Grammatical Gender Acquisition in German: Three-Year-Old Children Use Phonological Cues to Learn the Gender of Novel Nouns

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1. Introduction

Almost a half of the world's languages categorizes nouns by gender. The specific gender assigned to a noun can be based on semantic features and/or on formal features (Corbett, 2013a, 2013b). These assignment principles are language specific. For instance, the word for "sun" is neuter in Russian, masculine in French, and feminine in German. Learning a noun in one of these languages requires the learner to store gender information because the gender needs to be marked on accompanying articles and/or adjectives.

How challenging this acquisition task might be, can be observed in adult learners of German who often have trouble with gender assignment. Yet young children acquiring German as their native language seem to struggle much less than adult learners. Observational studies have shown that German-learning children master gender marking by their third birthday (Mills, 1986; Szagun et al., 2007). This is particularly impressive as gender marking in German interacts in quite complex ways with number and case marking, leading to the question of what the secret of success of young language learners is. One potential factor are the powerful learning mechanisms that they have at their disposal. Infants and young children are very efficient at detecting co-occurrence patterns and at tracking statistical regularities in the input (Gómez, 2007; Rebuschat & Williams, 2012; Saffran, 2003). This enables them to make use of cues even if they are not deterministic but probabilistic. Research on German shows that probabilistic information for gender assignment is available (e.g., Köpcke & Zubin, 1996).

With the current study we assess the role of phonological cues for children's gender assignment by testing a group of native German 3.5-year olds in a word-learning task. To date, an experimental investigation of children at this young age who learn a language with more than two gender categories is missing.

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2. Sensitivity to gender marking in young children

To be able to produce correct article-noun combinations, such as "le soleil" (French: the sun), requires the detection of the association between "le" and "soleil". This, in itself, does not yet reflect the formation of abstract grammatical knowledge but the representation of a co-occurrence pattern. Having stored this information, children should be able to discriminate "le soleil" (which they hear in their input) from "la soleil" (which they probably encounter rarely to never). Young infants' excellent abilities to track co-occurrence patterns in their input (e.g., Saffran et al., 1996) might initiate the acquisition of grammatical gender.

Previous research has shown that infants are sensitive to these associations from their second year of life on. Van Heugten and Christophe (2015) presented 18-month-old French-learning children with correct ("le soleil") and incorrect ("la soleil") article-noun combinations in a visual fixation procedure. They found that the children looked longer at an unrelated display when presented with the grammatical compared to the ungrammatical combinations. This sensitivity could also be shown for newly learned pseudowords in 20-month-old children (Cyr & Shi, 2013). In their third year of life, children begin to use gender information marked on the article to identify noun referents in a preferential looking task: French-learning children at 24-26 months (van Heugten & Shi, 2009), Dutch-learning children at 26-30 months (Johnson, 2005), and Spanish-learning children at 34-42 months (Lew-Williams & Fernald, 2007). To our knowledge, findings for languages with more than two gender categories are scarce to nonexistent. For German-learning children data from our lab suggests that the sensitivity for correct gender marking starts to emerge between 18 and 24 months (Fritzsche & Höhle, 2016).

These findings show that by the time that children start to produce first article-nouns combinations (requiring gender marking) they are sensitive to their associations. As mentioned above, this does not provide evidence for an early knowledge of (abstract) gender, but it is a first essential step into its acquisition.

3. Grammatical gender assignment in German

For a long time, going back at least to Mark Twain (1880), it has been assumed that gender assignment in German is arbitrary (Bloomfield, 1933; Maratsos, 1982; Maratsos & Chalkley, 1980; Werner, 1975). However, a number of authors have convincingly shown that there *are* regularities at play in German gender assignment (Altmann & Raettig, 1973; Köpcke, 1982; Köpcke & Zubin, 1983, 1984; Wegener, 1995). Their analyses of dictionaries and speech corpora identified several linguistic features that are associated with one of the three gender categories in German. These regularities can be assigned to three types of information: semantic, morphological, and phonetic-phonological (Altmann & Raettig, 1973; Heidolph et al., 1984; Köpcke, 1982; Köpcke & Zubin, 1983, 1984; MacWhinney et al., 1989; Mills, 1986).

Morphological cues consist of derivational affixes that specify the gender. For example, *-in*, *-ung* and *-heit* assign feminine gender (Mills, 1986), *-ling* the masculine, and *-lein* and *-chen* neuter (Szagun et al., 2007). These morphological cues are largely deterministic with a few exceptions.

Semantic cues are probabilistic but not very reliable. Köpcke and Zubin (1983) and Mills (1986) present an extensive analysis of semantically based gender assignment. While there is a strong association between the natural sex of a referent and its gender, this is much less the case for gender associations with specific semantic categories (e.g., colors and metals are mostly neuter, meteorological terms and beverages masculine, trees, and musical instruments feminine). Moreover, when in conflict with phonological cues, semantic cues tend to lose out (Köpcke & Zubin, 1984; Mills, 1986).

A number of phonological cues have been proposed for German, varying in their position on a scale from probabilistic to deterministic. Arndt (1970) described a dissociation between feminine gender and monosyllabic nouns, which was confirmed by Köpcke's (1982) analysis of 1466 monosyllabic German nouns. Another principle for monosyllabic nouns states that the more consonants the word has in its onset and coda, the more likely it is to be masculine (Köpcke & Zubin, 1996). For both mono- and polysyllabic nouns, the word ending serves as the strongest but still probabilistic phonological gender cue. Analyzing suffixes and pseudosuffixes on the basis of two German dictionaries, Augst (1975, 1979) showed that words ending in Schwa -e/[ə] are feminine in 90% of the cases, and that 71% of the words ending in -er/[ɐ] are masculine. Relevant to our study, both of these word endings are present already in a child's early vocabulary: Scupin and Scupin (1907) documented every new word their son spoke until the age of 2;11 and found that the Schwa ending was the most frequently used phonological form, being detected in 80 nouns. The ending -er followed in second place with 25 nouns. The high reliability of these two word endings for gender assignment combined with their high frequency in a child's lexicon might therefore make them especially important during gender acquisition (Wegener, 1995).

The German article declension exhibits a few intricacies that increases the complexity of the acquisition task that children face. As mentioned above, gender marking interacts with number and case (Table 1). German, being a fusional language, has no transparent one-to-one mapping between form and function.

Table 1. Paradigm for the German definite article

Case	Singular			Plural
	Feminine	Masculine	Neuter	All genders
Nominative	die	der	das	die
Accusative	die	den	das	die
Dative	der	dem	dem	den
Genitive	der	des	des	der

In nominative singular each gender has its unique definite article (which is not the case for indefinite articles). Gender is not marked in plural. However, the form of the definite article for nominative plural ("die") is identical to the nominative singular feminine. Such paradigm syncretisms exist also between the singular nominative masculine ("der"), singular feminine dative and genitive, and plural genitive. The relatively high number of different article forms (compared to languages like French, Spanish, and Dutch that lack case) entails that each form is less frequent in the input to a child.

4. Acquisition of grammatical gender in German

There seem to be no published studies on the perception of gender marking by German-learning children, apart from a study of our lab (mentioned under section 2). However, findings on the use of gender-marked forms in German children's language production do exist. In a longitudinal study, Szagun et al. (2007) analyzed spontaneous speech in a dense corpus of six children and found that the first gender-marked articles were produced around 1;5 to 1;8. The spontaneous speech analysis of three children in a study by Clahsen (1986) found first gender markings at around 2;0. At around 2;9, correct (definite) articles start to emerge for all three genders, although feminine forms are still often overgeneralized (Mills, 1986).

The question as to whether formal cues to gender marking are reflected in young children's early word productions was also addressed by Szagun and colleagues (2007). They analyzed spontaneous speech samples from 22 children collected at regular intervals between the age of 1;4 and 3;4. Gender marking was coded as conforming to various phonological cues established for German (section 3). The results show that gender marking in spontaneous production mirrors the cue association strength. For example, nouns ending in Schwa are marked by the children as feminine 92.2% of the time and nouns ending in -el, -en, or -er as masculine in 78.2%. Gender indexed by an affix was marked 100% in line with the cue. Szagun et al. (2007, p. 466) state that "children make use of the phonological patterns in word structure and their co-occurrence with gender marked articles" which enables them to acquire gender so rapidly.

The influence of phonological cues on gender assignment has also been observed with nonsense words. Mills (1986) showed that 7- to 8-year olds as well as adults relied on the nouns' phonological structure when assigning gender. The use of pseudowords provides the most reliable way to investigate children's sensitivity to phonological cues to gender since this method avoids the reliance on lexicalized gender knowledge. Therefore, our study used this method but tested much younger children.

5. Research questions and hypotheses

Based on the findings of Szagun and her colleagues (2007) that German children's gender assignment in their early word productions tends to correlate

with the phonological structure of the noun, the main goal of the current study is to assess the influence of phonological cues in early gender acquisition.

A prerequisite for acquiring the gender of a novel noun in an experimental setting is that the noun is learned after just a few exposures. The ability of fast mapping (see Höhle, 2010) emerges at 18 months and allows children to do just that. Therefore, we expected that three-year-old German-learning children are able to correctly (re-)produce a new noun after hearing it only a few times. Primarily, we were interested in whether children store a novel noun's gender information (which was indicated by a gender-marked article or adjective during the learning phase) and whether phonological cues to gender would have an effect on their gender choice when reproducing the words. We hypothesized that children would mark the gender of new words more accurately if the phonological structure cued its gender than if it did not. Therefore, gender assignment errors were expected to be systematic. An incongruent phonological cue would lead to regularizations, i.e., changing the gender of the article to conform to the noun's phonological structure.

6. Methods
6.1. Participants

The analysis sample comprises of 21 typically developing children (11 girls) acquiring German as a native language. Their mean age was 3;5 years (M = 41,9 months, range: 40–43). Seven additional children were tested, whose data were excluded from the analysis due to noncompliant behavior and/or parental interference (n=4) or incomplete data acquisition (n=3) because of the stopping rule (see section 6.3). All children were recruited via the BabyLAB of the University of Potsdam.

6.2. Materials

The stimuli consisted of 32 test items, 16 words for real animals known to children and 16 pseudowords for fantasy animals (listed in Table 2). The phonological makeup of the pseudowords mimicked that of real words. Both word types were balanced for feminine and masculine gender. We focused on these two genders because neuter nouns lack strong phonological cues, which are a crucial feature of the stimulus design.

Half of the words and half of the pseudowords contained a phonological cue that was consistent with the nouns' gender and the other half contained a conflicting cue. The cue for feminine gender was a Schwa ending -e/[ə] in the second syllable. We verified the association of feminine gender with this phonological cue by an analysis of the 311 singular nouns in the German version of the MacArthur-Bates Communicative Development Inventories (CDI, Szagun et al., 2009) and found that the number is almost identical (92%) to what Augst (1975, 1979) had found in his lexical analysis (90%). For masculine nouns, the ending -er/[ɐ] was used as a cue. This association was also checked based on the

CDI vocabulary resulting in 59% congruence of cue and noun gender (a smaller value than the 71% reported by Augst 1975, 1979).

All nouns were two syllables long with the exception of the inconsistent feminine real words. According to our design we would have needed feminine animal names ending in -er for this category but we could find only one ("Natter", colubrid), which would not be known to young children. Therefore, we chose monosyllabic words for this category. Monosyllabicity is a cue for masculine gender as well, with 64% of monosyllabic German nouns being masculine (Arndt, 1970; Köpcke, 1982), a figure that is reduced to 53%in the nouns from the CDI. This deviation was not considered to have a detrimental impact on the study because real animals were included mainly to make the task easier and more fun for children as well as to have a reference level of gender assignment accuracy.

Table 2. Linguistic stimuli

Gender	Words		Pseudowords	
	Consistent	**Inconsistent**	**Consistent**	**Inconsistent**
Feminine	Katze *cat* Schlange *snake* Spinne *spider* Eule *owl*	Kuh *cow* Maus *mouse* Gans *goose* Laus *louse*	Romme [ʁɔmə] Speme [ʃpeːmə] Tiese [tiːzə] Keipe [kaɪpə]	Linner [lɪnɐ] Steker [ʃteːkɐ] Liemer [liːmɐ] Dauler [daʊlɐ]
Masculine	Käfer *bug* Tiger *tiger* Adler *eagle* Hamster *hamster*	Löwe *lion* Hase *bunny* Affe *monkey* Rabe *raven*	Nüter [nyːtɐ] Muker [muːkɐ] Schleser [ʃleːzɐ] Oler [oːlɐ]	Böle [bøːlə] Hewe [heːvə] Schnofe [ʃnoːfə] Ulpe [ʊlpə]

By reversing the gender assignment for the pseudowords, we created a second version of the item set. This made sure that the gender assignment of the pseudowords was counterbalanced across participants, which controlled for item effects. The order of the trials was pseudorandomized for each version and by reversing the sequence we created four experimental lists. In each of the 16 test trials one word and one pseudoword, always of different gender, was presented to the child. The trials were balanced for cue consistency such that either both items were consistent or inconsistent or one being consistent and the other inconsistent.

Every item was assigned a representative colored picture card that was used as a figurine during the test procedure. The images of the real animals were obtained from several online sources while the images of the fantasy animals had been created by van de Vijver and Baer-Henney (2014) and were used with their permission. The shape and color of the fantasy animals were selected such that they did not afford any gender biases. In addition to the test items, there were two pairs of training items (three real animals, one fantasy animal) and a bear figurine which led through the experiment (see Procedure). Differently shaped boxes and a gift bag were used as hiding places for the animals.

6.3. Procedure

Testing was conducted by the first author with the child in a quiet room at the University of Potsdam. Parents sat in an adjacent room and could follow the procedure through a one-way mirror while filling out the consent form, a parental questionnaire, and a vocabulary checklist. The questionnaire assessed the child's current well-being, general and linguistic development as well as their linguistic environment. The vocabulary checklist contained the real words that were included in the experiment. The whole experiment lasted about 30 to 45 minutes and was video recorded.

The experiment was introduced as a hiding game in which the child was to help "Bruno the Bear", who had trouble seeing, to find the animals (Figure 1). The task was inspired by Karmiloff-Smith (1979, especially experiments 7–9 in chapter 6). The child and the experimenter sat at a low table on which Bruno and the objects for hiding the animals were placed. After Bruno had been introduced, two training trials followed which familiarized the child with the task and with one example of a fantasy animal. The task instructions were the same as in the subsequent test phase: The experimenter first introduced the real animal and then the fantasy animal as follows (each animal three times): "That is a [indefinite article + item]. That is a [gender-marked adjective + item]. [Gender-marked demonstrative pronoun + item] is very [descriptive adjective]." An example is given in (1) for a real word of feminine gender and in (2) for a pseudoword of masculine gender. The wording of this introduction was carefully chosen to mark the gender only on indefinite articles, adjectives, and demonstratives. This is a natural way to introduce new referents to a discourse and to avoid providing the child with the definite article. In contrast, the child's response was expected to contain the definite article as this would be the most felicitous choice in this context.

(1) Das ist eine Schnecke.   *That is a$_{\text{FEM}}$ snail.*
     Das ist eine niedliche Schnecke.   *That is a$_{\text{FEM}}$ cute$_{\text{FEM}}$ snail.*
     Diese Schnecke ist sehr langsam.   *This$_{\text{FEM}}$ snail is very slow.*
(2) Das ist ein_ Böle.   *That is a$_{\text{MASC}}$ boele.*
     Das ist ein_ kleiner Böle.   *That is a$_{\text{MASC}}$ small$_{\text{MASC}}$ boele.*
     Dieser Böle ist besonders lustig.   *This$_{\text{MASC}}$ boele is very funny.*

After this introduction, the experimenter announced, "Now one animal is hiding" and went on to hide one of the animals (specified by the experimental list) in one of the hiding places. This action was followed by the question "Which animal is hiding?" After the child's response, the experimenter continued by asking "And which animal did not hide?" Both responses were written down and the next trial followed.

If the child was unable to name the animal, the experimenter repeated the name in isolation (i.e., without any gender marking) and the questions were asked again. If necessary, this procedure was repeated up to three times before it was

counted as a null response. If a child produced four unanalyzable responses in a row (see next section), the experiment was terminated (stopping rule).

Figure 1. Example of two items of a trial

6.4. Response coding

The child's response to each item (in case of more than one the final one) was documented on a log sheet. Responses were subsequently coded as *correct*, *incorrect,* or *not analyzable*. Correct responses included all productions of an unambiguous gender marking matching the gender of the animal (definite or indefinite articles, pronouns), regardless of whether the noun was produced at all or if there were errors in its pronunciation (unless the error affected the phonological cue at the word's ending). The production of an unambiguous gender marking mismatching the nouns gender was coded as incorrect. Nonverbal and null responses, article omissions, article reductions without clear gender marking (e.g., "de"), pronunciation errors that affected the noun ending, and ambiguous gender marking were coded as not analyzable.

7. Results

The 672 administered trials yielded 578 (86%) analyzable responses. The individual proportions of analyzable responses ranged from 44 to 100%. As expected, the number of not analyzable responses was higher for the pseudowords compared to the real words (57 vs. 37) while it was comparable for items with consistent and inconsistent cues (44 vs. 50) as well as for feminine and masculine nouns (45 vs. 49).

The nouns were produced correctly 93% of the time with no difference between real words (93%) and pseudowords (92%). Nevertheless, the task was

challenging for some of the children. This is reflected by the fact that about 40% of the items had to be repeated by the experimenter before a response was given. In the following sections the responses are evaluated with regard to their gender marking.

7.1. Gender marking accuracy

The effects of Word Status, Gender, and Cue Consistency on the response accuracy of the analyzable trials was assessed in a repeated-measure 2x2x2 by-subject ANOVA. Figure 2 displays the group results as well as individual performance patterns. There is no main effect of gender, i.e., children responded equally accurate to feminine and to masculine items ($F_{1,19} < 1$, $p = .548$). Accuracy was higher for real words compared to pseudowords ($F_{1,19} = 134.6$, $p < .001$) and for items with consistent compared to inconsistent cues ($F_{1,19} = 83.3$, $p < .001$). In addition, the two-way interaction between Word Status and Cue Consistency was significant ($F_{1,19} = 58.6$, $p < .001$). Follow-up t-tests establish that the consistency effect is not present in words ($t_{20} = 1.24$, $p = .230$) but strong in pseudowords ($t_{20} = 6.79$, $p < .001$). All other interactions were not significant (all F's < 1, p's > .36). According to the results of the vocabulary checklist, some children did not (yet) know the word for some of the real animals. We re-ran the analysis after removing the affected 18 trials (5.4% of the word trials) and obtained identical effects.

In an additional analysis we checked whether the accuracy of 58.4% for pseudowords (independent of cue consistency and gender) is different from chance level performance, which it is (one-sample t-test: $t_{20} = 2.352$, $p = .029$).
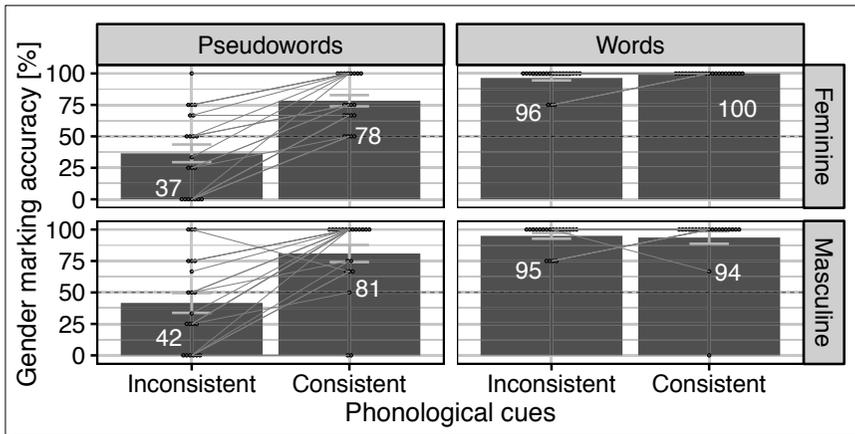

Figure 2. Accuracy scores, bars represent the mean, error bars ±1 SE, and connected dots individual children

7.2. Error patterns

Here we provide an overview of the error patterns in a descriptive analysis. Incorrect as well as not analyzable responses were classified into four broad categories. *Lexicalizations* were substitutions of a pseudoword with an existing word. *Regularizations* were gender markings based on the phonology and not the actual or the given gender of nouns with inconsistent gender cues. *Incorrect gender* responses were changes to the gender marking in items with consistent cues. *Other errors* included ambiguous gender marking or no gender marking at all, null responses, a change of the noun (e.g., "rabbit" to "bunny", which in German are neuter and masculine, respectively) or the marking with neuter gender (that was not used in the items of this study).

Figure 3 shows the frequency of the four error types. It is immediately apparent that the major error type in real words is of the category "Other" (85%, 39 out of 46 responses). The absolute number of this error type for real words is, however, lower as that for pseudowords (39 vs. 60 responses). For inconsistent pseudowords the predominant error type is regularization (73%, 83 out of 114 responses). This is a higher frequency than that of "incorrect gender" errors in consistent pseudowords (73% vs. 43%, in absolute numbers: 83 vs. 24), showing that the phonological structure had a profound impact on the article choice for pseudowords. It is interesting that there are even a few regularizations in inconsistent words (5 responses).
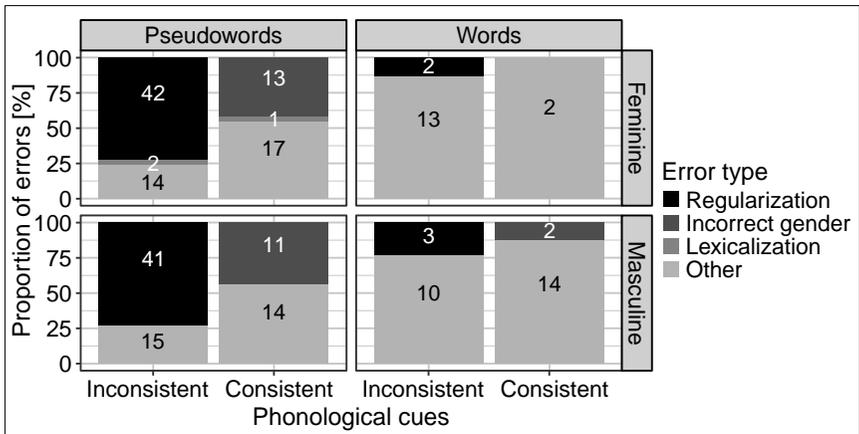

Figure 3. Frequency of error types, the size of the bars depicts the relative frequency in each design cell, the absolute counts are printed in the bars

7.3. Summary

Children were perfectly able to mark the gender of known words, their accuracy being at ceiling with 96.8% of all analyzable responses. Accuracies for gender marking of pseudowords were affected by the phonological cue: accuracy

for consistent cues being on average at 78.0%, and for inconsistent ones at 39.2%. The fact that gender had no effect whatsoever could be taken as an indication that the two cues used (-e/[ə] for feminine and -er/[ɐ] for masculine nouns) were of comparable efficacy. It should be noted that the vast majority of correct responses contained definite articles (97.3%), which had not been in the input during the introduction of the animals. Thus, the responses are not merely duplications of the gender marking provided to the children (learning of complete chunks) but reflect an active processing of gender information including the selection of an appropriate gender marker. Even though we observed some individual variation in response accuracy, the consistency effect in pseudowords was present in almost all children.

The error patterns corroborate the effects found for response accuracy. They show that for the majority of pseudowords with an inconsistent phonological cue, children chose to produce a gender marking based on the noun's phonology, thereby regularizing the gender.

8. Discussion

Children had no difficulties (>90% accuracy) remembering and producing the animal names (words and pseudowords alike) which is important as this was a prerequisite for the task of gender marking. The short time period between presentation and production is likely to have facilitated the correct retrieval of the novel words.

Accuracy of gender marking for the real words was at ceiling, which shows that the associated gender information is firmly established in the children's mental lexicon. The overall accuracy of gender marking for pseudowords was 58%. Together with the fact that more than a third of the items had to be repeated (in isolation without gender marking) by the experimenter before a response was given and that three children were not able to complete all trials shows that the task was quite challenging for the children at the tested age. However, accuracy in pseudowords varied with the consistency of the phonological cues as hypothesized. These phonological cues to gender assignment (-er/[ɐ] for feminine and -e/[ə] for masculine pseudowords) were the main focus of this study. Their strong effect on accuracy as well as on the error types is a clear indication for children's reliance on them: When learning novel nouns whose phonological structure cues the assigned gender, accuracy scores are boosted but are reduced if the noun's phonology is conflicting with its gender. This difference was present in nearly all children, even though to a varying degree, which might result from individual variation in the use of different learning strategies.

The effect of phonological structure on gender assignment has already been demonstrated for French by Karmiloff-Smith (1979) and is also assumed for Greek (Tsimpli & Hulk, 2013). In a series of experiments, Karmiloff-Smith presented three-year-old French-speaking children with pseudowords and their indefinite articles. The pseudowords contained suffixes that were either consistent with the nouns' gender (marked by the article) or not. The results show that the French children produced correct definite articles when the cue was consistent. In

contrast, when the cue was inconsistent, the children tended to mark gender based on the cue rather than on the gender of the indefinite article. The findings from French and German (Szagun et al., 2007, this study) are very similar. While the precise phonological cues to gender are, of course, language specific, the mechanism of exploiting probabilistic information in order to acquire linguistic knowledge is identical. It is conceivable that investigations in other languages, in which gender assignment is correlated with phonological properties of nouns, yield similar outcomes.

Given our finding it still remains an open issue to what extent gender information of novel nouns is stored by young children. Do the phonological cues facilitate the representation of a noun's gender (or hinder it in case of inconsistent cues) or are phonological cues merely used as a heuristic when gender information has not been acquired? In the latter case one would expect performance at ceiling for consistent nouns and floor performance for inconsistent nouns, yielding an overall performance at chance. However, the performance level for the pseudowords in this study was above chance, showing that the children did represent (some) gender knowledge of the novel nouns beyond the information provided by the phonological cues. This is important because the cues are only probabilistic and cannot replace the gender information as part of a noun's entry in the mental lexicon. The individual variability that was found in this study (the connected dots in Figure 2) could be related to children's reliance on phonology. Some children relied entirely on the phonological cue (100% accuracy for consistent pseudowords, 0% accuracy for inconsistent ones), a few were not affected by the phonological cue at all – having memorized the gender correctly (100% accuracy for both, consistent and inconsistent pseudowords), and the majority of children falling in between these extremes in their performance. These patterns might be related to the children's vocabulary size, which was not assessed in this study. With a larger lexicon more information about gender and phonological patterns can be retrieved and eventually generalized. On the other hand, the number of encountered exceptions will also increase with a larger vocabulary. A question for future research is to determine at what point children learn to disregard a phonological cue.

We would like to point out that the task in the current study required the children to apply abstract knowledge. The children used the definite articles in the majority of their responses, markers that had not been part of the input when introducing the pseudowords. This shows that children did not merely reproduce article-noun combinations and could not rely on co-occurrence patterns but had to select the appropriate form of the article themselves. This goes beyond what can be shown by observational studies (Mills, 1986; Szagun et al., 2007) and what has been found by most of the perception studies (Johnson, 2005; Lew-Williams & Fernald, 2007; van Heugten & Christophe, 2015; van Heugten & Shi, 2009), although in two studies abstract gender knowledge was necessary because the gender markers used in the test phase were different from the ones used during familiarization (Cyr & Shi, 2013; Melançon & Shi, 2015).

It needs to be noted that the current study investigated only two types of phonological cues, those with the strongest associations between phonological structure and gender. For a more detailed picture it would be interesting to extend the current findings to other cues with a more diverse set of items. In addition, it is not clear how stable gender assignment is for newly learned nouns. This could be investigated in a longitudinal study. Regarding syntactic development, knowing a noun's gender is just one piece of the puzzle when acquiring German. As the declension paradigm in Table 1 shows, there are complex interactions with case and number. While it has been assumed that gender knowledge is a prerequisite for the acquisition of case, recent work shows that both proceed, at least in part, simultaneously (Ulrich et al., 2016). To shed more light on these interrelations would surely be a fruitful endeavor.

9. Conclusion

The current study investigated whether German three-year-old children make use of two specific phonological cues when assigning gender to novel nouns. A high accuracy for the gender marking of cue-consistent pseudowords as well as a high proportion of gender regularizations for inconsistent pseudowords indicates that children are sensitive to existing phonological associations and actively exploit them when learning the gender of new nouns. This study corroborates the findings by Szagun and colleagues (2007) with spontaneous speech data from German children and adds to the evidence obtained for French (Karmiloff-Smith, 1979) that phonological regularities play a crucial role in gender acquisition.

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