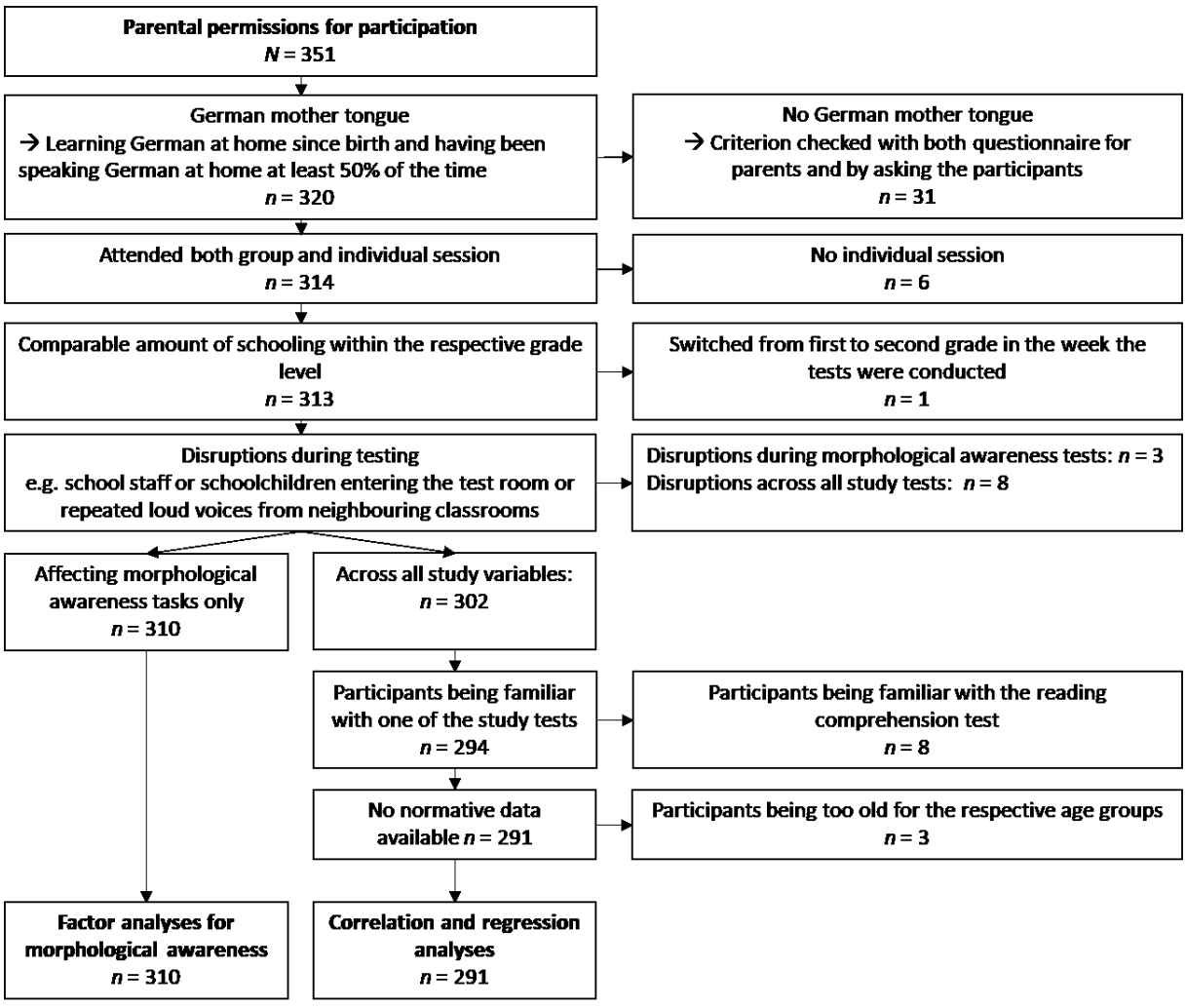
An a priori power analysis for the planned multiple linear regression with eight variables (morphological fluency, inflections, derivations, compounds, phonological awareness, rapid naming, verbal memory, vocabulary) using a power of $1\text{-}\beta = 0.80$, a moderate effect size of $f^2 = 0.15$ and an α-error probability of $\alpha = 0.05$ resulted in a required sample size of $N = 160$ for each grade. The power analysis was conducted with the software G*Power (Faul et al., 2009). Please note that the number of variables was later adjusted based on factor analyses for morphological awareness items (cf. section. 4.3.2.1). The required sample size could not be obtained because of logistical and time constraints. The normation period of the applied spelling test restricted the testing period to the last seven weeks of schooling within the school year for third and fourth graders. It was decided that the testing period should not exceed two months for all schoolchildren to ensure that all participants within one grade were comparable with regard to development and received time of schooling. Because the number of available rooms

in schools was usually limited, it was often not possible to conduct more than two parallel individual sessions, which restricted the number of participants that could be tested per school day. Moreover, some of the datasets could not be used in statistical analyses because exclusion criteria applied (see below). Post-hoc power analyses for the achieved sample sizes and the adjusted number of variables are presented in section 4.1.3.5 together with the description of the data analytic method.

For this study, 37 primary and comprehensive schools from the region mid-west-Thuringia were invited. Nine primary schools participated in this study. For each examined grade level, 6 different schools and between 10 and 12 different classrooms took part in this study. Parental permissions for participation were obtained for 351 children. Several datasets had to be excluded, which can be retraced in Figure 1.

Figure 1

Participant flow



Sample sizes vary for factor analyses, which were conducted to analyse the dimensionality of the construct morphological awareness, and correlation and regression analyses, which were

conducted to analyse the relationships between all study variables. This is because for the factor analyses, only the data of the morphological awareness tests was needed but for subsequent correlation and regression analyses data on all study variables was used. That is, if exclusion criteria applied to one of the study variables other than morphological awareness (disruptions during testing, being familiar with testing material, no normative data available) respective datasets were excluded from correlation and regression analyses but not from factor analyses. Taken together, 310 participants were included in the factor analyses and 291 participants were included in the correlation and regression analyses.

Whether participants were of German mother tongue was checked by asking both parents and children which language they usually speak at home. Children were additionally asked when they started learning German. Three hundred six children were rated to be native speakers of German because both children and parents stated that their only home language was German. Another 14 datasets were used in statistical analyses because responses by parents and children indicated that the child had extensive experience with German. That is, children were not excluded if both parent and child stated that they predominantly spoke German at home or if either parent or child stated that they spoke only German at home. If either parent or child indicated that German was spoken at home at 50% of the time and the child learned German since birth, the corresponding dataset was also not excluded from the analyses. The exact numbers of participating classrooms and participants along with sample characteristics regarding age and gender can be viewed in Table 13.

Table 13

Overview over sample characteristics with regard to age and gender of the whole sample and after exclusion criteria were applied for different analyses

Grade	*N* of participants with permission to participate	*n* in factor analyses	*n* in correlation and regression analyses
Grade 2	135	126	119
- Gender	72 female, 63 male	68 female, 58 male	65 female, 54 male
- Age	*M* = 8;4 (7;5 - 9;10)	*M* = 8;4 (7;7 - 9;10)	*M* = 8;4 (7;7 - 9;10)
Grade 3	109	94	87
- Gender	67 female, 42 male	60 female, 34 male	56 female, 31 male
- Age	*M* = 9;5 (8;6 - 12;3)	*M* = 9;4 (8;6 - 10;7)	*M* = 9;4 (8;6 - 10;7)
Grade 4	107	90	85
- Gender	54 female, 53 male	48 female, 42 male	46 female, 39 male
- Age	*M* = 10;6 (9;9 - 13;4)	*M* = 10;5 (9;9 - 11;8)	*M* = 10;4 (9;9 - 11;5)
Overall	351	310	291

Studies have shown that literacy competencies are associated with socio-economic status (Linnakylä et al., 2004; McBride-Chang et al., 2005; Reiss et al., 2019), the frequency of reading to the child by parents (Russell, Ukoumunne, Ryder, Golding, & Norwich, 2018) and children's print exposure (Boerma, Mol, & Jolles, 2017; Erbeli, van Bergen, & Hart, 2019). Accordingly, for testing the comparability of the three observed grade levels, distributions of variables concerning socio-economic status (books at home, parental schooling, parental education) and children's exposure to literature (leisure-time reading by child, reading to child by the responding parent, reading to child by spouse of the responding parent) were covered in the questionnaire for parents. It was analysed whether the distributions of these variables were comparable across grades. All comparisons were made by conducting Kruskal-Wallis Tests. The tests revealed that the distributions for the variables *books at home*, *parental education* and *reading by child* were not significantly different across grades. Differences between the distributions were observed for the other three variables: *parental schooling* ($p < .05$*), and *reading to child by responding parent* and *reading to child by spouse of responding parent* (both $p < .01$**). Post-hoc comparisons using Kruskal-Wallis Tests for two groups revealed that the distributions of the variables *reading to child by responding parent* and *reading to child by spouse of responding parent* differed significantly between second and third (responding parent: $p < .01$**; parent's spouse: $p < .05$*) and between second and fourth grade (both $p < .01$**). Inspections of frequency tables and medians showed that caregivers read more to second graders than to third and fourth graders (Table 14). This is not surprising, as third and fourth graders should have reached higher literacy competencies and therefore be able to read more on their own. Therefore, this difference between grades was considered as unproblematic for comparability between grades. Overall, in each grade more than 75 percent of children were reported to read daily or at several days a week. Combined with the finding that in second grade, regular reading to the child was still quite common (58% of responding parents read to their children daily or several times a week), most children experienced regular literature exposure.

The distributions of *parental schooling* were only significantly different between second and fourth graders ($p < .05$*). Table 14 shows that parents of second graders tended to have higher levels of school-leaving qualification than parents of fourth graders had. As the distributions of the other two socio-economic variables did not differ across grades, the socio-economic disadvantage of fourth graders compared to second graders is not strong. Therefore, comparability between grades with regard to socio-economic status was considered adequate.

Table 14

Sample characteristics with regard to socio-economic status and literature exposure.

		Grade 2		Grade 3		Grade 4	
Variable	Scale	*n*	%	*n*	%	*n*	%
Socio-economic variables							
Books at home	0 – 10 books	0	0.0	0	0.0	0	0.0
	11 – 25 books	1	0.8	6	6.9	5	5.9
	26 – 100 books	27	22.7	19	21.8	21	24.7
	101 – 200 books	30	25.2	17	19.5	12	14.1
	201 – 500 books	39	32.8	25	28.7	23	27.1
	> 500 books	18	15.1	17	19.5	20	23.5
Parental schooling	No school leaving certificate	0	0.0	1	1.1	1	1.2
	Secondary school[1]	2	1.7	3	3.4	4	4.7
	General Certificate of Secondary Education[2]	30	25.2	29	33.3	31	36.5
	Abitur/Fachabitur[3]	82	68.9	51	58.6	47	55.3
Parental education	No complete vocational training	1	0.8	1	1.1	4	4.7
	Completed vocational training	43	36.1	46	52.9	34	40.0
	Graduate/university degree	59	49.6	28	32.2	40	47.1
	Doctorate	5	4.2	8	9.2	1	1.2
Literature exposure							
Reading by child	Daily	35	29.4	32	36.8	33	38.8
	Several times a week	63	52.9	34	39.1	37	43.5
	Once a week	3	2.5	6	6.9	2	2.4
	Every now and then	11	9.2	14	16.1	9	10.6
	Rarely	3	2.5	1	1.1	1	1.2
	Never	0	0.0	0	0.0	0	0.0
Reading to child by responding parent	Daily	27	22.7	6	6.9	9	10.6
	Several times a week	42	35.3	20	23.0	14	16.5
	Once a week	15	12.6	8	9.2	5	5.9
	Every now and then	28	23.5	36	41.4	34	40.0
	Rarely	2	1.7	12	13.8	17	20.0
	Never	0	0.0	2	2.3	1	1.2
Reading to child by spouse of responding parent	Daily	13	10.9	3	3.4	1	1.2
	Several times a week	28	23.5	12	13.8	10	11.8
	Once a week	12	10.1	6	6.9	3	3.5
	Every now and then	36	30.3	31	35.6	27	31.8
	Rarely	14	11.8	14	16.1	24	28.2
	Never	2	1.7	8	9.2	7	8.2

Note. Grade 2: *n* = 119, Grade 3: *n* = 87, Grade 4: *n* = 85. Variables were measured with the questionnaire for parents. Missings occurred because some parents did not respond to all questions.

[1]9 years of schooling

[2]10 years of schooling

[3]Diploma from German secondary school qualifying for university admission

This study was conducted in accordance with applicable Thuringian laws (Thuringian school law, Thuringian data protection law) and adhered to the recommendations of the Thuringian Ministry of Education, Youth, and Sports. Following the guidelines for carrying out empirical research in Thuringian schools, a written permission for conducting this study in local schools and during lessons was given by the educational authority for the region of central Thuringia (Staatliches Schulamt Mittelthüringen, Weimar, Thuringia). Additional approval by an ethics committee was not required in compliance with institutional and federal (Thuringian) guidelines and regulations.

4.3.1.2 Instruments

The constructs were assessed with the same instruments as in the second pilot study. For some tests, other versions were used to ensure correspondence with the normation periods within the school year. Additionally, the recommended versions for third graders were used, were applicable. In the following, differences to the instruments as applied in the second pilot study are explained. General information on the respective tests were given in section 4.2.3.2.

Spelling

In line with the guidelines of the HSP manual, spelling was measured with the test books *HSP 2* for second graders, *HSP 3* for third graders and *HSP 4-5* for fourth graders. Analyses were run with raw scores for correctly written graphemes and raw scores for proficiency in alphabetic, orthographic and morphematic spelling strategies because within grade levels, all schoolchildren belonged to the same norm groups. The manual reports a high internal consistency for the number of correctly written graphemes (r = .98) for all three versions that were used in this study. Moreover, internal consistencies for alphabetic, orthographic and morphematic spelling strategies were reported to be between $.82 \leq r \leq .92$.

Reading Fluency

Real word and pseudoword reading fluency was measured with *version A* of the SLRT-II. Raw scores were used in the analyses because within grade levels, all schoolchildren belonged to the same norm group.

Reading comprehension

Reading comprehension was measured with the same test books of the ELFE-II in all three observed grade levels. All three subscales (word-, sentence- and text reading comprehension) were applied. As in the second pilot study, ELFE-II was administered in its paper-pencil version. In analyses, the mean t-value for reading comprehension across all three subscales was used (see explanations in section 4.2.3.2). Because of a technical failure with the stopwatch, testing time for the subscale word-reading comprehension could not be measured

accurately in one group session. For these 10 fourth graders, reading comprehension was computed from the values for sentence- and text-reading comprehension only. Likewise, for five further participants, who did not correctly follow the instructions of one subscale, means of the two correctly executed subtests were used.

Phonological awareness

Phonological awareness was measured in all grade levels with the phonological awareness subtest of the P-ITPA in the same way as in the second pilot study. Raw scores were used in statistical analyses as all schoolchildren belonged to the same norm group within their respective grade levels.

Verbal memory

Verbal memory was measured in all grade levels with the subtest "*Pseudowörter nachsprechen*" (Eng. "repeating pseudowords") of the ZLT-II in the same way as in the second pilot study. The raw score of the number of mistakes was used in statistical analyses because all children belonged to the same norm group. Cronbach's α for the respective grade levels is α = .75 at the end of second grade, α = .74 at the end of third grade, and α = .76 in fourth grade. Re-test reliability across all grade levels is r = .79.

Rapid naming

Rapid naming was measured with the subscale "*Schnelles Benennen*" (Eng. "rapid naming") of the ZLT-II in all grade levels and in the same way as in the second pilot study. The raw score of the time needed for naming the objects of version 1 was used in analyses as all children belonged to the same norm group. Re-test reliability across all grade levels for version 1 is r = .94.

Vocabulary

Vocabulary was measured with the vocabulary subtest of the KEKS-test-battery. The recommended test books for the respective grade levels were used: *KEKS Deutsch 3A* for second graders, *KEKS Deutsch 4A* for third graders and *KEKS Deutsch 4Ü* for fourth graders. All children were given version A of the respective test books. All other proceedings were kept as in the second pilot study. For analyses, the raw score of the sum of correct responses was used as all children belonged to the same norm group within their respective grade levels. Cronbach's α for the vocabulary subtests is α = .82 for *KEKS Deutsch 3A*, α = .78 for *KEKS Deutsch 4A* and α = .77 for *KEKS Deutsch 4Ü*.

Morphological awareness

The items for assessing morphological awareness were revised based on the results of pilot study 2. It was necessary to shorten the individual session by about 5 minutes to have an

overall testing period of 45 minutes. As the morphological fluency task consisted of only four items, it was decided to omit items from the pseudoword cloze task. The following exclusion criteria were applied:

1. If the item had an unusual grammatical structure for German, it was omitted from the morphological awareness task. The reason behind this was that participants could assume that for untypical words other rules than the standard ones of the German language could be adequate to change the specific test word to a new meaning. The decisions, which items to omit were based on expert feedback in a colloquium for researchers in the field of speech-related sciences at the University of Erfurt (cf. section 4.2.5.1). Two items for inflections and one item for derivations of the TMB tasks were identified as unusual for German.
2. If the correct answer to an item in the cloze task was an uncommon but existing word, this item was omitted to avoid confounding with vocabulary (cf. section 4.2.5.1). This concerned two items from the compound tasks.
3. All other items were analysed according to their item difficulty and discrimination indexes. For each item, a score of unfavourable item characteristics was computed. To determine unfavourable item characteristics, threshold criterions were used. For discriminatory power it was $r_{it} <. 3$ (cf. Wentura & Pospeschill, 2015) and for item difficulty it was $P < .3$ or $P > 1.7$ (cf. Moosbrugger, 2012). Accordingly, one point was given for discriminatory power $r_{it} <. 3$, two points for discriminatory power $r_{it} <.15$ and three points for discriminatory power $r_{it} < 0$. Another point was given if the item difficulty was above 1.7 or below .3. This sum score gave indications on which items were to be removed. Some items, *adjective derivations* and *derivational morphemes* of the HSET, could not be presented individually because three to four items formed part of a mini-story. A joint sum score of unfavourable item characteristics was computed for these groups of items. For the final decision, the sum score of favourable item characteristics, the relation of difficulty and discriminatory power and the item characteristics of alternative items of the same morphological category were considered. Based on these considerations, two item groups of the *adjective derivations* (6 items) were omitted. Further, two *singular-plural* and two *plural-singular* items from the HSET-tasks, and one further inflectional item from the TMB were omitted.

The final set of items in the pseudoword cloze task consisted of 14 items for inflections, 17 items for derivations and 8 compound items.

Development of a category system for rating the responses to the morphological awareness items

The rating guidelines of the TMB offer a list of common correct responses to the morphological awareness items. It is specified that further affixes should be rated as correct if they comply with German morphological rules. In the pilot studies, the variability of responses was moderate and the grammatical appropriateness of few affixes had to be checked. However, children produced a wide range of responses in the main study by giving 1466 different responses to the 4 morphological fluency items and another 1758 different responses to the 39 items of the pseudoword cloze task. Considering the huge diversity of responses, it was decided to set up a category system, which specified all correct suffixes for each grammatical category. To assure consistency of ratings across the different items from the HSET, TMB and compound tasks by Hasenäcker and Schroeder (2017a), the category system was set up for all morphological awareness items regardless from which test they originally came from. This was accomplished by setting rough overall rules for all items and then further specifying criteria for all subcategories of items.

The differentiation between correct, partly correct and false responses as specified in the pilot studies for the pseudoword cloze task items was maintained. This should ensure that a child's morphological awareness was not underestimated if it produced an answer that was not completely correct but that indicated the usage of an almost correct morphological rule (cf. section 4.2.3.2). The system of discriminating fully correct, partly correct and false responses was extended to the morphological fluency task for the current study to accomplish a finer differentiation between responses in this task, too. In the following, the rating criteria for the pseudoword cloze task and the morphological fluency task are explained in more detail.

Pseudoword cloze task

The items of the pseudoword cloze task covered a range of different morphological categories. Items were grouped according to these categories and subcategories (Table 15).

For each subcategory, a set of specific rules was compiled, which described the characteristics a response should have in order to be considered fully correct (2 points assigned), partly correct (1 point assigned) or false (no points assigned). These rules were set up in alignment with the rating guidelines of the HSET, the TMB and the compound task, and fine-tuned based on different grammatical resources. These grammatical resources comprised a main reference for grammatical questions for the German language (Dudenredaktion, 2016) and further literature on the plural system (Gallmann, 2016) derivational morphology (Fleischer & Barz, 2012; Kotulková, 2004) and compounds (Fleischer & Barz, 2012).

Table 15

Categories and subcategories of the pseudoword cloze task

Category	Subcategories
Inflections	- Change a noun from singular to plural - Change a noun from plural to singular - Forming a comparative of an adjective - Forming a superlative of an adjective - Change a verb in its infinitive form to past participle

Derivations	- Create a diminutive of a noun
	- Create an adjective from a noun
	- Create a verb in past participle from a noun
	- Create a noun describing a…
	  o male person
	  o female person
	  o proceeding or condition
	  o place

Compounds	- Forming a compound - Deconstructing a compound into its parts

As in the second pilot study, all rating decisions were based on how the child repeated the test word to ensure that deviations from the correct response did not occur due to mishearings (cf. section 4.2.3.2).

The rough criteria that had to be met by every response to be rated as fully correct, partly correct or wrong can be summarized in the following way:

Fully correct responses, for which two points were awarded, had to meet two criteria: Both the correct grammatical change was applied and no further changes were made in the word stem(s). How the criteria were applied can be retraced in Table 16, which illustrates the category system with the exemplary rating of a derivational test item that required the creation of a noun describing a male person. The cell "Fully correct (2 points)" exemplifies the rating of a fully correct response.

Partly correct responses, for which one point was awarded, fulfilled one of the described criteria for fully correct responses but deviated from the expectation in the other criterion. Accepted deviations were specified for each subcategory. Only one deviation was permitted in each response for a rating as partly correct, that is, either the grammatical change that was applied to the test word was atypical or an unnecessary change in the stem of the test word was made. Atypical grammatical changes were those that indicated the usage of an almost correct morphological rule, for example, an affix was applied that was not completely correct

but indicated that the response was based on a morphological rule. The premise to rate such responses as partly correct was adopted from the HSET (cf. Grimm & Schöler, 1991). A response was also rated as partly correct if a person used a correct grammatical change but unnecessarily changed another sound in the word stem because this indicated an uncertainty of the parts of the word that needed to be changed. The cells "Partly correct (1 point)" of Table 16 exemplify the rating of partly correct responses.

False responses, for which no points were awarded, showed either more than one deviation from the expected response, or no changes to the test word, or they were based on another word than the given test word. A failure to give a response was also rated with zero points. The cells "False (0 points)" of Table 16 exemplify the rating of false responses.

The specified rules for each subcategory of items can be viewed in Appendix D.

There was exactly one exception to the described criteria. In the category *Compounds*, there was one item that required an additional grammatical change compared to all other items. It was the third compound item presented to the child: "Ein Teller zum Werfen ist ein…" (Eng. "A plate for throwing is a …"). The required grammatical changes were:

1. The two test words are connected in the correct order. (Werfen + Teller)
2. The suffix of the defining word is omitted. (Werf + Teller)
3. Extra: The correct vowel change is applied. (Wurf + Teller)

If all three criteria were fulfilled, and the child made no other adaptions in the test words, three points could be gained (response: "Wurfteller"). If only criteria 1 and 2 were fulfilled and no other adaptations were made to the test words, the response was awarded with the regular two points (response: "Werfteller"). Deviations from the 2-point-answer were handled in line with the criteria above.

Table 16

Exemplification of the category system for the pseudoword cloze task illustrated with an exemplary rating of a derivational test item for a noun describing a male person, "Peter grellt schnell. Er ist ein schneller… ."[a]

Changes in the word stem[b]	Applied grammatical change on the test word[c]		
	correct	atypical	none or wrong
No sounds changed	**Fully correct (2 points)** Example: Either a) or b) fulfilled: a) Used a correct suffix for a noun describing a male person (agent) that has its base in a verb. *Greller, Grellbold* b) Used a compound with -mann. *Grellmann*	**Partly correct (1 point)** Example: Either c) or d) or e) fulfilled: c) Correct suffix for male person that does not have its base in a verb. *Grell, Grellner* d) Two correct suffixes or both suffix and compound. *Grellerer* (a+a), *Grellersmann* (a+b) e) Stressed a correct suffix or compound in an unusual way. *Grellér*	**False (0 points)** Example: Any of the following: - Did not use a correct suffix or compound. *Grelle* - Simply repeated the test word. *Grellt, grellt schnell* - Applied more than one atypical grammatical change. *Grellnerer* (c+d), *Grellerér* (d+e)
One sound changed	**Partly correct (1 point)** Example: *Grellter, Grellder*	**False (0 points)** Example: *Grelldner, Grellschner*	**False (0 points)** Example: *Grellte*
More than one sound changed	**False (0 points)** Example: *Grelltscher* Also: Another word than the given one was used. Mann, Läufer	**False (0 points)** Example: *Grelltschner, Gretscher,*	**False (0 points)** Example: *grelltsch*

Note. For further details on the exact specifications of the category system, see Appendix D.

[a]English: "Peter grells quickly. He is a quick… ."

[b]This decision was based on how the test words were repeated by the child. Example: If the child repeated "gellt" instead of "grellt", the following answers would have been rated as correct: Geller, Gelling, Gellbold and so on.

[c]Rating criteria in alignment with the rating guidelines of the original test, and fine-tuned based on Dudenredaktion, 2016; Fleischer & Barz, 2012; Gallmann, 2016; Kotulková, 2004.

Morphological Fluency task

For the morphological fluency task, children could produce any new word formation based on the test word. The rating criteria can be summarized in the following way:

Fully correct responses, which were awarded with two points, had to meet the following three criteria:

1. **Criterion 1:** The response was a correct word formation from the test word considering the grammatical rules of the German language (cf. Dudenredaktion, 2016; Fleischer & Barz, 2012; Gallmann, 2016; Kotulková, 2004).
2. **Criterion 2:** The word formation had to be etymologically related to the test word. This was checked using an etymology dictionary (Pfeifer, 1993) provided by the DWDS database (DWDS - Das Wortauskunftssystem zur deutschen Sprache in Geschichte und Gegenwart).
3. **Criterion 3:** The word formation was a term that is in usage in the German language to ensure that the meaning the produced word contained would be expressed that way in German. The reason behind this criterion was that some children formed highly unusual words such exemplified in Figure 2. Word usage was checked with the help of two corpora: Deutsches Nachrichten-Korpus (Abteilung Automatische Sprachverarbeitung, 2011) and the DWDS (Berlin-Brandenburgische Akademie der Wissenschaften, n.d.). Only if the word was listed in both corpora, this additional point was awarded because one of the corpora partly and the other corpus fully rely on Internet crawls, which means some words listed in the corpora come from blogs or other possibly non-edited sources. Thus, there is a danger of misspellings or incorrect language use in these sources. Therefore, hits in both corpora were needed to award this point.

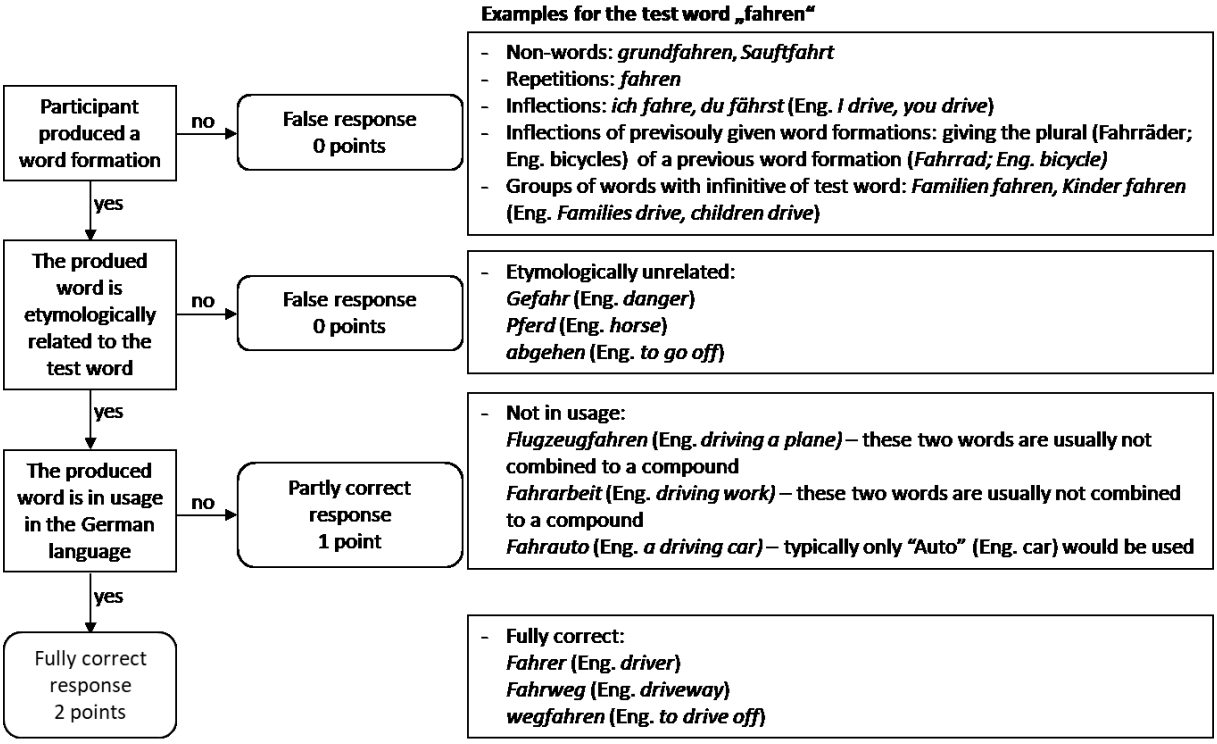
Partly correct responses, which were awarded with one point, had to meet criteria 1 and 2 from fully correct answers, but not criterion 3. That is, a correct word formation that was etymologically related to the test word was required. However, the provided answer was a word that was not typically used in the German language according to the two corpora used (Abteilung Automatische Sprachverarbeitung, 2011; Berlin-Brandenburgische Akademie der Wissenschaften, n.d.). Examples are listed in Figure 2.

False responses did not meet criteria 1 and 2. In addition, no points were awarded for repetitions or for inflections of word formations that the child had already given.

Figure 2 describes the rating procedure with an exemplary rating for answers to the test item “fahren” (Eng. “(to) drive”).

Figure 2

The rating of the morphological fluency task



The maximum number of points that was awarded for a response was set to two points. That is, even if the participant produced multiple word formations within a word (like “Fahrradfahren”; Eng. “cycling a bicycle”) no more than two points were awarded. The category system is inserted in Appendix D.

Psychometric criteria of the category system

Several measures were taken to ensure good psychometric quality of the category system. In a first step, content validity was taken into focus because it was a prerequisite for the further work with the category system. In a second step, objectivity and reliability were focused on simultaneously as measures used to ensure these psychometric qualities were overlapping each other. Psychometric criteria is explained in the following.

Validity

Two measures were taken to ensure the content validity of the category system.

1. Criteria for correct, partly correct and false responses were based on the rating guidelines of the original tests the items came from and fine-tuned based on standard resources on German grammar (Dudenredaktion, 2016; Fleischer & Barz, 2012). In cases that lacked in clarity, further resources were used to specify the criteria further. By this, a precise differentiation between appropriate plural suffixes (Gallmann,

2016) and suffixes and compounds used for describing a female person (Kotulková, 2004) was obtained.

2. The category system was checked by a student assistant for comprehensibility, clarity, and preciseness. For that, she was given the category system along with exemplary answers from the main study that were assigned to correct, partly correct and false responses for each category by the author. The student assistant checked whether it was comprehensible why the presented examples were classified as correct, partly correct or wrong. Based on this feedback, descriptions were clarified and sharpened.

Objectivity

All different responses to the morphological awareness items were brought in alphabetical order for each item. They were entered into the list only once regardless of how many participants had given that answer. These lists were rated by the author and another trained rater. Rating proceedings are described in the section on the reliability of the category system (see below).

This approach had two benefits:

1. The rating was executed independently from participants because previously given answers by a participant could not influence the rating of subsequent answers.
2. It ensured that the same response given by different participants was rated equally because every kind of response was rated only once. Recordings of all given answers to the pseudoword cloze task and the morphological fluency task were entered in Excel Workbooks for each participant. Out of these answers, all different answers were extracted and listed alphabetically for each item. The lists were complemented by the final rating, which was the result of two independent ratings. That is, every different response was rated by both the author and another trained rater. If mismatches between the two ratings occurred, the author made a final decision based on another consultation of the category system. Final ratings were then distributed automatically with the help of formulas to the responses from all participants. By this, it was ensured that every participant who gave a specific response received exactly the same rating. All ratings were then transferred to IBM SPSS Statistics 25 for Windows (IBM Corp., 2017) and MPlus (Muthén & Muthén, 1998-2018) for further analyses.

Inter-Rater Reliability

Next to the author of this work who developed the category system, all different responses were rated by a student assistant experienced with ratings based on category systems. Before the answers to the morphological items were rated, a training was organised. Throughout the training and the later rating of the actual responses, the author of this work and the student assistant used a version of the category system without any exemplary items from the main study to ensure that both ratings were completely independent from each other (Appendix D).

For the training, new rating material was generated by another student assistant, the one who formerly checked the category system for comprehensibility, clarity, and preciseness. She generated a variety of made-up-answers covering the different categories, and based on items from the HSET, the TMB and the compounds tasks that had not been used in the main study. The made-up answers were designed in a way that they should be rated as fully correct, partly correct and false according to the criteria of the category system.

The training was split into three rounds. In the first round, the author of this work explained the category system with the help of a first subset of the made-up answers to the student assistant. Then, another subset of the made-up answers was used for a first rating by the student assistant during which the author of this work was still present. Thus, questions on the category system were discussed and used for a revision of the wording of some categories.

In the second training round, the utilization of the category system was practised by the student assistant independently from the author with the help of a third subset of the made-up answers. After the practice trial, the student assistant and the author discussed the results. Mismatches were used to further improve and clarify the category system.

For the third practise trail, the author of this work generated another set of made-up answers that she deemed especially difficult, covering a range of exceptions and rare cases. Both raters rated these made-up-answers independently from each other. For this set, the inter-rater reliability was calculated using Spearman's rho (ρ) as a nonparametric measure of rank correlation (cf. Wirtz & Caspar, 2007). Because a good inter-rater reliability of $\rho = .83$ was reached, it was decided to move on to the rating of the actual responses from the main study.

The category system reached good to very good inter-rater reliability for actual responses. Spearman's rho was between $.81 \leq \rho \leq 1.00$ signifying good to perfect agreement between the two raters (cf. Appendix E). In addition, the Wilcoxon test was conducted for measuring whether raters had different tendencies in their ratings (cf. Wirtz & Caspar, 2007), which are indicated by a significant result in the Wilcoxon test (Wirtz & Caspar, 2007). For the items of the pseudoword cloze task, no differing tendencies were observed. However, for all

four morphological fluency items, there were significant differences. An examination of frequency tables revealed that the author of this work assigned 1 point more often than the student assistant did, whereas the student assistant assigned 2 points more often than the author did. Nonetheless, the inter-rater reliability for the morphological fluency items was good to very good reaching values between $.83 \leq \rho \leq .92$. Therefore, inter-rater reliability was deemed appropriate despite different tendencies for 1- and 2-point answers. All mismatches were examined by the author of this work, who then made a final decision on how many points to assign to a specific response, which was based on a further consultation of the category system. Inter-rater reliabilities, Wilcoxon test statistics and frequencies are displayed in Appendix E.

Convergent validity of the morphological awareness tasks

Convergent validity of the two morphological awareness tasks was assessed by inspecting the correlations of the subcategories of the pseudoword cloze task, *inflections*, *derivations*, *compounds*, and the morphological fluency task. The subcategories should be correlated with each other because theoretically they represent one underlying construct (cf. Fink et al., 2012).

The subcategories of the pseudoword cloze task *inflections*, *derivations* and *compounds* correlated with each other in all three observed grades (Table 17), which indicates convergent validity. However, *morphological fluency* had a significant correlation only with *derivations* and *compounds* and only in second grade. The morphological fluency task is a speed task in which word formations have to be found for real words. In contrast, the pseudoword cloze task has no speed component, and grammatical changes have to be applied to pseudowords based on grammatical, syntactic and phonological information. The result might indicate that morphological fluency measures a different facet of morphological awareness that is not closely related to those aspects of morphological awareness covered by the pseudoword cloze task. It is possible that the speed component of the morphological fluency task is responsible for the low convergent validity with the pseudoword cloze task. It is also possible that the two tasks measure fundamentally different constructs. This latter explanation is less likely, however, because both tasks had been derived from theoretical considerations and are internationally used as measures of morphological awareness (section 4.1.1). The aspect of uni- versus multidimensionality was investigated further in factor analyses (section 4.3.2).

Table 17

Descriptive statistics and correlations for morphological awareness categories in second, third and fourth grade

				Correlations		
Categories	Max	*M* (*SD*)	Range	1	2	3
Second grade						
1 Inflections	28	20.1 (4.1)	7 - 27	-		
2 Derivations	34	21.4 (5.3)	2 - 32	.39**	-	
3 Compounds	17	9.7 (3.9)	0 - 17	.28**	.41**	-
4 Morphological Fluency		16.2 (10.7)	0 - 43	.06	.24**	.34**
Third grade						
1 Inflections	28	22.2 (3.5)	13 - 28	-		
2 Derivations	34	24.3 (5.7)	4 - 34	.45**	-	
3 Compounds	17	11.0 (3.8)	0 - 17	.25*	.39**	-
4 Morphological Fluency		27.3 (9.2)	0 - 47	.09	.17	.19†
Fourth grade						
1 Inflections	28	22.5 (3.4)	10 - 28	-		
2 Derivations	34	24.8 (5.1)	9 - 34	.44**	-	
3 Compounds	17	11.7 (3.8)	1 - 17	.28**	.42**	-
4 Morphological Fluency		26.0 (9.4)	2 - 48	.12	.15	.10

Note. Second grade: $n = 126$. Third grade: $n = 94$. Fourth grade: $n = 90$.
†$p < .1$ *$p < .05$ **$p < .01$.

Reliability of the morphological awareness tasks

Reliability was assessed using Cronbach's α, which indicates the lower boundary of the reliability (Eid, Gollwitzer, & Schmitt, 2013). Values of $\alpha \geq 0.7$ are generally rated as acceptable (Field, 2018). However, it has been noted that even values as low as $\alpha \geq 0.5$ can be expected in early stages of research (Field, 2018). Lower values of α usually occur because of a low number of questions, because items are poorly interrelated and/or because the underlying construct is not unidimensional (Tavakol & Dennick, 2011).

The overall reliabilities for the pseudoword cloze task are acceptable across all three grades (Table 18). It has to be noted that for the subcategory *inflections*, reliability scores are considerably lower. Of the inflectional items, most had low discriminatory power. It was lowest for items for which a plural form had to be turned into a singular form. This indicates that these

items have little contribution to the measurement of morphological awareness. This was further investigated with the help of factor analyses (section 1254.3.2.1).

For the morphological fluency task, the reliability score is acceptable across all three grades (α = 0.76), however somewhat lower for third and fourth grade. This could be due to the relative low number of items. Whether items are adequately related and whether the underlying construct is unidimensional is addressed in section 4.3.2.1.

Table 18

Cronbach's α for the morphological awareness tasks

		Cronbach's α			
Category	*N* of items	Grade 2	Grade 3	Grade 4	Grades 2-4
Pseudoword cloze task	39	0.78	0.81	0.80	0.82
Inflections	14	0.54	0.48	0.48	0.54
Derivations	17	0.69	0.77	0.73	0.75
Compounds	8	0.69	0.70	0.71	0.71
Morphological Fluency	4	0.77	0.63	0.62	0.76

Note. Grade 2: *n* = 126, Grade 3: *n* = 94, Grade 4: *n* = 90.

Questionnaire for parents

In the letter that explained the implementation and aim of this study, parents were asked to fill in a short questionnaire in addition to giving their permission for their child to participate in this study. The questionnaire for parents from the second pilot study was slightly revised so that it differentiated better between socio-economic variables. The questionnaire for the present study consisted of variables concerning socio-economic status (number of books at home, parental schooling and further parental education), literacy exposure (frequencies of reading by child and of reading to the child by caregivers) and mother tongue (language that is mostly spoken at home). It can be viewed in Appendix C.

4.3.1.3 Design

A correlational, cross-sectional design was chosen. The between-subjects variable was school grade at the grade levels 2, 3 and 4. The explaining variable morphological awareness was measured with the pseudoword cloze task and the morphological fluency task. Four further cognitive variables were measured as control variables: phonological awareness, vocabulary, rapid naming and verbal memory. Age was a control variable as an indicator of development. To determine whether the different grade levels were comparable with regard to sample characteristics, variables on socio-economic status and on literacy exposure were measured. The explained variables were measures on literacy competencies, namely word reading fluency,

pseudoword reading fluency, reading comprehension, spelling and proficiency in alphabetic, orthographic and morphematic strategy use.

4.3.1.4 Procedure

All test sessions were taking place between April and June 2018. It was important to keep the testing period this short to ensure that pupils tested at the beginning of the testing period were not at a disadvantage compared to pupils tested at the end of the testing period due to more teaching time and/or developmental processes.

The tests were administered in two group sessions and one individual session and adjusted to the length of the standard period of a lesson in German schools, which is 45 minutes. The group sessions lasted 45 minutes each and were conducted consecutively, but separated through a break. The break was either a scheduled school break or a break initiated and organized by the researchers. Group sessions were administered in a classroom. In the first group session, children's spelling abilities and vocabulary knowledge was tested. In the second session, reading comprehension was assessed.

For the individual sessions, a quiet room on the school grounds was used. The individual sessions lasted 45 minutes. First, morphological awareness was tested with the morphological fluency task followed by the pseudoword cloze task. After that, the child's verbal memory, rapid naming ability and phonological awareness were assessed. Finally, reading fluency in real and pseudoword reading was tested. During the individual session, the researcher talked to the child about the languages it speaks at home and made notes on the child's response. All children were rewarded with a certificate for their contribution to research.

Data was collected by four trained student assistants and the author of this work. Group sessions were additionally assisted by one student doing a practical course as part of her studies.

4.3.1.5 Data analytic method

Data was analysed using factor analyses, correlations, multiple-linear regression analyses and group comparisons.

Factor analyses

Exploratory factor analyses were run for both the morphological fluency task and the pseudoword cloze task. The theoretical base for the pseudoword cloze task were the grammatical categories inflection, derivation and compounding. Using exploratory factor analysis, it was analysed whether these three categories could be found as factors in the pseudowords cloze task. It was deemed possible, that the grammatical subcategories (Change a noun from singular to plural, change a noun from plural to singular, create a diminutive of a noun etc.) yielded a better factor solution than the three main categories because they offer a

finer discrimination between morphological categories. Accordingly, solutions with different numbers of factors were compared. For the morphological fluency task, a one-factor solution was expected, as the four items are very similar to each other (all items are verbs with a relatively large morphological family size).

In confirmatory factor analyses, different constellations of factors for the morphological fluency task and the pseudoword cloze task were analysed. Theoretically, it was proposed that morphological fluency and the pseudoword cloze task measure different facets of morphological awareness as the underlying construct (cf. Fink et al., 2012). Factors for the confirmatory factor analyses were deduced from the exploratory factor analyses and compared to factor solutions that were derived from theory (one factor morphological fluency and three factors for the pseudoword cloze task: inflections, derivations and compounds). It was tested, whether the different factors can be described by the one underlying factor morphological awareness.

All factor analyses were run with the whole sample. To reach stable results in factor analysis, an adequate sample size is necessary. A sample size of $N = 100$ is regarded as poor, $N = 300$ is regarded as good and $N \geq 1000$ is regarded as excellent (Comrey & Lee, 1992). The factor analyses were run with a sample size of $N = 310$, which can be classified as good. Therefore, results of the factor analysis are expected to be stable. It is possible that optimal factor solutions for the construct morphological awareness vary in different grades, for example because items vary in their difficulties across grades. However, as it was an aim of this dissertation to compare the relevance of morphological awareness for literacy skills in different grades, it was necessary to find an appropriate factor solution across all three observed grades. Otherwise, subsequent analysis would have been run with different morphological awareness items in different grades, which would have reduced comparability. The items and facets that described best the construct morphological awareness across grades were chosen for subsequent correlation and regression analyses.

It is recommended to inspect several model fit indices in factor analyses (Kleinke, Schlüter, & Christ, 2017). The χ^2-Test of Model Fit, the Root Mean Square Error of Approximation (RMSEA), the Tucker-Lewis Index (TLI) and the Comparative Fit Index (CFI) were used for model evaluation. The χ^2-Test of Model Fit tests the null hypothesis that the covariance matrix that is implied by the model and the covariance matrix that is observed are equal. A significant result implies that the model does not fit the data well. In cases of high sample sizes, however, even small deviation of the observed from the estimated model become significant (Kleinke et al., 2017). Therefore, χ^2-Test of Model Fit should not be the only index

used for model evaluation, although it is useful for model selection (Kleinke et al., 2017). Descriptive fit indices as the RMSEA, the TLI and the CFI should be inspected for model evaluation to gain a more comprehensive understanding of the model fit (Kleinke et al., 2017). The RMSEA is an indicator of the approximate model fit and is scaled as a badness-of fit index, where lower values indicate a better fit (Kline, 2011). RMSEA values of RMSEA ≤ .05 are viewed as good and values of RMSEA ≤ .08 are viewed as acceptable (Kleinke et al., 2017). The CFI measures the relative improvement of the implied model over the baseline model (Kline, 2011). The baseline model has the assumption that there are no relations between the observed variables (Kline, 2011). The TLI analyses the discrepancy between the χ^2 value of the implied and the χ^2 value of the observed model (Tucker & Lewis, 1973). Both, the CFI and TLI can take values between zero and one with one indicating a perfect fit. Values ≥ .95 indicate a good model fit (Kleinke et al., 2017).

For the factor analyses, the statistics software MPlus version 8 (Muthén & Muthén, 1998-2018) was used. MPlus was chosen, because it allows the user to run factor analyses suitable for ordinal data. As the items of the morphological awareness items were categorised in fully correct, partly correct and false answers, an ordinal handling of the data was necessary. Not considering the ordinal structure of the data, the relationships between variables might be underestimated (Field, 2018).

Correlation analyses

Correlation analyses between all observed variables were conducted. It was expected that all variables correlate positively with each other, except for correlations with rapid naming and verbal memory. Rapid naming represents the time needed for that task, i.e. the more time needed, the lower the performance. Negative correlations for verbal memory were expected because errors were counted for this variable. For all other variables, correct responses were counted. All variables were checked for a possible correlation with age because older schoolchildren within a specific grade might have progressed further in their language development than younger pupils.

Because the a-priori calculated sample size had not been reached, post-hoc power analyses were conducted using the programme GPower (Faul et al., 2009). They were executed for the sample sizes of $n_{\text{second\_grade}} = 119$, $n_{\text{third\_grade}} = 87$ and $n_{\text{fourth\_grade}} = 85$, in which complete datasets were available for all participants. Power for small, medium and high correlations at an α-error probability of $\alpha = .05$ are reported in Table 19. Due to the many different variables observed in this study, 91 correlations were conducted per independent sample (i.e. per grade). Such a large number of computed correlations increases the risk of making a type I error (Field,

2018), i.e. falsely rejecting the null hypothesis saying that there is no correlation between the variables. The family-wise error rate, that is the risk of making a type I error in this "family of tests" is FWER = 1 - (probability of type I error)$^{number\_of\_comparisons}$ = 1 - .95^{91} = .99 (cf. Field, 2018). That is, the probability of making a type I error when computing 91 correlations is 99%. Therefore, a correction method is applied that sets the family-wise error rate to FWER = .05. This can be achieved by using the Bonferroni correction, for which the α-error rate is divided by the number of observations *k*: P_{Crit} = α / *k* = .05/91 = .00055 (cf. Field, 2018). Thus, the critical *p*-value that indicates a significant correlation is *p* < .00055 when applying Bonferroni corrections for 91 observations. However, adjusting the α-error rate affects the testing power (Field, 2018). Therefore, the power calculations differ for the α-error rate of α = .05 and the Bonferroni-corrected α-error rate of α = .00055. The respective power calculations are displayed in Table 19. The statistical power for Bonferroni-corrected α-error levels is only adequate for high correlations of *r* ≥ .5, as the power of a statistical test should be 1-β ≥ .80 to have not too great a risk of making a type II error, i.e. falsely not-rejecting the null-hypothesis (Cohen, 1992). Sufficient statistical power is also reached for medium correlations when the α-error rate is not Bonferroni-corrected. For small correlations, the risk of making a type II error is high for both α-error rates. It can be deduced that small correlations would most likely not be detected in this sample. Medium correlations would have to be interpreted with caution considering type I and type II error probabilities. High correlations would most likely be detected even when using the Bonferroni-corrected α-error rate, because the α-error probability and the statistical power were both adequate for interpretation.

Table 19

Estimated power for correlations for corrected and uncorrected α-error probabilities

	Grade 2		Grade 3		Grade 4	
Correlation height	α = .05	α = .00055	α = .05	α = .00055	α = .05	α = .00055
Small: *r* = .1	.19	< .01	.15	< .01	.15	< .01
Medium: *r* = .3	.93	.46	.82	.27	.82	.25
High: *r* = .5	>.99	>.99	>.99	.96	>.99	.95

Note. Grade 2: *n* = 119, Grade 3: *n* = 87, Grade 4: *n* = 85. Two-tailed testing.

Comparisons of correlations between grade levels

Whether the height of correlations between morphological awareness and literacy variables changed across grades was tested based on the procedure for comparing correlation coefficients as presented in Eid, Gollwitzer, and Schmitt (2011) with the help of an online calculator (Lenhard & Lenhard, 2014). To compare correlations, correlation coefficients are transformed into z-values using Fisher's-*r*-to-*z* transformation. These *z*-values are then

compared, giving a *z*-test statistic and a significance value *p*. A meaningful change in the strength of correlations between grades is indicated by a significant *p*-value.

Regression analyses

Multiple linear regression analyses were run for all dependent variables and for each grade separately. There were four dependent variables for spelling: correctly spelled graphemes, and proficiency in alphabetic, orthographic and morphematic spelling strategy. The three dependent variables for reading were reading comprehension, word reading fluency and pseudoword reading fluency. Explaining variables were phonological awareness, rapid naming, verbal memory, morphological awareness variables as deduced from the factor analyses and age if there was a correlation between age and any of the other variables.

All regressions were run using the forced entry method, which means that all explaining variables were entered into the regression simultaneously. The forced entry method was chosen instead of stepwise methods because stepwise methods are influenced by random variation in the data and therefore often are not replicable when the model is retested (Field, 2018). Furthermore, IBM Statistics reports its significance values to be invalid for stepwise procedures because the significance values are based on fitting a single model (IBM Knowledge Center, 2019).

Per independent sample, i.e. per grade, seven regressions were run. Per regression, eight *p*-values were interpreted: seven for the explaining variables and one for the adjusted R^2. This adds up to 56 *p*-values that were inspected per grade in this family of tests. Using the Bonferroni correction, the corrected critical *p*-value is $P_{Crit} = \alpha / k = .05/56 = .00089$. Table 20 shows the statistical power for the regression analyses for different effect sizes and the Bonferrroni-corrected and the uncorrected α-error rates.

Table 20

Estimated power for regression analyses for corrected and uncorrected α-error probabilities

	Grade 2		Grade 3		Grade 4	
Effect size	α = .05	α = .00089	α = .05	α = .00089	α = .05	α = .00089
Small: $f^2 = .02$	.15	< .01	.12	< .01	.12	< .01
Medium: $f^2 = .15$	.87	.39	.71	.19	.70	.18
Large: $f^2 = .35$	> .99	.95	.99	.77	.98	.75

Note. Grade 2: *n* = 119, Grade 3: *n* = 87, Grade 4: *n* = 85. MA: Morphological awareness.

It can be concluded that statistical power for high effect sizes in Grade 2 was good. For not-corrected α-error rates, the statistical power was also adequate for high effect sizes in Grades 3 and 4 and for medium effect sizes in Grade 2. The statistical power for all other cases

has to be considered as inadequate. Results have to be interpreted in light of the type I and type II error probabilities.

When conducting regression analyses with data from schoolchildren, it has to be considered that the data are multi-level in nature because data points are nested within schools and within classrooms. It is necessary to take the multi-level structure of data into consideration if participants within a group are more similar to each other than participants between groups are. For the present data, this could be the case because schoolchildren within a classroom are taught by the same teacher with the same didactic approach but schoolchildren between classrooms might have different teachers and encounter different didactic approaches. As didactic approaches influence reading and spelling skills (cf. Thompson, Connelly, Fletcher-Flinn, & Hodson, 2009) and possibly performance in the other applied measures such as vocabulary and morphological awareness, the multi-level structure of the data should not be ignored. In multi-level data, residuals can be autocorrelated, which means that errors are not independent (Field, 2018). However, independency of errors is one of the model assumptions of linear regression (Field, 2018; Rasch, Naumann, Friese, & Hofmann, 2014). Violating this assumption leads to invalid standard errors, confidence intervals and significance tests in the regression model (Field, 2018). Field (2018) suggests two methods to test for autocorrelation: the Durbin-Watson test and regression scatterplots of the standardised outcomes predicted by the model with the standardised residuals. The Durbin-Watson test did not apply in this case, because it tests for serial correlations between errors, i.e. it tests whether contiguous residuals are correlated (Field, 2018; Savin & White, 1977). Consequently, it is affected by the order in which the cases are entered in the dataset. Cases in cross-sectional designs usually do not have a meaningful order, which is also true for this study. Therefore, the second option, the inspection of scatterplots, was used to detect possible correlations of errors. If errors are uncorrelated, the scatterplot shows a cloud of dots where the points are randomly and evenly spread across the plot (Field, 2018). Assessment of model assumptions and outcomes of the regression analyses are presented in the following section.

For correlation and regression analyses, the statistics software IBM SPSS Statistics 25 for Windows (IBM Corp., 2017) was used.

4.3.2 Results

4.3.2.1 Factor analyses

To select the optimal factor solutions, both model fit indices and the meaningfulness of factors have to be considered. In the following, first model fit indices for factors analyses are detailed, and second, indices are interpreted with regard to the meaningfulness of the respective solutions.

For the morphological fluency task, one factor was extracted with exploratory factor analysis (Table 21). The two-factor solution was not identified because a factor with just two items can only be extracted if the items loading on this factor are highly correlated (i.e., $r > .70$) and relatively uncorrelated with other items (Worthington & Whittaker, 2006). Correlations of the four items were between $.30^{**} \leq r \leq .59^{**}$, which does not imply that there are two different factors. Theoretical implications suggested a one-factor solution as well, as all items were verbs with relatively large morphological family sizes. However, of the model fit indices of this one factor solution, only the CFI can be considered adequate (cf. Kleinke et al., 2017). Therefore, factor loadings were inspected to identify items that do not represent the factor well. No such item was identified because all items loaded positively and significantly on the factor.

Table 21

Exploratory factor analysis for the morphological fluency items

	Factor 1	Model Fit			
Item	Loadings (*SD*)	RMSEA (90% C.I.)	$p_{RMSEA} \leq .05$	CFI / TLI	χ^2-Test of Model Fit
Verb 1	.58* (.05)	.19 (.13 - .26)	$p < .0001$	.93 / .79	23.996 (*df* = 2; p < .01**)
Verb 2	.56* (.05)				
Verb 3	.65* (.04)				
Verb 4	.86* (.04)				

Note. Estimator: ML. Rotation: GEOMIN (oblique). *$p < .05$.

Large differences in item difficulties can also cause a low model fit (Aryadoust, 2009).

Table 22 shows that item difficulties, which can be inferred from the item means, varied across items and grades. Higher values indicate lower item difficulty because participants were able to find more correct responses.

Table 22

Item characteristics for the four morphological fluency items

	Grades 2-4		Grade 2		Grade 3		Grade 4	
Item	*M* (*SD*)	Range	*M* (*SD*)	Range	*M* (*SD*)	Range	*M* (*SD*)	Range
Verb 1	7.7 (4.0)	0 - 20	6.2 (4.1)	0 - 16	8.6 (3.4)	0 - 17	8.9 (3.6)	0 - 20
Verb 2	5.1 (3.2)	0 - 13	3.9 (3.1)	0 - 12	6.1 (3.0)	0 - 12	5.8 (3.0)	0 - 13
Verb 3	4.2 (3.4)	0 - 14	2.8 (3.2)	0 - 12	5.4 (3.1)	0 - 14	4.9 (3.2)	0 - 14
Verb 4	5.4 (4.0)	0 - 16	3.3 (3.4)	0 - 14	7.2 (3.8)	0 - 16	6.4 (3.8)	0 - 16

Note. N = 310. Grade 2: n = 126, Grade 3: n = 94, Grade 4: n = 90.

Table 23 displays paired *t*-tests for the comparison of the four item means in the overall sample. All comparisons were significant ($p < .01$**), except for the comparison between verbs 2 and 4 ($p = .262$). That is, item difficulties differed significantly between most items, which could be a reason why some of the parameters indicated poor model fit. Yet, different item difficulties were deemed necessary to be able to differentiate between schoolchildren in all three grades. Moreover, all items loaded significantly on the factor. For these two reasons, it was decided to keep all four items for subsequent analyses.

Table 23

Paired t-Tests for Differences in Item Difficulties across Grades 2-4

Compared Items	Mean difference	*SD*	*df*	*t*	*p*
Verb 1 - Verb 2	2.6	3.7	309	12.3	< .01**
Verb 1 - Verb 3	3.5	4.3	309	14.5	< .01**
Verb 1 - Verb 4	2.3	4.1	309	10.1	< .01**
Verb 2 - Verb 3	.9	3.9	309	4.2	< .01**
Verb 2 - Verb 4	-.2	3.8	309	-1.1	.262
Verb 3 - Verb 4	-1.1	3.4	309	-6.0	< . 01**

Note. N = 310. Grade 2: n = 126, Grade 3: n = 94, Grade 4: n = 90.

This one-factor solution for the morphological fluency task was further investigated in confirmatory factor analyses (see below).

For the exploratory factor analysis for the pseudoword cloze task, different factor solutions were compared. An initial examination of the data revealed that 15 factors with eigenvalues > 1 could be extracted. Using eigenvalues > 1 for factor extraction is only the starting point to find the best factor solution (Kleinke et al., 2017). Thus, an exploratory factor analysis that computed solutions for 1 to 15 factors was run. The χ^2-model-comparisions revealed that all consecutive factor solutions fitted the data significantly better than the factor

solutions with one factor less up until the 13-factor solution, which fitted the data significantly better than the 12-factor solution ($\chi^2 = 41.65$, $df = 27$, $p = .036$). That is, the factor solutions with 14 and 15 factors were not better than the 13-factor solution (Table 24).

Table 24

Exploratory factor analysis: Model comparisons for factor solutions with 1 to 15 factors

Models Compared	χ^2	*df*	*p*
1-factor against 2-factor	505.667	38	< .01
2-factor against 3-factor	252.494	37	< .01
3-factor against 4-factor	169.676	36	< .01
4-factor against 5-factor	179.891	35	< .01
5-factor against 6-factor	129.067	34	< .01
6-factor against 7-factor	108.097	33	< .01
7-factor against 8-factor	83.945	32	< .01
8-factor against 9-factor	68.599	31	< .01
9-factor against 10-factor	68.448	30	< .01
12-factor against 13-factor	41.649	27	.036
13-factor against 14-factor	35.633	26	.100
14-factor against 15-factor	33.473	25	.120

Note. Estimator: WLSMV. Rotation: GEOMIN (oblique). In the first run of the exploratory factor analyses, the 11-factor solution was not specified because the number of iterations was insufficient. Therefore, comparisons with the 11-factor solution are missing in this table. In a later run for the 11-factor solution only, and with increased iterations, the 11-factor solution was specified. Conclusions drawn from the model comparisons as presented in this table were not affected by the initial failure to specify the 11-factor solution because the critical comparisons were between the 12- to 14-factor solutions.

To approximate the optimal factor solution further, model fit indices of the factor solutions with 1 to 13 factors were inspected (Table 25). Good values for the RMSEA were obtained for solutions of ≥ 5 factors, values of the CFI were good for solutions of ≥ 7 factors and values for the TLI were good for solutions with ≥ 9 factors. The χ^2-Test of Model Fit was not significant for solutions with ≥ 11 factors. Thus, for the 11- to 13-factor solution all model fit indices were in the optimal range.

Table 25

Exploratory factor analysis: Model fit parameters for different factor solutions for the pseudoword cloze task

Number of factors	Number of parameters	RMSEA (90% C.I.)	$p_{RMSEA} \leq .05$	CFI / TLI	χ^2-Test of Model Fit
1	39	.08 (.07 - .08)	< .01	.64 / .62	1997.49 (*df* = 702, *p* < .01)
2	77	.06 (.06 - .07)	< .01	.77 / .74	1491.55 (*df* = 664, *p* < .01)
3	114	.06 (.05 - .06)	.016	.83 / .80	1236.65 (*df* = 627, *p* < .01)
4	150	.05 (.05 - .06)	.315	.87 / .83	1074.72 (*df* = 591, *p* < .01)
5	185	.05 (.04 - .05)	.944	.90 / .87	903.53 (*df* = 556, *p* < .01)
6	219	.04 (.03 - .05)	.999	.93 / .90	779.24 (*df* = 522, *p* < .01)
7	252	.04 (.03 - .04)	> .999	.95 / .92	676.60 (*df* = 489, *p* < .01)
8	284	.03 (.02 - .04)	> .999	.96 / .94	593.88 (*df* = 457, *p* < .01)
9	315	.03 (.02 - .04)	> .999	.97 / .95	529.56 (*df* = 426, *p* < .01)
10	345	.02 (.01 - .03)	> .999	.98 / .97	460.90 (*df* = 396, *p* < .05)
11	374	.02 (.00 - .03)	> .999	.99 / .98	403.18 (*df* = 367, *p* > .05)
12	402	.02 (.00 - .03)	> .999	.99 / .99	363.20 (*df* = 339, *p* > .05)
13	429	.01 (.00 - .02)	> .999	> .99 / .99	321.53 (*df* = 312, *p* > .05)

Note. Estimator: WLSMV. Rotation: GEOMIN (oblique).

To select the optimal factor solution, the interpretability of the different factor solutions was inspected. The 8-factor solution was identified as providing meaningful factors and having adequate to good descriptive model fit indices (cf. Kleinke et al., 2017). It includes two factors for inflections (*plural on -e* and *plural on -s*), three factors for derivations *(person*, *place*, *diminutive*), one factor for compounds (*compound*) and two mixed factors covering inflections and derivations (*adjective* and *no picture*). The factor *adjective* consists of two derivational and four inflectional items for adjectives. The factor *no picture* consists of all items taken from the TMB, which were seven derivations of various kinds and one inflection. All items loaded positively on their respective factors. The 8-factor solution can be viewed in detail in Table 26. All significant loadings are displayed. All items were assigned to the factor on which they had the highest loading (highlighted in boldface).

Table 26

Exploratory factor analysis: Loadings and standard errors for the 8-factor solution for the pseudoword cloze task

Item	Plural on -e	Plural on -s	Adjective	No picture	Person	Place	Diminutive	Compound
Plural 1[I]	**.26* (.11)**		*.25* (.13)*					
Plural 2[I]		**.89* (.08)**						
Plural 3[I]	*.21* (.08)*	**.79* (.08)**						
Plural 4[I]	**.79* (.08)**							
Plural 5[I]	**.89* (.07)**							
Singular 1[I]					*.24* (.09)*			
Singular 2[I]								
Singular 3[I]								
Singular 4[I]								
Adjective 1[D]			**.49* (.09)**					
Adjective 2[D]			**.52* (.08)**	*.22* (.10)*				
Comparative 1[I]	*.25* (.12)*		**.89* (.09)**					
Comparative 2[I]			**.84* (.06)**					
Superlative 1[I]			**.70* (.09)**					
Superlative 2[I]	*.27* (.12)*		**.76* (.08)**					
Male 1[D]					**.79*(.08)**			
Male 2[D]				*.29* (.12)*	**.60* (.09)**			
Male 3[D,NP]				**.52* (.12)**				
Male 4[D,NP]		*.36* (.12)*		**.71* (.12)**				
Female 1[D]					**.72* (.07)**			
Female 2[D]				*.40* (.14)*	**.58* (.11)**	*.31* (.13)*		
Female 3[D,NP]	*.30* (.15)*			**.36* (.15)**				
Place 1[D]						**.90* (.07)**		

Item	Plural on -e	Plural on -s	Adjective	No picture	Person	Place	Diminutive	Compound
Place 2[D]						**.97* (.08)**		
Diminutive 1[D]							**1.02* (.09)**	
Diminutive 2[D]							**.79* (.10)**	
Proceeding 1[D,NP]				**.22* (.09)**			*.20* (.08)*	
Proceeding 2[D,NP]		*.30* (.11)*		**.70* (.11)**				
Past Participle 1[D,NP]				**.55* (.11)**				
Past Participle 2[D,NP]				**.58* (.09)**				
Past Participle 3[I,NP]				**.43* (.10)**				
Compound 1[C]								**.44* (.14)**
Compound 2[C]								**.54* (.12)**
Plural 1[I]								**.45* (.09)**
Plural 2[I]								**.66* (.08)**
Plural 3[I]								**.65* (.11)**
Plural 4[I]								**.64* (.11)**
Plural 5[I]								**.60* (.14)**
Singular 1[I]								**.61* (.14)**

Note. Estimator: WLSMV. All variables defined as categorical. Rotation: GEOMIN (oblique). Of the 39 pseudoword items, four items did not load on any factor and were therefore excluded (all four were items for which a plural had to be turned into a singular).

Boldface: Highest loadings; corresponds to the factor the items were assigned to.

* $p < .05$

[I]Inflection. [D]Derivation. [C]Compound. [NP]Item presented without a picture.

In a next step, confirmatory factor analyses were computed comparing three different models explaining the underlying structure of the construct morphological awareness. Two models were theoretically driven (Figure 3 and Figure 4) and one model was based on the results of the exploratory factor analyses (Figure 5).

Figure 3

Model 1: Theoretically driven model on facets of morphological awareness

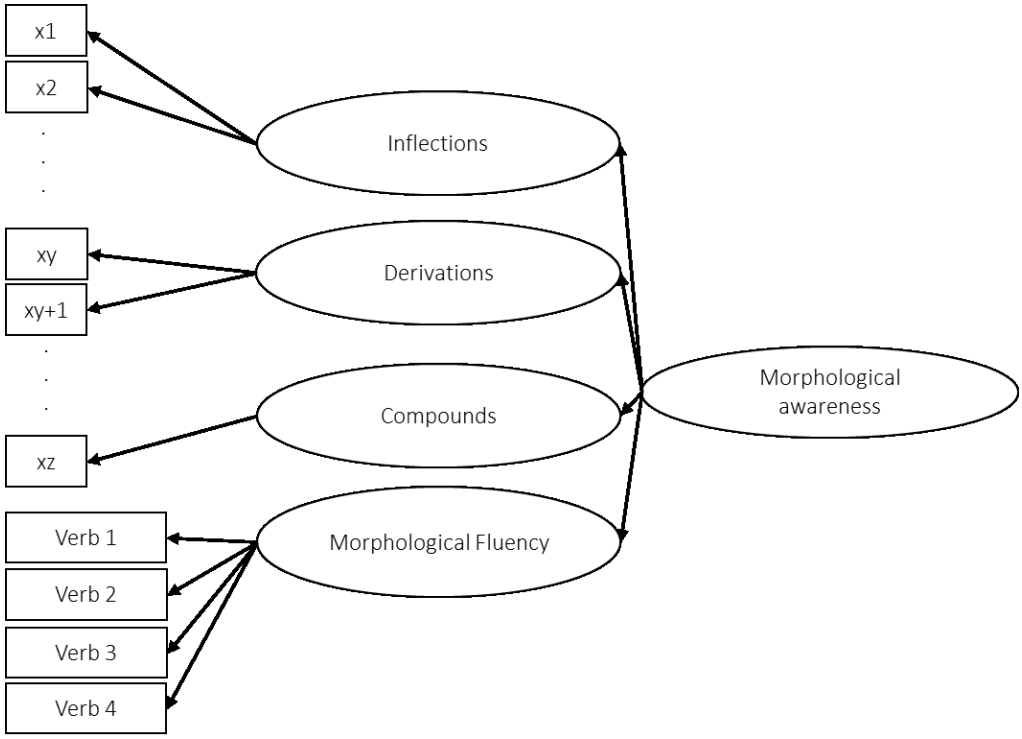


Figure 4

Model 2: Theoretically driven model on facets of morphological awareness

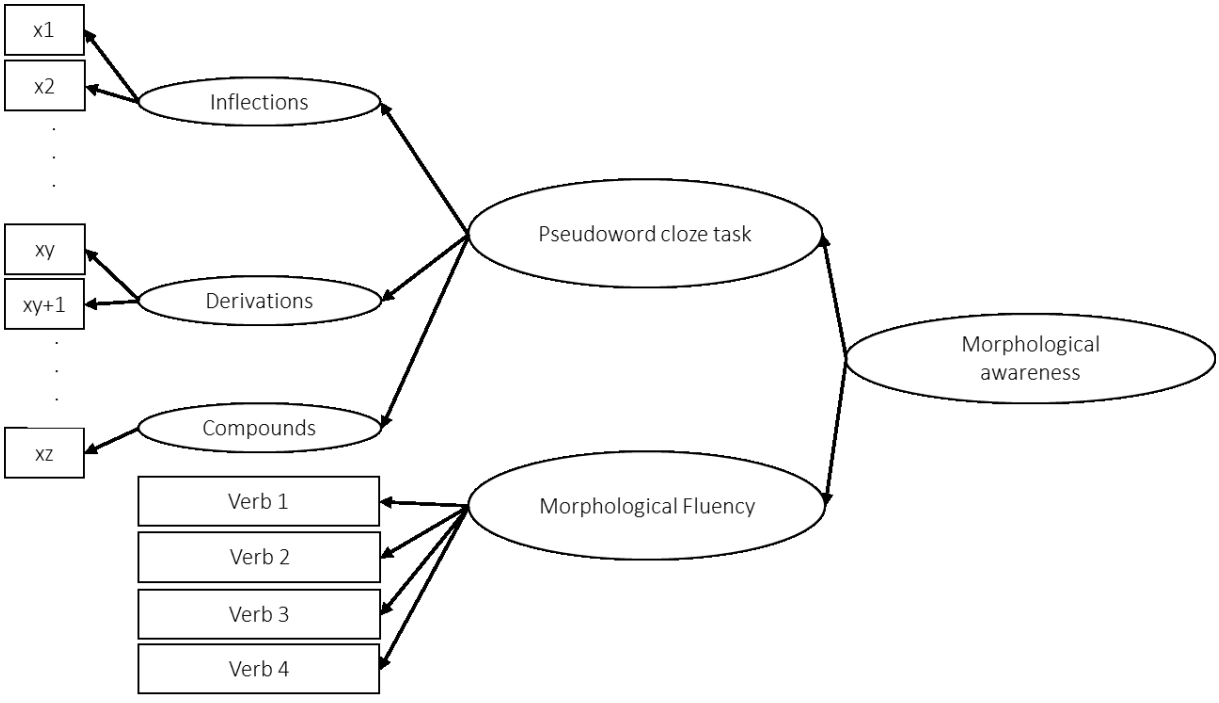
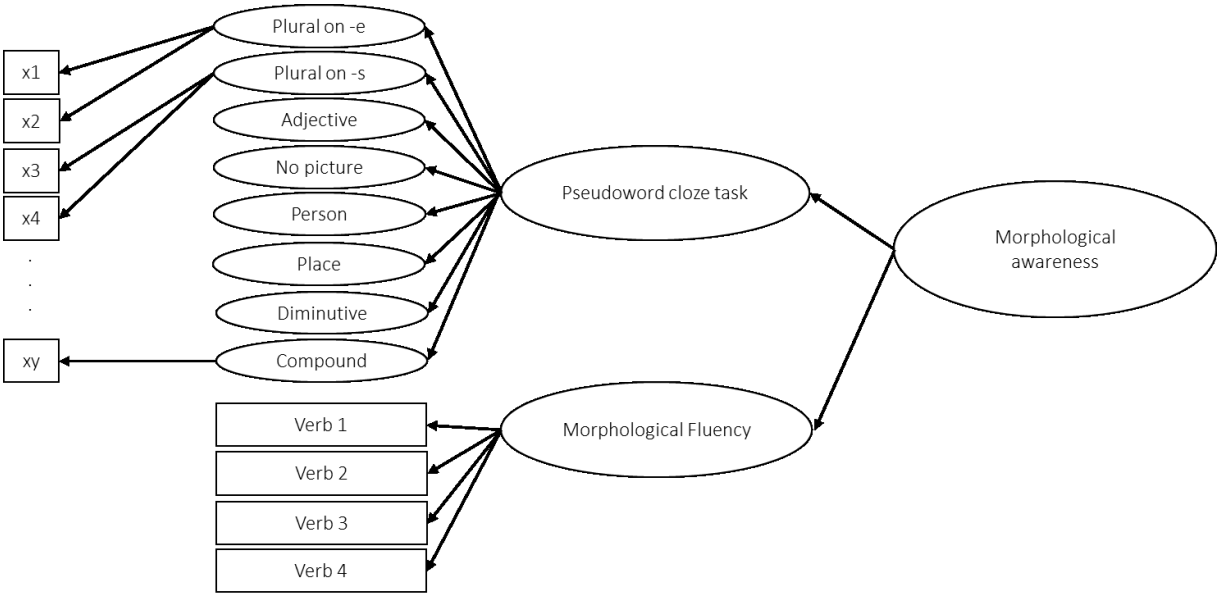


Figure 5

Model 3: Facets of morphological awareness derived from results of exploratory factor analyses



Results on the confirmatory factor analyses can be viewed in Table 27.

Table 27

Model fit parameters for confirmatory factor analyses for morphological awareness

Model	RMSEA (90% C.I.)	$p_{RMSEA} \leq .05$	CFI / TLI	χ^2-Test of Model Fit
Model 1[a]	.068 (.063 - .072)	p < .0001	.647 / .625	1602.249 (*df* = 662; *p* < .0001)
Model 2[a]	.073 (.069 - .077)	p < .0001	.585 / .561	1769.909 (*df* = 664; *p* < .0001)
Model 3[b]	.027 (.019 - .033)	p > .999	.948 / .944	758.936 (*df* = 621; *p* = .0001)

Note. Estimator for all models: WLSMV. Pseudoword cloze task items defined as categorical. Iterations set to 10000.

[a]Theoretically based. [b]Based on EFA results.

For both theoretically based models, only the RMSEA showed an adequate model fit but not the other model fit parameters. In the model that was based on the exploratory factor analyses, the first-order factor *place* had to be omitted because of a negative residual variance of one of its two items. The final model had a significant χ^2-Test of Model Fit. However, all descriptive model fit indices were adequate or good (cf. Kleinke et al., 2017). As the χ^2-Test of model fit is dependent on sample size, and all descriptive model fit indices were acceptable, the plausibility of model 3 was accepted. That is, the factors *pseudoword cloze task* (described by seven first-order factors) and *morphological fluency* (described by four items) could explain the factor *morphological awareness* well. This indicates that the two task types are measuring two aspects of one underlying construct – *morphological awareness*. It was decided to use these

two components of morphological awareness in further analyses, i.e. morphological awareness and the pseudoword cloze task instead of all first-order factors in order to reduce problems with testing power and α-error accumulation (cf. section 4.3.1.5).

Sum scores were calculated for both morphological fluency and the pseudoword cloze task, adding up all items that could be included in model 3 of the confirmatory factor analyses. Thus, all four items for which a plural had to be turned into a singular and both items for which a word for a place had to be found were omitted. Sum scores consisted of 4 items for morphological fluency and 33 items for the pseudoword cloze task.

Reliability analyses were re-run for the pseudoword cloze task with the reduced set of items. Reliability indices changed only marginally: Across second to fourth grade Cronbach's α was α = 0.82. In second grade Cronbach's α was α = 0.79, and in third and fourth grade it was α = 0.81. That is, reliability indices remained in an acceptable to good range. An updated reliability analysis for the morphological fluency task was not necessary because no changes were applied to this task.

4.3.2.2 Descriptive statistics

Descriptive statistics for study variables are presented in Table 28.

In most tests, children were given the exactly same tasks across grades. Only the spelling and vocabulary tests were grade-specific. Therefore, raw scores of all tests except those for spelling and vocabulary are comparable across grades.

Morphological awareness tasks were analysed further for differences between grades. A one-way independent ANOVA revealed that the means of both morphological awareness variables varied across grades, for the morphological fluency task: $F(2,288) = 39.23$, $p < .01$** and for the pseudoword cloze task: $F(2,288) = 15.25$, $p < .05$*. Planned contrasts for the pseudoword cloze task showed that the means for third- and fourth graders were higher than that for second graders: $t_{2vs3}(189.6) = 3.9$, $p < .01$** and $t_{2vs4}(189.2) = 5.2$, $p < .01$**. However, the means for third and fourth graders did not differ significantly: $t_{3vs4}(170.0) = 1.1$, $p = .255$. For the morphological fluency task, the same pattern was observed. The mean for third graders was higher than that for second graders: $t_{2vs3}(199.5) = 7.9$, $p < .01$**, as was the mean of fourth graders: $t_{2vs4}(197.3) = 6.9$, $p < .01$**, but the means for third and fourth graders did not differ significantly: $t_{3vs4}(170.0) = -1.0$, $p = .327$. When applying Bonferroni corrections all previously significant results remained significant.

Table 28

Descriptive statistics of study variables

	Grade 2				Grade 3				Grade 4			
Variable	Max	*M*	*SD*	Range	Max	*M*	*SD*	Range	Max	*M*	*SD*	Range
Age (years;months)		8;4	5.0	7;7 - 9;10		9;4	5.5	8;6 - 10;7		10;4	5.2	9;9 - 11;5
Correctly spelled graphemes	148	131.8	12.2	62 - 147	191	175.7	10.5	147 - 190	277	257.2	17.9	189 - 277
Alphabetic spelling strategy (points)	20	18.1	3.2	2 - 20	20	19.0	1.4	14 - 20	25	22.1	3.6	2 - 25
Orthographic spelling strategy (points)	15	9.0	4.0	0 - 15	15	11.8	3.1	3 - 15	20	15.9	3.6	2 - 20
Morphological spelling strategy (points)	10	5.2	2.6	0 - 10	10	6.8	2.3	2 - 10	15	11.1	3.0	1 - 15
Reading comprehension (averaged *t*-value)	75	50.3	9.3	25 - 67	75	51.1	10.1	29 - 75	75	53.1	8.2	30 - 71
Word reading fluency (correctly read words)	156	42.3	19.0	4 - 89	156	59.9	22.5	19 - 117	156	72.0	21.1	20 - 111
Pseudoword reading fluency (correctly read pseudowords)	156	29.4	9.7	4 - 57	156	35.1	11.1	15 - 66	156	41.6	13.1	10 - 68
Phonological awareness (points)	64	47.9	9.3	15 - 61	64	52.0	7.5	21 - 64	64	53.8	7.6	15 - 64
Rapid naming (in seconds)		23.2	3.6	15.1 - 34.2		21.4	5.4	13.9 - 59.6		20.4	3.8	13.5 - 37.4
Verbal memory (errors)	25	7.0	3.1	0 - 16	25	6.2	3.4	0 - 18	25	6.1	3.1	0 - 14
Vocabulary (points)	15	12.1	2.1	5 - 15	15	11.3	2.3	5 - 15	15	11.4	2.0	6 - 15
MA: Pseudowords (points)	67	44.5	9.3	16 - 62	67	49.5	8.9	18 - 63	67	51.0	8.6	17 - 65
MA: Morphological fluency (points)		16.5	10.8	0 - 43		27.4	9.1	0 - 46		26.1	9.0	2 - 48

Note. Grade 2: *n* = 119, Grade 3: *n* = 87, Grade 4: *n* = 85. MA: Morphological awareness.

4.3.2.3 Correlation analyses

Correlations between cognitive variables, literacy variables and age were computed for each grade (Table 29 - Table 31). At the α-error level of α = .05 almost all correlations were significant. Using the Bonferroni-corrected α-error level of α = .00055, still many correlations reached significance (emphasized in boldface). The pseudoword cloze task was correlated with both reading and spelling variables in all three grades, even when applying Bonferroni corrections. The morphological fluency task significantly correlated with both reading and spelling variables in all three grades only when using uncorrected α-error levels. When applying Bonferroni corrections, significant correlations could only be observed with reading comprehension in second and fourth grade. The correlation coefficient between the two morphological awareness tasks dropped from r = .28** in second grade to r = .07 in fourth grade.

The other cognitive variables correlated significantly with reading and spelling variables in all three observed grades. Medium to high correlations were observed between phonological awareness and all literacy variables in all grades. Rapid naming, verbal memory and vocabulary also correlated with literacy variables, but not all correlations were significant. Using Bonferroni corrections, all correlations between phonological awareness and literacy variables remained significant. Rapid naming was only significantly correlated with literacy variables in second, but not in third and fourth grade. Both verbal memory and vocabulary correlated with reading variables in all three grades. For spelling variables, the pattern was more divergent. Whereas vocabulary correlated with spelling variables only in second and third grade, verbal memory correlated with spelling variables only in second and fourth grade.

Significant correlations between morphological awareness and the other cognitive variables were observed in all three grades. When using Bonferroni corrections, the following pattern was observed: The pseudoword cloze task correlated highly with phonological awareness in all observed grades. Morphological fluency and phonological awareness were only correlated in second grade, but not later. Of the other cognitive variables, verbal memory and vocabulary correlated with the pseudoword cloze task in second grade and verbal memory additionally in fourth grade.

Medium to high correlations were observed for most other relationships between cognitive variables. Field (2018) recommends to look for correlations of $r \geq .80$ to identify multicollinearity. According to this criterion, correlations between explaining variables in the subsequent regression analyses did not show signs of multicollinearity (r_{max} = .61).

Using Bonferroni corrections, age was uncorrelated with all other study variables in second and third grade but correlated negatively with correctly spelled graphemes and phonological awareness in fourth grade, indicating that younger schoolchildren within fourth grade tended to outperform their older peers.

Correlation coefficients between morphological awareness tasks and literacy variables were compared between grade levels to tests whether the height of correlations changes. As can be seen in Table 32, for neither of the two morphological awareness tasks significant changes in the height of the correlation coefficients could be detected (all $p > .05$).

Table 29

Correlations of study variables in second grade

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13
1 Age	-												
2 Correctly spelled graphemes	-.10	-											
3 Alphabetic spelling strategy	-.01	**.73****	-										
4 Orthographic spelling strategy	-.14	**.79****	**.44****	-									
5 Morphological spelling strategy	-.01	**.66****	.27**	**.70****	-								
6 Reading comprehension	-.06	**.67****	**.40****	**.68****	**.68****	-							
7 Word reading fluency	-.06	**.61****	.30**	**.63****	**.65****	**.87****	-						
8 Pseudoword reading fluency	-.16	**.53****	.26**	**.48****	**.50****	**.75****	**.87****	-					
9 Phonological awareness	-.29**	**.74****	**.60****	**.61****	**.46****	**.55****	**.50****	**.46****	-				
10 Rapid naming	.18*	-.21*	-.11	**-.38****	-.16	-.29**	-.26**	**-.33****	-.31**	-			
11 Verbal memory	.13	**-.41****	**-.34****	**-.34****	**-.34****	**-.33****	**-.31****	-.22**	**-.44****	.12	-		
12 Vocabulary	.02	**.44****	**.44****	**.31****	**.32****	**.42****	**.35****	.27**	**.51****	-.12	**-.39****	-	
13 MA: Pseudowords	-.15	**.48****	**.40****	**.37****	**.33****	**.40****	.30**	.23*	**.61****	-.08	**-.56****	**.42****	-
14 MA: Morphological fluency	-.09	.28**	.25**	.29**	.17	**.33****	.17	.07	**.42****	-.10	-.29**	.28**	.28**

Note. *n* = 119. MA: Morphological awareness.

**p* < .05 ***p* < .01. Boldface: Significant at the Bonferroni-corrected α-error level α < .00055.

Table 30

Correlations of study variables in third grade

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13
1 Age	-												
2 Correctly spelled graphemes	-.25*	-											
3 Alphabetic spelling strategy	.13	**.71****	-										
4 Orthographic spelling strategy	-.13	**.89****	**.57****	-									
5 Morphematic spelling strategy	-.31**	**.85****	**.52****	**.76****	-								
6 Reading comprehension	-.30**	**.67****	.36**	**.65****	**.63****	-							
7 Word reading fluency	-.26*	**.68****	**.42****	**.61****	**.66****	**.84****	-						
8 Pseudoword reading fluency	-.14	**.54****	.27*	**.47****	**.51****	**.68****	**.83****	-					
9 Phonological awareness	-.19	**.61****	**.44****	**.58****	**.55****	**.64****	**.59****	**.54****	-				
10 Rapid naming	.14	-.25*	-.12	-.26*	-.21*	-.30**	-.27*	-.18	-.17	-			
11 Verbal memory	.19	-.23*	-.16	-.17	-.19	**-.39****	-.28**	-.10	**-.38****	.29**	-		
12 Vocabulary	-.12	**.44****	.35**	.32**	.31**	**.50****	**.44****	.30**	**.53****	-.16	**-.39****	-	
13 MA: Pseudowords	-.36**	**.38****	.28**	**.37****	.31**	**.47****	**.38****	.28**	**.53****	-.18	-.36**	**.53****	-
14 MA: Morphological fluency	-.05	.24*	.14	.26*	.13	.26*	.13	.08	.23*	-.02	-.22*	.32**	.20

Note. *n* = 87. MA: Morphological awareness.

**p* < .05 ***p* < .01. Boldface: Significant at the Bonferroni-corrected α-error level α < .00055.

Table 31

Correlations of study variables in fourth grade

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13
1 Age	-												
2 Correctly spelled graphemes	**-.41****	-											
3 Alphabetic spelling strategy	-.26*	**.76****	-										
4 Orthographic spelling strategy	-.32**	**.89****	**.67****	-									
5 Morphematic spelling strategy	-.27*	**.86****	**.69****	**.77****	-								
6 Reading comprehension	-.26*	**.66****	**.60****	**.62****	**.64****	-							
7 Word reading fluency	-.23*	**.70****	**.64****	**.70****	**.66****	**.82****	-						
8 Pseudoword reading fluency	-.10	**.61****	**.56****	**.56****	**.56****	**.73****	**.83****	-					
9 Phonological awareness	**-.50****	**.70****	**.64****	**.58****	**.60****	**.62****	**.54****	**.47****	-				
10 Rapid naming	.02	-.26*	-.32**	-.23*	-.17	-.44**	-.36**	-.28**	-.33**	-			
11 Verbal memory	.22*	**-.42****	**-.41****	-.26*	-.36**	**-.44****	**-.44****	**-.41****	**-.61****	.21	-		
12 Vocabulary	.03	.13	.14	.07	.19	**.39****	.26*	.21	.27*	-.30**	**-.42****	-	
13 MA: Pseudowords	-.32**	**.48****	**.44****	**.37****	**.42****	**.44****	**.45****	.35**	**.61****	-.35**	**-.54****	.33**	-
14 MA: Morphological fluency	-.13	.29**	.17	.24*	.28*	**.38****	.35**	.23*	.34**	-.18	-.23*	.25*	.10

Note. *n* = 85. MA: Morphological awareness.

**p* < .05 ***p*< .01. Boldface: Significant at the Bonferroni-corrected α-error level α < .00055.

Table 32

Comparison of correlation coefficients of morphological awareness with literacy variables between grades.

	Correlations						Comparisons											
	Pseudoword cloze task			Morphological fluency			Pseudoword cloze task						Morphological fluency					
							2 vs. 3		3 vs. 4		2 vs. 4		2 vs. 3		3 vs. 4		2 vs. 4	
	Grade 2	Grade 3	Grade 4	Grade 2	Grade 3	Grade 4	*z*	*p*	*z*	*p*	*z*	*p*	*z*	*p*	*z*	*p*	*z*	*p*
Correctly spelled graphemes	**.48****	**.38****	**.48****	.28**	.24*	.29**	-0.86	.20	0.79	.21	0.00	.50	-0.30	.38	0.35	.36	0.08	.47
Alphabetic spelling strategy	**.40****	.28**	**.44****	.25**	.14	.17	-0.95	.17	1.19	.12	0.34	.37	-0.80	.21	0.20	.42	-0.58	.28
Orthographic spelling strategy	**.37****	**.37****	**.37****	.29**	.26*	.24*	0.00	.50	0.00	.50	0.00	.50	-0.23	.41	-0.14	.45	-0.37	.36
Morphematic spelling strategy	**.33****	.31**	**.42****	.17	.13	.28*	-0.16	.44	0.82	.21	0.73	.23	-0.29	.39	1.01	.16	0.80	.21
Reading comprehension	**.40****	**.47****	**.44****	**.33****	.26*	**.38****	0.60	.27	-0.24	.40	0.34	.37	-0.54	.30	0.86	.19	0.40	.35
Word reading fluency	.30**	**.38****	**.45****	.17	.13	.35**	0.63	.26	0.55	.29	1.21	.11	-0.29	.39	1.51	.07	1.34	.09
Pseudoword reading fluency	.23*	.28**	.35**	.07	.08	.23*	1.08	.14	0.50	.31	-0.91	.18	0.07	.47	0.99	.16	1.14	.13

Note. Grade 2: $n = 119$, Grade 3: $n = 87$, Grade 4: $n = 85$.

*$p < .05$, **$p < .01$, Boldface: Significant correlations at the Bonferroni-corrected α-error level $\alpha < .00055$.

4.3.2.4 Regression analyses

Multiple linear regression analyses were computed for each grade separately. The assumption of uncorrelated errors was checked using scatterplots of the standardised values that are predicted by the model and the standardised errors, i.e. the standardised differences between the observed and the predicted values of the outcome variable (cf. Field, 2018). The scatterplots are displayed in Appendix F. A close inspection reveals that not all plots meet the requirements of randomly and evenly distributed dots. There are several scatterplots where a small number of outlier dots disturb the picture of a random cloud. Specifically, this applies to all plots for fourth grade, to spelling (correctly spelled graphemes) in second grade and to the orthographic spelling strategy in third grade. As these outlier cases did not meet any of the exclusion criteria (cf. section 4.3.1.1), these outliers were considered unusual but legitimate cases and were therefore kept in the analyses. However, the plots for the alphabetic spelling strategy deviate heavily from the expected picture. For the alphabetic spelling strategy, it has to be inferred that the assumptions for regression analyses are not met. As such, significance tests have to be considered as invalid and should not be interpreted. Regression coefficients are nonetheless interpretable (cf. Field, 2018). For the other regression analyses, significance tests are considered valid.

The results of all regression analyses can be viewed in Table 33 for spelling variables and in Table 34 for reading variables. Phonological awareness significantly explained variance in all grades in all computed regressions at an α-error level of α = .05, except for the regression on word reading fluency in fourth grade. Further, rapid naming significantly contributed to explaining variance in the orthographic spelling strategy in second and third grade, and in pseudoword reading fluency in second grade. Age significantly explained variance in the morphematic spelling strategy in third grade. Its negative regression coefficient indicated that older students tended to reach lower values for morphematic spelling than younger students did. The adjusted R^2s were significant at an α-error level of α = .05 in all instances.

Using Bonferroni corrections (α-error level of α = .00089), phonological awareness still explained unique variance in all regressions on spelling variables except for the morphological spelling strategy in fourth grade. For reading variables, phonological awareness failed to reach significance in fourth grade and for reading comprehension in second grade. All other variables did not uniquely predict any of the outcome variables at the Bonferroni-corrected α-error level. The adjusted R^2s were significant at the Bonferroni-corrected α-error level, except for reading comprehension and pseudoword reading fluency in fourth grade.

Table 33

Regression analyses for spelling variables

	Correctly spelled graphemes			Alphabetic spelling strategy[1]			Orthographic spelling strategy			Morphematic spelling strategy		
Variable	$\beta_{Grade\ 2}$	$\beta_{Grade\ 3}$	$\beta_{Grade\ 4}$	$\beta_{Grade\ 2}$	$\beta_{Grade\ 3}$	$\beta_{Grade\ 4}$	$\beta_{Grade\ 2}$	$\beta_{Grade\ 3}$	$\beta_{Grade\ 4}$	$\beta_{Grade\ 2}$	$\beta_{Grade\ 3}$	$\beta_{Grade\ 4}$
Age	.12†	-.13	-.08	.14†	-.04	.07	.07	.00	-.03	.13	-.22*	.06
Phon. awareness	**.75****	**.51****	**.57****	**.59****	.36**	**.62****	**.53****	**.54****	**.58****	.41**	**.52****	**.56****
Rapid naming	.01	-.15†	-.05	.07	-.05	-.12	-.22**	-.20*	-.06	-.03	-.12	.07
Verbal memory	-.11	.10	-.02	-.08	.06	-.05	-.09	.14	.13	-.17†	.07	.06
Vocabulary	.04	.15	-.10	.13	.17	-.09	-.03	-.04	-.09	.06	.05	.01
MA: Pseudowords	-.02	-.02	.10	-.03	.00	.06	-.00	.09	.08	-.00	-.07	.14
MA: Morph. fluency	-.06	.09	.09	-.02	.02	-.04	.02	.16†	.08	-.06	.01	.10
Adjusted R^2	**.55****	**.39****	**.47****	**.37****	.15**	**.39****	**.39****	**.35****	**.31****	**.21****	**.30****	**.32****

Note. Grade 2: $n = 119$, Grade 3: $n = 87$, Grade 4: $n = 85$. Phon.: Phonological. MA: Morphological awareness. Regression procedure: Enter.

†$p < .10$, *$p < .05$, **$p < .01$. Boldface: Significant at the Bonferroni-corrected α-error level $\alpha < .00089$.

[1]Significance tests of the alphabetic spelling strategy have to be considered as invalid because assumptions for regressions were not met. Regression coefficients are nonetheless interpretable.

Table 34

Regression analyses for reading variables

	Reading comprehension			Word reading fluency			Pseudoword reading fluency		
Variable	$\beta_{Grade\ 2}$	$\beta_{Grade\ 3}$	$\beta_{Grade\ 4}$	$\beta_{Grade\ 2}$	$\beta_{Grade\ 3}$	$\beta_{Grade\ 4}$	$\beta_{Grade\ 2}$	$\beta_{Grade\ 3}$	$\beta_{Grade\ 4}$
Age	.09	-.15†	-.01	.10	-.14	-.00	-.01	-.05	.14
Phonological awareness	.35**	**.45****	.44**	**.44****	**.47****	.25†	**.45****	**.56****	.34*
Rapid naming	-.16†	-.15†	-.12	-.13	-.15†	-.18†	-.20*	-.12	-.11
Verbal memory	-.04	-.06	-.01	-.13	-.03	-.12	-.05	.17	-.18
Vocabulary	.15	.17	.18†	.10	.19†	-.01	.07	.07	-.03
MA: Pseudowords	.08	.03	.04	-.05	-.03	.16	-.07	-.03	.05
MA: Morph. fluency	.11	.07	.16†	-.07	-.03	.19†	-.15	-.03	.08
Adjusted R^2	**.33****	**.47****	.42**	**.25****	**.36****	**.33****	**.23****	**.26****	.22**

Note. Grade 2: n = 119, Grade 3: n = 87, Grade 4: n = 85. MA: Morphological awareness. Regression procedure: Enter.
†p < .10, *p < .05, **p < .01. Boldface: Significant at the Bonferroni-corrected α-error level α < .00089.

4.3.3 Discussion

This study analysed the relationship of morphological awareness with literacy variables in German with a focus on three research questions and four corresponding hypotheses (cf. section 3). Before the research questions can be addressed, the methodical decision on the facets with which morphological awareness was represented in statistical analyses is discussed.

Morphological awareness items were analysed using factor analyses. From three models tested with confirmatory factor analysis, the model that was based on exploratory factor analysis had the best model fit as all descriptive model fit parameters were in an adequate range. The resulting factor structure implied that the pseudoword cloze task was best described by seven underlying factors on different categories, that the morphological fluency task was best described by one factor, and that both morphological fluency and the pseudoword cloze task loaded on a joint factor that was described as morphological awareness. That is, morphological fluency and the pseudoword cloze task are two facets of the construct morphological awareness.

Of the pseudoword cloze task, six items were discarded. Four items for which a plural had to be turned into a singular were removed because they did not load on a factor in exploratory factor analysis. Prior inspections of item characteristics already indicated that those items had low discriminatory power. Exploratory factor analysis confirmed that these plural-singular items did not contribute significantly to the measurement of morphological awareness in second to fourth grade. All of these plural-singular items came from the HSET. It is not surprising that some of the HSET items that were originally developed for children aged 3 to 9 could not discriminate between skills of older children. Two further HSET-items for which a noun had to be derivated to describe a place were removed because of a negative residual variance of one of the two items in confirmatory factor analysis. As these two items were the only items on the factor *place*, both were removed to avoid having a factor with only one item because single-item factors are considered unreliable (Worthington & Whittaker, 2006).

The seven resulting factors of the pseudoword cloze task were *plurals on -e*, *plurals on -s*, *persons*, *diminutives*, *compounds*, *adjectives* and *no picture*. Both *plurals on -e* and *plurals on -s* comprised only inflectional items, *persons* and *diminutives* comprised only derivational items, and *compounds* comprised all compounding items. The factors *adjectives* and *no picture* crossed the border between the theoretically based factors inflections and derivations because they comprised both inflectional and derivational items. Therefore, the originally contemplated differentiation between the categories inflections, derivations and compounds in the pseudoword cloze task was not supported by the factor structure. This implies that the items of the pseudoword cloze task are best described using a finer resolution than that of the theoretically deduced categories. The best factor structure comprised factors on specific grammatical categories and on the presentation

method in the case of the factor *no picture*. The fact that *morphological awareness* could be identified as a third-order factor suggests that *morphological awareness* is a multi-dimensional construct that comprises several distinct facets.

Although the seven first-order factors of the pseudoword cloze task provide a fine resolution on different morphological categories, they were merged to avoid a further accumulation of variables in subsequent analyses with the resulting difficulties of α-error accumulation (cf. section 4.3.1.5). Therefore, it was decided to use the facets *pseudoword cloze task* and *morphological fluency* in subsequent analyses. Compiling all pseudoword cloze task items in one factor is in line with previous research on the factor structure of morphological awareness. Muse (2005) found a one-factor solution to be the preferred model for describing morphological knowledge in fourth graders. This model comprised various tasks on real words and pseudowords, and on derivations and compounds. None of the applied tasks had a speed-component, though. Therefore, results from Muse's study are comparable with the pseudoword cloze task of the present study, but not with the morphological fluency task. Likewise, an unidimensional factor structure was found in a sample of adult university students for three different morphological awareness tasks on relatedness and derivations of real words and on derivations of pseudowords (Wilson-Fowler, 2011). As in the study by Muse (2005), no speed task was used.

The two chosen facets of morphological awareness for the present study represent two aspects of morphological awareness with divergent interpretation. The pseudoword cloze task comprises items in which a morphological alteration has to be applied to a pseudoword based on grammatical, phonological and syntactic information. The morphological fluency task comprises items where as many word formations as possible have to be found for a real word in a given time. That is, the facets differ with respect to the components speed, real words versus pseudowords and with respect to useable context information. For this reasons, it was not attempted to unite the two tasks on one factor. Analyses of the relationship between these two facets and literacy variables are reported in the following section.

4.3.3.1 How are different facets of morphological awareness related to different literacy competencies?

Correlation analyses between the different facets of literacy variables and the facets of morphological awareness that were based on factor analyses indicated that morphological awareness is related to reading and spelling skills in second, third and fourth grade. Findings are discussed with regard to hypotheses one and two.

H1. There is a relationship between morphological awareness and literacy skills in German schoolchildren.

Both facets of morphological awareness, the pseudoword cloze task and the morphological fluency task, were associated with reading and spelling skills in all three observed grades. Adjusting for α-error accumulation, the pseudoword cloze task was still related to both reading and spelling skills in all three grades, and the morphological fluency task was still significantly correlated with reading comprehension in second and fourth grade. That is, the evidence for the relationship between the pseudoword cloze task and literacy variables is stronger than for the relationship between morphological fluency and literacy variables. The non-corrected α-error levels imply significant small to medium correlations between morphological fluency and both reading and spelling variables in all three grades. However, only for high correlation, α- and β-error probabilities are in an adequate range when using Bonferroni corrections. The finding that many correlations of the pseudoword cloze task with literacy variables became significant, even at the corrected α-error levels, emphasizes that this facet of morphological awareness has a meaningful relation with both reading and spelling variables from second to fourth grade. In addition, a meaningful relationship between morphological fluency and reading comprehension was detected. Based on these findings, hypothesis 1 was accepted.

The findings are an extension to empirical evidence from other German studies. Fink et al. (2012), who also used a pseudoword cloze task, reported a high correlation of this task with spelling skills (r = .59**) and a medium correlation with basal reading skills (r = .49**) in fifth and sixth graders. In two further studies, a pseudoword cloze task was used. They found significant relations with spelling skills (Kargl et al., 2018; Kargl & Landerl, 2018) and with proficiency in orthographic and morphological spelling strategies (Kargl et al., 2018) in children from fourth to seventh grade. The present study adds to the existing research base by disclosing that correlations of a pseudoword cloze task with correctly spelled graphemes, proficiency in spelling strategies and with basal reading competencies can be found prior to fourth grade and additionally for reading comprehension. Moreover, Volkmer et al. (2019) found medium relationships between a real word cloze task and reading fluency (r = .29**) and spelling (r = .34**) in second grade. The current study found that medium correlations with spelling and reading fluency also appear for a pseudoword cloze task in this grade level. In line with the reported observations of other German studies, the heights of observed correlations in the current study were small to medium, e.g. for basal reading skills (.23* $\leq r \leq$ .45**), for proficiency in the morphological spelling strategy (.31** $\leq r \leq$ .42**) and for correctly spelled graphemes (.38** $\leq r \leq$ .48**).

A morphological fluency task was also used by Fink et al. (2012) who reported correlations with spelling (r = .22**) and with basal reading ability (r = .23**) in fifth and sixth graders. The

present study expands the evidence on findings for primary school children, for whom also correlations with spelling (correctly spelled graphemes: .24* ≤ *r* ≤ .29**) were found. It was observed that correlations between morphological fluency and basal reading skills were not significant in second and third grade (.07 ≤ *r* ≤ .17), but reached significance in fourth grade .23* ≤ *r* ≤ .35**. This might signify that this facet of morphological awareness is less relevant for basal reading competencies of beginning readers, but unfolds its relevance at later stages of reading competency. In contrast, significant correlations between the pseudoword cloze task and reading fluency were observed from second grade onwards. Possibly, the pseudoword cloze task is a finer measure of the mastery of different morphological rules in second and third grade. Whereas in the pseudoword cloze task a range of different morphological rules had to be applied to given target words, the morphological fluency task was more open in the options of responses. With increasing grade level, an increasing number of responses was given in the morphological fluency task, which means that more diverse affixes and compounds were used. This might imply that at the end of primary school, a speeded access to word formation rules is more available than in earlier primary school grades. This speeded access to word formation rules could be helpful for speeded reading as in the reading fluency tasks.

Of all inspected correlations between morphological fluency and literacy variables, the evidence for a relationship between morphological fluency and reading comprehension was strongest. This finding is in line with meta-analyses for English studies that suggested that the relationship of morphological awareness with reading comprehension is stronger than the one with more basic reading skills such as reading accuracy or reading fluency (Lee, 2011; Ruan et al., 2018; cf. section 2.2.5.1). The dual route approach to word reading comprehension by Grainger and Ziegler (2011) can be used to explain the relationship of morphological awareness with reading comprehension. This approach proposes that reading comprehension is accomplished by the flexible and interactive usage of two routes. While combinations of the most informative letters are coded and used to maximize information on word identity and corresponding semantic information in the coarse-grained route, the precise ordering of letters and their exact position within the word is processed in the fine-grained route (cf. section 2.2.4.3). With regard to morphological information, the coarse-grained route is associated with morpho-semantic processing, i.e. the activation of word fields, and the fine-grained route is associated with morpho-orthographic processing, e.g. the activation of affixes. The activation of word fields in the coarse-grained route facilitates a quick assignment of an approximate meaning to a word. The morphological fluency task should induce an activation of a world field, too, because children are asked to find as many morphologically related words as possible for the given word. Children who are able to find more related words might have advantages in reading comprehension because the coarse-grained route capitalizes on

the activation of familiar, morphologically related words. Because both the reading comprehension task and the morphological fluency task were applied under time pressure the association could have been intensified, as a rapid access to morphologically related words was advantageous in both tasks. Moreover, morphemes are the smallest units of meaning in a language (Elsen, 2014). It is intelligible that the ability to recognize, to reflect on and to manipulate morphemes is related to the extraction of meaning from writing in reading comprehension. In contrast, for reading fluency measures, reading comprehension was not necessarily involved, which could explain why no association between morphological fluency and reading fluency was observed in second and third grade. Furthermore, the dual route approach to reading words aloud can clarify further why reading fluency could be less associated with morphological fluency than reading comprehension. The lexical route to word reading capitalizes on whole-word representations, whereas the non-lexical route makes use of grapheme-phoneme-correspondence rules to generate word pronunciation. Within the non-lexical route, morphological units are used among other information for the translation of graphemes into phonemes (Coltheart et al., 2001). That is, for reading comprehension, both routes might profit from morphological fluency abilities, i.e. from awareness of word formation rules and the activation of word fields, whereas for reading fluency only the non-lexical route might profit from morphological awareness abilities.

One could be surprised that a relationship between morphological awareness and pseudoword reading fluency was observed, although pseudowords did not carry any subtractable meaning. The dual route approach to reading words aloud provides clues as to why these variables could be related. Pseudoword reading can be accomplished only with the non-lexical route because no whole-word representations are available for unfamiliar words. As stated above, the non-lexical route uses, among other information such as letter position and context information, morphological information for the translation of graphemes into phonemes (Coltheart et al., 2001). Some, albeit not all, of the pseudowords contained letter combinations that could have been processed as morphological units because they corresponded to German affixes (“re-”, “-en”, “-in”). For these specific items, morphological awareness might have speeded up the reading process because these morphemes are associated with a certain pronunciation.

A significant relationship of morphological awareness with spelling was observed in all three grades. Theoretical considerations implied that the relationship of morphological awareness with spelling should be stronger than that with reading. The corresponding hypothesis is answered next.

H2. There is a stronger relationship of morphological awareness with spelling skills than with reading skills in German schoolchildren.

Due to the asymmetric consistency in the German orthography, it was expected that the relationship of morphological awareness with spelling was stronger than with reading. However,

the correlations of morphological awareness with spelling (.13 ≤ *r* ≤ .48**) and with reading (.07 ≤ *r* ≤ .47**) did not imply a stronger relationship with spelling. Moreover, there was no indication that morphological awareness was a stronger predictor of spelling skills than of reading skills in regression analyses, as it was no unique predictor of any of the observed variables. Based on these findings, hypothesis 2 was rejected.

Although being in contrast to theoretical considerations (cf. section 3.1), these results are in line with previous German research because in the studies of Volkmer et al. (2019) on second graders and of Fink et al. (2012) on fifth and sixth graders, there was no indication that the relationship of morphological awareness was stronger for spelling than for basal reading skills (cf. section 2.2.5.2). A further observation that might add to the understanding on this question was that the relationship between morphological awareness skills and proficiency in the morphematic strategy for spelling (.13 ≤ *r* ≤ .42**) was not stronger than the relationship with proficiencies in alphabetic (.14 ≤ *r* ≤ .44**) or orthographic strategies (.24* ≤ *r* ≤ .37**). This is contra-intuitive because for morphematic strategy use, morphemes have to be considered for correct spelling, whereas alphabetic strategies capitalize on phoneme-grapheme correspondence rules and orthographic strategies capitalize on the application of orthographic rules (cf. section 2.2.2.2). An explanation might be derived from Klassert et al. (2018) who found that although third graders made use of more morphological strategies than second and first graders do, this did not result in less spelling errors. They asserted that morphological strategy use does not immediately lead to better spelling performances but to more diverse mistakes. Descriptive statistics of the present study shed further light on differences in the mastery of different strategies. While children in second grade gained on average 18.1 of 20 points for alphabetic strategy use, they received on average only 5.2 of 10 points for morphematic strategy use. These values resemble 90.5% and 52% of possible points, respectively. In third grade, the values were 95% for alphabetic strategy use and 68% for morphematic strategy use, and in fourth grade, they were 88% for alphabetic strategy use and 74% for morphematic strategy use. The percentages show that, although proficiency in morphematic strategy use increases with grade level, in each grade the proficiency in alphabetic strategies is higher than the proficiency in morphematic strategy use. The findings could be indicative of primary school children being unsure on how to apply their knowledge of morphemes in spelling situations. In line with this, a reason for why spelling variables were not closer related to morphological awareness than reading variables could be that until the end of fourth grade, schoolchildren are still uncertain in morphological strategy use, which hampers their ability to capitalize on morphological information for spelling. It is evident from the increasing percentages for proficiency in morphematic strategy use with increasing grade level that they do make use of some morphological units in spelling. Therefore, relationships with morphological awareness variables already occur in

primary school. However, German primary school children might capitalize less on morphological strategies than on alphabetic strategies for spelling decisions until the end of fourth grade.

A second remarkable finding was that morphological awareness was not a stronger predictor for spelling than for reading in regression analyses, although German orthography is less consistent in the spelling than in the reading direction. Phonological awareness was the strongest predictor for spelling in all observed grades. The predictive power of phonological awareness for spelling skills until fourth grade has been found in some previous German studies (Berendes et al., 2010; Ennemoser et al., 2012; Landerl & Wimmer, 2008). However, it is surprising that morphological awareness could not additionally contribute to explaining variance in spelling skills as international literature suggested that morphological awareness increases in its importance with decreasing transparency of the orthography of a language (Desrochers et al., 2018). The results of the present study might be indicative of the relative importance of alphabetic spelling strategies until fourth grade in German.

4.3.3.2 Does morphological awareness uniquely predict literacy skills above and beyond other cognitive skills?

H3. Morphological awareness uniquely predicts literacy skills in German schoolchildren when accounting for phonological processing skills and vocabulary.

Regression analyses indicated that morphological awareness does not uniquely predict literacy skills in German second to fourth graders. In contrast, phonological awareness turned out to be the best predictor of both reading and spelling skills in all three grade levels. After applying Bonferroni corrections, no other variable contributed to the explanation of variance of any of the literacy variables. However, due to low testing power (cf. section 4.3.1.5), regression results should be interpreted as an indication for the relationships of the tested variables. After applying Bonferroni corrections, phonological awareness significantly contributed to explaining variance in most spelling variables in all three grades and most reading variables in second and third grade, but not in fourth grade. This suggests that phonological awareness remains an important predictor of spelling skills until the end of primary school, while for reading skills the predictive power can only be detected with adequate certainty for second and third, but not for fourth grade. Low testing power for medium and small effects makes it difficult to interpret the results beyond phonological awareness. Using non-Bonferroni-corrected α-error levels of $\alpha = .05$ or $\alpha =. 10$ discloses further possibly relevant variables. Morphological fluency might play a role for reading comprehension and word reading fluency in fourth grade, which could be indicative of morphological awareness continuing to unfold its relevance in later school years. Findings on cognitive variables besides morphological awareness are discussed in more detail in section 4.3.3.4. The multi-level structure

of the data led to a correlation of residuals in regression analyses on performance in alphabetic spelling strategy, which violated the assumptions for regression analyses. Therefore, significance tests for these analyses have to be considered invalid. Model parameters can still be considered valid, though (Field, 2018). For proficiency in alphabetic spelling strategy, high regression coefficients were observed for phonological awareness in all three grades and additionally a medium regression coefficient for vocabulary in third grade. Therefore, albeit having to ignore the significance tests, phonological awareness also proves to be a predictor for alphabetic spelling strategy in all three grades. Based on their scatterplots, all other regressions were considered adequate for interpretation of significance tests. Therefore, the multi-level structure of the data did not cause concern for the interpretation of other outcome variables. Considering the regression results and the α- and β-error rates, it can be concluded that morphological awareness is not a reliable predictor of literacy variables in second to fourth grade when accounting for other cognitive skills. Therefore, hypothesis 3 was rejected.

This finding is in contrast to both German (Volkmer et al., 2019) and English (e.g. Lee, 2011; Ruan et al., 2018) research. In Volkmer et al.'s study, both morphological awareness and phonological awareness were unique predictors of reading speed, reading fluency and spelling abilities in German second graders. Additionally, phonological awareness, but not morphological awareness uniquely predicted pseudoword reading fluency. It is interesting to note that in Volkmer et al.'s study, morphological awareness and phonological awareness conjointly explained 15% of variance in spelling, 18% of variance in word reading fluency and 11% of variance in pseudoword reading fluency. Variables of the present study explained higher amounts of variance, especially in spelling (55%), but also in word reading fluency (25%) and in pseudoword reading fluency (23%) in second graders. Because phonological awareness was the only significant predictor in second graders in the present study, this implies that phonological awareness was a more important predictor in the present study than in the study by Volkmer et al. The predictive power of phonological awareness for reading and spelling skills was extraordinarily high in the present study, which can be inferred from a meta-analysis by Pfost (2015) who found that phonological awareness predicted on average about ten percent of variance in spelling and reading measures in primary school children. Although Pfost used longitudinal data only, and the present study was conducted cross-sectionally, the discrepancy is evident.

A reason for the observed findings of the present study could be a focus on a phonological approach to literacy and, especially, spelling instruction in Thuringian schools, where this study was conducted. About 70% of German fourth graders have been introduced to initial sound tables throughout their primary school years, and about one half of these children worked almost every lesson with these tables in first and second grade (Bremerich-Vos & Wendt, 2019). Observed

percentages in a study by Hagemann (2018) were even higher because 88,3% of German schools and 93,6% of Thuringian schools reported using initial sound tables in their lessons. An initial sound table is a chart on which graphemes are displayed next to objects that start with the sounds corresponding to the displayed graphemes (Bross, 2016). For example, the grapheme "b" is displayed next to the picture of a **b**all. Concerns about these tables have been raised because first, the relation between German graphemes and phonemes is simplified (cf. section 1.4 on orthographic transparency), and second, some German phonemes never occur at word beginnings and are therefore missing like the phoneme /ŋ/ that corresponds to the grapheme "ng" like in "Ring": /ʁɪŋ/ (cf. Bross, 2016). The high proportion of schoolchildren working with initial sound tables might be indicative of a focus on alphabetic strategies during the first years of schooling. Moreover, official curricula are vague on the instruction of morphological strategies until fourth grade. The *Standing Conference of Ministers of Education and Cultural Affairs* of Germany defined educational standards for the school subject "German" in primary education (Kultusministerkonferenz, 2004). Only for spelling, but not for speaking, listening and reading, it was explicated that children should be able to make use of morphological rules by the end of fourth grade. The curriculum of the federal state of Thuringia expands this guideline insofar that already in the school entry phase (i.e. first and second grade), children should be able to use morphological rules (Thüringer Ministerium für Bildung, Wissenschaft und Kultur, 2010). However, again the application of morphological rules was only explicitly specified for spelling, but not for the other areas of competencies.

It is important to note that the educational standards and curricula specify the competencies that should be reached by schoolchildren, but make no specifications on methods of instructions. Accordingly, German teachers are free to choose their teaching methods. In practise though, individual decisions on teaching methods are often determined by the textbooks the school conference chose to purchase (Hagemann, 2018). The official Thuringian catalogue for textbooks lists 125 different textbooks and related learning materials for German classes in primary school (Thüringer Ministerium für Bildung, Jugend und Sport, 2019). Materials cover different didactical approaches for literacy instructions. Besides, most textbooks do not follow a single didactic approach but combine different approaches (cf. e.g. Bünstorf, Eschenbach, Häusler, & Schramm, 2013; Handt, Kittel, Kuhn, Mrowka-Nienstedt, & Zeller, 2013; Metze, 2004). Therefore, it is very likely that schoolchildren encounter several different didactical approaches throughout their primary school years. However, which activities and exercises are implemented might vary considerably between classrooms. Therefore, it should be considered that strategy use for reading and spelling is not solely attributable to characteristics of German grammar and orthographic consistency, but might vary with different didactic approaches. This would be in line with a study on English-

speaking participants by Thompson et al. (2009) who found that reading instruction experienced in the first school years still influences reading strategies used in adulthood.

Nonetheless, it has to be acknowledged that rather accurate reading can be achieved using grapheme-phoneme-correspondence rules in German, i.e. larger entities are of less importance for accurate reading than in opaque orthographies like English (cf. section 1.4). This characteristic of the German language justifies a phonological approach to literacy instruction and offers an explanation for the importance of phonological awareness for reading skills. The circumstance that phonological awareness was not predictive of reading skills in fourth grade when using Bonferroni-corrected α-error levels might be indicative for a decrease of the importance of phonological awareness skills for reading in higher school grades. This observation is in line with findings of Berendes et al. (2010) who reported that phonological awareness was predictive of reading and spelling in third grade but of spelling only in fourth grade in German.

From models of reading and spelling, it can be assumed that children rely increasingly on orthographic and morphological entities with increasing literacy proficiency, which means that morphological awareness skills should become more important with increasing grade level (cf. 2.2.1.2). However, this did not manifest in a unique contribution of morphological awareness to reading skills in the present study. In a study with fifth and sixth graders, Fink et al. (2012) reported a medium relationship between morphological awareness and reading. However, in this study phonological awareness was not accounted for. Future studies could investigate whether morphological awareness is predictive of reading skills when accounting for phonological awareness skills in higher grades in order to see whether there is a point at which the relative importance of these two skills changes.

Another point to be taken into consideration is that the predictor variables from the regression analyses were in part highly correlated. Especially phonological awareness was correlated highly with a range of other predictor variables in all three grades. Yet, the observed correlations were mostly in line with previous German research that reported medium correlations between phonological awareness and rapid naming in primary school children (Landerl & Wimmer, 2008; Moll et al., 2012) and medium to high correlations between phonological awareness and vocabulary (Berendes et al., 2010). In addition, Landerl and Wimmer (2008) reported a medium correlation of r = .30** between verbal memory and phonological awareness. The observed correlations in the present study are in line with previous literature for rapid naming (-.17 ≤ r ≤ -.33**), and vocabulary (.27 ≤ r ≤ .53**) but are higher for verbal memory (-.38** ≤ r ≤ -.61**). In addition, Volkmer et al. (2019) observed a correlation of r = .24** between morphological awareness and phonological awareness in German second graders. A similar correlation was observed for morphological fluency and phonological awareness in third graders in the present study

($r = .23$*), while it was $r = .42$** for second graders and $r = .34$** for fourth graders. The relationship between the pseudoword cloze task and phonological awareness was even stronger ($.53$** $\leq r \leq .61$**). That is, most correlations in the present study were higher than those previously observed by Volkmer et al. Results of the present study exemplify that different morphological awareness tasks differ in their correlations with phonological awareness. Furthermore, it should be considered that phonological awareness skills might have played a part in correctly solving other tasks. For example, in the pseudoword cloze task, the phonological properties of the test words had to be used for finding the correct inflection, derivation or compound. This was not an error in the design of the task, but rather represents the complex German morphology in which the phonological structure of a word co-determines, among other factors, which morphological rules for inflections, derivations or compounds are to be applied (cf. Dudenredaktion, 2016; Gallmann, 2016). For example, the typical plural suffix for masculine or neutral German nouns is -e (e.g. "der Pinguin" / "the penguin" → "die Pinguine" / "the penguins"). However, for German nouns that end on an unreduced vowel, the typical plural affix is -s (e.g. "der Flamingo" / "the flamingo" → "die Flamingos" / "the flamingos"). Thus, the phonological properties of words have to be analysed and taken into account for morphological decisions. By this, phonological awareness is linked to morphological awareness.

The close relationship between the morphological awareness and phonological awareness variables can also be interpreted in light of the assumption that phonological awareness is a predecessor of morphological awareness. Carlisle and Nomanbhoy (1993) suggested that phonological awareness contributes to morphological awareness because morphemes also carry phonological information. For the identification of morphemes, phonological information has to be analysed in order to find sound units that have a particular meaning (McWhinney, 1978). Distinguishing these sound units from ones that are phonologically identical but do not adhere to the same meaning needs additional morphological analysis. By this, identifying phonological units is a prerequisite for further morphological analysis in which meaning can be assigned to a word or part of a word and transferred to new contexts. For example, the syllable "un" appears in numerous words. Morphological processing helps differentiating between its meaning in "undo" and instances in which it sounds the same but carries another meaning like in "under" (cf. Carlisle & Nomanbhoy, 1993). This reasoning could explain the observed correlation between phonological awareness and the morphological awareness variables, especially in the pseudoword cloze task. Nevertheless, phonological awareness and morphological awareness are distinct constructs (cf. Casalis & Colé, 2009). It is possible that the relationship between phonological awareness and morphological awareness decreases once a certain threshold level of phonological awareness skill is achieved, and that subsequently the two constructs become better distinguishable. This could be further

investigated in future studies with older children or with high achievers in phonological awareness tasks.

4.3.3.3 Is there an increase in the relationship between morphological awareness and literacy skills with increasing literacy proficiency?

H4. The relationship between morphological awareness and literacy skills becomes stronger with increasing literacy proficiency, i.e. with increasing grade level.

The present study was conducted cross-sectionally with children from second, third and fourth grade to analyse whether the strength of relations between morphological awareness and literacy skills increases throughout primary school years. Grade level was used as a rough marker of literacy proficiency, which is an operationalisation that has been used in various studies before (cf. section 2.5).

Comparisons of correlations indicated no significant changes in the height of the correlations between grades. This means, that the relationship between morphological awareness and any literacy skill was not stronger at the end of fourth grade compared to second and third grade. Therefore, hypothesis 4 was rejected.

The observations are in line with the meta-analysis by Lee (2011) who did not find changes in the strength of the relationship between morphological awareness and literacy skills throughout primary school years. Ruan et al. (2018), who found increases in the strength of the relationship of morphological awareness with reading fluency, covered a much wider grade range. Possibly, differences in the strength of the relationships between morphological awareness and literacy variables do not become apparent in primary school years.

However, previous German research suggested an increase in the relationship between morphological awareness and spelling between second and third grade (Klassert et al., 2018). The present study could not confirm this result. This could be due to the measured outcome variables. Whereas Klassert et al. (2018) measured spelling of consonant clusters, the present study used a more general measure of correctly spelled graphemes and looked at proficiency in different spelling strategies. Possibly, changes in the strength of the relationship between morphological awareness and spelling become evident when looking at very specific spelling skills for which the recognition and use of morphemes are necessary. Yet, the relationship between morphological awareness and morphematic spelling strategy did not increase with increasing grade level in the present study, either. An alternative explanation of the observed differences offer the different sample sizes. Possibly the sample of 26 second graders in Klassert et al.'s study could have been too small to detect a relationship with adequate testing power, while the sample size for third graders (n = 157) was presumably large enough for providing adequate testing power. Despite this lack of clarity for the special case of consonant clusters, correlation analyses of the present study imply that the

strength of the relationship with morphological awareness does not seem to change for overall spelling skills and for proficiency in different strategies from second to fourth grade.

In regression analyses, no morphological awareness variable was able to explain unique variance in any of the criterion variables. A tendency of morphological fluency to explain unique variance in reading variables was observed in fourth grade, though. Although this result has to be interpreted with caution due to the accumulation of α-error probabilities, it might indicate that morphological awareness continues to gain significance in higher grade levels. In previous German research, morphological awareness had proven to be a significant correlate of spelling skills until seventh grade (Kargl et al., 2018; Kargl & Landerl, 2018). Future research could test whether morphological awareness is a unique predictor of literacy skills in these higher grade levels and beyond.

A point that has to be considered is that grade level might not be the optimal operationalisation for literacy proficiency. As can be deduced from descriptive statistics, variation within grade levels was huge. Best comparability offer the variables word reading fluency and pseudoword reading fluency because both implementation and rating were conducted in exactly the same way across grades. Although means for these two variables increase across grades, one can see that the best second graders clearly outperformed the fourth graders with the lowest reading performances. That is, operationalising literacy proficiency with grade level is imprecise. In the present study, it was nevertheless chosen to contrast grade levels in order to be able to compare results with national and international studies that used the same approach (cf. section 2.5). In future studies, a focus could be laid on subgroup analyses with high-performers versus low-performers to further clarify the role of literacy proficiency for the strength of the relationship between morphological awareness and literacy skills.

To sum up, the relationship between morphological awareness and literacy competencies does not seem to change across second, third and fourth grade. Future research could aim to clarify whether very specific literacy abilities and the operationalisation of literacy proficiency might play a role in this relationship.

4.3.3.4 Further observations on relationships between cognitive and literacy variables

Phonological awareness

Phonological awareness was the dominant predictor of literacy skills from the end of second grade up until the end of primary school. When controlling for α-error accumulation, phonological awareness explained spelling variables in all three observed grades. For reading variables, however, predictive power of phonological awareness could only be observed in second and third but not in fourth grade. It has to be taken into account that reduced testing power might have led to an inability to detect the significance of the regression coefficients. However, the observed result is in line with

former studies that suggested that phonological awareness is more important for spelling than for reading in German (cf. Wimmer et al., 2000). The result might be indicative of a decrease in the relative importance of phonological awareness for reading variables in later school years. A possible reason for this could be that reading strategies are organised differently in later school years, and that less weight is put on alphabetic and more on orthographic reading strategies (cf. Frith, 1985, 1986).

Correlation coefficients of phonological awareness with literacy skills were compared with those of other German studies. In the present study the correlations of phonological awareness were high with correctly spelled graphemes (.61** $\leq r \leq$ .74**) and with reading comprehension (.55** $\leq r \leq$ .64**), and medium to high with basal reading skills (.46** $\leq r \leq$ .59**). Previous German research reported medium to high correlations for phonological awareness with spelling and non-significant to medium correlations with basal reading competencies in primary school children. For example, in a correlational study covering the second to fourth grade, partial correlations of phonological awareness were r = .47** with pseudoword reading fluency, r = .49** with word reading fluency, and r = .44** with spelling (Moll et al., 2012). These partial correlations were controlled for age. Berendes et al. (2010) observed high correlations between phonological awareness and spelling (.55** $\leq r \leq$ .57**), but no significant relationships between phonological awareness and basic reading competencies (.10 $\leq r \leq$ .22) in German third and fourth graders. That is, the correlations observed in the present study tended to be somewhat higher than previously reported relationships. It has to be stressed that no reading skills were necessary for the phonological awareness task as it was measured entirely in an oral presentation and response format. Additionally, all applied tests were standardised measures and designed for the respective grade levels. Therefore, a flawed measurement of the study constructs is ruled out as a possible explanation at this point. The height of the observed correlations were also higher compared with reported relationships between phonological awareness and literacy skills in the P-ITPA manual (Esser & Wyschkon, 2010). For reading fluency measured with the SLRT, the P-ITPA manual reports a medium correlation of r = .37* (n = 68; Grades 2-4). In the present study correlations were between .50** $\leq r \leq$ .59** for the equivalent reading fluency variable measured with the revised version of the SLRT (SLRT-II) in the respective grades. Further, the P-ITPA manual reports a medium correlation of phonological awareness with the HSP of r = .31* (n = 106; Grades 2-5). In the present study, correlations of phonological awareness with correctly spelled graphemes of a revised version of the HSP were between .61** $\leq r \leq$ .74**.

It cannot be ruled out that specific sample characteristics are accountable for this finding. Although care was taken to generate a large sample with children from different schools and

classrooms and from diverse socio-economic backgrounds in the present study, sample characteristics might nevertheless be different compared to other studies.

The close relationship between phonological awareness and literacy variables might be indicative of phonological reading still playing an important role in fourth grade. As the orthography of the German language is rather consistent in the reading direction, alphabetic reading strategies can lead to an accurate reading result (section 1.4). Orthographic reading strategies, however, should speed up the reading process (section 2.2.1.2). As all three reading tests were speed tests, it is surprising that phonological awareness nevertheless showed such a close relationship with the reading variables. Possibly, didactic approaches to literacy instruction played a role. As explained in section 4.3.3.2, literacy instruction could be an influential factor in the relationship between different cognitive variables and literacy skills. It is possible that a focus on phonological strategies in literacy instruction could contribute to such a close relationship between phonological awareness and literacy variables. Future research could try to illuminate this aspect by controlling for different didactic approaches.

One could wonder why proficiency in alphabetic spelling strategy had similar correlations with phonological awareness (.44** $\leq r \leq$ .64**) as proficiency in orthographical (.58** $\leq r \leq$ .61**) and morphological (.46** $\leq r \leq$ .60**) spelling strategy. This observation can be considered with regard to the importance of phonological awareness for building up word-specific orthographic representations in the mental lexicon (cf. Moll et al., 2014). Orthographically correct spelling builds on word-specific orthographic representations (Moll et al., 2014). It has been argued that inconsistencies and irregularities in an orthography put additional challenge on phonological processing abilities when building up orthographic representations in the mental lexicon (Moll et al., 2014). As the German orthography incorporates several inconsistencies and irregularities in spelling, phonological awareness might not only be important for alphabetic spelling strategies but also for orthographic spelling strategies. In addition, phonological awareness might be relevant for morphological spelling strategies because according to the binding agent theory of morphological knowledge, morphology contributes to spelling by integrating semantic and phonological information of words (cf. Kirby & Bowers, 2017). As such, morphological strategy use might be dependent on semantic knowledge and phonological abilities.

With regard to phonological awareness, the results indicate that phonological awareness is strongly associated with literacy variables in primary school. This can be explained by specific characteristics of the German orthography and might be intensified by didactic approaches focusing on phonological strategies.

Rapid naming

Correlation and regression analyses indicated a relationship between rapid naming and both reading and spelling variables in all observed grades. Rapid naming significantly contributed to proficiency in orthographic spelling in second and third grade and to pseudoword reading fluency in second grade. Moreover, rapid naming exhibited a tendency for significance as a unique predictor for correctly spelled graphemes in third grade, for reading comprehension in second and third grade and for word reading fluency in third and fourth grade. When applying Bonferroni corrections, only the correlation with proficiency in the orthographic spelling strategy and the correlation with pseudoword reading fluency in second grade remained significant. That is, the data suggest that rapid naming is related to both reading and spelling in second grade. Furthermore, results might be indicative of a decrease in the importance of rapid naming in later primary school years.

The observation that rapid naming was associated with reading fluency was unsurprising, as rapid naming ability is associated with how quickly and efficiently children are able to make use of phonological information during decoding (Torgesen et al., 1994). This ability would be helpful in reading fluency tasks.

For spelling, Savage, Pillay, and Melidona (2008) suggested that rapid naming enhances access to mental representations of orthographic units. That is, children with stronger rapid naming skills tend to make use of resemblances of word parts stored in their long-term memory from where they can be retrieved when orthographic rules have to be applied. The authors further proposed that rapid naming abilities could especially help with irregular words for which a fully specified orthographic representation is necessary for correct spelling. This can explain the observed relationship between rapid naming and spelling.

Former studies suggested that rapid naming might be more important for reading than for spelling (Landerl & Wimmer, 2008; Moll et al., 2012). The present study could not confirm this finding. This might be due to differences in the study designs and rapid naming measures. While Landerl and Wimmer (2008) conducted a longitudinal study with rapid naming measured in kindergarten functioning as a predictor of reading and spelling skills at a time of up to eight years later, the present study used a cross-sectional design measuring rapid naming at the same testing period as reading and spelling skills. It is possible that the point in development at which rapid naming was measured (prior to literacy acquisition vs. after initializing literacy acquisition) could be the cause for the observed differences in predictive power for reading and spelling skills. The difference between the study by Moll et al. (2012) and the present study could be attributed to different rapid naming measures. While Moll et al. (2012) assessed rapid number naming, the present study assessed rapid object naming. It has been found that rapid naming tasks using numbers as stimuli tend to have higher correlations with reading than rapid naming tasks using pictures of

familiar objects, which was explained by the closer similarity between numbers and letters than between pictures and letters (cf. Araújo et al., 2015). Besides divergent study designs and rapid naming measures, testing power has to be taken into consideration. As explicated before (section 4.3.1.5), testing power was low for most medium and small correlations and effect sizes in the present study. Therefore, the relevance of the tested variables might be underestimated, which is indicated by significant uncorrected correlation and regression coefficients. That is, although the present study could not confirm that rapid naming has a stronger relationship with reading than with spelling, the presented evidence should not be interpreted as counterevidence.

To sum up, results of the present study suggest that rapid naming is associated with both reading and spelling skills, especially in earlier primary school years.

Verbal memory

Verbal memory was significantly correlated with all literacy variables in second and fourth grade. In third grade, it was only significantly related with correctly spelled graphemes, reading comprehension and word reading fluency, but not with proficiency in spelling strategies and not with pseudoword reading fluency. When controlling for α-error accumulations, verbal memory was related to spelling and reading variables in second and fourth grade and only to reading comprehension in third grade. In regression analyses, verbal memory displayed a tendency to be a unique predictor of morphematic spelling strategy in second grade. No other possible relationship was observed in regression analyses.

The present study adds to the existing literature by providing data on a cross-sectional observation of the relationship between verbal memory and literacy skills in German primary school children. Previous empirical evidence on the relationship between verbal memory and literacy skills in primary school years was inconclusive. While some relations were found in English studies (Mann & Liberman, 1984; Torgesen et al., 1994; Wagner et al., 1997), empirical evidence for German indicated no or only small relationships between verbal memory and literacy variables (Landerl & Wimmer, 2008). When regarding the reported correlations of preschool verbal memory with later literacy variables by Ennemoser et al. (2012), there was no clear trend in the height of the correlations across primary school years.

The present study observed a reduced certainty on the relationship in third grade compared with second and fourth grade. The results could indicate that the relationship between verbal memory and literacy skills is not stable across primary school years.

A trend for significance was observed in regression analysis for proficiency in morphological spelling strategy in second grade. Verbal memory is regarded as an important factor in language processing (Jacquemot & Scott, 2006). When children work on a spelling-to-dictation task, as was the case in the current study, the ability to hold phonological information present in

working memory for an ongoing task could help to write down the correct words and make use of its phonological information. As verbal memory is affected by the length of stimuli (Jacquemot & Scott, 2006), this might be especially true for longer, morphologically complex words.

Verbal memory had medium to large correlations with phonological awareness (-.38** ≤ r ≤ -.61**) and the pseudoword cloze task (-.36** ≤ r ≤ -.56**). Correlations with the other cognitive variables were non-significant to medium (-.42** ≤ r ≤ .12). The observed medium to high correlations of verbal memory with phonological awareness and morphological awareness could be explained by the aspect that participants have to hold phonological information present while solving the morphological and phonological awareness tasks. For example, in oral morphological awareness tasks, participants hear a word or a whole sentence to which they have to apply a grammatical manipulation (cf. section 4.3.1.2). In phonological awareness tasks, individuals also receive oral stimuli. For example, they have to change a phoneme of or find a rhyme for a presented word. Holding such phonological information present while solving a phonological or morphological awareness task puts stress on verbal memory (Moll et al., 2014). Using an explicit measure of verbal memory, a researcher can account for variance in phonological and morphological awareness tasks that is due to differences in verbal memory rather than to differences in phonological and morphological awareness. Therefore, including verbal memory in studies that assess other cognitive variables can be useful for controlling for verbal memory effects in phonological processing (cf. McBride-Chang, 2004) and in morphological awareness tasks even if verbal memory is no unique predictor of the outcome measure.

The present study found that verbal memory is related to both reading and spelling variables in primary school years. Results imply that the relationship of verbal memory and literacy skills is not stable across primary school years. Although the evidence suggests that verbal memory is no unique predictor of literacy skills when accounting for other language-related variables, including verbal memory in regression analyses can improve the interpretability of results by accounting for variance in phonological and morphological awareness tasks that is caused by differences in verbal memory instead of phonological and morphological awareness abilities.

Vocabulary

Vocabulary was significantly correlated with all literacy variables in second grade and third grade but with reading comprehension and word reading fluency only in fourth grade. In regression analyses, vocabulary displayed a tendency for significance as a predictor for word reading fluency in third grade and for reading comprehension in fourth grade. When applying Bonferroni corrections, vocabulary was correlated with all literacy variables except pseudoword reading fluency in second grade, with correctly spelled graphemes, reading comprehension and word reading fluency in third grade and with reading comprehension only in fourth grade. That is, the

evidence for associations with spelling variables decreases across primary school years. Of the reading variables, word reading fluency and reading comprehension are associated with vocabulary across all three grades. Reading comprehension comes to the fore as the variable with the strongest and most reliable association of all literacy variables. In light of α- and β-error probabilities, vocabulary could be interpreted as a potential further predictor of word reading fluency in third grade and reading comprehension in fourth grade beyond phonological awareness.

Juska-Bacher et al. (2016) reported a medium relationship (r = .31**) of vocabulary with basal reading abilities in second graders. However, vocabulary did not have any predictive power for basal reading ability beyond that of phonological awareness in that study. Observed results for basal reading abilities in the present study are in line with the findings of Juska-Bacher et al.

In a study by Berendes et al. (2010), vocabulary was significantly associated with basal reading ability in third but not in fourth grade after accounting for phonological awareness and nonverbal intelligence. In the present study, vocabulary was a potential unique predictor of the basal reading skill word reading fluency in third grade, but not in second and fourth grade. This mirrors the findings by Berendes et al. It might imply that the role of vocabulary varies with different stages of reading acquisition. Basal reading skills can rely on alphabetic reading strategies (cf. Frith, 1985, 1986) especially in the rather transparent German orthography (cf. section 1.4), which was reflected by phonological awareness as a unique predictor of word reading fluency in second and third grade. In fourth grade, phonological awareness showed only a trend for significance as a unique predictor of basal word reading skills, which might reflect a decrease of the importance of alphabetic strategies in word reading. Yet, vocabulary showed a trend for significance in third grade and rapid naming and morphological awareness showed a trend for significance in fourth grade. This might imply that more semantic and morphological information is processed in word reading with increasing reading competence, which might reflect an increased relevance of orthographic and morphological reading strategies (cf. section 2.2.3).

Observed relationships of vocabulary were stronger with reading comprehension (.39** $\leq r \leq$ .50**) and word reading fluency (.26* $\leq r \leq$ .44**) than with pseudoword reading fluency (.21 $\leq r \leq$ .30**). This is explicable in light of the importance of vocabulary for reading when familiar words are recognized in a text or when less familiar words are recognized through sounding them out (cf. Kirby et al., 2008). In the pseudoword reading fluency task, no words could be recognized because all stimuli were non-existing words.

Observed correlation coefficients in the present study for vocabulary and correctly spelled graphemes in second graders (r = -.42**) and in third graders (r = -.44**) match the reported medium correlation between vocabulary and spelling skills in a study across English second and third graders (r = .41*) by Apel et al. (2012).

Berendes et al. (2010) found vocabulary to be a positive predictor for spelling in German third graders but a negative predictor in German fourth graders after accounting for phonological awareness and nonverbal intelligence. In contrast, in the present study, vocabulary did not explain any additional variance in spelling after accounting for phonological information processing and morphological awareness variables. That is, the surprisingly negative predictive power in fourth grade could not be confirmed in the present study. On the other hand, vocabulary did not uniquely contribute to explaining spelling skills in earlier grades in the present study. Perhaps reduced testing power for small and medium regression coefficients prevented the observation of such a relationship. Yet, in Apel et al.'s (2012) study with English-speaking third and fourth graders, vocabulary was no unique predictor of spelling when accounting for morphological awareness, orthographic processing, rapid naming and age, either. Possibly, knowing the semantic meaning of a word does not necessarily reflect that an orthographic representation of the word is recorded in the mental lexicon. Therefore, phonological processing variables could be more important because they are needed for alphabetic spelling strategies (cf. section 2.2.2.2).

Vocabulary had medium to large correlations with the pseudoword cloze task (.33** $\leq r \leq$ .53**) and small to medium correlations with the morphological fluency task (.25* $\leq r \leq$ .32**). The results show that vocabulary has a closer association with the pseudoword cloze task than with the morphological fluency task, although in the morphological fluency task participants could have profited from vocabulary knowledge, whereas in the pseudoword cloze task items could not have been solved on purely semantic knowledge. This observation emphasizes that with the morphological fluency task more than vocabulary knowledge was measured. The association between morphological awareness tasks is nonetheless evident and needs some consideration. Vocabulary has been discussed as a predictor of morphological awareness. Sparks and Deacon (2015) argued that a large vocabulary could give children more opportunities to detect morphological regularities in their language, and by this, it could enhance morphological awareness. They explained further that a larger vocabulary would also reflect an increased exposure to morpheme use in their language, and children would have, thereby, more cases from which they could deduce morphological rules. Empirical testing did not support this assumption, though. In a longitudinal study, vocabulary in second grade was not predictive of changes in morphological awareness during the following school year (Sparks & Deacon, 2015). In contrast, second grader's morphological awareness predicted their vocabulary growth in the following school year. The authors concluded that morphological awareness helps deduce meaning from unknown words, and by this, enhances vocabulary acquisition. In line with this argumentation, McBride-Chang et al. (2005) found support that morphological awareness in kindergarteners was predictive of vocabulary in second grade after accounting for age, word reading, pseudoword reading, phonological

awareness, rapid naming and verbal memory. Kirby et al. (2008) suggested a causal pathway between morphological awareness, vocabulary and reading, saying that morphological awareness is a causal determinant of vocabulary, which in turn is a causal determinant of word reading ability. Taking the evidence together, the observed associations between morphological awareness and vocabulary could be due to the assumption that morphological awareness facilitates vocabulary acquisition. However, only few studies have been conducted analysing this aspect so far, and studies for German are missing altogether. Therefore, conclusions should be considered preliminary.

To sum up, the present study suggests that vocabulary is associated with reading and spelling variables in second grade. The association seems to be strongest for reading comprehension, which can be explained by the importance of vocabulary for the recognition of words (cf. Kirby et al., 2008). Observed associations between morphological awareness and vocabulary could be due a facilitating impact of morphological awareness skills on vocabulary acquisition.

Age

Surprisingly, age was negatively associated with some of the observed variables, indicating that older students were outperformed by younger students within a grade level. Using Bonferroni corrections, these significant correlations remained in fourth grade for spelling (correctly spelled graphemes) and for phonological awareness. International findings on the relationship between age and literacy skills are inconclusive. In a sample of American kindergarteners and first graders, age was positively correlated with a range of literacy and language-related variables (McBride-Chang et al., 2005). Likewise, in Finnish fourth graders, age was positively associated with reading comprehension (Müller & Brady, 2001). In a study on Greek and Canadian schoolchildren, age was positively correlated with rapid naming in Canadian first graders, but had a negative predictive power for reading fluency in Greek first graders (Georgiou, Parrila, & Papadopoulos, 2008). Age was also negatively associated with reading fluency in a sample of fourth-grade Portuguese-speaking Brazilian children (Freitas et al., 2018). The authors of the Brazilian study argue that the negative relationship is due to the circumstance that in Brasilia, schoolchildren are grouped by ability rather than by age within grades. That is, differences in the observed relationships could be due to differences in age homogeneity within grade levels.

In Germany, letting struggling schoolchildren repeat a grade is a common means to provide them with more learning time and to homogenise variation in performance levels within a specific grade (Krohne, 2004). Studies on the question of whether the repetition of a grade has positive effects on academic performance are scarce. A study with ninth graders could not find differences in mathematical achievement between students who repeated a grade and matched students who did not repeat a grade (Ehmke, Sälzer, Pietsch, Drechsel, & Müller, 2017). Lamote, Pinxten, van den Noortgate, and van Damme (2014) found no short-term gains in language achievement for eighth

graders who repeated a grade compared to peers who did not repeat a grade. One year later, for students who repeated a grade even lower language skills were measured than for the control group. Although participants in these studies were older than those in the present study, the findings of Ehmke et al. (2017) and Lamote et al. (2014) imply that schoolchildren who repeated a grade might still be struggling with reading, writing and related skills in later years.

The circumstance that with increasing grade an increasing number of negative relations between age and other variables was found could indicate that with higher grades it becomes more likely that a struggling child repeated a grade. Additionally, the difference between children who struggle to acquire basic literacy skills and typically learning classmates becomes more evident in higher school grades when typically learning classmates have developed their literacy skills much further than classmates in earlier grades had. Thus, the negative association between age and other variables might be due to children who repeated one or more grades because they are struggling with literacy and other skills. Therefore, age should not be interpreted as a control for development in which older children have an advantage. Age might rather be an indicator for whether students are normally aged within respective grades or older than they would be if they never repeated a grade.

4.3.3.5 Limitations and directions for future research

Limitations of the present study and directions for future research are addressed in this section.

One point that needs to be addressed is the relatively high number of study variables in comparison with the number of participants within the respective grades, which caused an accumulation of both α- and β-error probabilities. Using Bonferroni corrections to control for α-error accumulation caused a further inflation of the β-error probability. Therefore, results have to be assessed in light of the α- and β-error probabilities. When interpreting non-corrected results, it has to be acknowledged that some relationships reach significance although the variables are uncorrelated (cf. Field, 2018). Yet, when applying Bonferroni corrections, it is likely that some relationships remain undetected (cf. Cohen, 1992; Field, 2018). Therefore, both corrected and uncorrected results were reported for the current study. For future studies, it is advisable to increase testing power by using larger samples and/or reducing the number of variables tested.

Another point that has to be considered are the in part unexpectedly high correlations between some of the study variables, like the correlations between phonological awareness and literacy skills and the correlations between phonological awareness and verbal memory. It was discussed that the results could be indicative of a relative importance of alphabetic reading and spelling strategies up until the end of fourth grade in the relatively transparent German orthography. Moreover, some of the applied tasks share certain demands. For example, verbal memory skills

were necessary for solving phonological awareness and morphological awareness tasks by holding phonological information present while manipulating a given test word. An alternative explanation that should be considered is that these relationships could be in part moderated by an underlying ability like intelligence. An explicit measure of intelligence was deliberately not included in the present study because it had been suggested that the causal pathway between intelligence and literacy is less clear than causal pathways between literacy and specific cognitive variables such as phonological information processing, vocabulary and morphological awareness (Kirby et al., 2008). As a reason for this, Kirby et al. (2008) specified that intelligence has more diffuse relations to word reading than specific cognitive factors have because intelligence is related to a greater variety of different behaviours and skills. As some of the observed correlations were unexpectedly high, it would be a valuable direction for future research to include intelligence as a control variable to analyse whether it is accountable for the observed relationships in German primary school children.

A further point that needs consideration is the question of the didactic approach to literacy the participants of the current study experienced in German lessons. Reading and spelling instruction practices have been shown to influence literacy skills until adulthood (Thompson et al., 2009). However, it is typically difficult to separate the impact of language characteristics such as orthographic transparency or morphological complexity from that of teaching practices when studying the relationship between cognitive variables and literacy skills (Desrochers et al., 2018). In the present study, the didactical approach had deliberately not been assessed to lower the stakes for participation for teachers because the study was already very demanding with regard to the number of school lessons needed for testing. Yet, the results of the present study motivate an investigation of the impact of literacy instruction practices because phonological awareness was unexpectedly the sole dominant predictor of literacy skills in German primary school children, which could be due to a phonological approach to literacy instruction. To obtain a better understanding on the impact of language characteristics and didactic approaches on the relationship between morphological awareness and literacy skills, future studies could ask teachers which textbook they use in German lessons. This could help to get an idea on which didactical approach is applied in a certain classroom because teaching methods are often determined by the textbooks that are available to the teacher (Hagemann, 2018).

Finally, this study used a cross-sectional, correlational design, which does not allow conclusions on causation. Indeed, previous English studies indicated that the relationship between morphological awareness and literacy variables is most likely a bi-directional one (Deacon et al., 2013; Kuo & Anderson, 2006), which could not be represented with the chosen design. The cross-sectional, correlational design was selected because it was an aim of this study to gain an overview on the relationship of morphological awareness and literacy skills in different literacy proficiency

levels and with regard to other language-related variables in German. It would be a valuable direction for future research to collect evidence on the development of the relationship between morphological awareness and literacy skills in German in a longitudinal study.

4.3.3.6 Conclusion

This study gives valuable insights into the relevance of morphological awareness in German, a rather transparent but asymmetric language. Because the German language has a rich morphology, an effort was made to cover different morphological categories (inflections, derivations, compounds) for the assessment of morphological awareness. A pseudoword cloze task was used to avoid confounding with vocabulary. The assessment of morphological awareness was complemented with a morphological fluency task to have a measure for speeded handling of morphological rules with real words. Furthermore, all morphological awareness tasks were administered in an oral presentation and response format to avoid confounding with reading and spelling skills. A category system was developed for a fine-tuned rating of morphological awareness items originally coming from different tests.

The present study found evidence that morphological awareness is a construct that consists of different facets. The two different task types conjointly described morphological awareness. The pseudoword cloze task also comprised several facets, having an exclusive factor for compounds and several more that described finer grammatical and methodical categories. Five factors covered exclusively inflections or derivations, but two factors crossed the borders of inflections and derivations, indicating that inflections and derivations should not be viewed as rigid categories in the assessment of morphological awareness.

In this study, different facets of reading and spelling were assessed to test whether there are differential relationships between morphological awareness skills and different reading and spelling skills. Morphological awareness was related to reading and spelling in all grades. The pseudoword cloze task was significantly related to all literacy variables in all three grades, which indicates that morphological awareness is an important correlate of literacy skills from second through fourth grade. Correlations between morphological fluency and literacy variables were not as strong and therefore not as certain as relationships between the pseudoword cloze task and literacy skills. An exception was reading comprehension, with which morphological fluency significantly correlated even when applying Bonferroni corrections. This might indicate that the ability to speedily recognize and manipulate morphemes is especially helpful for reading comprehension. Children could use this ability to quickly infer the meaning of unknown words during reading.

Comparisons of correlations coefficients showed that the relations of morphological awareness with literacy variables were not stronger for spelling than for reading. Thus, in German,

morphological awareness is a relevant factor for explaining differences in literacy skills, but at least until the end of fourth grade it does not seem to be more important for spelling than for reading.

This study included a variety of further cognitive variables to compare the relative importance of morphological awareness with the importance of other language-related variables for literacy skills in German primary school children. Phonological awareness was the strongest unique predictor of literacy variables. Morphological awareness did not uniquely contribute to literacy skills above and beyond phonological awareness and rapid naming. This might be indicative of a reliance on alphabetic reading and spelling strategies until the end of fourth grade in the orthographically rather transparent German language.

A cross-sectional design was used in this study to analyse differences in the relationship of morphological awareness with literacy variables between grades. The study was conducted in second, third and fourth grade, covering different stages of literacy proficiency in schoolchildren. There was limited evidence of a strengthening of relationships between morphological awareness and literacy skills with increasing literacy proficiency, i.e. increasing grade level. Morphological fluency showed a tendency to explain reading variables in fourth grade, but not in earlier grades, which might indicate that morphological awareness continues to gain significance in higher grade levels.

To conclude, this study adds valuable insights on the relationship between morphological awareness and literacy skills in German primary school children. Morphological awareness proved to be an important correlate, but not a unique predictor of literacy skills when accounting for phonological processing variables and vocabulary. Evidence for a change of the relationship between morphological awareness and literacy skills with increasing literacy competency was limited. Although still much research is needed in the area of morphological awareness, this study helped to answer several questions on morphological awareness and its relation to literacy skills in a rather transparent orthography.

Part II

5 Introductory Notes

Literacy proficiency plays an important role for adequate participation in social activities in adulthood (Rüsseler, Boltzmann, & Grosche, 2019). Yet, 6.12 million German adults (12.1 %) were identified to be of low literacy in a large-scale study on reading competencies, which means their reading skills sufficed for reading single words or sentences, but not for reading simple text passages (Grotlüschen, Buddeberg, Dutz, Heilmann, & Stammer, 2018). This is in stark contrast to the notion of literacy as a "basic human right" that was formulated by the UNESCO (Carr-Hill, 2008, p. 11). A better understanding of correlates of literacy skills in adults could help finding important determinants of proficient adult reading and spelling. This exploratory part of this dissertation focused on cognitive correlates of literacy in German-speaking adults with a spotlight on morphological awareness.

The international research on morphological awareness and its relation to literacy skills in adults is limited, and it is, to the best of the author's knowledge, non-existent for German so far. The only evidence on morphological awareness available for German comes from studies on schoolchildren. The main study of this dissertation found relationships between morphological awareness and literacy skills in German primary school children, which is in line with other German studies (Kargl et al., 2018; Kargl & Landerl, 2018; Klassert et al., 2018; Volkmer et al., 2019). However, in contrast to results by Volkmer et al. (2019), the main study did not support the assumption that morphological awareness uniquely predicts literacy competencies beyond phonological processing skills in German primary schoolchildren.

This exploratory part of this dissertation had two purposes. The first purpose was identifying potentially confusing items by applying the morphological awareness tasks from the main study to a sample of literacy-proficient adults. If adults had problems with finding the correct response to a specific item, it could indicate that this item was unsuitable for children. Such an examination was regarded as informative because the morphological awareness tasks had not been applied within the framework of a standardised test, but had been adapted from their original sources. This adaptation could have caused single items to be ambiguous or confusing. Therefore, it was an aim to gather further support on the validity of the adapted morphological awareness tasks. The second purpose was gathering first evidence on a possible relationship between morphological awareness and literacy skills in German adults.

6 Theoretical Background

6.1 Theoretical considerations on the relationship between morphological awareness and literacy skills in adults

Theoretical considerations on the relationship between morphological awareness and literacy skills from part I of this dissertation (section 2.2.4) are revisited in this section and regarded in light of implications for reading and spelling in unimpaired adults.

6.1.1 Reading and spelling strategies

As described in section 2.2.4.1., different reading and spelling strategies are necessary for proficient reading and spelling (Frith, 1985, 1986; Nunes et al., 1997; Varnhagen, 1995). Both skilled readers and skilled spellers capitalize on a flexible utilisation of different strategies (Frith, 1985, 1986; Varnhagen, 1995). This includes orthographic and morphological strategies that make use of orthographic and morphological units such as stems and affixes. Morphological awareness abilities could facilitate the recognition and usage of these morphemes for pronunciation and reading comprehension. In addition, the recognition and manipulation of morphemes could be used to retrieve orthographic representations from the mental lexicon for spelling decisions. For example, when pondering the correct spelling of a word like "ocularist", it could be helpful to reflect on the morphemes in this word and manipulate them. One could deduce that this word comprises two morphemes ("ocular" and "-ist"). This information could then be used to infer the orthographically correct spelling of "ocularist". What is more, when being unfamiliar with the word "ocularist", one could use the morphological information to infer its meaning. The stem "ocular" indicates that the word has something to do with eyes, and the suffix "-ist" signals that a person is referred to. Indeed, an ocularist is a person who fabricates artificial eyes for patients.

However, there is evidence that not only children but also adults struggle with the application of morphological spelling strategies when presented with novel words (Kemp et al., 2017; Kemp & Bryant, 2003). Especially adults with lower levels of education seem to find it difficult to make use of morphological strategies (Mitchell, Kemp, & Bryant, 2011). It has been suggested that struggling spellers might rather rely on memorised word-specific spellings and frequency patterns of letter co-occurrences than on morphological structures (Kemp et al., 2017). As stated above, morphological awareness could be an ability that helps to make use of orthographic and/or morphological strategies by enabling the recognition and manipulation of morphological structures. Therefore, morphological awareness might still play a role in literacy competencies of adults.

6.1.2 The binding agent theory of morphological knowledge

Kirby and Bowers (2017) proposed in their binding agent theory of morphological knowledge that morphology is crucial for reading comprehension, pronunciation and spelling

because it connects semantics, orthography and phonology. This model does not make different assumptions for different literacy proficiency levels. That is, both beginning readers and skilled readers presumably make use of morphology for pronunciation, reading comprehension and spelling. Kirby and Bowers (2017) pointed out that empirical evidence for automatic morphological processing in adults (e.g. Feldman, 2000; Rastle, Davis, Marslen-Wilson, & Tyler, 2000; Taft & Kougious, 2004) underlines the importance of morphology in skilled reading.

6.1.3 Dual route approaches to reading and spelling

Dual route approaches to word reading (cf. section 2.2.4.3) differentiate between a direct lexical route and an indirect non-lexical route (Coltheart et al., 1993; Coltheart et al., 2001; Coltheart, 2006). Both routes can be activated for processing complex words, with the lexical route being more associated with processing familiar words and the non-lexical route being more associated with processing unfamiliar words. Coltheart et al. (2001) specify that within the non-lexical route grapheme-phoneme correspondences are analysed while taking into account context information, letter position and morphological units. Morphological awareness skills could facilitate the recognition and usage of morphological units for pronunciation. Schründer-Lenzen (2013) argues that beginning readers typically use the non-lexical route to derive pronunciation because only few whole word representations are stored in the orthographic lexicon in early stages of literacy acquisition, whereas skilled readers can process familiar words using the lexical route because they have access to plenty whole word representations in their mental lexicon. If morphology is associated more with the non-lexical route (cf. Coltheart et al., 2001), the importance of morphological awareness for reading aloud familiar words might be lower for skilled readers than for beginning ones.

The dual route approach to word reading comprehension by Grainger and Ziegler (2011) can be used to explain why morphological awareness might still be important for reading comprehension of adults. This dual-route approach explicitly makes assumptions for skilled readers and therefore applies to adult reading. Assumptions on morpho-semantic processing in the coarse-grained route (i.e. activation of word fields) and morpho-orthographic processing in the fine-grained route (e.g. activation of affixes) explain why morphological units play an important role in the reading performance of adults (cf. section 2.2.4.3). Accordingly, morphological awareness skills could be important for processing in both routes.

Empirical support for the importance of morphemes as reading units in adults was summarized by Amenta and Crepaldi (2012) in their review on morphological effects in word recognition. They concluded from a range of different experimental settings that skilled readers are sensitive to morphological information during reading. For German adult readers, Hasenäcker et al.

(2017) also found support that morphemes are used as reading units when asked to make a lexical decision whether the presented item is a real word or a pseudoword.

That is, morphological awareness, i.e. the ability to recognize, reflect on and manipulate morphemes, could be a relevant cognitive correlate of reading skills in adults. The relationship of morphological awareness with reading comprehension might be stronger than the relationship with basal reading skills because for basic reading skills skilled readers can capitalize on the lexical route, which is less associated with morphological units than the non-lexical route, while for reading comprehension both routes process and make use of morphological information.

Analogous to dual-route approaches to reading, dual-route models for spelling differentiate two routes. The lexical route capitalizes on memorised spellings stored in and retrieved from the mental lexicon, and the sublexical route capitalizes on phoneme-grapheme-correspondence rules (Houghton & Zorzi, 2003). It was explained in section 2.2.4.3 that researchers make different assumption concerning the role of morphology in this dual route approach. While Sheriston et al. (2016) suspect that morphological units are processed in the sublexical route, Schründer-Lenzen (2013) presumes that morphological knowledge is part of the inner lexicon that is used in the lexical route. Whether the assumptions of dual route models apply to adult readers is uncertain. Burt (2006) called attention to the matter that dual route approaches typically do not make assumptions on which specific spelling of a word would be realised if the two routes resulted in conflicting spelling solutions for a given word. She suggested that a more parsimonious approach would be to assume that skilled spellers usually retrieve spellings from the mental lexicon, and only in cases of uncertainty, the sublexical route would be used. In addition, she pointed out that word identification and spelling are based on a word's phonology, orthography and morphology, and that these properties should be included in a model of adult spelling. Indeed, the ability to make use of grapheme-phoneme correspondence rules, the processing of orthographic information during reading, and knowledge on morphology all proved to be unique predictors of adult spelling performances (Burt, 2006).

6.2 Empirical evidence on morphological awareness and its relation to literacy skills in adults

Morphological awareness is associated with word reading (To, Tighe, & Binder, 2016; Wilson-Fowler & Apel, 2015), reading comprehension (To et al., 2016; Wilson-Fowler & Apel, 2015) and spelling abilities (Wilson-Fowler & Apel, 2015) in English-speaking adults.

Mahony (1994) measured morphological awareness abilities of 26 university undergraduates with single-choice tasks. Participants were asked to pick the word with the suffix that fitted the structure of the test sentence. There was one task with items that had real word stems and one task with items that had pseudoword stems. In both tasks, real English suffixes were used, making the

solution unambiguous. In a third task, students were presented with word pairs and asked to decide whether or not the two words were etymologically related. The suffix test using pseudowords had a significant correlation of $r = .34$* with the verbal score in the *Scholastic Aptitude Test* (SAT), which participants took one to five years before this study was conducted. The other two tests were not significantly correlated with the SAT scores. In this study, the SAT score was interpreted as a measure of processing abilities in written language. That is, a measure of morphological awareness using pseudowords was associated with processing abilities in written language in English undergraduates.

It has been shown that the relationship between morphological awareness and reading abilities persists even after accounting for phonological awareness (Law, Wouters, & Ghesquière, 2015; Metsala et al., 2019) and vocabulary (Guo et al., 2011; Law et al., 2015) in English-speaking university students. The measurement method of morphological awareness differed considerably across studies. Law et al. (2015) measured morphological awareness with items that were presented orally and in writing. Participants had to complete sentences using derivations of real words or pseudowords. Metsala et al. (2019) assessed morphological awareness in a written speed test by asking participants to draw a line between morphemes in words that had different levels of morphological complexity. Guo et al. (2011) measured morphological awareness in a written test format in which participants had to complete sentences with inflections of pseudowords. This measure was an adaption of Berko's (1958) pseudoword task originally developed for children aged 4 to 7. Differing measurements of morphological awareness limit the comparability of the studies. However, they strengthen the research base insofar that relations between morphological awareness and reading skills in adults are found in a variety of morphological awareness measures tapping different facets of the construct. Although few studies are available, the ones that exist bring forward evidence with regard to the morphological categories inflection and word formation (section 2.1.1) and with regard to pseudowords and real words (section 2.1.2.2) in both written and oral+written presentations (section 2.1.2.1).

Further support for the assumption that morphological awareness is an ability related to literacy competencies in adults comes from studies comparing skilled adult readers with struggling adult readers. For instance, university students who reported a history of reading difficulties showed deficits in morphological awareness skills as compared to students who did not report past reading difficulties (Metsala et al., 2019). In line with this study, Law et al. (2015) found morphological awareness and phonological processing deficits in university students with non-compensated dyslexia compared to university students with normal reading abilities.

With regard to spelling, only limited empirical evidence is available. Law et al. (2015) found that spelling abilities from university students were uniquely predicted by their phonological

awareness and morphological awareness skills when accounting for vocabulary. Moreover, Wilson-Fowler and Apel (2015) reported that morphological awareness was a stronger predictor for spelling than for word reading and sentence comprehension in English-speaking undergraduate college students (M_{age} = 21 years, Range = 18 - 35 years).

To the best of the author's knowledge, there are no studies investigating the relationship between morphological awareness and literacy skills for German adults so far. Therefore, support for a possible relationship between these skills can only be deduced from studies with schoolchildren. They suggest that there is a relationship between morphological awareness and literacy skills for children between second and seventh grade (cf. section 2.2.5.2). The main study of this dissertation (section 4.3) gave further support for this relationship. It is to be investigated whether the theoretical assumption that there is an association between morphological awareness and literacy skills in German adults, too, (section 6.1) can be supported empirically.

Summarizing the presented findings, English studies empirically support that there is a relationship between morphological awareness and literacy skills for both schoolchildren and adults. Support for the relationship between these skills in German has only been reported for schoolchildren so far.

6.3 Morphological awareness and further cognitive variables in adults

As with children, other language-related skills should be taken into consideration when exploring the relationship between morphological awareness and literacy skills in adults because they still seem to play a role for reading and spelling proficiency (Guo et al., 2011; Law et al., 2015; Metsala et al., 2019). Such skills are, for example, phonological processing skills and vocabulary (cf. section 2.3). These variables are discussed in the following sections. Additionally, a closer look is taken at the concept of intelligence. Because studies on the relationship between language-related cognitive variables and literacy skills in German adults are scarce, mainly evidence on English adults is summarized.

6.3.1 Phonological processing variables

A study with English-speaking second- to twelfth graders found that phonological awareness seems to grow until about seventh grade for good readers and a bit longer for less good readers of English (Scarborough, Ehri, Olson, & Fowler, 1998). After that, no obvious gain in phonological awareness skills could be observed until 12th grade. Interestingly, the results of Scarborough et al.'s study implied that even skilled adult readers without a history of reading difficulties did not show full competence in phonological awareness, but rather displayed quite systematic error patterns. The authors suggested that the emergence and acquisition of competing reading strategies and habits might affect phonological awareness abilities. Therefore, it might be difficult for older schoolchildren and adults "to selectively use purely phonemic analyses" (Scarborough et al., 1998,

p. 138). In addition, phonological awareness skills of dyslectic university students and university students with self-reported difficulties in reading acquisition were reported to be significantly lower than phonological awareness skills of unimpaired students (Deacon, Cook, & Parrila, 2012).

Phonological awareness was a unique predictor of word reading accuracy (Law et al., 2015; Metsala et al., 2019) and spelling (Law et al., 2015), but not of reading comprehension in unimpaired English-speaking university students when accounting for vocabulary and morphological awareness (Law et al., 2015) and when accounting for orthographic processing skills and morphological awareness (Metsala et al., 2019). Metsala et al. additionally controlled for word reading accuracy and word reading efficiency when analysing reading comprehension. Burt (2006) found that although phonological awareness was highly correlated with spelling in English-speaking university students, it was no unique predictor of spelling when accounting for morphological knowledge, pseudoword reading and orthographic processing skills. As such, studies are inconclusive with regard to the unique predictivity of phonological awareness for spelling in English adults.

In a study with German university students, several phonological awareness tasks were tested for their relationships with reading and spelling variables (Multhauf, Marschallek, & Steinbrink, 2017). The task that exhibited the closest relationship with literacy variables was a phoneme reversal task in which participants had to speak the phonemes of a word in reverse based on the phonological structure of the word. For example, the word “plan” (/plaːn/) would be reversed into /naːlp/. This task had small correlations with spelling (r = .23*), word reading fluency (r = .27**) and pseudoword reading fluency (r = .21*). In a second study by the same authors, this phonological awareness task correlated with spelling (r = .33*), word reading fluency (r = .27) and pseudoword reading fluency (r = .31*) in young adults attending a vocational school (Multhauf et al., 2017). This evidence suggests that phonological awareness is still associated with literacy skills in German adults.

Rapid naming seems to be moderately associated with reading comprehension and reading rate in adults, which was reported in a study with English university students (Arnell, Joanisse, Klein, Busseri, & Tannock, 2009). Reading rate was assessed with a task in which participants had to read as many words as possible with good comprehension in a given time. In studies with children, rapid digit naming and rapid letter naming seemed to predict reading skills better than rapid colour naming and rapid object naming (Araújo et al., 2015). The reverse was observed in the study by Arnell et al. with adults, in which rapid colour naming and rapid object naming predicted reading comprehension as well as or better than the other two rapid naming measures.

As reported in section 2.3.1.3, evidence on verbal memory as a unique predictor of literacy skills in children was not strong. In line with that, verbal memory was not identified as a unique contributor to literacy skills in primary school children in the main study (section 4.3). With regard

to adults, verbal memory was reported to be uncorrelated with spelling in English-speaking university students with an age range of 17 to 47 years (Burt & Shubsole, 2000). In this study, all participants were native speakers of English. In addition, verbal memory was no unique predictor of reading comprehension after accounting for listening comprehension, pseudoword reading ability and vocabulary (Braze, Tabor, Shankweiler, & Mencl, 2007).

In summary, phonological awareness and rapid naming seem to be correlates of literacy skills in adults. In contrast, verbal memory seems to have no unique predictive power for literacy skills in adults.

6.3.2 Vocabulary

Vocabulary development continues beyond school years and does not reach an obvious point of completion (Nippold, 2006). As observed for phonological processing variables, there is limited research on the relationship of vocabulary and literacy skills in non-impaired adult readers and spellers. Empirical evidence is summarized in the following.

In a study with 16 poor adult spellers and 16 good adult spellers, poor spellers were reported to have significantly lower vocabulary than good spellers (Holmes & Ng, 1993). In addition, a positive relationship between vocabulary and spelling has been found for English-speaking university students (Burt & Butterworth, 1996). Furthermore, a study with English-speaking students aged between 16 and 24 years found that vocabulary was related to reading skills (Braze et al., 2007). In this study, vocabulary uniquely predicted reading comprehension after accounting for listening comprehension and decoding skills, which was measured by pseudoword reading accuracy. These studies suggest that vocabulary plays a role for reading and spelling in English-speaking adults.

6.3.3 Fluid intelligence

Intelligence has been linked to many variables. To name some examples, meta-analyses suggest that intelligence is positively associated with the ability to recognize emotions (Schlegel et al., 2019), serves as a protective factor against becoming a criminal offender (Ttofi et al., 2016) and is negatively associated with mortality even when controlling for socio-economic status (Calvin et al., 2011). A meta-analysis on the relation between intelligence and school grades found a positive correlation between these two variables (Roth et al., 2015). Moderator analyses in this meta-analysis indicated that the relation between intelligence and school grades was stronger in higher grade levels, and that the relationship was weaker in more recent studies.

Despite the immense research interest in intelligence, to date, researchers have agreed neither on a single definition of intelligence nor on a set of dimensions that should be covered in an intelligence test (for an overview see Weber & Rammsayer, 2012). It is not the aim of this section to give a comprehensive overview of the debate on intelligence. However, it could be asked whether

morphological awareness is related to literacy variables when controlling for intelligence. Due to the many views on intelligence, a control for intelligence is not as straightforward as it might seem.

Kirby et al. (2008) argued that causal pathways for word reading are clearer with specific cognitive factors (e.g. phonological processing skills, vocabulary and morphological awareness) than with broader cognitive factors such as intelligence. The reason is that intelligence is related to a greater variety of different behaviours and skills (e.g. Calvin et al., 2011; Schlegel et al., 2019; Ttofi et al., 2016) and therefore its relations to word reading skills are more diffuse than those of specific cognitive factors (Kirby et al., 2008). It is interesting to note that vocabulary has been described as a measure of a component of intelligence that has been named crystallized intelligence by Cattell (1963). Cattell proposed that everyone has a general mental ability that can be distinguished in the factors fluid and crystallized intelligence. Fluid intelligence is described as the ability to adapt to new situations, whereas crystallized intelligence refers to abilities that have been acquired through past learning situations such as collected knowledge (Cattell, 1963; Horn & Cattell, 1967). In this sense, vocabulary is a way to measure stored knowledge. The fluid factor of intelligence is measured by tasks in which relations have to be detected, for instance, in matrices or in continuing series of numbers (Horn & Cattell, 1967). Fluid intelligence could be associated with literacy skills and also with morphological awareness because in reading and writing and in morphological awareness tasks, relations between different language units have to be detected and manipulated.

Kirby et al. (2008) did not specify to which kind of intelligence they referred. Given that they named vocabulary as a specific cognitive factor, possibly they referred to the fluid factor in their remarks on intelligence. There is some empirical evidence on relationships of intelligence with literacy skills and morphological awareness in adults. In a study by Metsala et al. (2019), matrix reasoning was only associated with orthographic processing but not with morphological awareness, phonological awareness, word reading accuracy, word reading fluency, pseudoword reading fluency, and reading comprehension. In another study, which did not include an assessment of morphological awareness, no association was found between a matrices test and spelling in English-speaking adults (Burt & Shubsole, 2000). In contrast, Holmes and Ng (1993) found a weak but significant correlation between a measure of fluid intelligence and spelling in 156 psychology students. That is, empirical evidence is in line with Kirby et al. (2008) and additionally suggests that fluid intelligence is not associated with morphological awareness skills. However, relationships between fluid intelligence and spelling are ambiguous.

Evidence on relationships between intelligence, morphological awareness and literacy in German can only be inferred from studies with children. Two studies covering schoolchildren from fourth to sixth grade reported small to medium correlations between morphological awareness and

fluid intelligence (Fink et al., 2012; Kargl et al., 2018). The relationship between fluid intelligence and spelling was reported to be small to medium in studies covering Grades 1 to 6 (Berendes et al., 2010; Ennemoser et al., 2012; Kargl et al., 2018). Intelligence measured at the end of kindergarten was a unique predictor of spelling in second to fourth grade in one study (Ennemoser et al., 2012; study 1). Results of other studies did not confirm this finding: Intelligence measured at the beginning of first grade did not uniquely predict spelling in first to fourth grade when accounting for phonological processing skills and linguistic competencies measured at the end of kindergarten (Ennemoser et al., 2012; study 2). In addition, intelligence did not uniquely predict spelling when accounting for phonological awareness and vocabulary in third and fourth grade (Berendes et al., 2010). Likewise, findings of German studies on the relations between reading variables and fluid intelligence are inconclusive. There was some indication that fluid intelligence measured at the end of kindergarten or at the beginning of first grade could be predictive of reading speed in second grade, and of reading comprehension in second and fourth grade (Ennemoser et al., 2012). In another study, no significant correlations were reported between basal reading skills and fluid intelligence in third and fourth graders (Berendes et al., 2010).

Results indicate that the role of fluid intelligence for reading and spelling is not clear. Including fluid intelligence as a control variable could help to explain the relationship between morphological awareness and literacy skills further.

6.4 Development of morphological awareness with respect to adults

Few studies explored the development of morphological awareness skills into adulthood. Some studies analysed changes in morphological awareness skills throughout school years. In addition, Berko (1958) compared morphological awareness skills of preschoolers and first graders to those of adults. Findings of these studies are summed up in the following.

There is evidence that morphological awareness continues to grow as children get older, for example for English (Apel et al., 2013; Nunes et al., 1997), French (Casalis & Louis-Alexandre, 2000) and German (Kargl et al., 2018). Nagy et al. (1993) found that knowledge on derivational suffixes of English-speaking students increased from fourth grade until high school (ninth to twelfth grade) with the strongest increase between fourth and seventh grade. In this study, students had to choose in which of four presented sentences a rarely occurring derivation of a common neutral word (e.g. “powderize”) fitted the sentence structure. In the case of “powderize”, the suffix indicates that the target word is a verb, and that therefore a sentence had to be picked in which the target word had the function of a verb. It is noteworthy that most students’ knowledge of common derivational suffixes was discovered to be incomplete even in high school.

Berko (1958) demonstrated that adults had considerably higher morphological awareness skills and used other morphological rules than pre-schoolers and first graders. For example, 50% to

75% of adults recognized signs for irregular patterns in pseudoword verbs and inflected the verb accordingly (e.g. “gling” – “glang” – “glung”), but only 1% to 2% of children used irregular verb inflection in their responses. In addition, adults derived new words considerably more often than children who almost exclusively used compound structures for nominalisation and for diminutive forms. For instance, all adults, but only 11% of children named a man who “zibs” a “zibber”. Children also used compounds such as “zibbingman” or “zibman” or responded with a real word (e.g. “clown”). In Berko's study, all adult participants were university students. Although coming from a presumably literacy competent population, not all of their responses corresponded to the expected ones. This indicates varying degrees of morphological awareness. In this study, adults had the most problems when asked to form a possessive.

To the best of the author’s knowledge, there are no studies on morphological awareness proficiency in German adults, so far. It can be expected that also German adults have acquired higher levels of morphological proficiency than children have. A comparison between morphological awareness proficiency in adults and in children would be valuable for understanding developmental aspects of morphological awareness in German.

6.5 Orthographic transparency

As explained in sections 1.4 and 2.4, German has a rather transparent orthography, but with greater transparency in the reading than in the spelling direction (Landerl, 2017). It has been suggested that morphological awareness might be more important for literacy skills in less transparent orthographies than in rather transparent ones due to less reliable grapheme-phoneme and phoneme-grapheme-correspondence rules in opaque orthographies (Desrochers et al., 2018). As the orthographic consistency of German is asymmetric, a stronger relationship of morphological awareness with spelling than with reading would be expected. So far, studies have not found evidence for such a differential relationship in German schoolchildren (Fink et al., 2012; Volkmer et al., 2019). The results of the main study of this dissertation (section 4.3) did not support this assumption, either. One potential reason could be that phonological approaches to reading and spelling take a distinctive role in German literacy instruction (cf. section 4.3.3.2). This could lead to schoolchildren favouring alphabetic strategies for both reading and spelling in their literacy acquisition. It has been shown that the type of literacy instruction in childhood (explicit phonics instruction or not) led to differing use of grapheme-phoneme-correspondence rules in adulthood when sounding out unknown words (Thompson et al., 2009). Thompson et al.'s study demonstrated that individuals who received explicit phonics instruction in childhood relied more on grapheme-phoneme correspondence rules, whereas individuals who did not receive explicit phonics instructions relied more on cues from familiar vocabulary and context when pronouncing unknown words.

According to Frith (1985, 1986), the relative importance of different reading and spelling strategies changes with increasing reading and spelling proficiency. Possibly, in German, with a rather transparent orthography and an explicit phonics instruction, the consistent usage of orthographic and/or morphological units in reading and spelling increases relatively late compared to less transparent languages and didactical approaches where phonics instruction is not a key element of literacy instruction. Therefore, a study investigating the relationships of morphological awareness with reading versus the one with spelling in adults would enhance the knowledge on the relations between these variables in German further.

6.6 Deduction of research questions and hypotheses of part II of this dissertation

The presented studies show that morphological awareness develops beyond primary school years and is associated with literacy skills in English-speaking adults. To the best of the author's knowledge, no studies exist that explore the role of morphological awareness in German adults. This exploratory part of the dissertation aims at illuminating the role of morphological awareness for literacy skills in German adults. Two studies are presented addressing three research questions that are described in the following.

6.6.1 How do morphological awareness skills in German adults differ from those in primary school children?

As described in section 6.4, there is empirical evidence from English studies that morphological awareness continues to grow beyond primary school years. It is to be expected that adults outperform children on morphological awareness tasks in German, too.

If literacy proficient adults had difficulties with a morphological awareness item previously applied with children, this could be a sign of potential problems with the interpretation of that given item because it might be ambiguous or unclear. However, it has been shown that even in developed readers, i.e. in high school students, morphological awareness of common English suffixes is incomplete (Nagy et al., 1993). Even university students showed uncertainties in several morphological categories (Berko, 1958). Therefore, a university student population not reaching ceiling effects in a morphological awareness item does not per se implicate a problematic item. This means, performances on individual items should be compared between schoolchildren and adults while considering item difficulties. If differences did not reach significance, this indicates either an ambiguous task or a very easy task in which children already performed very well, which can be inferred from the item difficulty value for schoolchildren.

The following hypothesis was specified:

H1. Adult university students have higher morphological awareness skills than primary school children.

6.6.2 Is morphological awareness related to literacy skills in German adults?

International studies have shown that there is a relationship between morphological awareness and literacy skills in schoolchildren. Moreover, English studies revealed that morphological awareness is related to literacy skills in unimpaired adults (section 6.2). To the best of the author's knowledge, no German studies on this question are available, so far. Therefore, the investigation of the relationship between morphological awareness and literacy skills in German adults is a valuable contribution to existing research. When investigating this relationship, the role of orthographic transparency (section 6.5) should be taken into account. Although no differential relationship of morphological awareness with spelling compared to the one with reading could be found in the main study, it was deemed possible that such a differentiation can be found for readers and spellers with higher levels of literacy proficiency (cf. section 6.5).

The following two hypotheses were formulated:

H2. There is a relationship between morphological awareness and literacy skills in German adults.

H3. There is a stronger relationship of morphological awareness with spelling skills than with reading skills in German adults.

6.6.3 Does morphological awareness uniquely predict literacy skills above and beyond other cognitive skills in German adults?

There is some evidence that morphological awareness is a unique predictor of literacy skills in English-speaking adults (section 6.2). English studies with adults suggest that phonological awareness (section 6.3.1), rapid naming (section 6.3.1) and vocabulary (section 6.3.2) also play a role for literacy skills. Evidence on relationships between morphological awareness, other cognitive variables and literacy skills in German is only available from research with schoolchildren, so far. Although Volkmer et al. (2019) identified morphological awareness as a unique predictor of literacy skills in second graders when accounting for phonological awareness, morphological awareness could not be confirmed as a unique predictor of literacy skills in primary school children in the main study of this dissertation (section 4.3). Phonological processing variables were important predictors of literacy skills in both the study by Volkmer et al. (2019) and the main study of this dissertation. It is an open question whether morphological awareness is a unique predictor of literacy skills in German adults. The following hypothesis was tested:

H4. Morphological awareness uniquely predicts literacy skills in German adults when accounting for other cognitive variables.

7 Empirical Studies Part II

The same morphological awareness tasks that had been used with schoolchildren in the main study (cf. section 4.3) were applied with adults. This served two purposes:

First, individual morphological awareness items could be inspected for ambiguities (cf. section 6.6.1). This aspect was addressed with the data of both adult studies and the main study. Data from both adult studies was combined to increase testing power in the analyses. Therefore, research question 1 was addressed in adult study 2 using a joint data set (section 7.2.4.1).

Second, if variability in the morphological awareness tasks could be observed in adults, which was expected for the morphological fluency task and deemed possible for the pseudoword cloze task (cf. section 6.4), potential relationships between morphological awareness and literacy skills in German adults could be analysed. This aspect was addressed in both adult studies using different control variables. The first exploratory study with adults tested whether morphological awareness is a unique predictor of literacy skills in German adults when accounting for vocabulary, fluid intelligence, academic achievement and age. The second exploratory study with adults assessed whether morphological awareness uniquely predicts literacy skills in German adults when controlling for phonological awareness, rapid naming, vocabulary, academic achievement and age. Therefore, research questions 2 and 3 were addressed in both studies.

7.1 Exploratory Study with Adults 1

7.1.1 Preliminary considerations

Preliminary considerations regarded control variables in the present study with adults. In the main study of this dissertation, in part unexpectedly high correlations were observed between phonological awareness and literacy variables and between phonological awareness and verbal memory (cf. section 4.3). While phonological approaches to literacy instruction could be a reason for the observed high correlations, it cannot be ruled out that some other underlying ability is jointly responsible for the observed relationships. Therefore, this study included control variables that reflect two kinds of not specifically language-related abilities: a non-verbal measure of fluid intelligence and a measure of academic achievement.

Empirical evidence on the relationship between morphological awareness, literacy skills and intelligence is inconclusive (cf. section 6.3.3). In addition, there are many, in part contradictory, theories on the concept of intelligence (cf. Weber & Rammsayer, 2012). Because it was already planned to control for vocabulary, which is seen as a specific cognitive factor (Kirby et al., 2008), but also as a measure of crystallized intelligence (Horn & Cattell, 1967), it was decided to include a measure of fluid intelligence as a control variable in the present study. By this two factors of intelligence were represented that, according to Cattell (1963), constitute a general mental ability.

Therefore, both fluid intelligence and vocabulary could be accounted for in analyses testing the relations of morphological awareness and literacy skills in German adults.

Academic achievement can be measured domain-specifically, for example, for maths, for sciences or for reading (Susperreguy, Davis-Kean, Duckworth, & Chen, 2018). Individuals generally succeeding in achievement situations can be identified with the help of a grade point average across several achievement domains (Susperreguy et al., 2018). As such, a grade point average can be used as an indicator of general performance outcomes in achievement situations. With such as measure it can be tested whether the performance in literacy tasks can be better explained by academic achievement than by morphological awareness, for example, because of general differences in performances on achievement-related tasks. Final school exam grades are a direct measure of academic achievement (Roth et al., 2015), and they are associated with later academic and professional success as they are positively related to the achieved grade for a university degree (Janke & Dickhäuser, 2018) and to later earnings (Schwerdt & Woessmann, 2017). Therefore, they were chosen as an informative measure of academic achievement in a university student population.

Age was included as a third control variable in this study because performance on cognitive tasks is correlated with age in adults according to a meta-analysis by Verhaeghen and Salthouse (1997). Relationships with age were found, for example, with speed of processing, working memory and reasoning. Morphological awareness had not been included in this meta-analysis, however, as it is also a cognitive variable and no normative data was available for the utilised tasks, it was decided to control for age in statistical analyses.

7.1.2 Research questions and hypotheses

As described in section 6.6, the following research questions with corresponding hypotheses were addressed in this pilot study:

Research question 2: Is morphological awareness related to literacy skills in German adults?

H2. There is a relationship between morphological awareness and literacy skills in German adults.

H3. There is a stronger relationship of morphological awareness with spelling skills than with reading skills in German adults.

Research question 3: Does morphological awareness uniquely predict literacy skills above and beyond other cognitive skills in German adults?

H4. Morphological awareness uniquely predicts literacy skills in German adults when accounting for other cognitive variables.

7.1.3 Methods

7.1.3.1 Sample

An a priori power analysis for the planned multiple linear regression with six variables (morphological fluency, pseudoword cloze task, vocabulary, fluid intelligence, final school exam grade, age) using a power of 1-β = 0.80, a moderate effect size of $f^2 = 0.15$ and an α-error probability of α = 0.05 resulted in a required sample size of $N = 146$. The power analysis was conducted with the software G*Power (Faul et al., 2009). The required sample size could not be obtained due to limited time and logistic resources; and some of the collected datasets could not be used in statistical analyses because exclusion criteria applied. Post-hoc power analyses for the achieved sample size are presented in section 7.1.3.5 together with the description of the data analytic method.

One hundred and two university students were recruited for participation (89 female, 13 male) with a mean age of $M = 20.7$ years ($SD = 2.4$ years). Participants were required to be native speakers of German, which was defined as learning German since birth and speaking German at least 50% of the time at home. This criterion was checked with a questionnaire (cf. section 7.1.3.2) and led to the exclusion of six participants. All participants affirmed in the questionnaire that they had normal or corrected-to-normal seeing and hearing abilities. The final sample was $N = 96$ (84 female, 12 male) with a mean age of $M = 20.6$ ($SD = 2.5$; Range = 18 – 36 years). All participants were in their first term at university. Participants received sweets for participation. Psychology students ($n = 56$) additionally received course credit equivalent to their testing time.

7.1.3.2 Instruments

Spelling

Spelling was measured using the subtest "Rummelplatz" [Eng. "fairground"] of the *Rechtschreibungstest* (RT) by Kersting and Althoff (2003). The RT is a spelling test designed for adults in which 60 dictated words have to be spelled correctly in a cloze task. Words are rated as either correct (no spelling mistakes) or false (one or more spelling mistakes). No matter how many spelling mistakes were made in a word, a maximum of one error per word is counted. Errors are added up to a sum score. As all participants belonged to the same norm group, raw scores were used in statistical analyses. Testing time is about 15 minutes. The manual reports internal consistency of this subtest to be α = .90 and re-test reliability after four weeks to be $r_{tt} = .88$.

Reading Fluency

Real word and pseudoword reading fluency were assessed with version A of the SLRT-II (Moll & Landerl, 2014; cf. section 4.2.3.2). Because all participants belonged to the same norm group, raw scores of correctly read words and non-words were used in later analyses. The manual reports reliability indices for schoolchildren, but not for adults. Parallel-form reliabilities for second

to sixth graders are between $.93 \leq r \leq .98$ for word reading and between $.90 \leq r \leq .96$ for pseudoword reading.

Intelligence

Fluid intelligence was measured with the short version of part 1 of the *Grundintelligenztest Skala 2 - Revision* (CFT 20-R) *mit Wortschatztest und Zahlenfolgentest – Revision* (WS/ZF-R) by Weiß (2006). This test consists of four different tasks comprising 11 to 15 items each. Correctly solved items were added up to a sum score and transformed into IQ scores. As participants fell into two different norm groups, not raw scores, but IQ values were used for subsequent analyses. Reliability is reported to be $r = .92$ for part 1 of the CFT 20-R (Weiß, 2006).

Vocabulary

Vocabulary was measured with the vocabulary subset of the *CFT 20-R mit WS/ZF-R.* The vocabulary subtests consists of 30 single-choice tasks in which a semantic alternative of a target word has to be identified from a set of five possible answers (one correct solution and four distractors). Participants read the tasks silently and make their choices by ticking the selected answer. Correct solutions are added up to a sum score. These raw scores were used in later analyses. Normative data is available for ages 8.5 to 19. Some of the participants were older than 19 years. This was accounted for in regression analyses by controlling for age. Reliability for this subtest is reported to be $r = .87$ (Weiß, 2006).

Morphological awareness

Morphological awareness was assessed with the pseudoword cloze task and the morphological fluency task in the same way as in the main study with schoolchildren (cf. section 4.3.1.2). Instructions were adapted slightly to inform participants that the presented tasks were originally designed for children and therefore some of the wordings might seem a bit odd. The rating of responses was executed using the category system developed for the main study (cf. section 4.3.1.2). Sum scores of achieved points were calculated for the pseudoword cloze task and the morphological fluency task. Of the pseudoword cloze task, the same 33 of 39 items were used in subsequent analyses as had been used in the main study. Cronbach's α was $\alpha = .49$ for the pseudoword cloze task and $\alpha = .65$ for the morphological fluency task. Both values indicate an insufficient reliability. However, as it was one aim of the exploratory studies with adults to find out how adults perform on the tasks that had been applied in the main study, it was decided to stick with exactly the same items as had been used in the main study.

Correlations were calculated between the morphological fluency task and the facets inflections, derivations and compounds of the pseudoword cloze task (Table 35). Results indicated that the facets of the pseudoword cloze task are related to each other in university students. This can be interpreted as a marker for concurrent reliability, and it legitimates the usage of a sum score for

items of the pseudoword cloze task. Morphological fluency and the facets of the pseudoword cloze task were unrelated, which indicates that both tasks measure different abilities in adults.

Table 35

Descriptive statistics and correlations for morphological awareness categories

				Correlations		
	Max	*M* (*SD*)	Range	1	2	3
1 Inflections	28	24.3 (2.2)	18 - 28	-		
2 Derivations	34	29.8 (2.7)	22 - 34	.21*	-	
3 Compounds	17	14.7 (2.2)	6 - 17	.21*	.19†	-
4 Morphological fluency		44.4 (12.0)	24 - 83	-.01	-.01	.04

Note. *N* = 96. †< .1 *< .05 **< .01.

Questionnaire

Participants filled in a questionnaire concerning their age, final school exam grade, attended school type, seeing and hearing impairments, subject of study at university, their current term and their mother tongue. The items of this questionnaire were self-generated. The questionnaire can be viewed in Appendix G.

7.1.3.3 Design

This study used a within-subjects, correlational design. Criterion variables were spelling and reading abilities. Morphological fluency and the pseudoword cloze task were explaining variables. Vocabulary, intelligence, age and academic achievement were included as control variables.

7.1.3.4 Procedure

Testing for this study was divided in a group session and an individual session. All participants started with the group session, in which spelling, fluid intelligence and vocabulary were measured. Up to three participants took part in a group session. To avoid sequence effects, the tests were administered in a randomised order. The group session was followed by a short break, after which participants passed through all three parts of the individual session in a randomised order. In one part of the individual session, morphological fluency was measured and the questionnaire on socio-demographic data was administered. In a second part, the pseudoword cloze task with items on inflections and derivations was applied. In a third part, the pseudoword cloze task with items on compounds and the reading fluency test were conducted. Working with parallel sessions allowed the simultaneous testing of up to three participants within each testing slot, which increased the number of participants that could be tested considerably. All tests were conducted in the laboratories of the University of Erfurt. Testing time was 90 minutes in total. Data for this study was collected as part of course work by students in their third semester. The course work was supervised by the

author. In total, there were 13 conductors of the study. The collected data was re-analysed for this dissertation.

7.1.3.5 Data analytic method

Correlations and multiple linear regressions were computed. Family-wise error rates and Bonferroni corrections were identified analogous to the procedure in the main study (cf. section 4.3.1.5). Post-hoc power analyses were calculated with the programme GPower (Faul et al., 2009). Sample size was $N = 96$ for both correlation and regression analyses.

Correlation analyses were used to identify relationships between study variables. The family-wise error rate in correlation analyses, that is the risk of falsely assuming a relationship between any two variables, was 84%: FWER = 1 - (probability of type I error)$^{n\_of\_comparisons}$ = 1 - $.95^{36}$ = .84. Therefore, Bonferroni corrections were applied to the α-error level. The adjusted α-error level was $P_{Crit} = \alpha / k = .05/36 = .0014$. Post-hoc power analyses were computed for two-tailed testing and the achieved sample size. Table 36 shows the results for uncorrected and Bonferroni-corrected α-error probabilities. Adequate power was achieved for medium and high correlations at an uncorrected α-error level. At the corrected α-error level, only high correlations reached an adequate power (cf. Cohen, 1992).

Regression analyses were used to identify variables that uniquely predicted spelling, reading fluency and pseudoword reading fluency. The family-wise error rate in regression analyses was 66%: FWER = 1 - $.95^{21}$ = .66. The Bonferroni correction adjusted the α-error level to P_{Crit} = .05/36 = .0024. The enter-method was used for regression analyses (cf. section 4.3.1.5). Power analyses for regression analyses revealed that an adequate power was achieved only for high regression effect sizes for both the uncorrected and the corrected α-error levels (Table 36).

Table 36

Estimated power for correlation and regression analyses for corrected and uncorrected α-error probabilities

	Testing power	
Relationships	Uncorrected	Bonferroni-corrected
Correlation heights	α-error level: α = .05	α-error level:α = .0014
Small: r = .1	.16	.01
Medium: r = .3	.86	.42
High: r = .5	>.99	.99
Regression effect sizes	α-error level: α = .05	α-error level: α = .0024
Small: f^2 = .02	.13	.01
Medium: f^2 = .15	.79	.38
Large: f^2 = .35	>.99	.93

Note. N = 96. Two-tailed testing for correlations. Six predictors in regression analyses.

Correlation and regression analyses were executed with the statistics software IBM SPSS Statistics 25 for Windows (IBM Corp., 2017).

7.1.4 Results

Descriptive statistics of study variables are presented in Table 37. Variation between participants was observed for all study variables, including both morphological awareness tasks. High scores were reached by almost all participants in the vocabulary test, indicating a ceiling effect.

Table 37

Descriptive statistics of Adult Study 1

Variable	Max	*M*	*SD*	Range
Age		20.6	2.5	18 - 36
Spelling (raw score; errors)	60	13.9	8.5	2 - 44
Word reading fluency (raw score)	156	120.5	16.8	48 - 147
Pseudoword reading fluency (raw score)	156	74.0	16.9	38 - 112
Fluid intelligence (IQ values)		104.6	14.3	68 - 134
Final school exam grade[1]		2.2	.05	1.0 - 3.5
Vocabulary (raw score)	30	28.0	1.4	23 - 30
MA: Pseudoword cloze task (raw score)	67	58.8	4.1	42 - 65
MA: Morphological fluency (raw score)		44.4	12.0	24 - 83

Note. N = 96. MA: Morphological awareness.

[1]All participants held a Diploma from German secondary school qualifying for university admission. Participants were asked to give their overall grade on this Diploma. Grades for passed Diplomas can range from 1.0 (very good) to 4.0 (sufficient). 5.0 is assigned to failed Diplomas, which was not applicable in the present sample.

Correlation analyses between study variables revealed relationships between morphological awareness and both spelling and reading variables (Table 38). Spelling was additionally correlated with vocabulary, final school exam grade, fluid intelligence and reading variables. Besides morphological fluency and spelling, no other cognitive or control variable was correlated with reading variables. Vocabulary was correlated with age and fluid intelligence.

Using Bonferroni corrections, spelling remained significantly correlated with the pseudoword cloze task and the final school exam grade. In addition, all literacy variables were significantly correlated with each other. No significant relationships could be observed between reading variables and any of the cognitive or control variables.

Table 38

Correlations of variables in adult study 1

Variable	1	2	3	4	5	6	7	8
1 Spelling (errors)	-							
2 Word reading fluency	**-.37****	-						
3 Pseudoword reading fluency	**-.45****	**.74****	-					
4 Age	-.08	.05	.10	-				
5 Fluid intelligence	-.26*	-.01	-.08	.08	-			
6 Final school exam grade	**.37****	-.04	.06	.16	-.09	-		
7 Vocabulary	-.30**	.00	.04	.31**	.32**	-.06	-	
8 MA: Pseudoword cloze task	**-.37****	.03	.12	-.06	.15	-.10	.15	-
9 MA: Morphological fluency	-.29**	.21*	.22*	-.01	.10	-.16	.15	-.01

Note. *N* = 96. MA: Morphological awareness.

*p < .05 **p < .01. Boldface: Significant at the Bonferroni-corrected α-error level α < .0014.

Regression analyses were run for spelling and both reading variables. Both morphological awareness tasks and the final school exam grade uniquely predicted spelling in adult university students (Table 39). Together they explained 32% of variance in spelling. Reading fluency and pseudoword reading fluency were uniquely predicted by morphological fluency only. However, explained variance in reading variables did not deviate significantly from zero. The adjusted R^2 indicates how well the model generalizes, i.e. how much variance would be explained in the population (Field, 2018). While non-adjusted R^2s indicated that the regression models explain 5,5% of variance of word reading fluency and 9,3% of variance of pseudoword reading fluency in the present sample, adjusted R^2 signify that morphological awareness does not explain variance significantly above zero in the population. Both, variability in the data and the number of insignificant variables in the regression are responsible for this observation. While regression coefficients represent means, R^2 values represent variability (cf. Steyer, 2003). The interpretation of regression coefficients does not change with the height of R^2 (Gelman & Hill, 2006). That is, morphological fluency alone is a predictor of reading skills. However, adjusted R^2 is reduced because the additional predictors decrease degrees of freedom and do not contribute to the prediction of reading (Field, 2018; Gelman & Hill, 2006). This together with the high variability in the data causes the model to not generalize to the population.

When applying Bonferroni corrections, the pseudoword cloze task and the final school exam grade remained unique predictors of spelling. No other regression coefficient reached significance. Explained variance in spelling was confirmed to be significantly different from zero.

Table 39

Regression analyses for literacy variables

Variable	Spelling	Word reading fluency	Pseudoword reading fluency
	β	β	β
Age	-.09	.08	.10
Fluid Intelligence (IQ)	-.12	-.03	-.13
Final school exam grade	**.29****	-.02	.09
Vocabulary	-.14	-.05	-.00
MA: Pseudoword cloze task	**-.31****	.05	.15
MA: Morphological fluency	-.22*	.22*	.25*
Adjusted R^2	**.32****	-.01	.04

Note. N = 96. MA: Morphological awareness. Regression procedure: Enter.
*p < .05 **p < .01. Boldface: Significant at the Bonferroni-corrected α-error level α < .0024.

7.1.5 Discussion

The purpose of this study was twofold. One aim was to collect more information on the morphological awareness measure that was applied with schoolchildren in the main study. Data collected in the present study was conjointly analysed with data of the second adult study to compare item characteristics to those from the main analysis. Therefore, this aspect is not discussed here, but in section 7.2.4.1. The second aim of the present study was to gather first evidence on the relationship of morphological awareness with literacy skills in literacy competent German adults. The corresponding research questions are answered in the following.

7.1.5.1 Is morphological awareness related to literacy skills in German adults?

H2. There is a relationship between morphological awareness and literacy skills in German adults.

Morphological fluency was related to spelling, word reading fluency and pseudoword reading fluency. The pseudoword cloze task was only related to spelling but not to basic reading skills. The correlations of morphological fluency with literacy variables could not be confirmed using Bonferroni corrections, but the correlation between the pseudoword cloze task and spelling remained significant even when applying Bonferroni corrections. The evidence suggests that morphological awareness stands in relation to spelling skills and basic reading skills in German university students. Thus, hypothesis 2 was accepted.

To the best of the author's knowledge, this is the first empirical evidence on the relationship between morphological awareness and literacy skills in German adults. Findings are in line with empirical evidence for English, where a relationship between morphological awareness and spelling

abilities (Wilson-Fowler & Apel, 2015) and between morphological awareness and word reading abilities (To et al., 2016; Wilson-Fowler & Apel, 2015) was found for literacy competent adults. As in the present study, a small relationship between morphological awareness and word reading abilities for skilled adult readers was found in a previous English study (r = .23*) by To et al. (2016). Wilson-Fowler and Apel (2015) did not report correlations, but results from path analyses that implied a moderate relationship between morphological awareness and basic reading skills and a somewhat stronger relationship between morphological awareness and spelling skills in university students. This pattern is in line with findings of the present study. This aspect is discussed in more detail with regard to the third hypothesis, which is acknowledged below.

It is noteworthy that the pseudoword cloze task was only correlated with spelling but not with basic reading skills, while the morphological fluency task was correlated with all three literacy variables. A reason could lie in the speed component of the morphological fluency task because in the morphological fluency task but not in the pseudoword cloze task quick responses were required. A quick access to one's morphological awareness skills could be advantageous in reading fluency tasks, in which words have to be read as quickly and as accurately as possible. The literacy task without time pressure, i.e. the spelling task, was correlated with both morphological awareness tasks. That is, for writing without time pressure, the speed of access to one's morphological awareness skills seems to be less relevant. Another explanation for the observed pattern could lie in differences of general processing speed between participants. It is possible that individuals who are generally quicker in executing mental tasks have advantages in both the morphological fluency task and the reading fluency tasks. As general processing speed was not measured in this study, this cannot be decided with certainty. However, an argument contrary to this reasoning is that processing speed has been found to be strongly associated with age (Kail & Salthouse, 1994; Salthouse, 2000), yet none of the considered variables was correlated with age in the present study. Although vocabulary was found to correlate with age, descriptively little variation on the variable age was observed between participants in the present study (M = 20.6, SD = 2.5, Range = 18 – 36). Therefore, the question whether speeded access to one's morphological awareness skills or differences in processing speed between participants are responsible for the observed findings, cannot be resolved with certainty at this point.

H3. There is a stronger relationship of morphological awareness with spelling skills than with reading skills in German adults.

The relationship between the pseudoword cloze task and spelling was of medium height and remained significant even when applying Bonferroni corrections. In contrast, the correlations between morphological awareness and basic reading skills were either small or non-significant, and small correlations became insignificant when Bonferroni-corrections where applied. This implies

that there was stronger evidence for a relationship of morphological awareness with spelling than with reading in German adults. This supports the theoretical assumption of a closer relationship of morphological awareness with spelling than with reading because the German orthography is less consistent for spelling than for reading. In addition, morphological awareness variables contributed to the explanation of a significant amount of variance of spelling abilities in regression analyses, whereas the explained variance in analyses for reading variables did not deviate significantly from zero. Because of these observations, hypothesis 3 was accepted.

This finding is in line with evidence from Wilson-Fowler and Apel (2015) who reported that morphological awareness had a stronger relationship with spelling than with word reading. They argued that differences in task demands could be a reason for this observation because for reading familiar words, the analysis of morphological characteristics of the word is less important than for spelling. They explained that for word reading, whole-word representations can be retrieved from memory (cf. section 6.1.3), which does not require a morphological analysis of the word. In contrast, spelling requires the individual to pay attention to the phonological, orthographic and morphological structure of the word to produce an accurate and complete representation of the spelled word (Wilson-Fowler & Apel, 2015). Therefore, morphological awareness skills could be more helpful in spelling than in reading familiar words. Hence, both the asymmetry of the German orthography and different task demands could explain the observed findings in German adults. Comparing the relationship between morphological awareness and spelling with that between morphological awareness and reading comprehension would generate valuable additional evidence with regard to the present research question because reading comprehension as a higher-level reading skill is more demanding than word reading fluency (cf. Hoover & Gough, 1990; Verhoeven & Perfetti, 2017). In addition, theoretical implications (cf. section 2.2.5) and the results of the main study suggested that morphological awareness could play a greater role for reading comprehension than for basal reading skills in schoolchildren. Comparing the relationship between morphological awareness and reading comprehension with that between morphological awareness and basal reading skills in German adults would be a further valuable extension to the existing research base. For these reasons, reading comprehension was included in the second exploratory study with adults.

7.1.5.2 Does morphological awareness uniquely predict literacy skills above and beyond other cognitive skills in German adults?

H4. Morphological awareness uniquely predicts literacy skills in German adults when accounting for other cognitive variables.

Morphological awareness was a unique predictor of spelling skills when accounting for age, fluid intelligence, final school exam grade and vocabulary. Morphological awareness was also a predictor of both reading fluency variables; however, the regression models did not generalize to

the population due to high variability in the data and reduced degrees of freedom from non-significant predictors. When applying Bonferroni corrections, the pseudoword cloze task and the final school exam grade remained significant predictors of spelling. Because only the regression model for spelling, but not the models for word reading fluency and pseudoword reading fluency generalized to the population, hypothesis 4 was partly accepted.

Morphological awareness had been identified as a unique predictor of spelling in unimpaired English-speaking adults (Law et al., 2015; Wilson-Fowler & Apel, 2015). The present study extends this observation to the German language. The observed results imply that morphological awareness is relevant for skilled spelling in German adults. This is in line with theoretical assumptions that suggested that morphological information have to be analysed and used in skilled spelling (Burt, 2006). Morphological awareness was measured with the same tasks as in the main study with children. Whereas it was no unique predictor of literacy skills in the main study, it uniquely predicted spelling in the present study. This could indicate that morphological awareness continues to unfold its relevance after primary school years.

Results on whether morphological awareness was a unique predictor of basic reading skills were inconclusive in English studies. While Metsala et al. (2019) identified morphological awareness as a unique predictor of word reading ability, Law et al. (2015) could not identify any predictive power of morphological awareness for word reading. The present study measured basic reading skills with word reading fluency and pseudoword reading fluency. For both variables, morphological fluency was a predictor, although the regression models did not generalize to the population. These results imply that the predictive power of morphological awareness has to be rated as insufficient for explaining variance in basic reading skills in German adults. The observation that also no other reliable predictor of basic reading skills was identified implies that a key predictor was missing in the analyses. Phonological awareness is a promising candidate for explaining literacy skills in German adults. It was identified as a unique predictor of word reading accuracy in English-speaking adults (Law et al., 2015; Metsala et al., 2019). Moreover, phonological awareness was the key predictor of literacy skills in primary school children in the main study. Yet, it has been argued that the importance of phonological awareness decreases in later stages of reading acquisition in consistent orthographies, while rapid naming remains to be associated with reading skills (Landerl & Wimmer, 2000). Therefore, both phonological awareness and rapid naming were included in the second exploratory study with adults.

7.1.5.3 Further observations

Vocabulary

Vocabulary was moderately correlated with spelling, but not with basic reading skills. In regression analyses, vocabulary was no unique predictor of spelling or basic reading skills. When

using Bonferroni corrections, no association between vocabulary and any other variable remained significant. Results of the current study indicate that vocabulary is a potential correlate but no unique predictor of spelling in German adults.

A positive association between vocabulary and spelling skills is in line with previous studies on English-speaking adults (Burt & Butterworth, 1996; Holmes & Ng, 1993). The observed findings indicate that the knowledge of the semantic meaning of words aids spelling. This is in line with the binding agent theory of morphological knowledge that makes explicit assumptions on semantics (Kirby & Bowers, 2017). According to the binding agent theory, morphology is helpful for spelling by integrating semantic and phonological information. Indeed, both morphological awareness and vocabulary were correlates of spelling in the present study. Phonological processing variables had not been measured, though. Therefore, the third component of this approach to spelling could not be inspected at this point. Phonological processing variables were included in the second exploratory study with adults. There, the binding agent theory was addressed again (cf. section 7.2.4.4).

The observation of the present study that vocabulary was no unique predictor of spelling has to be viewed in light of possible ceiling effects in the vocabulary task. On average, participants received $M = 28.0$ ($SD = 1.4$) of Max = 30.0 points. Therefore, it is possible that not enough variation between participants could be measured with the applied test, which could have affected the regression analysis. Using a different vocabulary measure could help making a reasoned decision on vocabulary being a unique predictor of spelling in German adults or not. This was realized in the second study with adults (cf. section 7.2).

Vocabulary has been associated with reading comprehension in English-speaking adults (Braze et al., 2007). In the present study, reading comprehension was not assessed; yet, the association between vocabulary and basic reading skills was analysed. A relationship between vocabulary and reading variables was found neither in correlation nor in regression analyses. According to the binding agent theory of morphological knowledge, semantics should be relevant for pronunciation because morphology connects semantic and orthographic information and by this gives clues to pronunciation (Kirby & Bowers, 2017). This was not reflected in the observed results. It is possible that due to the transparency of the German orthography in the reading direction, semantic information is less relevant than in the opaque English orthography. For example, quite accurate pronunciation can be achieved using alphabetic reading strategies in German (Landerl, 2017). Moreover, the pseudoword reading fluency task did not entail any semantic information that could have been used for pronunciation. This might explain the missing relationship between vocabulary and basic reading skills. In addition, the observed ceiling effects for the vocabulary task could have prevented the observation of a relationship between vocabulary and word reading skills.

Therefore, it cannot be decided with certainty whether there is a relationship between vocabulary and reading fluency or not.

A positive correlation of vocabulary with age was detected in the present study. This is in line with the observation that vocabulary grows beyond school years and reaches no obvious point of completion (Nippold, 2006). Age was entered in regression analyses to account for differences in vocabulary that was due to the age of participants. Results indicated that neither age nor vocabulary were unique predictors of reading or spelling.

No correlation between vocabulary and both morphological awareness tasks were observed in the current study. This implies that morphological awareness tasks and the vocabulary test measured different abilities. In previous studies on English adults, results indicated that morphological awareness and vocabulary had small (Guo et al., 2011) to medium (Law et al., 2015) correlations. Ceiling effects might have prevented the detection of a relationship between vocabulary and morphological awareness in the present study. Yet the results could also imply that the applied morphological awareness tasks tap different abilities than those assessed by a receptive vocabulary test. The morphological fluency task required the quick production of words belonging to a certain word family. As the target words were all familiar words even for children, which had been secured by choosing the test words of the original TMB test with the largest morphological family sizes in the ChildLex corpus (Schroeder et al., 2015; cf. section 4.3.1.2), a large vocabulary might not have been necessary for solving this task for a literacy competent adult. In addition, in the pseudoword cloze task, all target words were pseudowords. Therefore, this task could not have been solved based on semantic knowledge (cf. Fink et al., 2012). Whether the detection of a relationship between morphological awareness and vocabulary skills was prevented by ceiling effects or because morphological awareness tasks and vocabulary tasks indeed tap different abilities cannot be resolved at this point. This question was addressed again in the second study with adults (cf. section 7.2.4.4).

To conclude, vocabulary was identified as a correlate but not as a unique predictor of spelling. In addition, no association between vocabulary and basic reading skills was observed. As ceiling effects were observed in the vocabulary task, results have to be considered preliminary.

Fluid intelligence

Fluid intelligence had been chosen as a control variable to determine whether differences in literacy competencies were better explained by an underlying non-verbal ability than by morphological awareness or vocabulary in German adults.

Fluid intelligence was correlated with spelling and with vocabulary, but with no other variable in the present study. In addition, fluid intelligence was no unique predictor of literacy variables in German adults. When applying Bonferroni corrections, none of the relationships

remained significant. It was concluded that fluid intelligence does not explain differences in literacy skills better than the specific cognitive variables morphological awareness and vocabulary.

The finding that intelligence was associated with spelling skills in German adults adds to the existing literature. Previous findings on the association between intelligence and spelling in studies on English adults were inconclusive. While no association was found between fluid intelligence and spelling in a study by Burt and Shubsole (2000), Holmes and Ng (1993) found a weak but significant correlation between fluid intelligence and spelling in 156 psychology students. The observed small relationship between fluid intelligence and errors in a spelling test of the present study (r = -.26*) is in line with the observation by Holmes and Ng (1993). It has been argued that fluid intelligence is associated with spelling because the active manipulation of language information (e.g. graphemic and phonemic information) relies on the efficiency with which mental processes are executed (Stuart-Hamilton & Rabbitt, 1997). That is, fluid intelligence might aid spelling by facilitating the detection of and the operation with relations between different language units.

The result that intelligence was not associated with reading skills is in line with findings on English-speaking adults (Metsala et al., 2019). It also confirms Kirby et al.'s (2008) reasoning that associations of word reading with specific cognitive factors such as vocabulary and morphological awareness are clearer than those with boarder cognitive factors such as intelligence.

No association between fluid intelligence and morphological awareness was found which is in line with an English study on adults (Metsala et al., 2019). For German, only studies with children are available on these two variables. They found small to medium correlations between morphological awareness and fluid intelligence in schoolchildren from fourth to sixth grade (Fink et al., 2012; Kargl et al., 2018). The different findings for children and adults could imply that the role of fluid intelligence decreases with increasing morphological awareness.

Fluid intelligence was moderately correlated with vocabulary in the present study. Considering vocabulary as a measure for crystallized intelligence, this finding is in line with literature as it has been found that fluid intelligence and crystallized intelligence have a moderate relationship (e.g. Ackerman, Bowen, Beier, & Kanfer, 2001; M. Ziegler, Danay, Heene, Asendorpf, & Bühner, 2012).

Interestingly, fluid intelligence was uncorrelated with the final school exam grade. This was unexpected because a meta-analysis by Roth et al. (2015) found a high population correlation of ρ = .54 between intelligence and school grades. Moderator analyses of that meta-analysis indicated that the correlation became weaker in recent years; however, there was no indication that the correlation could disappear. An explorative German study found that despite being of comparable, normal intelligence, students could vary greatly with respect to school grades, final school exam grade and the probability of enrolling in a university course (Sparfeldt, Buch, & Rost, 2010). The

authors found that the academic self-concept differs significantly between students that have comparable intelligence scores but vary with respect to the achieved exam grades. Possibly, such differences in academic self-concept could have caused the missing relationship in the present study.

To summarize, fluid intelligence was identified as a correlate of spelling and vocabulary. It was no unique predictor of literacy variables when accounting for specific cognitive factors. Observed associations are in line with theoretical considerations and empirical findings, except the one between intelligence and final school exam grade. From regression analyses, it was concluded that fluid intelligence is not explaining literacy competencies better than specific cognitive factors such as morphological awareness and vocabulary.

Academic achievement

Academic achievement had been chosen as a control variable to find out whether differences in literacy competencies could be better explained by a measure of academic achievement than by morphological awareness or vocabulary, for example, due to general differences in performances on achievement-related tasks (cf. Susperreguy et al., 2018).

The only significant correlation observed for final school exam grade was the one with spelling (r = .37**). It remained significant when applying Bonferroni corrections. The correlation has a positive direction because both in the spelling test and in the final school exam grade lower values indicate a better performance. In addition, final school exam grade was identified as a unique predictor of spelling skills. The regression coefficient remained significant when Bonferroni corrections were applied.

This finding corresponds to observations from the British Cohort Study (BCS) that found a medium correlation of r = .32** between the grade point average and spelling skills in a large-scale study on 11,315 British 16-year-olds (Borghans, Golsteyn, Heckman, & Humphries, 2016). The observed finding implies that spelling has a relevant association with the final school exam grade of young German adults. Because both morphological awareness tasks were additional predictors of spelling, it was concluded that even though academic achievement was an additional predictor of spelling, it was not a better one than morphological awareness was.

A small but significant correlation (r = .14**) between the grade point average and vocabulary skills had been found in the BCS (Borghans et al., 2016). The correlation between final school exam grade and vocabulary skills did not reach significance in the present study (r = -.06). The result indicates that vocabulary knowledge is not a relevant correlate of the final school exam grade in young German adults.

As the relationship with spelling was the only association found for academic achievement, it was concluded that general differences in achievement-related tasks were not mainly responsible for differences in performances in the applied tests. In addition, academic achievement was not a

better predictor of spelling than morphological awareness was; it was merely an additional one. The relationship between spelling and academic achievement can be regarded from two angles. Academic achievement could explain spelling skills because individuals who generally succeed in achievement-related tasks are better in spelling tests. Yet, as no other correlation between academic achievement and the other study variables was identified, it is also plausible that spelling skills are important for succeeding in school tests, which is reflected by the final school exam grade. Due to the correlational nature of the present study, this question must remain unsolved at this point.

7.1.5.4 Limitations and directions for future research

This section addresses limitations of the current study and directions for future research.

A first point that needs consideration regards α- and β-error probabilities. An accumulation of α-error probability occurred due to the number of comparisons between study variables in the present study (cf. Field, 2018). Using a Bonferroni-corrected α-error level increased the β-error probability, which caused the testing power to shrink below the threshold criterion of 1-β = .80 (cf. Cohen, 1992). Therefore, results were reported both with and without Bonferroni corrections. It is likely that a relationship was falsely interpreted as meaningful when not applying Bonferroni corrections. However, testing power for medium and small correlation and regression coefficients was too low when using Bonferroni corrections. At least strong relationships could be detected with adequate certainty. Lowering the number of study variables while increasing the number of participants could help solving the problem of inflated α- and β-error probabilities in future studies.

Another point that should be addressed is that some cognitive variables that have been identified as unique predictors of adult literacy skills have not been assessed in the current study. For example, phonological awareness was not included in this study although it was identified as a unique predictor of spelling (Law et al., 2015) and word reading accuracy (Law et al., 2015; Metsala et al., 2019) in English-speaking adults. Moreover, there is some indication that rapid naming could be associated with adult reading skills (Arnell et al., 2009). In light of the results of the main study with schoolchildren, in which phonological awareness was the dominant predictor of literacy skills, and rapid naming an additional unique predictor of proficiency in orthographic spelling strategy and pseudoword reading fluency, it has to be considered that phonological processing variables could be relevant predictors of literacy skills in German adults, too. Therefore, phonological processing variables should be included in future studies to gauge the relative importance of morphological awareness and other language-related skills for literacy skills in German adults.

In this study, reading skills were operationalised only with the basic reading skills word reading fluency and pseudoword reading fluency. Including a measure of reading comprehension in a future study would be a valuable extension of the gathered evidence because reading comprehension is most often the actual goal of reading (cf. McBride-Chang, 2004). Moreover,

morphological awareness could be more important for reading comprehension than for basal reading skills because morphemes are the smallest units of meaning (cf. Elsen, 2014), which makes them crucial entities for extracting meaning from writing, which is important for reading comprehension but not necessary for pronunciation in the rather transparent German orthography (cf. section 1.4). Including reading comprehension in a future study with German adults would additionally allow re-testing the hypothesis that morphological awareness is more important for spelling than for reading in German. Testing this hypothesis with a higher-level reading skill would strengthen the evidence on possibly differential relationships of morphological awareness with reading and spelling due to the asymmetric German orthography.

A further point that needs consideration is that the sample characteristics are not representative of the general population of German adults because only university freshman participated in this study. Therefore, the within-sample variation of study variables is presumably smaller than in the general population. Results of the current study are an indication on the relationships between morphological awareness and literacy skills in a literacy competent sample of young adults, but they might not generalize to the German adult population.

A final point that has to be addressed concerns the correlational design of the present study, which does not permit causal interpretation. In longitudinal studies with children it was suggested that the relationship between morphological awareness and literacy skills is bi-directional (Deacon et al., 2013; Kuo & Anderson, 2006). Whether this is also the case for adults, cannot be decided yet because longitudinal data for adults have not been reported so far. It is possible that both literacy skills and morphological awareness cease to develop meaningfully in early adulthood because neither literacy variables nor morphological awareness did correlate significantly with age in the present study, whereas vocabulary and age showed the significant correlation that had been expected. Therefore, a longitudinal study on the development of the relationship between morphological awareness and literacy variables might have to start at an earlier age. Alternatively, an experimental intervention study could shed further light on causal relationships.

7.1.5.5 Conclusions

Findings of the present study imply that morphological awareness is a correlate of literacy skills in German adults, while there was stronger evidence for a relationship with spelling than with reading, which is in line with theoretical and empirical implications. That is, the ability to recognize, reflect on and manipulate morphological structures in a language is associated with spelling performance and to a lesser degree with basic reading skills. Moreover, morphological awareness proved to be a unique predictor of spelling skills when accounting for fluid intelligence, vocabulary, academic achievement and age. This is substantial evidence that morphological awareness is an important cognitive variable for explaining spelling skills in German adults. Yet, in the main study

with primary school children, the strongest predictor of literacy variables was phonological awareness, a variable not controlled for in the current study. Therefore, at this point it remains unresolved whether morphological awareness is a unique predictor of spelling in German adults when accounting for phonological awareness. Moreover, theory implies that the relationship between morphological awareness and reading comprehension could be stronger than the relationship of morphological awareness with basic reading skills. To analyse these aspects further, phonological processing variables and reading comprehension were included in the next study. This second study with adults is presented in the following.

7.2 Exploratory Study with Adults 2

7.2.1 Research questions and hypotheses

This study addressed the three research questions with corresponding hypotheses that were deduced in section 6.6:

Research question 1: How do morphological awareness skills in German adults differ from those in primary school children?

H1. Adult university students have higher morphological awareness skills than primary school children.

Research question 2: Is morphological awareness related to literacy skills in German adults?

H2. There is a relationship between morphological awareness and literacy skills in German adults.

H3. There is a stronger relationship of morphological awareness with spelling skill than with reading skills in German adults.

Research question 3: Does morphological awareness uniquely predict literacy skills above and beyond other cognitive skills in German adults?

H4. Morphological awareness uniquely predicts literacy skills in German adults when accounting for other cognitive variables.

7.2.2 Methods

7.2.2.1 Sample

An a priori power analysis for the planned multiple linear regression with seven variables (morphological fluency, pseudoword cloze task, vocabulary, phonological awareness, rapid naming, final school exam grade, age) using a power of $1\text{-}\beta = 0.80$, a moderate effect size of $f^2 = 0.15$ and an α-error probability of $\alpha = 0.05$ resulted in a required sample size of $N = 153$. The power analysis was conducted with the software G*Power (Faul et al., 2009). The required sample size could not be obtained because many of the students usually invited to studies were already familiar with one or more of the study tests. In addition, some of the collected datasets could not be used in statistical analyses because exclusion criteria applied (see below). Post-hoc power analyses for the achieved sample size are presented in section 7.2.2.5 together with the description of the data analytic method.

Eighty-five university students were recruited for participation (61 female, 24 male) with a mean age of $M = 22.3$ years ($SD = 2.7$ years). Participants were required to be of German mother tongue, which was defined as learning German since birth and speaking German at least 50% of the time at home. All participants fulfilled this criterion, which was checked with a questionnaire. Seven participants had to be excluded because they reported being familiar with one or more of the applied tests. Four further participants were excluded because of mistakes in test instructions. Additionally,

one participant reported to have hearing impairments in the applied questionnaire; therefore, the corresponding dataset was excluded from analyses. All participants declared to have normal or corrected-to-normal seeing abilities. The final sample consisted of 73 university students (51 female, 22 male) with a mean age of M = 22.0 years (SD = 2.6 years; Range = 18 – 29 years). Participants were on average in their sixth semester at university (M = 6.2, SD = 3.7). Participants received cake and sweets for participation. Psychology students (n = 34) additionally received course credit equivalent to their testing time.

7.2.2.2 Instruments

Spelling

Spelling was measured with the subtest "Rummelplatz" of the *RT* as in the preceding study with adults (see section 7.1.3.2). Likewise analogous to the preceding study, a sum score of errors made in the dictation cloze task was used in subsequent analyses.

Reading comprehension

Reading comprehension was measured with the *Lesegeschwindigkeits- und verständnistest für die Klassen 5-12* (LGVT 5-12+; Eng. "Test of reading speed and reading comprehension for Grades 5-12") using the subtest "Laufbursche" (Eng. "footboy") by Schneider, Schlagmüller, and Ennemoser (2017). In this test, participants have to select one out of three words that fits best in the present position in the text at 47 occasions in the presented fictional story. All choices are semantical and not grammatical. For every correct choice, participants are awarded 2 points. If more than one or a false option was chosen, participants receive 1 point. Zero points are assigned if no choice was made. A sum score was calculated for every participant. Testing time is six minutes. The LGVT 5-12+ offers normative data for schoolchildren in Grades 5 to 13. The manual of the test indicates that after 10th grade almost no increases in reading comprehension skills were observed for grammar school students. Additionally, no ceiling effects were reported for students in Grades 12 and 13. As all our participants were former grammar school students, it was decided to work with this test despite unavailable normative data for university students. In subsequent analyses, raw scores were used. The manual reported a mean raw score of M = 40.7 (SD = 14.1) for 12th-graders. The present sample reached a mean of M = 42.2 (SD = 10.9). A two-sample t-test revealed that the means are not equal (t = -3.56, df = 480, p < .01**), indicating that the present university student sample performed significantly better than the 12th-graders with whom the test was normed. Nevertheless, it was deemed adequate to use the raw scores in subsequent analyses because they did not indicate signs of ceiling effects (observed range in the present sample: 9 – 72 points; maximum of points that can be awarded: 94 points). Re-test reliability of the applied subtest was reported to be r = .88.

Reading Fluency

As in the preceding studies, reading fluency was measured with version A of the SLRT-II (see section 4.2.3.2 for details). Raw scores of correctly read words and pseudowords were used in subsequent analyses.

Phonological awareness

Phonological awareness was assessed with one of five tasks that had been developed at the department of developmental psychology at the University of Erfurt for measuring phonological awareness in the narrower sense in German-speaking adults (cf. Multhauf & Steinbrink, 2016a, 2016b; modified version in Marschallek, 2017). Two of the five task types were applied in the present study: *phoneme reversal* and *segmentation*, however, only phoneme reversal was relevant for this dissertation. *Segmentation* was applied because of another research question that was pursued in a master's thesis of one of the conductors of the test. Therefore, it was not analysed in the context of this dissertation. *Phoneme reversal* was selected for the present study because it had the closest relationship of the five task types with both basal reading skills ($.21^{*} \leq r \leq .27^{**}$) and spelling ($r = .23^{*}$) skills in a pilot study with 101 university students (Multhauf et al., 2017). In the task *phoneme reversal*, participants are asked to speak the phonemes of a word or pseudoword in reverse without taking into account the spelling of the word (e.g. the word "plan" (/plaːn/) would be reversed into /naːlp/). The 16 items are presented via audio recordings of spoken words and pseudowords taken from the German computer-based phonological awareness training for children "Lautarium" (Klatte, Steinbrink, Bergström, & Lachmann, 2017). All target words have to be repeated by the participant before reversing the phonemes to ensure that participants do not lose points due to mishearings. Relative frequencies were calculated representing the ratio of correctly reversed words of all correctly repeated words. The rating of responses was based on a rating catalogue developed and tested in two pilot studies (Marschallek, 2017; Multhauf et al., 2017; cf. Multhauf & Steinbrink, 2016b). Internal consistency for *phoneme reversal* was $\alpha = .83$ in the pilot study with university students (Multhauf et al., 2017). Due to test protection requirements (cf. Diagnostik- und Testkuratorium der Föderation Deutscher Psychologenvereinigungen, 2019), items, protocol sheets and rating criteria cannot be presented in this dissertation.

Rapid naming

Rapid object naming was assessed using version 1 of the subscale "*Schnelles Benennen*" (Eng. "rapid naming") of the ZLT-II (Petermann & Daseking, 2015). This was the same measure as applied in the second pilot study (section 4.2) and the main study (section 4.3) with children. The raw score of the time needed to name the presented objects was used in subsequent analyses. The ZLT-II is standardised for grades one to eight. Therefore, no normative data and psychometric

criteria of the test is available for an adult sample. Re-test reliability for version 1 of the rapid naming test is $r = .94$ for schoolchildren.

Vocabulary

Vocabulary was assessed with part 2 of version A of the *Wortschatztest aktiv und passiv* (WST –AP) by Ibrahimovic and Bulheller (2005), which is the German version of the American Mill Hill Vocabulary Scale (Raven, Raven, & Court, 1998). In the applied subtest, participants are presented with 30 multiple-choice items. Each item consists of one target word and six further words. Participants are asked to select those of the six further words that semantically match the target word. Participants can gain a maximum of five points for each item. The number of points awarded depends on the ratio of correct and incorrect choices made by the participant. Testing time is 10 minutes. Normative data are available for adults up to age 62. Raw scores were used in subsequent analyses because all participants belonged to the same norm group. The manual reports split-half reliability to be $r_{tt} = .84$ for the applied subtest.

Morphological awareness

Morphological awareness was measured in exactly the same way as in the preceding study with adults (cf. section 7.1.3.2). It was tested again whether the different facets of the morphological awareness tasks correlated with each other. For this, the data of the preceding study with adults was updated with the data from the present study. The same 33 items of the pseudoword cloze task were used in calculations as in the preceding study. Significant correlations were found between compounds and inflections and between compounds and derivations (Table 40). The correlation between inflections and derivations was not significant which might have been due to ceiling effects in these tasks. Yet to be able to compare results between studies, it was decided to use a sum score for all three facets of the pseudoword cloze task nevertheless.

Table 40

Descriptive statistics and correlations for morphological awareness categories on the combined data of adult study 1 and adult study 2

				Correlations		
	Max	*M* (*SD*)	Range	1	2	3
1 Inflections	28	24.3 (2.3)	17 - 28	-		
2 Derivations	34	29.8 (2.7)	20 - 34	.06	-	
3 Compounds	17	15.1 (2.0)	6 - 17	.19*	.17*	-
4 Morphological fluency		45.0 (12.0)	22 - 83	.03	.03	.09

Note. $N = 169$. *$p < .05$.

Like in the preceding study, morphological fluency did not correlate significantly with any of the facets of the pseudoword cloze task. Possibly this was due to ceiling effects that were observed in the pseudoword cloze task but not in the morphological fluency task (cf. Table 40). Another reason could lie in the speed component of the morphological fluency task that might put a different weight on cognitive resources compared to the pseudoword cloze task in which participants were not under time pressure for finding a response.

Updated Cronbach's α calculated with the data from the preceding and the present study with adults (N = 169) was α = .47 for the pseudoword cloze task and α = .66 for the morphological fluency task. The results indicate a problem with reliability especially for the pseudoword cloze task. However, as a comparison between studies was intended, it was decided to continue with exactly the same set of items as in the previous studies.

Questionnaire

Participants filled in a questionnaire with questions concerning their age, final school exam grade, attended school type, seeing and hearing impairments, subject of study, their current term at university and their mother tongue. The questionnaire is included in Appendix H.

7.2.2.3 Design

A within-subjects, correlational design was used for this study. Criterion variables were spelling, reading comprehension, word reading fluency and pseudoword reading fluency. The explaining variable morphological awareness was measured with the pseudoword cloze task and the morphological fluency task. Control variables were phonological awareness, rapid naming, vocabulary, age and final school exam grade.

7.2.2.4 Procedure

Data collection for each participant lasted about two hours. Every participant took part in both a group and an individual session. Up to three participants could participate in the group session, in which spelling, reading comprehension and vocabulary were assessed. The individual session was divided in three parts. The order of the three parts varied between participants. In one part, the pseudoword cloze task was assessed, in a second part, the phonological awareness tasks were applied, and in a third part, all speed tests were conducted, i.e. the morphological fluency task, the reading fluency test and rapid naming. Testing took place in the laboratories of the University of Erfurt. Data was collected as part of three master's theses by graduate students (Kny, 2019; Moritz, 2019; Strauß, 2019). The master's theses were supervised by Prof. Claudia Steinbrink and the author of this work. Data were re-analysed for this dissertation.

7.2.2.5 Data analytic method

Data were analysed with *t*-tests for independent samples, and with correlation and regression analyses.

Difficulty indices of morphological awareness items were compared between adults and primary school children to analyse differences in morphological awareness competencies using *t*-tests for independent samples. Data from adult university students of the present and the previous study (section 7.1) were combined for this analysis (N_{Adults} = 169) and contrasted with data from fourth graders of the main study (N_{Grade_4} = 90; cf. section 4.3). The family-wise error rate for *t*-tests of independent samples was 19% for the morphological fluency task: FWER = 1 - (probability of type I error)$^{n\_of\_comparisons}$ = 1 - .95^4 = .19. Using the Bonferroni correction, the α-error level was adjusted to $P_{Crit} = \alpha / k = .05/4 = .0125$. The family-wise error rate for *t*-tests of independent samples was 82% for the pseudoword cloze task: FWER = 1 - .95^{33} = .82. The Bonferroni correction adjusted the α-error level to $P_{Crit} = .05/33 = .0015$.

Power analyses indicated that high differences between fourth graders and adults had an adequate testing power even at the Bonferroni corrected α-error level for both morphological awareness tasks (Table 41). Medium effect sizes had an adequate testing power with Bonferroni corrected α-error levels only for the morphological fluency task but not for the pseudoword cloze task. Testing power was too low for small effect sizes for both morphological awareness tasks.

Table 41

Estimated power for t-tests of independent samples for corrected and uncorrected α-error levels

	Testing power	
Effect sizes	Uncorrected	Bonferroni corrected
Morphological fluency task	α-error level: α = .05	α-error level:α = .0125
Small: *d* = .20	.33	.16
Medium: *d* = .50	.97	.91
High: *d* = .80	>.99	>.99
Pseudoword cloze task	α-error level: α = .05	α-error level: α = .0015
Small: *d* = .20	.33	.05
Medium: *d* = .50	.97	.73
High: *d* = .80	>.99	>.99

Note. N_{Adults} = 169. Study with adults 1: *n* = 96. Study with adults 2: *n* = 73.
N_{Grade_4}: 90 (sample from main study, cf. section4.3).

Correlations were computed to identify relationships between study variables. The family-wise error rate in correlation analyses was 94%: FWER = 1 - .95^{55} = .94. The Bonferroni correction adjusted the α-error level to $P_{Crit} = .05/55 = .0009$. Power analyses with the achieved sample size of *N* = 73 revealed that adequate testing power was only reached for high correlations but not for medium and small correlations at both the corrected and the uncorrected α-error levels (Table 42).

Regression analyses were executed for spelling, reading comprehension, word reading fluency and pseudoword reading fluency. The family-wise error rate for regression analyses was 81%: FWER = 1 - .95^{32} = .81. The Bonferroni-corrected α-error level was $P_{Crit} = .05/32 = .0016$.

Power analyses indicated adequate testing power only for large regression effect sizes for the uncorrected α-error level (Table 42).

Table 42

Estimated power for correlation and regression analyses for corrected and uncorrected α-error levels

	Testing power	
Relationships	Uncorrected	Bonferroni corrected
Correlation heights	α-error level: α = .05	α-error level:α = .0009
Small: *r* = .1	.14	.01
Medium: *r* = .3	.76	.30
High: *r* = .5	>.99	.95
Regression effect sizes	α-error level: α = .05	α-error level: α = .0016
Small: f^2 = .02	.10	<.01
Medium: f^2 = .15	.57	.16
Large: f^2 = .35	.95	.68

Note. *N* = 73. Two-tailed testing for correlations. Eight predictors in regression analyses.

Analyses were executed with the statistics software IBM SPSS Statistics 25 for Windows (IBM Corp., 2017).

7.2.3 Results

Descriptive statistics of study variables are displayed in Table 43.

Table 43

Descriptive statistics of Adult Study 2

Variable	Max	*M*	*SD*	Range
Age		22.0	2.6	18 - 29
Spelling (raw score; errors)	60	12.2	6.2	1 - 27
Reading comprehension (raw score)	94	42.2	10.9	9 - 72
Word reading fluency (raw score)	156	120.6	12.1	90 - 146
Pseudoword reading fluency (raw score)	156	74.8	14.1	33 - 111
Final school exam grade[1]		2.2	.06	1.0 - 3.3
Phonological awareness (relative frequencies)	1	.88	.14	.29 - 1
Rapid naming (raw score; seconds)		14.4	1.6	11.1 - 18.3
Vocabulary (raw score)	150	55.3	15.0	28.5 - 95.9
MA: Pseudoword cloze task (raw score)	67	59.4	3.6	49 - 67
MA: Morphological fluency (raw score)		45.8	11.9	22 - 80

Note. *N* = 73. MA: Morphological awareness.

[1]All participants held a Diploma from German secondary school qualifying for university admission. Participants were asked to specify their overall grade on this Diploma. Grades for passed Diplomas can range from 1.0 (very good) to 4.0 (sufficient). Grade 5.0 is assigned to Diplomas that were failed, which was not applicable in the present sample.

The combined data of both exploratory studies with adults was used for comparisons of items difficulties between adults and fourth graders from the main study. *T*-tests for independent samples revealed that adults received significantly more points on any of the morphological fluency items compared to fourth graders, even when applying Bonferroni corrections (Table 44).

Table 44

Item difficulty for the four morphological fluency items compared between adults and fourth graders of the main study

	Grade 4		Adults		Comparison			
Variable	*P* (*SD*)	Range	*P* (*SD*)	Range	*t*	*df*	*d*	*p*
Verb 1	8.9 (3.6)	0 - 20	13.8 (4.7)	2 - 27	-9.15	225.30	1.13	**<.01****
Verb 2	5.8 (3.0)	0 - 13	10.2 (4.4)	0 - 22	-9.53	242.30	1.11	**<.01****
Verb 3	4.9 (3.2)	0 - 14	8.5 (3.5)	0 - 20	-8.29	197.13	1.10	**<.01****
Verb 4	6.4 (3.8)	0 - 16	12.5 (4.3)	4 - 22	-11.91	-6.19	1.48	**<.01****

Note. N_{Adults} = 169 (Study with adults 1: *n* = 96. Study with adults 2: *n* = 73.).

N_{Grade_4}: 90 (Sample from main study, cf. section4.3).

***p* < .01, Boldface: Significant at the Bonferroni-corrected α-error level α < .0125.

T-tests for independent samples for the pseudoword cloze task indicated that performances on 26 of 33 items differed significantly between fourth graders and adults (Table 45). Significant differences were observed for *adjective derivations*, *diminutives*, *past participles*, *compounds* and two of four *nominalisations for a male person*. No item on female persons differed in difficulty between fourth graders and adults. Remarkably, fourth graders gained significantly more points than adults did on the second plural item that required the plural suffix -s (Plural on -s 2*)*. Using Bonferroni corrections, 14 comparisons remained significant. Differences between fourth graders and adults in *plurals*, *comparatives*, *superlatives* and *proceedings* could not be confirmed when using Bonferroni corrections.

Table 45

Comparison of item difficulties of the pseudoword cloze task between fourth grade and adults

	Grade 4		Adults		Comparison			
	P (*SD*)	Range	*P* (*SD*)	Range	*t*	*df*	*d*	*p*
Plural on -e 1^{I}	1.8 (0.5)	0 - 2	2.0 (0.1)	1 - 2	-3.1	93.31	0.66	<.01**
Plural on -s 1^{I}	1.3 (0.9)	0 - 2	1.4 (0.8)	0 - 2	-1.14	173.75	0.12	.25
Plural on -s 2^{I}	1.3 (0.7)	0 - 2	1.1 (0.6)	0 - 2	2.20	176.78	-0.31	.03*
Plural on -e 2^{I}	1.4 (0.9)	0 - 2	1.7 (0.6)	0 - 2	-3.24	137.53	0.42	<.01**
Plural on -e 3^{I}	1.4 (0.7)	0 - 2	1.7 (0.5)	0 - 2	-2.46	142.42	0.52	<.01**
Adjective 1^{D}	1.7 (0.7)	0 - 2	2.0 (0.2)	0 - 2	-3.31	101.44	0.68	**<.01****
Adjective 2^{D}	1.8 (0.6)	0 - 2	2.0 (0.1)	1 - 2	-3.43	90.58	0.55	**<.01****
Comparative 1^{I}	1.8 (0.5)	0 - 2	2.0 (0.2)	0 - 2	-2.39	104.22	0.60	.02*
Comparative 2^{I}	1.9 (0.5)	0 - 2	2.0 (0.2)	0 - 2	-2.09	103.76	0.30	.04*
Superlative 1^{I}	1.9 (0.5)	0 - 2	2.0 (0.2)	0 - 2	-2.22	101.34	0.30	.03*
Superlative 2^{I}	1.9 (0.4)	0 - 2	2.0 (0.2)	1 - 2	-1.88	105.48	0.35	.06
Male 1^{D}	1.6 (0.6)	0 - 2	1.7 (0.6)	0 - 2	-1.48	181.74	0.17	.14
Male 2^{D}	1.7 (0.6)	0 - 2	1.9 (0.3)	0 - 2	-3.60	121.55	0.47	**<.01****
Male $3^{D,NP}$	1.8 (0.5)	0 - 2	1.9 (0.3)	0 - 2	-1.58	125.04	0.26	.12
Male $4^{D,NP}$	1.8 (0.5)	0 - 2	2.0 (0.2)	0 - 2	-3.29	102.66	0.60	**<.01****
Female 1^{D}	1.8 (0.5)	0 - 2	1.7 (0.6)	0 - 2	0.47	202.59	-0.18	.64
Female 2^{D}	1.9 (0.4)	0 - 2	1.9 (0.3)	0 - 2	-1.75	138.61	0.00	.08
Female $3^{D,NP}$	2.0 (0.3)	0 - 2	2.0 (0.2)	0 - 2	-0.25	140.16	0.00	.80
Diminutive 1^{D}	0.6 (0.8)	0 - 2	1.0 (0.7)	0 - 2	-4.10	170.01	0.54	**<.01****
Diminutive 2^{D}	0.8 (0.9)	0 - 2	1.4 (0.8)	0 - 2	-5.67	160.59	0.72	**<.01****
Proceeding $1^{D,NP}$	1.3 (0.9)	0 - 2	1.6 (0.7)	0 - 2	-2.94	141.54	0.39	<.01**
Proceeding $2^{D,NP}$	1.7 (0.6)	0 - 2	1.8 (0.5)	0 - 2	-2.04	148.37	0.19	.04*
Past Participle $1^{D,NP}$	1.5 (0.7)	0 - 2	1.8 (0.4)	0 - 2	-3.92	128.11	0.57	**<.01****
Past Participle $2^{D,NP}$	1.1 (0.8)	0 - 2	1.4 (0.6)	0 - 2	-3.23	147.40	0.44	<.01**
Past Participle $3^{I,NP}$	1.5 (0.7)	0 - 2	1.9 (0.3)	0 - 2	-5.16	106.22	0.84	**<.01****
Compound 1^{C}	1.8 (0.6)	0 - 2	2.0 (0.0)	2 - 2	-2.95	89.00	0.57	<.01**
Compound 2^{C}	1.3 (0.9)	0 - 2	1.8 (0.6)	0 - 2	-4.60	130.38	0.70	**<.01****
Compound 3^{C}	1.9 (1.0)	0 - 3	2.7 (0.7)	0 - 2	-6.35	144.88	0.98	**<.01****
Compound 4^{C}	1.3 (0.9)	0 - 2	1.8 (0.6)	0 - 2	-4.37	124.61	0.70	**<.01****
Compound 5^{C}	1.5 (0.7)	0 - 2	1.8 (0.4)	0 - 2	-3.94	123.67	0.57	**<.01****
Compound 6^{C}	0.6 (0.8)	0 - 2	1.2 (0.8)	0 - 2	-5.69	184.70	0.75	**<.01****
Decomposition 1^{C}	1.6 (0.8)	0 - 2	1.8 (0.6)	0 - 2	-2.44	137.40	0.30	.02*
Decomposition2^{C}	1.7 (0.8)	0 - 2	2.0 (0.2)	0 - 2	-3.88	97.93	0.60	**<.01****

Note. N_{Adults} =169. Study with adults 1: *n* = 96. Study with adults 2: *n* = 73.

Grade 4: *n* = 90 (sample from main study, cf. section4.3).

*$p < .05$, **$p < .01$, Boldface: Significant at the Bonferroni-corrected α-error level $\alpha < .0015$.

Both morphological awareness tasks were correlated with spelling and with reading comprehension (Table 46). Morphological fluency was additionally correlated with pseudoword reading fluency. Vocabulary, phonological awareness and final school exam grade were additional correlates of spelling. Further, vocabulary and final school exam grade correlated with reading comprehension. Only few correlations were observed for basic reading skills. While rapid naming correlated with word reading fluency, morphological fluency correlated with pseudoword reading fluency. The correlation between the pseudoword cloze task and spelling remained significant even when applying Bonferroni corrections. All other correlations between cognitive or control variables and literacy variables did not reach significance at the Bonferroni-corrected α-error level.

Table 46

Correlations of study variables in Adult Study 2

	1	2	3	4	5	6	7	8	9	10
1 Spelling	-									
2 Reading comprehension	**-.41****	-								
3 Word reading fluency	-.22	.26*	-							
4 Pseudoword reading fluency	-.33**	.31**	**.72****	-						
5 Age	-.08	-.02	.01	-.06	-					
6 Final school exam grade	.37**	-.29*	.11	-.11	.18	-				
7 Phonological awareness	-.26*	-.02	-.00	-.04	.19	.08	-			
8 Rapid naming	.05	-.21†	-.30**	-.15	.19	.01	-.05	-		
9 Vocabulary	-.38**	.36**	.05	.11	.25*	-.06	.16	.12	-	
10 MA: Pseudoword cloze task	-.28*	.25*	.05	.01	-.06	.03	.18	-.17	.14	-
11 MA: Morph. fluency	**-.47****	.31**	.13	.26*	.12	-.25*	-.12	-.01	.07	.20†

Note. *N* = 73. MA: Morphological awareness. Two-tailed testing.
†$p < .1$ *$p < .05$ **$p < .01$. Boldface: Significant at the Bonferroni-corrected α-error level α < .00091.

Regression analyses revealed that morphological fluency, vocabulary, phonological awareness and the final school exam grade were unique predictors of spelling (Table 47). When using Bonferroni corrections, only morphological fluency remained a significant predictor of spelling. Reading comprehension was significantly explained by rapid naming and vocabulary. When applying Bonferroni corrections, only vocabulary remained a significant predictor.

Analogous to correlations, rapid naming was a predictor of word reading fluency, and morphological fluency was a predictor of pseudoword reading fluency. Both predictors were not significant at the Bonferroni corrected α-error level. Adjusted R^2*s* were significantly above zero for spelling and reading comprehension, but not for basal reading competencies.

Table 47

Regression analyses for literacy variables.

	Spelling	Reading comprehension	Word reading fluency	Pseudoword reading fluency
Variable	β	β	β	β
Age	.02	-.04	.00	-.10
Final school exam grade	.28**	-.21†	.16	-.01
Phonological awareness	-.26**	-.07	-.02	.00
Rapid naming	.05	-.22*	-.32**	-.16
Vocabulary	-.29**	**.36****	.10	.15
MA: Pseudoword cloze task	-.11	.13	-.05	-.10
MA: Morphological fluency	**-.39****	.20†	.17	.28*
Adjusted R^2	**.44****	**.26****	.04	.02

Note. N = 73. MA: Morphological awareness. Regression procedure: Enter.

†$p < .1$ *$p < .05$, **$p < .01$, Boldface: Significant at the Bonferroni-corrected α-error level α < .0016.

7.2.4 Discussion

7.2.4.1 How do morphological awareness skills in German adults differ from those in primary school children?

H1. Adult university students have higher morphological awareness skills than primary school children.

Performances on the morphological awareness items were compared between the participants of both adult studies and the fourth graders of the main study to analyse how morphological awareness skills in literacy competent adults differ from those of fourth graders. It was expected that adults outperform fourth graders because morphological awareness grows beyond primary school years (cf. section 6.4.). Not significant differences in performances on individual items could indicate either an ambiguous item or a very easy item on which fourth graders already performed very well, which can be inferred from item difficulty indices.

Comparisons of performances displayed that adults outperformed fourth graders on most morphological awareness items. Adults reached higher scores on all morphological fluency items than fourth graders even when applying Bonferroni corrections. In addition, adults were significantly better on 25 of 33 pseudoword cloze task items. When applying Bonferroni corrections, the performances on 14 items differed significantly between fourth graders and adults. These results signify that literacy competent adults clearly outperformed fourth graders in the morphological fluency task. In addition, the results indicate that literacy competent adults were better than fourth graders in most of the pseudoword cloze task items. Therefore, hypothesis 1 was accepted.

Results are in line with previous research that implied that morphological awareness continues to grow beyond primary school years in English (Nagy et al., 1993) and in German (Kargl et al., 2018).

A closer look was taken at the pseudoword cloze task items on which adults did not outperform fourth graders. Item difficulties were inspected to identify items that had already been easy for fourth graders, which would indicate that differences between performances of adults and schoolchildren could not be observed because of ceiling effects.

All three items on female persons ($1.8 \leq P \leq 2.0$) and the superlative item ($P = 1.9$) displayed low item difficulties for fourth graders indicating such ceiling effects. Of the two items on male persons, one displayed low item difficulty ($P = 1.8$). However, the other one was not that close to a ceiling effect ($P = 1.6$). The item with the higher item difficulty was the first item on a male person that was presented to the participants. The corresponding subscale *Ableitungsmorpheme* (Eng. derivational morphemes) from the HSET was adapted in a way that participants were only presented with the pseudoword items but not with the preceding real word items. Possibly the presentation of the real word items would have clarified the task because participants could have based their

responses on pseudoword items on the derivational suffixes that they used for the real word items. For future applications of the task, it should be considered to apply at least one of the real word items or to provide an exemplary item before presenting the pseudoword items.

Both items on *plurals on -s* were considered peculiar. Performances of fourth graders and adults did not differ significantly on the first item, although it did not exhibit particularly low item difficulty (P = 1.3). On the second item on *plurals on -s*, fourth graders reached on average even more points than adults did. In contrast, all items on *plurals on -e* displayed the expected significant differences between adults and children. A possible reason for this unexpected finding for s-plurals might be that both the exemplary item and the first test item, which preceded the two test items with plurals on -s, required a plural on -e. No exemplary item on a plural with -s was given. It could have been helpful to have a second exemplary item that required a plural marker on -s to prevent that participants adopt the strategy to use the same plural marker as in the exemplary item on all following items. However, the corresponding subscale *Plural-Singular-Bildungen* (Eng. plural-singular formations) was executed in line with the manual guidelines of the HSET, which does not provide an exemplary item for a plural on -s for children aged five or above. Besides, the decision to rate responses that used an -e(n)-plural for items that required an -s-plural as partly correct (i.e. with 1 out of 2 points) is in line with the rating guidelines of the HSET, too, and no adaptation due to the category system that was developed for this dissertation. Therefore, the items on plurals on -s might simply be more difficult than the other plural items for both schoolchildren and adults. The empirical finding that even high school students (Grades 9 to 12) exhibited incomplete knowledge on common derivational suffixes (Nagy et al., 1993) can be interpreted as an indication that even adults could have difficulties with some affixes. Accordingly, the finding of the present study that the highest item difficulty for adults was P = 1.0 for a diminutive item, underlines that even university students might be uncertain about some morphological rules.

To sum up, adults outperformed fourth graders on most morphological awareness items indicating that morphological awareness continues to grow beyond primary school years. Probably some of the applied items could be clarified if additional exemplary items were added in future studies. As some items of the pseudoword cloze task had medium difficulty indices even for adults it can be inferred that even university students are uncertain about some morphological rules.

7.2.4.2 Is morphological awareness related to literacy skills in German adults?

H2. There is a relationship between morphological awareness and literacy skills in German adults.

Both morphological awareness tasks were related to spelling and reading comprehension in this second exploratory study with adults. Morphological fluency was additionally related to pseudoword reading fluency. When applying Bonferroni corrections, the relationship between

morphological fluency and spelling remained significant, which underlines that these two variables are meaningfully related. With the exception of word reading fluency, hypothesis 2 was accepted.

The findings of the first study with adults (section 7.1) regarding the relationships of morphological awareness with spelling and pseudoword reading fluency could be confirmed with the present study. Yet in contrast to the first study, the correlation between morphological fluency and word reading fluency was not significant in the present study (r = .13). The correlation between these two variables was already small in the first study (r = .21*). The circumstance that the correlation was not found in the current study indicates that the relationship between morphological awareness and word reading fluency is questionable. Theory underscores that for reading familiar words aloud, morphological units do not necessarily play a role because the lexical route can activate whole-word representations in the mental lexicon that make processing morphological units superfluous (cf. Coltheart et al., 2001).

The findings of the current study extent those of the first adult study with respect to reading comprehension. A relationship between morphological awareness and reading comprehension was already found for English-speaking adults (To et al., 2016; Wilson-Fowler & Apel, 2015). The observations of the current study indicate that morphological awareness is related to reading comprehension in German adults, too. The pseudoword cloze task, in which affixes have to be applied to pseudowords, could be associated with reading comprehension through the fine-grained route in the dual route approach to word reading comprehension (cf. Grainger & Ziegler, 2011) because the fine-grained route capitalises among other things on morphological units such as affixes. The morphological fluency task could stand in relation to both routes because the activation of morphological units in the fine-grained route and the activation of morpho-semantic representations, i.e. word fields, in the coarse-grained route are both represented in the morphological fluency task (cf. section 4.3.3.1.).

The current study suggests that the relationship of morphological awareness with reading comprehension is stronger than that with basal reading skills in German adults. While both morphological awareness tasks were related to reading comprehension, only morphological fluency was related to pseudoword reading fluency and none of the morphological awareness tasks were related to word reading fluency. This finding is in line with that of To et al. (2016) who reported a medium correlation between morphological awareness and reading comprehension and only a small correlation between morphological awareness and basal reading skills for competent adult readers. In addition, this differential relationship had also been observed in the main study with schoolchildren (cf. section 4.3.3.1). Morphological awareness could be closer related to reading comprehension than to basal reading skills because morphemes are the smallest units of meaning

(cf. Elsen, 2014) and by this they are important for the extraction of meaning from writing, which is important for reading comprehension but not necessary for pronunciation.

H3. There is a stronger relationship of morphological awareness with spelling skills than with reading skills in German adults.

Correlation analyses revealed small to medium relationships between morphological awareness and spelling errors (-.28* $\leq r \leq$ -.47**) and non-significant to medium correlations between morphological awareness and reading variables (.01 $\leq r \leq$ .31**). The correlation between morphological fluency and spelling, but none of the other relationships, remained significant when applying Bonferroni corrections. In addition, evidence for morphological awareness being a unique predictor of literacy skills was stronger in the regression model for spelling than in those for reading skills. These observations imply a stronger relationship of morphological awareness with spelling than with reading skills in German adults. Therefore, hypothesis 3 was accepted.

Evidence of the first study with adults suggested that morphological awareness had a closer relationship with spelling than with reading fluency. Results of the current study confirm this finding and extent it to reading comprehension. Presumably, reading comprehension capitalizes on morphological information in more ways than basic reading skills (cf. section 6.1.3) which is also reflected in the stronger relationship of morphological awareness with reading comprehension than with basic reading skills. Moreover, reading comprehension, as a higher-level reading skill, is regarded as more demanding than basic reading skills (Hoover & Gough, 1990; Verhoeven & Perfetti, 2017). Nevertheless, morphological awareness seems to be closer related to spelling than to reading comprehension. This implies that the orthographic asymmetry of the German language induces a greater importance of morphological units for spelling than for reading. Yet previous findings of German studies with schoolchildren and the main study of this dissertation did not indicate a stronger relationship of morphological awareness with spelling than with reading in German (Fink et al., 2012; Volkmer et al., 2019). A reason might be that children master morphological spelling strategies later than alphabetic spelling strategies. In the main study it was found that primary schoolchildren had on average higher proficiency in alphabetic than in morphological spelling strategies in all three observed grade levels. In addition, Klassert et al. (2018) found that although German third graders applied morphological strategies this did not lead to less spelling errors but to a higher diversity in mistakes. Regarding the evidence of the main study and the adult studies together, the results indicate that primary school children and adults organise their reading and spelling strategies differently. Morphological strategies seem to play a more important role for literacy proficient adults than for beginning spellers. The observation is in line with models on literacy acquisition that propose alphabetic strategies are learned and used before orthographical and morphological strategies, and that orthographical and morphological strategies

are necessary for proficient reading and spelling (cf. sections 2.2.4.1 and 6.1.1). For this reason, the relevance of morphological awareness for spelling might continue to grow beyond primary school years.

7.2.4.3 Does morphological awareness uniquely predict literacy skills above and beyond other cognitive skills in German adults?

H4. Morphological awareness uniquely predicts literacy skills in German adults when accounting for other cognitive variables.

Morphological fluency was a unique predictor of spelling skills in German adults when accounting for final school exam grade, phonological awareness, rapid naming and vocabulary. Findings indicated that morphological fluency was also a predictor of pseudoword reading fluency; however, the model did not generalize to the population. In addition, morphological fluency showed a trend for significance as a predictor of reading comprehension. When applying Bonferroni corrections, morphological fluency remained a significant predictor of spelling and vocabulary remained a significant predictor of reading comprehension. None of the other predictors remained significant. That is, morphological awareness proved to be a reliable predictor of spelling, but not of reading competencies in German adults. Therefore, hypothesis 4 was partly accepted.

The results of the present study confirm and extent those of the first study with adults. Morphological awareness and final school exam grade uniquely predicted spelling in the first study with adults. The present study additionally identified phonological awareness and vocabulary as unique predictors of spelling abilities in German adults. Both morphological awareness and phonological awareness but not vocabulary had been found to be unique predictors of spelling in English adults (Law et al., 2015). That is, vocabulary might be more important for spelling in German than in English adults. The observations indicate that different cognitive variables, i.e. morphological awareness, phonological awareness and vocabulary, and academic achievement are relevant predictors of spelling in literacy competent adults.

It is interesting to note that in the current study, the pseudoword cloze task was no unique predictor of spelling abilities, although it was the stronger predictor of the two morphological awareness tasks in the first study with adults. This might be due to the different predictors entered in the regression analysis. Vocabulary was measured with a different test in the present study in order to prevent ceiling effects found in the first study. Additionally, phonological awareness was a new variable that had not been measured in the first study. These variables might have explained variance in spelling that had been accounted for by the pseudoword cloze task in the first study. Overall, the total amount of explained variance increased from 32% in the first study to 44% in the present study indicating that the variables in the current study could describe differences between spelling skills in literacy competent adults better than those in the first study with adults.

In the first adult study, it had been noted that morphological awareness predicted both reading fluency measures, but that the models did not generalize to the population. It was assumed that key predictors of word reading skills were missing in the analyses. Therefore, phonological awareness and rapid naming had been measured additionally in the present study. Indeed, rapid naming was identified to be a predictor of word reading fluency. However, phonological awareness did not explain any variance in basic reading skills in the present study. Morphological awareness remained a predictor of pseudoword reading fluency. As in the first study, both regression models did not generalize to the population because of high variability in the data and reduced degrees of freedom due to several non-significant predictors. The predictors could explain 14% of variance in word reading fluency (R^2 = .14) and 12% of variance in pseudoword reading fluency (R^2 = .12) in the present sample, but they explained no variance significantly above zero in the population. It could be fruitful to further explore the role of the variables rapid naming and morphological awareness for basal reading skills in German adults. For example, the facets rapid object naming or rapid number naming could have differential predictability for reading skills (cf. Arnell et al., 2009). Other variables, such as phonological awareness, age, academic achievement, fluid intelligence and vocabulary did not uniquely predict word reading fluency. Discarding these variables in future studies could help increasing testing power and reducing the observed problems with the generalizability of the statistical models.

Reading comprehension was uniquely predicted by rapid naming and vocabulary. Vocabulary was also identified as a unique predictor of reading comprehension in English studies with adults (Braze et al., 2007; Guo et al., 2011; Law et al., 2015). Moreover, morphological awareness was identified as a unique predictor of reading comprehension in several English studies (Guo et al., 2011; Law et al., 2015; Metsala et al., 2019). In the present study with German adults, morphological fluency displayed a tendency for significance as a unique predictor of reading comprehension. It is possible that the reduced testing power for small and medium regression coefficients prevented the identification of morphological fluency as a predictor of reading comprehension. The uncertainty on the role of morphological fluency for reading comprehension could be clarified in future studies using larger sample sizes.

In the present study, phonological awareness did not possess the key role it had in the main study with schoolchildren where it was the dominant predictor of literacy abilities in second, third and fourth grade. In contrast, several unique predictors of literacy skills could be identified for German adults, including morphological awareness. This signifies that in adults the relative importance of morphological awareness and other language-related variables compared to that of phonological awareness is higher than in beginning stages of literacy acquisition. This indicates that the relative importance of morphological awareness increases with increasing literacy proficiency.

7.2.4.4 Further observations

Phonological awareness

Phonological awareness was both a significant correlate and a unique predictor of spelling skills. No significant associations with reading skills could be observed, though. When applying Bonferroni corrections, none of the observed relationships remained significant.

Previous German studies reported small to medium correlations (.23* ≤ r ≤ .33*) between phonological awareness and spelling in adults (Multhauf et al., 2017). In line with this, the present study found a small correlation between phonological awareness and mistakes in a spelling test (r = -.26*). The present study extends the available empirical evidence with regard to the role of phonological awareness as a unique predictor of spelling abilities in German adults because phonological awareness uniquely predicted spelling when accounting for morphological awareness, vocabulary, rapid naming, final school exam grade and age. English studies were inconclusive with regard to the predictive power of phonological awareness for spelling because phonological awareness was identified as a unique predictor of spelling when accounting for vocabulary and morphological awareness (Law et al., 2015), but not when accounting for morphological knowledge, pseudoword reading and orthographic processing skills (Burt, 2006). The variables accounted for in the regression analysis of the present study extend those of Law et al., but differ somewhat from those of Burt. The range of variables controlled for in the present study signifies that phonological awareness is a relevant predictor of spelling in German adults. Additionally controlling for variables used by Burt could be a valuable direction for future research.

The present study could identify phonological awareness neither as a significant correlate (-.04 ≤ r ≤ -.00) nor as a unique predictor of basic reading skills in German adults. This result is in contrast to previous German evidence that found small, but significant correlations of phonological awareness with word reading fluency (r = .27**) and pseudoword reading fluency (r = .21*) in university students (Multhauf et al., 2017). The difference in the observed relationships is surprising because for phonological awareness and both reading fluency measures the exactly same tasks were applied. In addition, English studies identified phonological awareness as a unique predictor of word reading accuracy (Law et al., 2015; Metsala et al., 2019). The observation of the present study challenges the previous assumption that there is a meaningful relationship between phonological awareness and reading skills in German adults. Future studies could try clarifying the association between phonological awareness and literacy skills in German adults.

In the present study, no association between phonological awareness and reading comprehension was found in correlation (r = -.02) and in regression analysis (f^2 = -.07). To the best of the author's knowledge, this association has not been assessed in German adults before. Previous English studies were inconclusive with respect to the role of phonological awareness as a correlate

of reading comprehension because one study observed a significant correlation (Metsala et al., 2019) while another study could not identify a significant correlation (Law et al., 2015) between these variables. Yet neither study had identified phonological awareness as a unique predictor of reading comprehension in unimpaired adults (Law et al., 2015; Metsala et al., 2019). In line with English studies, the results of the current study imply that phonological awareness is not a relevant predictor of reading comprehension in adults.

When comparing the results of the present study with those of the main study on primary school children, phonological awareness was again a unique predictor of spelling skills in adults but not of reading abilities anymore. This might signify that the importance of alphabetic reading strategies is lower than in beginning readers which would be in line with developmental assumption on reading strategies (Frith, 1985, 1986). The observation that phonological awareness was more important for spelling than for reading is in line with assumptions proposed by Wimmer et al. (2000). This can be explained by the importance of phonological awareness for building up word-specific orthographic representations in the mental lexicon, which are necessary for orthographically correct spelling in inconsistent orthographies (Moll et al., 2014). The results of the current study suggest that this premise might still apply for literacy competent German adults.

To sum up, phonological awareness was identified as both a significant correlate and a unique predictor of spelling skills, but not of reading skills in German adults. The results indicate that phonological awareness remains an important cognitive skill for adult spelling, yet its role for reading in literacy competent adults seems to be lower than it was in beginning readers.

Rapid naming

In the present study, a medium correlation between rapid naming and word reading fluency (r = -.30**) was observed. Additionally, a tendency for significance was observed for the correlation between rapid naming and reading comprehension (r = -.21†). Correlations are negative because the time needed to name the presented objects was measured for rapid naming. The quicker the participants were at naming the presented objects, the better their rapid naming ability was. No significant correlations of rapid naming with spelling and pseudoword reading fluency were observed. In regression analyses, rapid naming was a predictor of reading comprehension and word reading fluency. However, the model for word reading fluency did not generalize to the population. Using Bonferroni corrections, none of the observed relationships remained significant. The results imply a medium association between rapid naming and word reading fluency in German adults. In addition, rapid naming seems to be a unique predictor of reading comprehension.

The present study extends the existing research on the relationships between rapid naming and literacy skills. Previously, medium associations had been found for rapid naming with reading comprehension (r = -.31*) and reading rate (r = -.41*) in English university students (Arnell et al.,

2009). Small to medium correlations between rapid naming and reading variables were found in the present study with German university students, too, albeit not for pseudoword reading fluency. In the present study, rapid naming was additionally identified as a unique predictor of reading comprehension. In contrast, rapid naming was not associated with spelling in the present study. This observation is in line with the assumption that in German rapid naming is more important for reading than for spelling (Wimmer et al., 2000). The association between rapid naming and the two reading variables could be explained with reading rate because it has been argued that rapid naming affects reading rate, i.e. the number of words that can be read with good comprehension in a given time (Lovett, 1987). The number of words read within a given time was relevant in both reading tests because both tests were speed tests. Future studies could control for reading rate when analysing the relationship between rapid naming and other reading variables to uncover the relationships between these skills further.

Vocabulary

The finding of a moderate association between vocabulary and spelling in the first study with adults could be confirmed with the present study. Likewise, the observation that vocabulary and basic reading skills were uncorrelated could be confirmed. This study adds that vocabulary and reading comprehension are moderately correlated. In contrast to the first study with adults, vocabulary was a unique predictor of spelling in the present study. In addition, vocabulary uniquely predicted reading comprehension even when applying Bonferroni corrections. None of the other associations was confirmed at the Bonferroni-corrected α-error level.

The observed associations are in line with previous literature on relationships of vocabulary with spelling (Burt & Butterworth, 1996; Holmes & Ng, 1993) and with reading comprehension (Braze et al., 2007).

The relationship of vocabulary with spelling and basic reading skills had already been addressed in the first pilot study. There it was discussed whether some associations might not have been detected due to a ceiling effect in the vocabulary test. In the present study, a different vocabulary test was used for which no indication of a ceiling effect could be detected (M = 55.3, SD = 15.0, Max = 150). This could be the reason why not only a correlation between vocabulary and spelling was found, but vocabulary was also a unique predictor of spelling skills in the present study. This underlines that vocabulary knowledge is relevant for spelling in German adults. The observed association is in line with previous literature on relationships of vocabulary with spelling (Burt & Butterworth, 1996; Holmes & Ng, 1993). Furthermore, results are in line with the binding agent theory of morphological knowledge that suggests that morphology aids spelling by integrating phonological and semantic information (Kirby & Bowers, 2017). The observation that phonological awareness, vocabulary and morphological awareness were identified as unique predictors of

spelling in the present study reflects the importance of the three constructs as proposed by Kirby and Bowers.

Findings on word reading fluency fit the binding agent theory less well but confirm results of the first study with adults. The model proposes that morphology integrates semantic and orthographic information for pronunciation. Despite orthographic processing not having been measured in the current study, neither morphological awareness nor vocabulary proved to be correlates or unique predictors of word reading fluency. Instead, rapid naming was identified to be significantly associated with word reading fluency. It is possible that this is due to the higher transparency of the German orthography compared to the English orthography in the reading direction (cf. section 1.4). In German, relatively accurate pronunciation can be achieved using alphabetic reading strategies (Landerl, 2017), which is reflected by the importance of the phonological processing variable rapid naming. In contrast, German is considered rather inconsistent in the spelling direction. Therefore, theoretical assumptions on spelling processes in the inconsistent English orthography might correspond better with findings on German than assumptions on reading processes.

The observed relationship between vocabulary and reading comprehension conforms with theoretical assumptions because understanding print requires the recognition of familiar words (cf. Kirby et al., 2008). Moreover, the dual route approach to word reading comprehension points to the relevance of vocabulary knowledge because it is postulated that the coarse-grained route optimises rapid access to semantics (cf. Grainger & Ziegler, 2011). The observation that vocabulary was the only significant predictor of reading comprehension at the Bonferroni-corrected α-error level underlines the relevance of semantic knowledge for reading comprehension in German adults. Yet, in the binding agent theory, vocabulary is not named as a key variable for reading comprehension because Kirby and Bowers (2017) postulate that the meaning of specific words is inferred from an integration of morphological, phonological and orthographic information. However, the observation that vocabulary was a unique predictor of reading comprehension is in line with a previous English study on adolescents and young adult readers aged 16 to 24 years (Braze et al., 2007). It has to be acknowledged that both the current study and the study by Braze et al. (2007) had not included a measure of orthographic skills. Vocabulary knowledge could be correlated with orthographic representations of the corresponding words in the mental lexicon in literacy competent adults. Therefore, it could be a valuable direction for future research to further explore the relative importance of vocabulary and orthographic processing skills for reading comprehension. Findings on phonological and morphological skills in the present study were in line with the theoretical assumption for reading comprehension of the binding agent theory. Rapid naming, representing a phonological processing skill, was a unique predictor of reading comprehension. Moreover,

morphological awareness was correlated with reading comprehension and had a tendency for significance in regression analysis, which indicates that this ability might be an additional unique predictor of reading comprehension in literacy competent German adults.

Like in the first study with adults, vocabulary correlated with age but not with the morphological awareness tasks. The correlation between vocabulary and age is in line with previous literature (Nippold, 2006). The finding that vocabulary and morphological fluency were uncorrelated in the present study eliminates ceiling effects as a possible explanation for the non-correlation found in the first study with adults (cf. section 7.1.5.3). Likewise, the pseudoword cloze task was uncorrelated with vocabulary skills, which is in line with the conceptualisation of this task that operates with pseudowords to measure morphological awareness independently from semantic knowledge (cf. Fink et al., 2012). It follows that the morphological awareness tasks and the vocabulary test measure different abilities.

To conclude, vocabulary is both a correlate and a unique predictor of spelling and of reading comprehension in German adults. An association between vocabulary and reading fluency could not be detected. This indicates that semantic knowledge is relevant for higher-level literacy skills but not for basic reading skills in literacy competent adults.

Academic achievement

In the first study with adults, academic achievement was both a significant correlate and a unique predictor of spelling. This observation was confirmed in the present study, which is in line with observations from the BCS that found a moderate correlation between the grade point average and spelling skills in British 16-year-olds (Borghans et al., 2016). In the present study, academic achievement additionally correlated with reading comprehension and with morphological fluency. In contrast to the first study with adults, academic achievement was not correlated with vocabulary in the present study. It showed a trend for significance in the regression analysis for reading comprehension. When applying Bonferroni corrections, no relationship remained significant.

In addition to findings of the first study, the current study presents evidence for a relationship between academic achievement and reading comprehension. The results indicate that individuals with better spelling and reading comprehension skills received better final school exam grades. This could either be due to general differences in performances on achievement-related tasks (cf. Susperreguy et al., 2018) or due to spelling and reading comprehension skills being relevant for examinations in school. Because of the correlational design of the present study, this question cannot be answered here.

It was noted that in the present study, academic achievement had small correlation with morphological fluency. This had not been observed in the first study with adults indicating that the meaningfulness of the relationship is questionable. The relationship might have occurred due to the

shared variance both variables have with spelling, i.e. because morphological awareness is associated with spelling and spelling is associated with academic achievement. A future study could aim for a moderator analysis to inspect the association between these variables further.

To conclude, academic achievement was not a better predictor of spelling skills and of reading fluency skills than morphological awareness was in German literacy-competent adults. The evidence with regard to reading comprehension was inconclusive because both variables showed a tendency for significance in the regression analysis. Longitudinal data and moderator analyses could help to unravel the relationships between morphological awareness, literacy skills and academic achievement further.

Age

In both exploratory studies on adults, age was correlated with vocabulary, but with no other study variable. The correlation with vocabulary was expected and is in line with previous literature (Nippold, 2006).

A finding of the main study was that age correlated negatively with other study variables. This was interpreted as an indicator of being untypically aged within the respective grade level, for example due to grade repetition. As such, age was not an indicator for development.

In the present study, a positive correlation with vocabulary was observed which was interpreted as an indicator of language development with respect to vocabulary. No other study variable correlated with age, which implies that observable language development is restricted to vocabulary in young, literacy-competent adults. This indicates that the interpretation of age differs between the main study and the exploratory studies with adults. While age was no indicator of development within the respective grades in the main study with schoolchildren, it indicated language development with respect to vocabulary growth in the sample of university students.

7.2.4.5 Limitations and directions for future research

Some limitations that applied for the first exploratory study with adults also apply for the present study. These are limitations with regard to inflated α- and β-error probabilities and the lack of causal interpretability (cf. section 7.1.5.4). Further limitations are addressed in the following.

A first point that needs to be addressed concerns the low reliability of the pseudoword cloze task of $\alpha = .47$, which indicated a low internal consistency. Low values of α usually occur because of a low number of items, because items are poorly interrelated and/or because the underlying construct is multidimensional (Tavakol & Dennick, 2011). As the number of items was not too low in the present study, one or both of the other two explanations must apply. Yet, previous findings for English implied that morphological awareness was an unidimensional construct in adults (Wilson-Fowler, 2011; Wilson-Fowler & Apel, 2015). It is possible that the pseudoword cloze task did not reliably measure morphological awareness in German adults because the tasks were

originally designed for children. Therefore, most items were relatively easy for adults: 16 out of 33 items had a difficulty of $P \geq 1.9$ (Theoretical range: $0.0 \leq P \leq 2.0$), which indicates that these items did not differentiate well between participants. The results imply that it would be beneficial to develop a pseudoword cloze task for German adults that measures morphological awareness with suitably difficult items and with adequate discriminatory power. Such a task could improve the informative value of studies with adults.

With regard to the comparisons between results of the adult studies and results of the primary school children from the main study, it has to be considered that in the main study the sample was much more representative because schoolchildren were not selected with regard to their academic capacity. In contrast, the adult studies were conducted with university students only which implies that participants were competent readers and spellers. Therefore, the observed differences are presumably attributable to differences in literacy competencies but results of the adult studies are not generalizable to the German adult population. Therefore, it cannot be concluded that relationships between morphological awareness and literacy competencies differ between primary school children and adults but presumably between primary school children and literacy competent adults.

A further point that needs consideration is that the applied vocabulary test was a test in which participants had to read the stimuli. When analysing the performances in the vocabulary test with regard to reading skills this could lead to an overestimation of the relationships because reading skills were needed in both the vocabulary test and the reading tests. In the first exploratory study with adults, no relationship between a vocabulary test that required reading and basal reading skills had been found, though. This indicates that the observed relationships in the present study might not be affected by the described confounding. An oral measure of vocabulary would help avoiding confounding of vocabulary knowledge with reading skills.

7.2.4.6 Conclusion

Two exploratory studies with adults were conducted to study the differences of morphological awareness skills between schoolchildren from the main study and literacy competent adults. In addition, it was an aim to gather first evidence on the relationship between morphological awareness and literacy skills in German adults.

The results of the present study revealed that literacy competent adults achieved higher levels of morphological awareness than primary school children did. The difference was evident in most morphological awareness items. Of the few exceptions, most were already relatively easy for fourth graders. The evidence suggests that morphological awareness continues to develop beyond primary school years.

Both studies with adults found that morphological awareness is an important correlate and a unique predictor of spelling skills in German university students. The first study with adults found academic achievement to be a further unique predictor of spelling skills in literacy competent German adults. The present study confirmed academic achievement as a unique predictor of spelling skills and additionally identified phonological awareness and vocabulary as further unique predictors of spelling skills in German adults.

In both adult studies, the evidence on a relation of morphological awareness with reading was weaker than the evidence with regard to morphological awareness and spelling, which is in line with theoretical assumptions regarding the asymmetric consistency of the German orthography. In the current study, vocabulary and rapid naming were unique predictors of reading comprehension while morphological awareness and academic achievement were identified as potential further predictors of reading comprehension due to the trend for significance they had in the regression analysis. Further, rapid naming was a predictor of word reading fluency and morphological awareness was a predictor of pseudoword reading fluency, albeit the regression models did not generalize to the population. The results indicate that phonological, semantic and morphological skills are important for reading skills in literacy competent adults.

This study presented evidence that phonological awareness is not the dominant predictor of literacy skills in literacy competent adults, which is a difference to the main study with primary school children where phonological awareness was the key predictor of literacy skills in second to fourth grade. The results imply that the relative importance of phonological awareness decreased and the relative importance of morphological awareness increased in comparison with the main study on primary school children. This is indicative of a higher relevance of orthographic and morphological reading and spelling strategies in literacy competent adults in comparison with primary school children.

To conclude, first evidence was gathered on the importance of morphological awareness for literacy skills in literacy competent German adults. Albeit much work is still to be done, both studies provided important findings on questions regarding differences between morphological awareness skills in primary school children and adults, the relationship of morphological awareness with literacy skills in adults, and further important predictors of literacy skills in German adults.

8 General Discussion

8.1 Overall results and findings

8.1.1 The relationship between morphological awareness and literacy skills in German

Morphological awareness proved to be an important correlate of literacy skills both in primary school children and in literacy competent adults. Morphological awareness had a stronger association with spelling than with reading in adults, which can be explained by the asymmetric consistency of the German orthography (cf. section 2.4). However, no such pattern was found in primary school children. A reason for this could be that beginning spellers master alphabetic spelling strategies earlier than morphological spelling strategies (cf. sections 2.2.3 and 4.3.3.1).

Both in primary school children and in adults, a stronger relationship of morphological awareness with reading comprehension than with reading fluency was observed. This might be because morphemes are the smallest units of meaning in a language (Elsen, 2014), and the extraction of meaning is essential for reading comprehension, but not mandatory for more basic reading skills such as reading words out (cf. Coltheart et al., 1993; Coltheart et al., 2001; Coltheart, 2006). Moreover, dual route approaches to reading explicate morphological processes in both routes to reading comprehension, but only in one route to reading words aloud (cf. section 2.2.4.3). Especially in the rather transparent German language, basic reading skills can be achieved with relatively high accuracy by using alphabetic reading strategies (Landerl, 2017). Nevertheless, the usage of orthographic and morphological units speeds up reading processes (cf. section 2.2.4), which would be an explanation why correlations between morphological awareness and reading fluency were observed in both primary school children and adults.

Remarkably, a difference in the association between the two morphological awareness tasks and literacy variables was observed between primary school children and adults. Literacy variables were stronger associated with the pseudoword cloze task than with the morphological fluency task in primary school children. The opposite was observed in adults. This might indicate that a speeded access to one's morphological awareness facilitates reading and spelling more in proficient readers and spellers than in beginning ones. On the other hand, the pseudoword cloze task might provide a finer measurement of the mastery of different morphological rules in second and third grade, while responses to the morphological fluency task were lower in number. This observation also demonstrates that both morphological awareness tasks complemented each other in the measurement of morphological awareness skills in participants of very different literacy proficiency levels.

8.1.2 Morphological awareness as a unique predictor of literacy skills

Morphological awareness was a unique predictor of spelling abilities in adults but not in primary school children when accounting for other language-related variables and control variables. There was some evidence for morphological awareness to be a predictor of reading skills both in primary school children and in adults, but either morphological awareness exhibited only a trend for significance or the regression models did not generalize to the population. Therefore, the predictive power of morphological awareness could be asserted with certainty neither in primary school children nor in adults. The observation that phonological awareness was the key predictor of literacy skills in primary school children might indicate that alphabetic reading and spelling strategies are relatively important until fourth grade in German. The finding that morphological awareness was no significant unique predictor of literacy skills in primary school children, but predicted spelling significantly in both adult studies indicates that morphological awareness continues to unfold its relevance beyond primary school years.

In both adult studies, there was stronger evidence for a correlational relationship of morphological awareness with spelling than with reading skills. Moreover, it was observed that morphological awareness was a reliable predictor of spelling but not of reading in adults. The higher inconsistency of the German orthography in the spelling direction than in the reading direction (cf. section 1.4) makes morphemes crucial for spelling because morphemes can disambiguate inconsistencies in phoneme-grapheme correspondence rules (cf. Desrochers et al., 2018). However, a greater importance of morphological awareness for spelling than for reading was not observed in primary school children. A reason could be that children were unsure on how to apply their knowledge of morphemes in spelling situations, which hampered their ability to capitalize on morphological information for spelling (cf. section 4.3.3.2).

8.1.3 Changes of the role of morphological awareness with increasing literacy competency

Across primary school years, there was scarce evidence for a change in the role of morphological awareness for literacy competencies. A tendency of morphological fluency to explain unique variance in reading variables was detected in fourth grade, but not in second and third grade. This result has to be interpreted with caution because of the accumulation of α-error probabilities. However, this observation might be indicative of morphological awareness continuing to gain significance in higher grade levels.

The absolute heights of the correlations of morphological awareness with literacy skills were comparable between primary school children ($.07 \leq r \leq .48$**) and adults ($.01 \leq r \leq |-.47|$**). This is in line with previous empirical evidence that found almost no differences in the height of the correlations between morphological awareness and spelling across fourth to seventh grade (Kargl

et al., 2018; Kargl & Landerl, 2018). Yet, the relative importance of the pseudoword cloze task and the morphological fluency task seemed to change, which was discussed in section 8.1.1.

In the main study with children, phonological awareness was the key predictor of all literacy variables, which is an observation that was not replicated with university students. Results of regression analyses in the exploratory studies with adults indicated that morphological awareness was a unique predictor of spelling skills when accounting for other language-related variables. In addition, a tendency to explain unique variance in reading comprehension was observed. The results indicate that morphological awareness could unfold its relevance as a predictor of spelling skills in literacy competent adults due to the decrease in the predictive power of phonological awareness. This implies that the relative importance of morphological awareness compared to that of phonological awareness increases with increasing literacy competency. In line with models on reading and writing, the results could be indicative of a higher relevance of morphological reading and spelling strategies in literacy competent adults than in primary school children (cf. Frith, 1985, 1986; Varnhagen, 1995).

8.2 Final conclusion

For this dissertation, a study with 351 primary school children and two exploratory adult studies comprising 187 university students were conducted. Findings provided evidence on the role of morphological awareness for literacy skills at different literacy proficiency levels. In all three observed grades and in adults, morphological awareness was associated with both reading and spelling skills. Morphological awareness was no unique predictor of literacy skills in primary school children, yet it uniquely predicted spelling in literacy competent adults. Moreover, phonological awareness was the key predictor of literacy skills in primary school children, whereas in university students it was a unique predictor only of spelling skills but not of reading skills. The evidence is indicative of a change of the relative importance of different language-related cognitive variables with increasing literacy proficiency. It can be assumed that sometime in secondary school, phonological awareness decreases in importance, while the relative importance of morphological awareness and vocabulary increases. Future research could aim to clarify at which point or in which period in secondary school this change occurs.

All things considered, evidence was found that morphological awareness is an important cognitive variable that stands in relation to literacy skills in German schoolchildren and adults. Findings of this work point to multiple directions for future research that could help to clarify the importance of morphological awareness at different literacy proficiency levels and for different literacy skills in German.

9 Appendix

A. Questionnaire on demographic data from Pilot Study 1

Demografische Daten

Nationalität	O deutsch O andere: _____
Muttersprache	O deutsch O andere: _____
Alter	
Geschlecht	O männlich O weiblich
Höchster Bildungsabschluss	O kein Schulabschluss O Hauptschulabschluss O Real-/ Regelschulabschluss (mittlere Reife) O Abitur/ Fachabitur O abgeschlossene Berufsausbildung O Hochschul-/ Fachhochschulabschluss O Promotion O einen anderen Abschluss, und zwar: _____
Haupt-/ Nebenstudienrichtung	
Fachsemester	

Haben Sie eine Einschränkung in der Sehfähigkeit?		
O Ja	O Nein	O Weiß nicht
Benötigen Sie eine Sehhilfe (Brille/ Kontaktlinsen)?		
O Ja, weil: _____		O Nein
Wenn ja, haben Sie diese während der Studie genutzt?		
O Ja		O Nein

Haben Sie Einschränkungen in der Hörfähigkeit?		
O Ja	O Nein	O Weiß nicht
Benötigen Sie ein Hörgerät?		
O Ja, weil: _____		O Nein
Wenn ja, haben Sie dieses während der Studie genutzt?		
O Ja		O Nein

Wie ist ihre Händigkeit ausgeprägt?		
O linkshändig	O rechtshändig	O beidhändig

Wurde bei Ihnen eine Lese-Rechtschreibstörung diagnostiziert?		
O Ja	O Nein	O Weiß nicht
Wenn ja, in welchem Alter?		
_____		
Von wem?		
_____		

Konnten Sie in den ersten beiden Schuljahren aufgrund von ernsthafteren Krankheiten oder Krankenhausaufenthalten längere Zeit nicht zur Schule gehen?	
O Ja	O Nein
Wenn ja, wie lange ca.?	
	Monate

Wie viele Bücher gibt es in Ihrem Elternhaushalt? Bitte schätzen Sie!					
O 0 bis 10 Bücher	O 11 bis 25 Bücher	O 26 bis 100 Bücher	O 101 bis 200 Bücher	O 201 bis 500 Bücher	O mehr als 500 Bücher

Vielen Dank für Ihre Mitarbeit!

Die Untersuchung ist nun beendet. Bitte melden Sie sich bei der Versuchsleitung.

B. Questionnaire for parents from Pilot Study 2

Elternkurzfragebogen

Bitte beantworten Sie uns kurz folgende Fragen:

Ich bin…

☐ Mutter ☐ Vater ☐ anderer Erziehungsberechtigter

… des teilnehmenden Kindes.

Welche Sprache sprechen Sie hauptsächlich zu Hause?

- ☐ Deutsch
- ☐ Andere: _____

(Falls Sie mehrere Sprachen gleichberechtigt zu Hause sprechen, nennen Sie bitte alle.)

Wie viele Bücher gibt es in Ihrem Haushalt? Bitte schätzen Sie:

☐ 0 bis 10 Bücher	☐ 11 bis 25 Bücher	☐ 26 bis 100 Bücher	☐ 101 bis 200 Bücher	☐ 201 bis 500 Bücher	☐ mehr als 500 Bücher

Bitte nennen Sie Ihren höchsten Bildungsabschluss:

☐ kein Schulabschluss	☐ Hauptschulabschluss	☐ Real-/ Regelschulabschluss (mittlere Reife)	☐ Abitur / Fachabitur
☐ abgeschlossene Berufsausbildung	☐ Hochschul-/ Fachhochschulabschluss	☐ Promotion	☐ anderer Abschluss: _____

Bitte schätzen Sie die (Vor)-Lesezeit ein:

	täglich	mehrmals pro Woche	einmal pro Woche	ab und zu	selten	nie
Mein Kind liest zuhause selbst. (Bücher, Zeitschriften)	☐	☐	☐	☐	☐	☐
Ich lese meinem Kind vor.	☐	☐	☐	☐	☐	☐
Mein Partner/meine Partnerin liest unserem Kind vor.	☐	☐	☐	☐	☐	☐

Vielen Dank!

Damit wir Ihre persönlichen Daten schützen können, geben Sie bitte diesen Fragebogen im verschlossenen Briefumschlag bei den HorterzieherInnen ab!

C. Questionnaire for parents from Main Study

Elternkurzfragebogen

Bitte beantworten Sie uns kurz folgende Fragen:

Ich bin… ☐ Mutter ☐ Vater ☐ anderer Erziehungsberechtigter:

_____

… des teilnehmenden Kindes.

Mein Kind wurde am

_____ . _____ . 20_____ geboren.

Bitte kreuzen Sie das Geschlecht Ihres Kindes an:

☐ Mädchen ☐ Junge

Wächst Ihr Kind mehrsprachig auf? (Hierzu zählt nicht der Sprachunterricht in der Schule.)

☐ Nein	☐ Ja, mit folgenden Sprachen (außer Deutsch): _____ Unsere Familiensprache, das heißt die Sprache, die wir zu Hause überwiegend sprechen, ist: _____

Wie viele Bücher gibt es in Ihrem Haushalt? Bitte schätzen Sie:

☐ 0 bis 10 Bücher	☐ 11 bis 25 Bücher	☐ 26 bis 100 Bücher	☐ 101 bis 200 Bücher	☐ 201 bis 500 Bücher	☐ mehr als 500 Bücher

Bitte kreuzen Sie Ihren höchsten Schulabschluss an:

☐ kein Schulabschluss	☐ Hauptschulabschluss	☐ Real-/ Regelschulabschluss (mittlere Reife)	☐ Abitur / Fachabitur	☐ anderer Abschluss: _____

Bitte kreuzen Sie Ihren höchsten Ausbildungsabschluss an:

☐ keine abgeschlossene Ausbildung	☐ abgeschlossene Berufsausbildung	☐ Hochschul-/ Fachhochschul-abschluss	☐ Promotion	☐ anderer Abschluss: _____

Bitte schätzen Sie die (Vor)-Lesezeit ein:

	täglich	mehrmals pro Woche	einmal pro Woche	ab und zu	selten	nie
Mein Kind liest zuhause selbst (Bücher, Zeitschriften).	☐	☐	☐	☐	☐	☐
Ich lese meinem Kind vor.	☐	☐	☐	☐	☐	☐
Mein Partner/meine Partnerin liest unserem Kind vor.	☐	☐	☐	☐	☐	☐

Vielen Dank!

Damit wir Ihre persönlichen Daten schützen können, geben Sie bitte diesen Fragebogen im verschlossenen Briefumschlag bei der Klassenlehrkraft Ihres Kindes ab!

D. Category system for the morphological awareness tasks

D1. Morphological fluency

2 points (all criteria fulfilled)	1 point (all criteria fulfilled)	0 points (at least one criterion fulfilled)
The response is a word formation. The word can be part of a group of words.	It is a word formation.	It is no word formation, but, for example, an inflection or a group of words with the inflected test word or with to-infinitive.
And: This word formation is in line with the grammatical rules of the German language. • Checked with the Duden-Grammatik	And: This word formation is in line with the grammatical rules of the German language. • Checked with the Duden-Grammatik	This word formation is not in line with the grammatical rules of the German language. • Checked with the Duden-Grammatik
And: This word formation is etymologically related to the test word. • In case of doubt checked with the DWDS-Etymologie	And: This word formation is etymologically related to the test word. • In case of doubt checked with the DWDS-Etymologie	This word formation is etymologically not related to the test word. • In case of doubt checked with the DWDS-Etymologie
And: This word formation exists in general language usage: Checked with • Das Wortauskunftssystem zur deutschen Sprache in Geschichte und Gegenwart: dwds.de • Leipzig Corpora Collection: Wortschatz Universität Leipzig: http://corpora.informatik.uni-leipzig.de/de?corpusId=deu_newscrawl_2011 The word formation is listed in both one of the two corpora.	But: This word formation does not exist in general language usage: Checked with • Das Wortauskunftssystem zur deutschen Sprache in Geschichte und Gegenwart.: dwds.de • Leipzig Corpora Collection: Wortschatz Universität Leipzig: http://corpora.informatik.uni-leipzig.de/de?corpusId=deu_newscrawl_2011 This word formation is listed in neither of the two corpora.	The word formation has been given before.
= maximum of points, even if several word formations were included in one word		It is an inflection of a word formation that has been given before.
		It is a simple repetition of the test word.

D2. Pseudoword cloze task

2.1 Inflections

2.1.1 Change a noun from singular to plural (5 items)

2.1.1.1 Overall rules for plurals

2 Points	1 Point	0 Points
Used the plural suffix that is **most frequently used with the grammatical gender and the phonological properties of the noun** (the criteria for each test item can be looked up in table 2.1.1.2)	Used the plural suffix that is **most frequently used with the grammatical gender and the phonological properties of the noun** (the criteria for each test item can be looked up in table 2.1.1.2)	Used an **incorrect** affix according to the grammatical rules of the German language
And: Did not change the stem of the word except for a possible umlaut in some cases (which are described in table 2.1.1.2). This decision is based on how the test words were repeated by the child.	**But:** A sound was changed in the test word other than a possible umlaut in some cases (which are described in table 2.1.1.2). This decision is based on how the test words were repeated by the child.	**Or**
	Or	Simply repeated the test word
	Used a plural affix that according to the grammatical gender and the phonological properties of the noun is **possible but not the most frequently used**	**Or**
	And: Did not change the stem of the word	Another word than the given one was used
	Or	**Or**
	Did not change the stem of the word	More than one deviation from the 2-point answer
	But: Used the correct plural affix that is most frequently used with the grammatical gender and the phonological properties of the noun but **stressed it in an unusual way**.	

2.1.1.2 Specific criteria for each item

Test item	Gender	Phonological properties	Animacy	Most frequent suffix	Less frequent but still possible suffixes
Plural 1	Masculine or neuter	Nothing that would affect the choice of the plural suffix	Not animate	• Masculine and neuter nouns generally have an **–e plural**	• **-s plural** acts as a makeshift plural for elements that are not or only weakly integrated into the inner lexicon, yet, and that do not end on -s • Masculine and neutral nouns can have the **–(e)n plural** • Masculine and neutral nouns can have the **–er plural** (if possible with umlaut)
Plural 2	Masculine or neuter	final sound of a noun is a vowel that can be stressed	Not animate	• Nouns that end on a vowel that can be stressed generally have a **–s** plural.	• Masculine and neuter nouns generally have an **–e plural** • Masculine and neutral nouns can have the **–(e)n plural** • Masculine and neutral nouns can have the **–er plural** (if possible with umlaut)
Plural 3	Masculine or neuter	final sound of a noun is a vowel that can be stressed	Animate	• Nouns that end on a vowel that can be stressed generally have a **–s** plural.	• Masculine and neuter nouns generally have an **–e plural** • Masculine and neutral nouns can have the **–(e)n** plural • Masculine and neutral nouns can have the **–er plural** (if possible with umlaut)
Plural 4	Masculine or neuter	Word ending on an s-sound	Animate	• Masculine and neuter nouns generally have an **–e plural** • There is a tendency for animate masculine nouns without special phonological properties to have an **umlaut**.	• Masculine and neutral nouns can have the **–(e)n plural** • Masculine and neutral nouns can have the **–er plural** (if possible with umlaut)
Plural 5	Masculine or neuter	Nothing that would affect the choice of the plural suffix	Animate	• Masculine and neuter nouns generally have an **–e plural** • There is a tendency for animate masculine nouns without special phonological properties to have an **umlaut**.	• **s plural** acts as a makeshift plural for elements that are not or only weakly integrated into the inner lexicon, yet, and that do not end on -s • Masculine and neutral nouns can have the **–(e)n plural** • Masculine and neutral nouns can have the **–er plural** (if possible with umlaut)

2.1.2 Change a noun from plural to singular (4 Items)

2.1.2.1 Overall rules for singulars

2 Points	1 Point	0 Points
Correctly omitted the plural suffix	Correctly omitted the plural suffix	Simply repeated the test word
And: Did not change the stem of the word (except for a possible elimination of the umlaut in animate nouns without special phonological properties). This decision is based on how the test words were repeated by the child.	**But:** A sound was changed in the test word. The stem of the word still had to be recognisable. It has to be evident that the *plural suffix was dropped and not just anything at the end of the word*. This decision is based on how the test words were repeated by the child.	**Or**
		Added an affix
		Or
		Another word than the given one was used
		Or
		More than one deviation from the 2-point answer

2.1.2.2 Specific criteria for each item

Test item	Gender	Phonological properties	Animacy	Suffix that should be omitted
Singular 1	female	Nothing that would affect the choice of the plural suffix	Animate	• Female nouns haven an **–(e)n plural**
Singular 2	Masculine or neuter	Nothing that would affect the choice of the plural suffix	Animate	• Masculine and neuter nouns generally have an **–e plural** • There is a tendency for animate masculine nouns without special phonological properties to have an **umlaut**.
Singular 3	Masculine or neuter	Nothing that would affect the choice of the plural suffix	Animate	• Masculine and neutral nouns can have the **–(e)n plural**
Singular 4	Masculine or neuter	final sound of a noun is a vowel that can be stressed	Animate	• Nouns that end on a vowel that can be stressed generally have a **–s** plural.

2.1.3 Inflections of the adjectives: comparatives (2 Items) and superlatives (2 Items)

2.1.3.1 Comparatives

2 Points	1 Point	0 Points
Used the correct suffix **–er** with a correct adjective (see table "Create an Adjective")	Used the correct suffix **–er** with a correct adjective (see table "Create an adjective")	Did not use a the correct suffix –er or adverb describing "more of something"
And: Made no changes in the stem of the word. This decision is based on how the test words were repeated by the child.	**But:** A sound was changed in the test word. This decision is based on how the test words were repeated by the child.	**Or**
	Or	Simply repeated the test word
	Made no changes in the stem of the word. This decision is based on how the test words were repeated by the child.	**Or**
	But: Doubled the correct suffix **–er: –erer**	Another word than the given one was used
	Or	**Or**
	Made no changes in the stem of the word. This decision is based on how the test words were repeated by the child.	More than one deviation from the 2-point answer
	But: used adverbs describing "more of something" with a correct adjective (see table "Create an adjective") Examples for possible adverbs: • **Sehr …** • **Mehr …** • **Ganz viel …**	
	Or	
	Made no changes in the stem of the word. This decision is based on how the test words were repeated by the child.	

	But: Stressed a correct affix that is listed in the 2-points-column in an unusual way.	

2.1.3.2 Superlativs

2 Points	1 Point	0 Points
Used the correct suffix with a correct adjective (see table "Create an Adjective") • **–sten** • **Or: –esten** if the adjective ended on -t	Used the correct suffix with a correct adjective (see table "Create an Adjective") • **–sten** • **Or: –esten** if the adjective ended on –t	Did not use a the correct suffix or an adverb describing "most of something"
And: Made no changes in the stem of the word. This decision is based on how the test words were repeated by the child.	**But:** A sound was changed in the test word. This decision is based on how the test words were repeated by the child.	**Or**
	Or	Simply repeated the test word
	Made no changes in the stem of the word. This decision is based on how the test words were repeated by the child.	**Or**
	But: Adding one sound to the superlative suffix like using • **–esten** for an adjective not ending on –t or using • **–ersten** • **–stlen** Or doubling a correct suffix , e.g.: • **–stensten** All of the **following sounds** still have to be part of the suffix: "**s**", "**t**", "**e**" and "**n**" and the suffix has to **end on** "**en**".	Another word than the given one was used
	Or	**Or**
	Made no changes in the stem of the word. This decision is based on how the test words were repeated by the child.	More than one deviation from the 2-point answer

	But: Used adverbs describing ”most of something” with a correct adjective (see table “Create an adjective”) Examples for possible adverbs: • **meisten** • **ganz**	
	Or	
	Made no changes in the stem of the word. This decision is based on how the test words were repeated by the child.	
	But: Stressed a correct affix that is listed in the 2-points-column in an unusual way.	

2.1.4 Change a verb in its infinitive form to past participle (1 item)

2 Points	1 Point	0 Points
Used one of the correct affixes: • **ge– … –(e)t** • **ge– … –en**	Used one of the correct affixes: • **ge– … –(e)t** • **ge– … –en**	Did not use a the correct affixes
And: All three criteria were met: • Made no changes in the stem of the word • Made no changes in the prefix of the word • Did not omit the prefix of the word This decision is based on how the test words were repeated by the child.	**But:** One of the following criteria was met: • A sound was changed in the test word. • Exchanged the prefix of the test word. • Omitted the prefix of the test word. This decision is based on how the test words were repeated by the child.	**Or**
	Or	Simply repeated the test word
	All three criteria were met: • Made no changes to the stem of the word • Made no changes to the prefix of the word • Did not omit the prefix of the word This decision is based on how the test words were repeated by the child.	**Or**
	But: Adding one sound to the suffix like using • **–(e)lt**	Another word than the given one was used

240

	• –(e)rt • Doubled the suffix (e.g. –(e)tet) The suffix still has to **end on –t or –n** respectively.	
	Or	Or
	Made no changes in the stem of the word. This decision is based on how the test words were repeated by the child.	More than one deviation from the 2-point answer
	But: Stressed a correct affix that is listed in the 2-points-column in an unusual way.	

2.2 Word formation

2.2.1 Create a diminutive (2 items)

2 Points	1 Point	0 Points
Used a correct and frequent diminutive suffix for a neuter noun: **Suffixes:** **–chen** • But: nouns ending on –ng don't have the –chen diminutive **–lein** • Possible for both test words **Or:** **Compounds:** all words describing something small and form a compound with the test word, e.g. **Mini-, Zwerg-, Klein-, Baby-, Kind-, Mikro-, -zwerg** **Or** **A combination of one of the above suffixes and one compound.**	Used a correct and frequent diminutive suffix for a neuter noun: **Suffixes:** **–chen** • But: nouns ending on –ng don't have the -chen diminutive **–lein** • Possible for both test words **Or:** **Compounds:** all words describing something small and form a compound with the test word, e.g. **Mini-, Zwerg-, Klein-, Baby-, Kind-, Mikro-, -zwerg** **Or** **A combination of one of the above suffixes and one compound**	Did not use a correct diminutive affix or compound
And: Made no changes in the stem of the word except using a possible umlaut. This decision is based on how the test words were repeated by the child.	**But:** A sound was changed in the test word. This decision is based on how the test words were repeated by the child.	**Or**
	Or	Simply repeated the test word
	Made no changes in the stem of the word. This decision is based on how the test words were repeated by the child.	**Or**
	But: Used one of the following suffixes: • **–el** (very infrequent, bound to certain lexemes) • **–le** (very infrequent, bound to certain lexemes) • **–ke** (very infrequent, bound to certain lexemes) • **–i** (because mostly used for people);	Another word than the given one was used

	• **–li** (used in Switzerland but not in Standard German) • **–chen** for a word ending on **-ng** • **–elchen** (expansion of –chen) • **–erchen** (expansion of -chen) • **Doubled the suffix: e.g. –chenchen, –leinchen (But: –ng cannot be directly followed by –chen!)**	
	Or	**Or**
	Made no changes in the stem of the word. This decision is based on how the test words were repeated by the child.	More than one deviation from the 2-point answer
	But: Stressed a correct affix or compound that is listed in the 2-points-column in an unusual way.	

2.2.2 Create an adjective (2 items)

2 Points	1 Point	0 Points
Used a correct adjective suffix or compound (specifying that the noun has or owns sth.): **Suffixes:** **–haft** • for words ending on –e also: -enhaft **–ig** • if a word ends on –e, this –e is eliminated • if a word ends on –el, -e *might* be eliminated **–(er)isch** • if a word ends on –el, -e *might* be eliminated **–lich** • if a word ends on –e, this –e is eliminated)	Used a correct adjective suffix or compound (specifying that the noun has or owns sth.): **Suffixes:** **–haft** • for words ending on –e also: -enhaft **–ig** • if a word ends on –e, this –e is eliminated • if a word ends on –el, -e *might* be eliminated **–(er)isch** • if a word ends on –el, -e *might* be eliminated **–lich** • if a word ends on –e, this –e is eliminated)	Did not use a correct adjective suffix or compound

• Not possible for nouns ending on –el! **be–…–t** • if a word ends on –e, this –e might be eliminated **ge–…–t** • if a word ends on –e, this –e might be eliminated **ver–…–t** • if a word ends on –e, this –e might be eliminated **Or:** **Compounds:** all words describing that the noun contains something, e.g. **–haltig, –reich, –voll** • **Test word ending on –e: –+n+noun** • **Otherwise: –+noun**	• Not possible for nouns ending on –el! **be–…–t** • if a word ends on –e, this –e might be eliminated **ge–…–t** • if a word ends on –e, this –e might be eliminated **ver–…–t** • if a word ends on –e, this –e might be eliminated **Or:** **Compounds:** all words describing that the noun contains something, e.g. **–haltig, –reich, –voll** • **Test word ending on –e: –+n+noun** • **Otherwise: –+noun**	
And: Made no changes in the stem of the word. This decision is based on how the test words were repeated by the child.	**But:** A sound was changed in the test word. This decision is based on how the test words were repeated by the child.	**Or**
	Or	Simply repeated the test word
	Made no changes in the stem of the word. This decision is based on how the test words were repeated by the child.	**Or**
	But	Another word than the given one was used
	Suffix: -ig • if a word ends on –e: **did not eliminate –e** **Compounds:** • Test word ending on –e: **–+noun: did not add –n–**	**Or**
	Or	More than one deviation from the 2-point answer
	Made no changes in the stem of the word. This decision is based on how the test words were repeated by the child.	

	But: Stressed a correct affix or compound that is listed in the 2-points-column in an unusual way.	

2.2.3 Create a noun

2.2.3.1 Noun describing a male person (base: verb) – (4 items)

2 Points	1 Point	0 Points
Used a correct suffix for a noun describing a male person (agent) that has its base in a verb: • –er, • –ler, • –ling • –bold • –i Or Used a compound with: –mann	Used a correct **suffix** for a noun describing a male person (agent) that has its base in a verb: • –er, • –ler, • –ling • –bold • –i Or Used a compound with: –mann	Did not use a correct suffix or compound
And: Made no changes in the stem of the word. This decision is based on how the test words were repeated by the child.	**But:** A sound was changed in the test word. This decision is based on how the test words were repeated by the child.	Or
	Or	Simply repeated the test word
	Made no changes in the stem of the word. This decision is based on how the test words were repeated by the child.	Or
	But: Used a correct suffix for a noun describing a male person (agent) that *does not have its base in a verb*: • –ner • – • –chen • –o	Another word than the given one was used
	Or	Or
	Made no changes in the stem of the word. This decision is based on how the test words were repeated by the child.	More than one deviation from the 2-point answer

245

	But	
	Used two correct suffixes or both suffix and compound with or without a possible –s– between Suffix and compound: • **Two suffixes e.g.: –erer or –erling etc.** • **Suffix and compound e.g.: –er(s)mann or–ler(s)mann etc.**	
	Or	
	Made no changes in the stem of the word. This decision is based on how the test words were repeated by the child.	
	But: Stressed a correct affix or compound that is listed in the 2-points-column in an unusual way.	

2.2.3.2 Noun describing a female person (3 items)

2 Points	1 Point	0 Points
Used a correct suffix for a noun describing a female person. (**–in**). The suffix is added to a noun describing a male person and ending on: • **–er + –in** • **–ler + –in** • **–ling + –in** • **–bold + –in** **Or** Used a compound describing a female person: e.g. • **–frau** • **–dame** **Or** Used a compound describing a person is the wife of someone if the item allows this interpretation (“Das ist die Frau vom…”):	Used a correct suffix for a noun describing a female person. (**–in**). The suffix is added to a noun describing a male person and ending on: • **–er + –in** • **–ler + –in** • **–ling + –in** • **–bold + –in** **Or** Used a compound describing a female person: e.g. • **–frau** • **–dame** **Or** Used a compound describing a person is the wife of someone if the item allows this interpretation (“Das ist die Frau vom…”):	Did not use a correct suffix or compound

• –er(s)frau	• –er(s)frau	
And: Made no changes in the stem of the word. This decision is based on how the test words were repeated by the child.	**But:** A sound was changed in the test word. This decision is based on how the test words were repeated by the child.	Or
	Or	Simply repeated the test word
	Made no changes in the stem of the word. This decision is based on how the test words were repeated by the child.	Or
	But: Used –er(s)frau if the item **did not** suggest the female person could be the wife of someone	Another word than the given one was used
	Or	Or
	Made no changes in the stem of the word. This decision is based on how the test words were repeated by the child.	More than one deviation from the 2-point answer

	But: Used one of the following suffixes that are possible but are infrequent or archaic:
	• –inne
	• –ine
	• –ice
	• –ess
	• –esse
	• –isse
	• –euse
	• Doubled the suffix –in: –inin
	• Used both suffix and compound:
	  ○ –infrau
	  ○ –indame	

	Or	
	Made no changes in the stem of the word. This decision is based on how the test words were repeated by the child.	

247

	But: Stressed a correct affix or compound that is listed in the 2-points-column in an unusual way.	

2.2.3.3 Noun describing a proceeding or a condition (base: verb or noun) – (2 items)

2 Points	1 Point	0 Points
Used a **correct affix** for a **female noun** describing a **proceeding or condition** (base: **verb or noun**) which is still productive in present-day German: • **–e** • **–erei** (But pejorative: not for positive wording in the test item: "Das war eine tolle…") • **–ung** • **–enschaft** • **Ge–…–t+schaft** • **Ge–…–en+schaft** Or **Used a compound describing a proceeding or condition in a female noun. The defining word of the compound can be** - The stem of the pseudoword or - The noun correctly describing a male person. (An "s" between the two compounds is allowed) **Possible compounds: e.g.** • **–arbeit** • **–möglichkeit** • **–zeit**	Used a **correct affix** for a **female noun** describing a **proceeding or condition** (base: **verb or noun**) which is still productive in present-day German: • **–e** • **–erei** (But pejorative: not for positive wording in the test item: "Das war eine tolle…") • **–ung** • **–schaft** • **Ge–…–t+schaft** • **Ge–…–en+schaft** Or **Used a compound describing a proceeding or condition in a female noun. The defining word of the compound can be** - The stem of the pseudoword or - The noun correctly describing a male person. (An "s" between the two compounds is allowed) **Possible compounds: e.g.** • **–arbeit** • **–möglichkeit** • **–zeit**	Did not use a correct affix or compound.
And: Made no changes in the stem of the word. This decision is based on how the test words were repeated by the child.	**But:** A sound was changed in the test word. This decision is based on how the test words were repeated by the child.	Or
	Or	Simply repeated the test word

248

	Made no changes in the stem of the word. This decision is based on how the test words were repeated by the child.	
	But: Used a correct suffix for a noun describing a proceeding or condition but not fitting the characteristics of the test item: • **–heit** (base not a verb) • **–keit** (base not a verb) • **–igkeit** (base not a verb) • **–ei** (not fitting the phonological properties) • **–elei** (not fitting the phonological properties) • **Ge–…–e** (neutral gender) • **–s** (masculine gender) • **–er** (masculine gender) • **–** (masculine gender) • **–erei** (pejorative) after positive wording in the test item: "Das war eine tolle…" • **Doubled a correct suffix (e.g. –ungung or –ungerei)**	**Or**
	Or	Another word than the given one was used
	Made no changes in the stem of the word. This decision is based on how the test words were repeated by the child.	**Or**
	But: Stressed a correct affix or compound that is listed in the 2-points-column in an unusual way.	More than one deviation from the 2-point answer

2.2.3.4 Noun describing a place (2 items)

2 Points	1 Point	0 Points
Used a correct suffix for a female noun describing a place (base: verb or noun): • **–erei**	Used a correct suffix for a female noun describing a place (base: verb or noun): • **–erei**	Did not use a correct suffix or compound

• –e Or Used a compound describing a place in conjunction with the stem of the word or the corresponding noun correctly describing a male person. The gender of the resulting noun has to be female: e.g. • –werkstatt • –stube • –küche (An "s" between the two compounds is allowed)	• –e Or Used a compound describing a place in conjunction with the stem of the word or the corresponding noun correctly describing a male person. The gender of the resulting noun has to be female: e.g. • –werkstatt • –stube • –küche (An "s" between the two compounds is allowed)	
And: Made no changes in the stem of the word. This decision is based on how the test words were repeated by the child.	But: A sound was changed in the test word. This decision is based on how the test words were repeated by the child.	Or
	Or	Simply repeated the test word
	Made no changes to the stem of the word. This decision is based on how the test words were repeated by the child.	
	But: Used a compound describing a place in conjunction with the stem of the word or the corresponding noun describing a male person. The gender of the resulting noun was not of female gender: e.g. • –laden • –haus	Or
	Or	Another word than the given one was used
	Made no changes to the stem of the word. This decision is based on how the test words were repeated by the child.	Or
	But: Used the suffix • –ei (instead of –erei)	More than one deviation from the 2-point answer
	Or	

	Made no changes to the stem of the word. This decision is based on how the test words were repeated by the child.	
	But: Stressed a correct affix or compound that is listed in the 2-points-column in an unusual way.	

2.2.4 Create a verb in past participle from a noun (2 items)

2 Points	1 Point	0 Points
Used one of the correct affixes: • **ge– … –(e)t** • **ge– … –en**	Used one of the correct affixes • **ge– … –(e)t** • **ge– … –en**	Did not use a the correct affixes
And: Both criteria were met: • **Made no changes to the stem of the word** • **Added no other prefix to the word besides ge-.** This decision is based on how the test words were repeated by the child.	**But:** One of the following criteria was met: • A sound was changed in the test word. • Added another prefix to the word besides ge-. Example: ○ **vor–** ○ **mit–** This decision is based on how the test words were repeated by the child.	**Or**
	Or	Simply repeated the test word
	Both criteria were met: • Made no changes to the stem of the word • Added no other prefix to the word besides ge- This decision is based on how the test words were repeated by the child.	**Or**
	But: Adding one sound to the suffix like using • **–(e)lt** • **–(e)rt** • **Doubled the suffix (e.g. –(e)tet)** The suffix still has to **end on –t or –n** respectively.	Another word than the given one was used
	Or	**Or**

251

	Did not change the stem of the word. This decision is based on how the test words were repeated by the child.	More than one deviation from the 2-point answer
	But: Stressed a correct affix that is listed in the 2-points-column in an unusual way.	

252

2.3 Compounds

2.3.1 Forming a compound (6 items)

2 Points	1 Point	0 Points
The two test words were connected in the right order	The two test words were connected in the right order	Compounds were connected in the false order
And: The suffix of the defining word was omitted. (an "e" between the two compounds is allowed)	**And:** No other adaptions were made in the test words. This decision is based on how the test words were repeated by the child.	**Or**
And: No other adaptions were made in the test words. This decision is based on how the test words were repeated by the child.	**But:** One of the two: • The suffix of the defining word was not omitted • The suffix of the defining word was slightly changed. For example to **-er**	No compound was formed
	Or	**Or**
	The two test words were connected in the right order	Other words than the given ones were used
	And: The suffix of the defining word was omitted (an "e" between the two compounds is allowed)	**Or**
	But: A sound was changed in one of the test words. This decision is based on how the test words were repeated by the child.	More than one deviation from the 2-point answer
Special case: if a test word requires a vowel change when turned into a compound: 1 extra point was awarded for the correct vowel change	**Special case: if a test word requires a vowel change when turned into a compound: 1 extra point** was awarded for the correct vowel change	

2.3.2 Deconstructing a compound into its parts (2 items)

2 Points	1 Point	0 Points
A deconstruction of the compound using a **grammatically correct sentence** that showed **which of the both words defined the other one**	A deconstruction of the compound using a **grammatically correct sentence** that showed **which of the both words defined the other one**	A deconstruction was made, but the word that defined the other one was incorrectly assigned.
And: If a verb is part of the compound, adding an infinitive ending to the defining verb.	**And:** If a verb is part of the compound, adding an infinitive ending to the defining verb.	**Or**
And: No other adaptions were made in the test words. This decision is based on how the test words were repeated by the child.	**But:** A sound was changed in one of the test words. This decision is based on how the test words were repeated by the child.	No deconstruction was made.
	Or	**Or**
	A deconstruction of the compound using a **sentence that is grammatically flawed** but still unambiguously shows **which of the both words defined the other one.**	The participant used other words than the given ones.
	And: If a verb is part of the compound, adding an infinitive ending to the defining verb.	**Or**
	And: No other adaptions were made in the test words. This decision is based on how the test words were repeated by the child.	More than one deviation from the 2-point answer

E. Inter-Rater reliabilities for the morphological awareness items in the main study

Table 48

Inter-Rater reliability for the rating of the answers on the morphological items based on the category system

				Frequencies					
				0 points		1 point		2 points	
Item	ρ[a]	*W*[b]	*N*[c]	Rater 1[d]	Rater 2[e]	Rater 1	Rater 2	Rater 1	Rater 2
Inflections									
Plural 1	.98	.317	13	8	8	4	3	1	2
Plural 2	.93	.317	45	37	36	7	8	1	1
Plural 3	.93	.317	24	15	16	7	6	2	2
Plural 4	.94	.317	28	18	19	8	7	2	2
Plural 5	.85	1	23	15	15	6	6	2	2
Singular 1	.81	.564	32	23	22	7	8	2	2
Singular 2	1.0	1.0	16	13	13	1	1	2	2
Singular 3	1.0	1.0	14	11	11	2	2	1	1
Singular 4	1.0	1.0	15	12	12	2	2	1	1
Comparative 1	.98	.317	37	16	15	11	12	10	10
Comparative 2	.95	.564	49	28	28	9	10	10	11
Superlative 1	.95	.317	31	14	14	12	11	5	6
Superlative 2	.98	.157	36	19	19	13	11	1	6
Past Participle 1	.94	.157	61	43	41	12	14	6	6
Derivations									
Diminutive 1[f]	1.0	1.0	74	58	58	9	9	7	6
Diminutive 2	.97	.317	67	46	45	12	13	9	9
Adjective 1	.90	.083	50	34	37	9	6	7	7
Adjective 2	.90	.180	40	28	30	3	2	9	8
Male 1	.90	.317	34	21	20	11	11	2	3
Male 2	.95	.317	24	9	10	11	10	4	4
Male 3	.95	.317	24	11	10	10	11	3	3
Male 4	.92	.317	24	16	15	7	8	1	1
Female 1	.97	.317	43	24	23	14	15	5	5
Female 2	.96	.317	31	16	17	9	8	6	6

				Frequencies					
				0 points		1 point		2 points	
Item	ρ[a]	*W*[b]	*N*[c]	Rater 1[d]	Rater 2[e]	Rater 1	Rater 2	Rater 1	Rater 2
Female 3	1.0	1.0	15	12	12	2	2	1	1
Proceeding 1	.92	.655	62	46	46	8	9	8	7
Proceeding 2	.94	1.0	58	40	40	9	9	9	9
Place 1	1.0	1.0	63	30	30	18	18	15	15
Place 2	.96	1.0	62	33	33	12	12	17	17
Past Participle 1	.94	.157	56	38	36	14	16	4	4
Past Participle 2	.93	.157	75	59	57	13	15	3	3
Compounds									
Compound 1	1.0	1.0	23	20	20	2	2	1	1
Compound 2	1.0	1.0	19	15	15	2	2	1	1
Compound 3	1.0	1.0	25	19	19	3	3	2	2[g]
Compound 4	1.0	1.0	63	55	55	5	5	3	3
Compound 5	1.0	1.0	37	33	33	2	2	2	2
Compound 6	1.0	1.0	123	111	111	12	12	5	5
Decomposition 1	.91	.564	74	37	42	11	3	26	29
Decomposition 2	.82	.417	57	36	41	10	3	11	13
Morphological Fluency									
Verb 1	.91	.003**	294	81	81	54	36	159	177
Verb 2	.85	.002**	333	103	113	116	69	114	151
Verb 3	.83	.037*	349	234	231	49	38	66	80
Verb 4	.92	.008**	458	219	224	101	68	138	166

Note. For further details on the exact specifications of the category system, see Appendix D.
[a] Spearman's rho [b] Wilcoxon [c] Number of different responses
[d] Rater 1: Author of this dissertation [e] Rater 2: trained student assistant
[f] One item not rated by Rater 2 (missing)
[g] For this item a maximum of three points could be awarded. Both, rater 1 and rater 2 awarded 3 points for exactly one solution.

F. Scatterplots of standardised predicted outcome values and standardised residuals for regression analyses from the main study

Figure 6

Scatterplot of standardised predicted outcomes and standardised residuals for correctly spelled graphemes in second grade

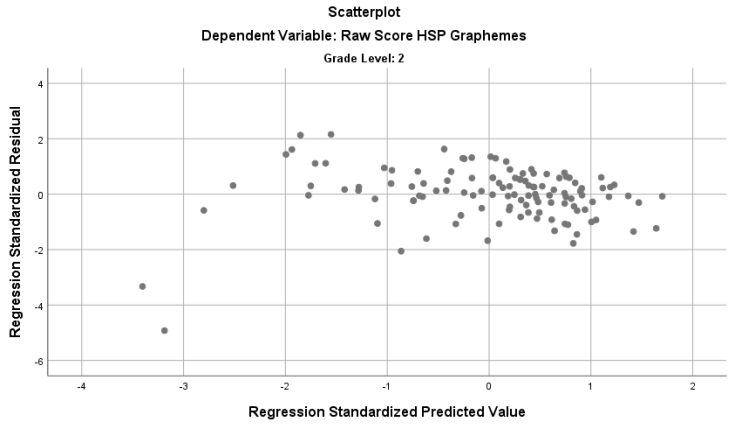


Figure 7

Scatterplot of standardised predicted outcomes and standardised residuals for correctly spelled graphemes in third grade

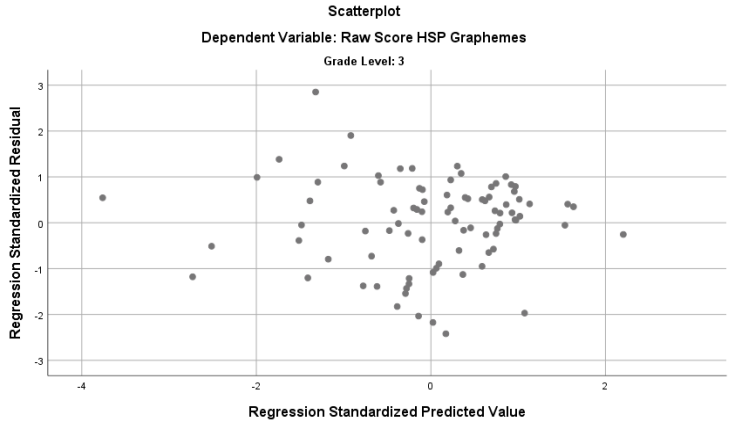


Figure 8

Scatterplot of standardised predicted outcomes and standardised residuals for correctly spelled graphemes in fourth grade

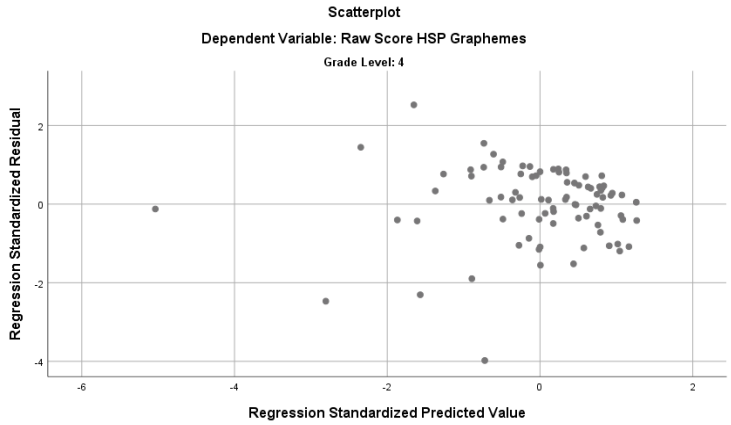


Figure 9

Scatterplot of standardised predicted outcomes and standardised residuals for alphabetic spelling strategy in second grade

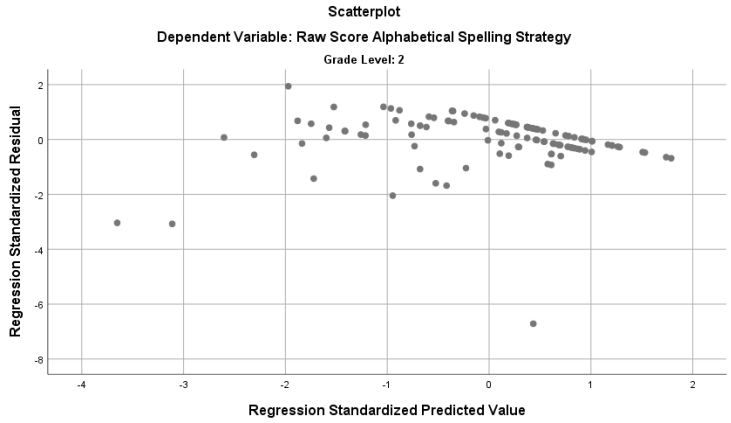


Figure 10

Scatterplot of standardised predicted outcomes and standardised residuals for alphabetic spelling strategy in third grade

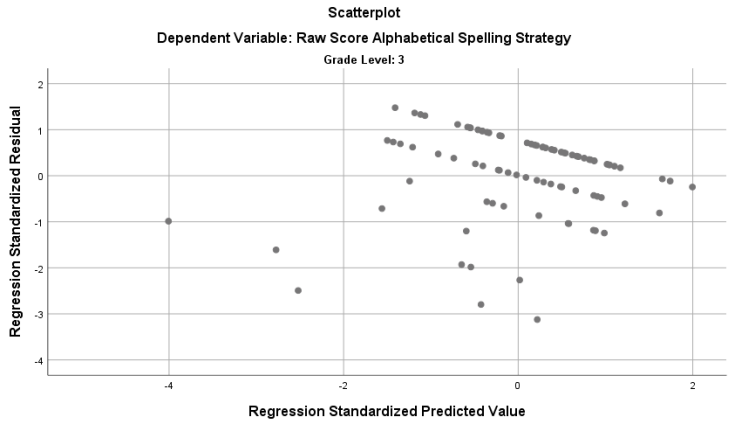


Figure 11

Scatterplot of standardised predicted outcomes and standardised residuals for alphabetic spelling strategy in fourth grade

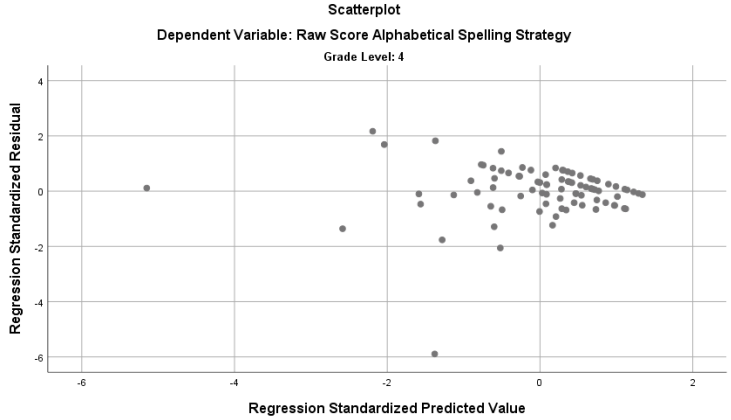


Figure 12

Scatterplot of standardised predicted outcomes and standardised residuals for orthographic spelling strategy in second grade

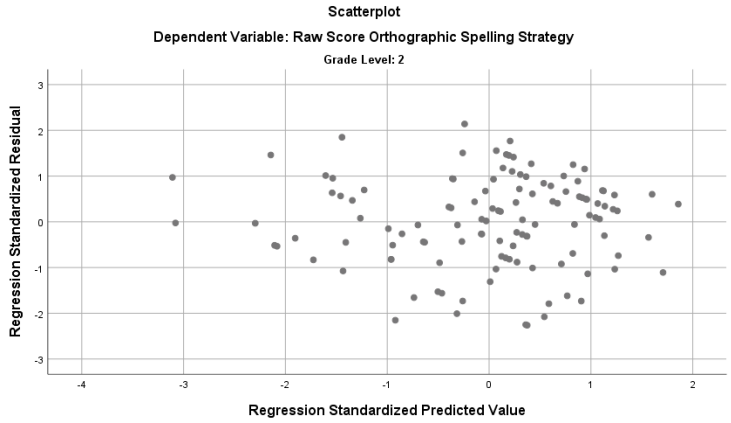


Figure 13

Scatterplot of standardised predicted outcomes and standardised residuals for orthographic spelling strategy in third grade

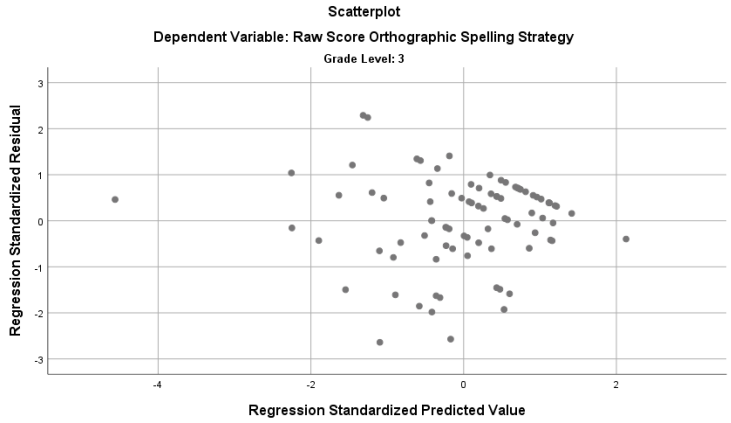


Figure 14

Scatterplot of standardised predicted outcomes and standardised residuals for orthographic spelling strategy in fourth grade

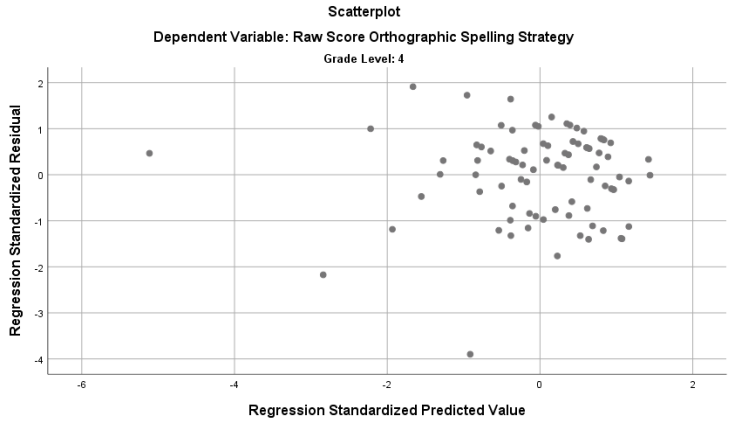


Figure 15

Scatterplot of standardised predicted outcomes and standardised residuals for morphematic spelling strategy in second grade

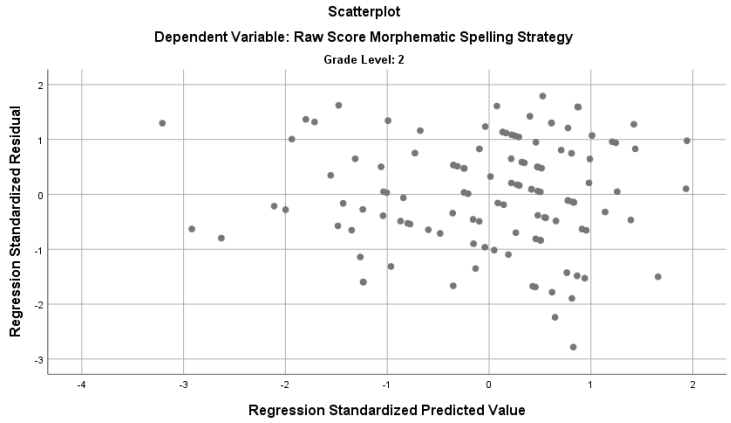


Figure 16

Scatterplot of standardised predicted outcomes and standardised residuals for morphematic spelling strategy in third grade

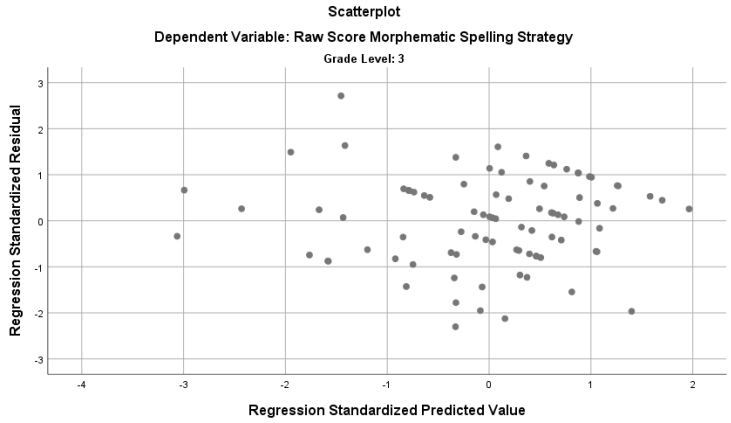


Figure 17

Scatterplot of standardised predicted outcomes and standardised residuals for morphematic spelling strategy in fourth grade

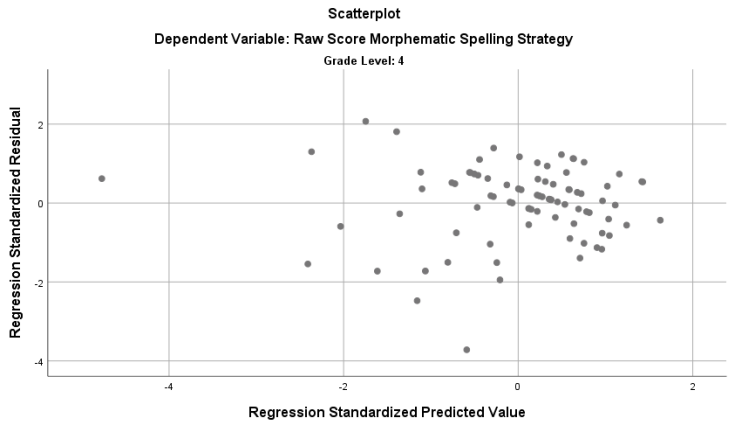


Figure 18

Scatterplot of standardised predicted outcomes and standardised residuals for reading comprehension in second grade

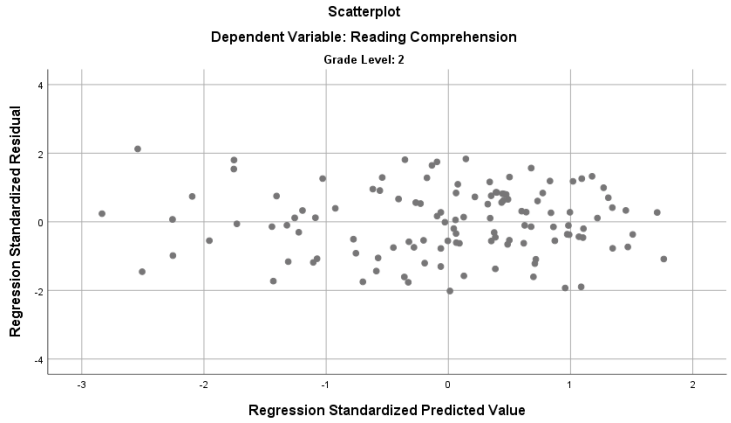


Figure 19

Scatterplot of standardised predicted outcomes and standardised residuals for reading comprehension in third grade

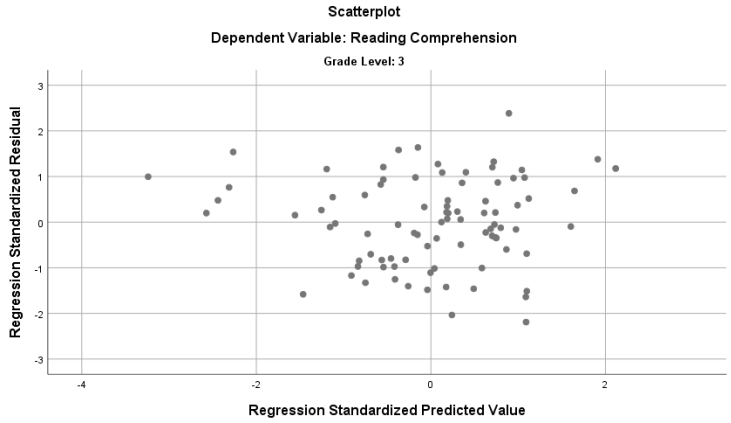


Figure 20

Scatterplot of standardised predicted outcomes and standardised residuals for reading comprehension in fourth grade

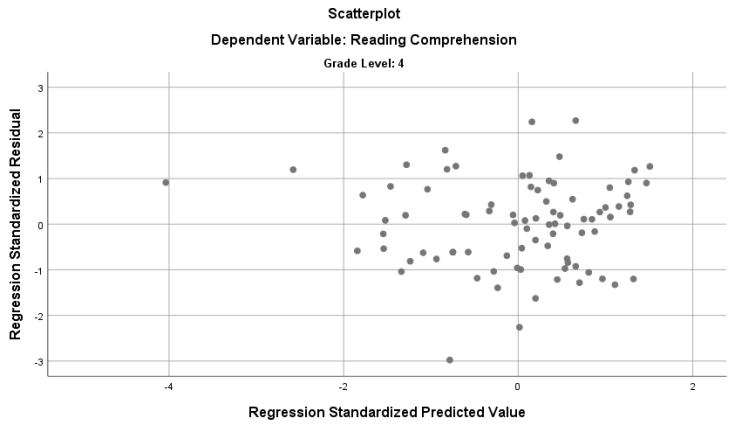


Figure 21

Scatterplot of standardised predicted outcomes and standardised residuals for word reading fluency in second grade

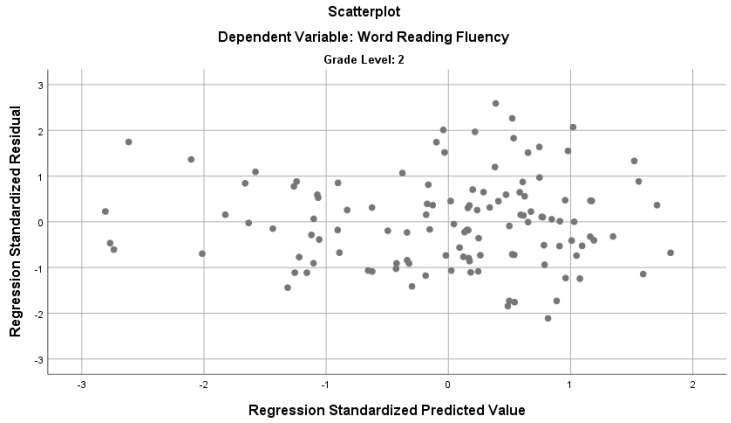


Figure 22

Scatterplot of standardised predicted outcomes and standardised residuals for word reading fluency in third grade

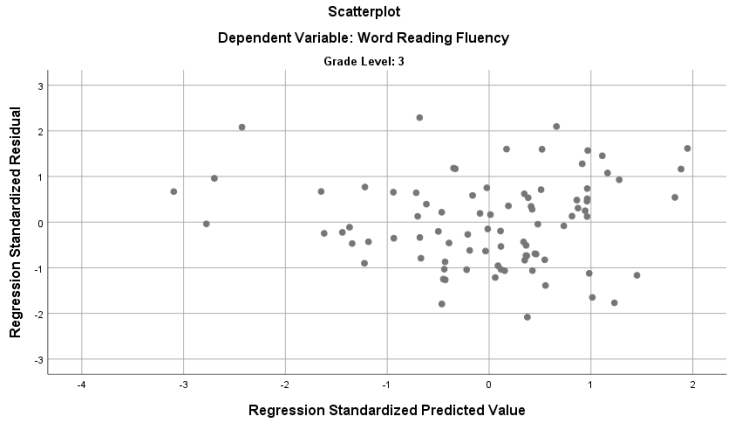


Figure 23

Scatterplot of standardised predicted outcomes and standardised residuals for word reading fluency in fourth grade

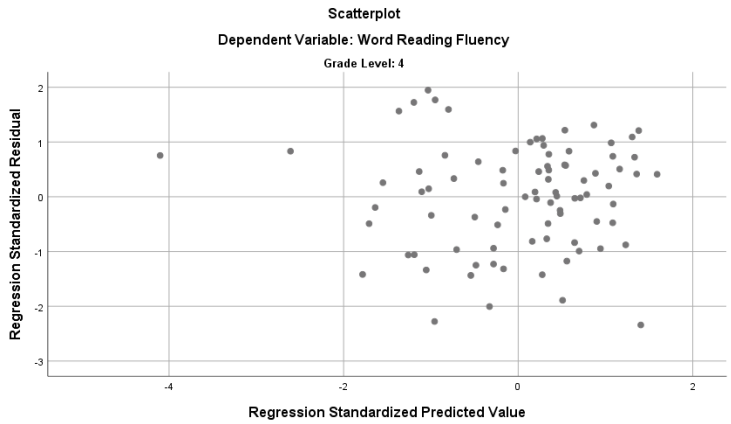


Figure 24

Scatterplot of standardised predicted outcomes and standardised residuals for pseudoword reading fluency in second grade

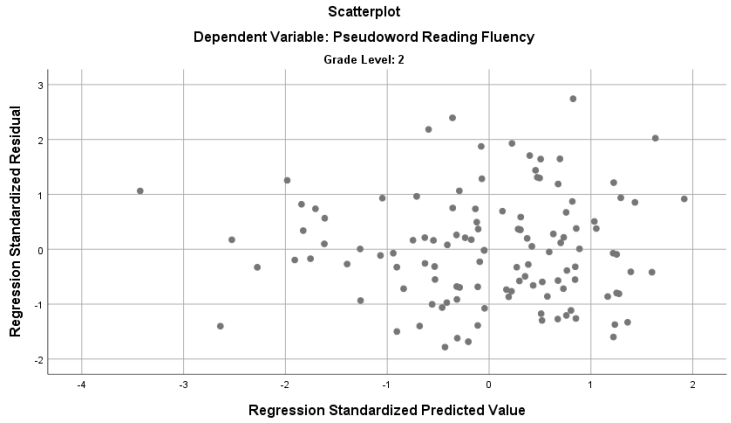


Figure 25

Scatterplot of standardised predicted outcomes and standardised residuals for pseudoword reading fluency in third grade

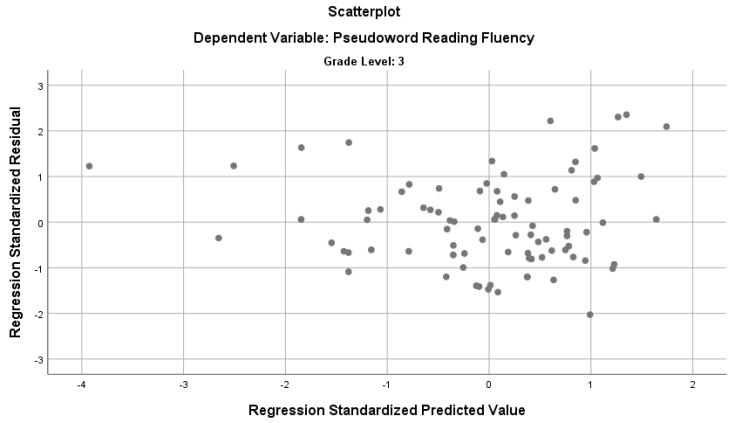
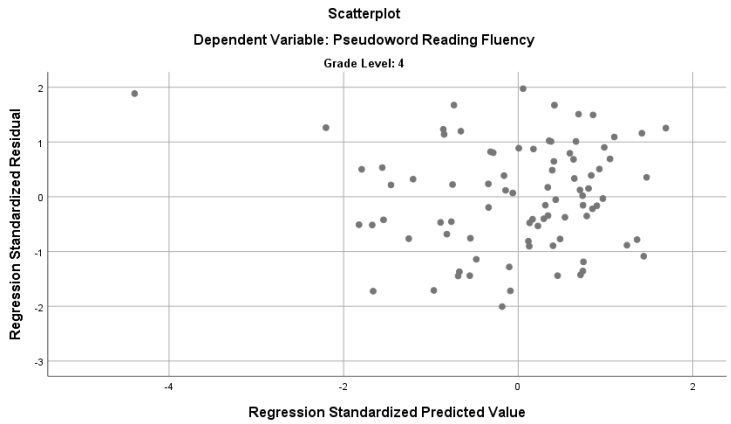


Figure 26

Scatterplot of standardised predicted outcomes and standardised residuals for pseudoword reading fluency in fourth grade



G. Questionnaire from Adult Study 1

Fragebogen

Versuchspersonencode:

Bitte beantworten Sie uns die folgenden Fragen zu Ihrer Person.

In welchem Bundesland haben Sie Allgemeine Hochschulreife erlangt?

- ☐ Baden-Württemberg
- ☐ Bayern
- ☐ Berlin
- ☐ Brandenburg
- ☐ Bremen
- ☐ Hamburg
- ☐ Hessen
- ☐ Mecklenburg-Vorpommern
- ☐ Niedersachsen
- ☐ Nordrhein-Westfalen
- ☐ Rheinland-Pfalz
- ☐ Saarland
- ☐ Sachsen
- ☐ Sachsen-Anhalt
- ☐ Schleswig-Holstein
- ☐ Thüringen
- ☐ Ausland: _____

Was trifft auf die Schule zu, in der Sie die allgemeine Hochschulreife erlangt haben?

- ☐ Staatlich
- ☐ Privat
- ☐ Gymnasium
- ☐ Gemeinschaftsschule
- ☐ Andere: _____
- ☐ Spezifisches pädagogisches Konzept: _____

Gesamtdurchschnitt: ☐ , ☐

Welchem Geschlecht fühlen Sie sich zugehörig?:

- ☐ Weiblich
- ☐ Männlich
- ☐ 3. Geschlecht

Was studieren Sie?: _____

In welchem Fachsemester studieren Sie?: _____

Wie alt sind Sie?: _____

Was war Ihre Familiensprache als Sie ein Kind waren, also die Sprache, die Sie zuhause überwiegend gesprochen haben?

- □ Nur Deutsch
- □ Eher Deutsch, aber auch: _____
- □ Deutsch und andere gleichermaßen. Andere: _____
- □ Eher andere: _____
- □ Nur andere: _____

Wann haben Sie angefangen, Deutsch zu lernen?

- □ Seit meiner Geburt
- □ Als kleines Kind mit etwa 1-3 Jahren
- □ Mit etwa 4-5 Jahren
- □ Als ich in die Schule gekommen bis (mit etwa 6-7 Jahren)
- □ Später: _____

Haben Sie eine Einschränkung der Sehfähigkeit?

- □ Ja
- □ Nein

Wenn ja, benötigen Sie eine Sehhilfe (Brille/Kontaktlinsen)?

- □ Ja
- □ Nein

Wenn ja, haben Sie diese während der Studie genutzt?

- □ Ja
- □ Nein

Haben Sie eine Einschränkung der Hörfähigkeit?

- □ Ja
- □ Nein

Wenn ja, benötigen Sie eine Hörhilfe (Hörgerät)?

- □ Ja
- □ Nein

Wenn ja, haben Sie dieses während der Studie genutzt?

- □ Ja
- □ Nein

Vielen Dank!

Bitte wenden Sie sich jetzt an die Versuchsleitung!

H. Questionnaire from Adult Study 2

Fragebogen

Versuchspersonennummer: ☐☐☐☐

Bitte beantworten Sie uns die folgenden Fragen zu Ihrer Person.

In welchem Bundesland haben Sie Allgemeine Hochschulreife erlangt?

- ☐ Baden-Württemberg
- ☐ Bayern
- ☐ Berlin
- ☐ Brandenburg
- ☐ Bremen
- ☐ Hamburg
- ☐ Hessen
- ☐ Mecklenburg-Vorpommern
- ☐ Niedersachsen
- ☐ Nordrhein-Westfalen
- ☐ Rheinland-Pfalz
- ☐ Saarland
- ☐ Sachsen
- ☐ Sachsen-Anhalt
- ☐ Schleswig-Holstein
- ☐ Thüringen
- ☐ Ausland: _____

Was trifft auf die Schule zu, in der Sie die allgemeine Hochschulreife erlangt haben?

- ☐ Staatlich
- ☐ Privat
- ☐ Gymnasium
- ☐ Gemeinschaftsschule
- ☐ Andere: _____
- ☐ Spezifisches pädagogisches Konzept: _____

Gesamtdurchschnitt: ☐☐ , ☐

In welchem Jahr haben Sie Allgemeine Hochschulreife erlangt? ☐☐☐☐

Welchem Geschlecht fühlen Sie sich zugehörig?:

- ☐ Weiblich
- ☐ Männlich
- ☐ Divers

Wie alt sind Sie?: _____ Jahre

Was studieren Sie?:

Hauptfach: _____ Nebenfach: _____

Befinden Sir sich im Bachelor- oder im Masterstudiengang?

- ☐ Bachelor
- ☐ Master

Absolvieren oder absolvierten Sie Ihren Bachelor an der Universität Erfurt?

- ☐ ja
- ☐ nein

Im wievielten Fachsemester studieren Sie?:

Insgesamt: _____

Im aktuellen Studiengang: _____

Was war Ihre Familiensprache als Sie ein Kind waren, also die Sprache, die Sie zuhause überwiegend gesprochen haben?

- ☐ Nur Deutsch
- ☐ Eher Deutsch, aber auch: _____
- ☐ Deutsch und andere gleichermaßen. Andere: _____
- ☐ Eher andere: _____
- ☐ Nur andere: _____

Wann haben Sie angefangen, Deutsch zu lernen?

- ☐ Seit meiner Geburt
- ☐ Als kleines Kind mit etwa 1-3 Jahren
- ☐ Mit etwa 4-5 Jahren
- ☐ Als ich in die Schule gekommen bis (mit etwa 6-7 Jahren)
- ☐ Später: _____

Benötigen Sie eine Sehhilfe (Brille/Kontaktlinsen) beim Lesen?

- ☐ Ja
- ☐ Nein

Wenn ja, haben Sie diese während der Studie genutzt?

- ☐ Ja
- ☐ Nein

Haben Sie eine Einschränkung der Hörfähigkeit?

- ☐ Ja
- ☐ Nein

Wenn ja, benötigen Sie eine Hörhilfe (Hörgerät)?

- ☐ Ja
- ☐ Nein

Wenn ja, haben Sie dieses während der Studie genutzt?

- ☐ Ja
- ☐ Nein

Vielen Dank!

Bitte wenden Sie sich jetzt an die Versuchsleitung!

10 References

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12 Declaration of authorship

Ehrenwörtliche Erklärung

Ich erkläre hiermit ehrenwörtlich, dass ich die vorliegende Arbeit ohne unzulässige Hilfe Dritter und ohne Benutzung anderer als der angegebenen Hilfsmittel angefertigt habe; die aus fremden Quellen direkt oder indirekt übernommenen Gedanken sind als solche kenntlich gemacht. Bei der Auswahl und Auswertung des Materials sowie bei der Herstellung des Manuskripts habe ich Unterstützungsleistung von folgender Person erhalten:

Prof. Dr. Claudia Steinbrink

Weitere Personen waren an der geistigen Herstellung der vorliegenden Arbeit nicht beteiligt. Insbesondere habe ich nicht die Hilfe einer Promotionsberaterin bzw. eines Promotionsberaters in Anspruch genommen. Dritte haben von mir weder unmittelbar noch mittelbar geldwerte Leistungen für Arbeiten erhalten, die im Zusammenhang mit dem Inhalt der vorgelegten Dissertation stehen.

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Erfurt, 24.02.2020

13 Vita

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14 List of publications

14.1 Peer-reviewed journal articles

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Haase, A. (2019). *Morphologische Bewusstheit und schriftsprachliche Leistungen im Grundschulalter*. Pre-Conference Workshop for Ph.D. students at the Joint Conference of the Sections Developmental Psychology and Educational Psychology (paEpsy) in Leipzig, 09.09.2019. (talk)

Haase, A. & Steinbrink, C. (2019). *Der Zusammenhang zwischen morphologischer Bewusstheit und schriftsprachlichen Leistungen bei deutschsprachigen Grundschulkindern*. 34th working conference of the section "Psychologie der Kommunikation und ihrer Störungen" of the BDP in Rauischholzhausen, 09.05.2019. (talk)

Haase, A. & Steinbrink, C. (2018). *Morphologische Bewusstheit und schriftsprachliche Kompetenzen bei deutschsprachigen Grundschulkindern - Ergebnisse einer Pilotstudie*. 51th Congress of the German Psychological Society (DGPs) in Frankfurt am Main, 19.09.2018. (poster)

Haase, A. & Steinbrink, C. (2017). *Adaptation und Erprobung von Aufgaben zur Erfassung der morphologischen Bewusstheit*. Joint Conference of the Sections Developmental Psychology and Educational Psychology (paEpsy) in Münster, 12.09.2017. (poster)

Haase, A. (2017). *Morphologische Bewusstheit und Schriftspracherwerb*. Pre-Conference Workshop for Ph.D. students at the Joint Conference of the Sections Developmental Psychology and Educational Psychology (paEpsy) in Münster, 10.09.2017. (talk)

Haase, A. & Steinbrink, C. (2016). *Morphologische Bewusstheit und Schriftspracherwerb*. 34th working conference of the section "Psychologie der Kommunikation und ihrer Störungen" of the BDP in Rauischholzhausen, 02.06.2016. (talk)

14.3 Talks in the interdisciplinary colloquium for speech-related sciences at the University of Erfurt

Haase, A. (2019). *Zusammenhänge zwischen morphologischer Bewusstheit und schriftsprachlichen Leistungen bei Grundschulkindern. Faktoren- und strukturgleichungsanalytische Auswertungen.* Kolloquium des Erfurter Promotions- und Postdoktoranden-Programms (EPPP) "Sprachbeherrschung", 07.05.2019. (talk)

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Haase, A. (2018). *Morphologische Bewusstheit und schriftsprachliche Leistungen im Grundschulalter*. Kolloquium des EPPP "Sprachbeherrschung", 16.01.2018. (talk)

Haase, A. (2015). *Dissertationsvorhaben - Der Zusammenhang zwischen morphologischer Bewusstheit und schriftsprachlichen Kompetenzen.* Kolloquium des EPPP "Sprachbeherrschung", 1.12.2015. (talk)