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Grammatical Gender and Inferences About Biological Properties in German-Speaking Children

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Abstract

In German, nouns are assigned to one of the three gender classes. For most animal names, however, the assignment is independent of the referent's biological sex. We examined whether German-speaking children understand this independence of grammar from semantics or whether they assume that grammatical gender is mapped onto biological sex when drawing inferences about sex-specific biological properties of animals. Two cross-linguistic studies comparing German-speaking and Japanese-speaking preschoolers were conducted. The results suggest that German-speaking children utilize grammatical gender as a cue for inferences about sex-specific properties of animals. Further, we found that Japanese- and German-speaking children recruit different resources when drawing inferences about sex-specific properties: Whereas Japanese children paralleled their pattern of inference about properties common to all animals, German children relied on the grammatical gender class of the animal. Implications of these findings for studying the relation between language and thought are discussed.

Keywords: Linguistic relativity; Categorization; Grammatical gender; Property inference; Preschool children

1. Introduction

For English speakers, it may seem odd to say that ''*he* is really beautiful'' when describing a colorful butterfly passing by or that ''*she* was running across the kitchen'' when reporting the shocking discovery of a cockroach inside the house, even though the speaker does not know the referent's sex. However, this is very common for German speakers because German is a language with a grammatical gender system that classifies 'butterfly'

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as masculine and 'cockroach' as feminine (regardless of the individual animal's biological sex).

Languages of the world differ in whether they have a semantic gender system or a grammatical gender system (Corbett, 1991; Corbett & Fraser, 2000). Languages with grammatical gender, such as German, French, Italian, and Spanish, assign gender to all nouns regardless of whether the referents have a biological sex. In German, for example, the feminine pronoun *sie* (she) and the feminine article *die* (the$_{[FEM]}$) are used to refer to grammatically feminine nouns regardless of whether the noun's referent is an animal without a known biological gender (e.g., a giraffe) or an inanimate object (e.g., a banana).

The link between gender assignment and the conceptual properties of a non-human referent has been widely recognized to be arbitrary (Aikhenvald, 2000; Boroditsky, Schmidt, & Phillips, 2003; Fox, 1990). There are a number of reasons for this view. First, for the great majority of words, biological sex is irrelevant to grammatical gender. Entities without a biological sex must receive a grammatical gender, whereas for entities with a biological sex, grammatical gender often does not map to biological sex. For example, the feminine article *die*$_{[FEM]}$ must be applied even when the animal's biological sex is explicitly specified by a sex-marking adjective (e.g., *die männliche* (male) *Giraffe*), and the feminine pronoun *sie* must be used for anaphoric reference to the male giraffe. When someone asks you if you have a pet, your answer would be ''*Ich habe einen*$_{[MAS]}$ *Hund*'' (I have a dog), even if your dog is female. Second, the gender assignments of nouns vary widely among different grammatical gender languages. For example, in German, the grammatical gender of the word ''seal'' is feminine [*die*$_{[FEM]}$ *Robbe*] and that of ''frog'' is masculine [*der*$_{[MAS]}$ *Frosch*]. In French, the grammatical gender assignments of ''seal'' and ''frog'' are the opposite of those in German. Certainly, there are also cases in which grammatical gender and biological sex are in clear correspondence. In German, for example, salient female terms such as ''woman,'' ''aunt,'' and ''mother'' are grammatically feminine, whereas salient male terms such as ''man,'' ''uncle,'' and ''father'' are grammatically masculine (the Natural Sex Principle, cf. Zubin & Köpcke, 1986). Note, however, that this gender-sex correspondence does not generally hold outside the terms for human in the German noun lexicon, and even among those terms, there are a few cases in which the actual sex of the noun's referent is not reflected in the noun's grammatical gender (e.g., *das*$_{[NEUTER]}$ *Mädchen* = the girl; *das*$_{[NEUTER]}$ *Weib* = an offensive term referring to a woman).

Of course, in theory, speakers of a language with a grammatical gender system should soon realize that the grammatical gender of a basic-level animal name does not directly reflect that animal's biological sex. However, it is worth asking whether the cases of semantic correspondence between grammatical gender and biological sex observed in the terms for humans have resulted in an overgeneralization in the process of language acquisition; human terms are very salient, and children tend to use their knowledge about humans as a basis for various types of inferences (e.g., Carey, 1985). Children may erroneously generalize this rather *exceptional* mapping between gender class and biological sex to words for animate entities in general. Using the pronoun ''she'' for giraffes does not mean that all giraffes are females and have female-specific biological properties. An interesting question, then, is whether children that speak a language with grammatical gender are able to refrain

from using the mapping between grammatical gender and biological sex when making inferences about sex-specific biological properties of (non-human) animals.

Previous research examining the influence of grammatical gender on cognitive processes has usually asked whether grammatical gender influences the speakers' concepts of entities when assigning typically feminine/masculine attributes to those entities. For example, Konishi (1993) examined how Spanish and German speakers construe the femininity or masculinity of inanimate objects by having participants rate various nouns on semantic differential potency scales that were related to sex-role stereotypes (e.g., weak vs. strong; tender vs. vigorous). For example, German speakers rated the noun meaning ''sun'' (which is feminine in German, i.e., *die*$_{[FEM]}$ *Sonne*, and masculine in Spanish, i.e., *el*$_{[MASC]}$ *sol*) lower in masculinity than the word for ''moon'' (which is masculine in German, i.e., *der*$_{[MASC]}$ *Mond*, and feminine in Spanish, i.e., *la*$_{[FEM]}$ *luna*), while Spanish speakers showed the reverse pattern. Likewise, Sera and her colleagues (Sera, Berge, & del Castillo Pintado, 1994; Sera et al., 2002) asked children and adult speakers of different languages with grammatical gender whether they would assign a female or a male voice to artificial or natural (but mostly inanimate) objects. They found that Spanish and French speakers assigned a voice that corresponds with the object's grammatical gender (see also Boroditsky et al., 2003; Flaherty, 2001; Phillips & Boroditsky, 2003). However, Sera et al. (2002) did not find the same effect with German speakers. They attributed the absence of this effect to the irregular gender-sex mapping in German, which has three classes of grammatical gender (masculine, feminine, and neuter) instead of two.

Other studies also suggest that grammatical gender influences the speakers' judgments of similarity among entities (Vigliocco, Vinson, Indefrey, Levelt, & Hellwig, 2004; Vigliocco, Vinson, Paganelli, & Dworzynski, 2005). Vigliocco et al.'s (2005) *sex and gender hypothesis* holds that this similarity originates from the fact that speakers notice the correspondence between grammatical and conceptual classes when referring to humans. In other words, the awareness of the link between biological sex and the grammatical gender class of human-related words leads speakers to develop an (unconscious) general notion that even non-human animals belonging to the same grammatical gender class are more similar to one another than animals from different grammatical gender classes. Here again, however, Vigliocco et al. (2005) found support for their hypothesis only in Italian, a language with two gender classes, but not in German.

Thus, given the existing results, there appears to be some influence of grammatical gender on conceptual structures, but the effect seems to depend on the language, the task, and the conceptual domain of nouns. In particular, the results reported in the literature are mixed with respect to whether grammatical gender affects speakers' concepts when the gender-sex mapping is not perfectly straightforward in the speakers' language (i.e., masculine-male and feminine-female), as in the case with German (see Boroditsky et al., 2003; Konishi, 1993; and Phillips & Boroditsky, 2003 for results that show an influence of grammatical gender in German speakers; but see Sera et al., 2002 and Vigliocco et al., 2004 for evidence to the contrary).

Further, to our knowledge, the natural question we raised earlier—whether speakers of a language with grammatical gender project sex-specific biological properties onto entities

with sex (i.e., animals, some plants) on the basis of grammatical gender—has not been investigated. This question is important and goes beyond what has been revealed by previous studies using the voice-attribution paradigm (Sera et al., 2002), the adjective-rating paradigm (Boroditsky et al., 2003; Konishi, 1993), or the similarity or categorization paradigm (Phillips & Boroditsky, 2003; Vigliocco et al., 2005), all of which involve judgments of femininity or masculinity of mostly inanimate objects. Asking whether the femininity/masculinity of inanimate objects varies as a function of the grammatical gender assignment in the speaker's language is interesting, but this judgment may not be relevant to everyday cognitive activities or connected to deep inferences about the object. In contrast, inferences about biological properties are extremely important for understanding animals.

Children build their body of knowledge (i.e., concepts of the world) largely through making inferences on their own. Property inference is thus considered to be the core of human cognition (Carey, 1985; Gelman, 2003; Murphy, 2002), which goes beyond mere similarity judgments or categorization. Previous studies have shown that children, like adults, are more selective and rely on previous knowledge more strongly when drawing inferences about properties than when making similarity judgments or categorizing objects (e.g., Hatano & Inagaki, 1994; Heit & Rubinstein, 1994; Imai, Saalbach, & Stern, 2010a; Ross, Medin, Coley, & Atran, 2003; Saalbach & Imai, 2007). Thus, the cognitive processes involved in property inference are not identical to the processes involved in classification.

Many studies in the literature have investigated how children generalize a novel property inductively, that is, on what basis children infer what other objects have the property in question. For example, previous research has suggested that young children are likely to utilize a noun label as a basis for this kind of inference (e.g., Gelman & Markman, 1986), along with other cues (e.g., Sloutsky & Fisher, 2004; Sloutsky, Lo, & Fisher, 2001). The process of property inference, however, also involves another direction of inference: children may be taught that a particular *kind* of object in general has a particular property. In this case, children need to determine (by inference) whether the object at hand has this property. Here again, it is necessary to understand what bases or cues children utilize to assign properties. Although this question is important, it has remained largely unexplored, as compared with the former case.

Therefore, we investigated whether children speaking a language with a grammatical gender system utilize grammatical gender as a cue when determining whether a general biological property applies to a given object. As we have noted, speakers of a language with grammatical gender must *refrain from projecting grammatical gender onto biological sex.*

In the case of adults, Imai, Schalk, Saalbach, and Okada (2010b) found that German speakers projected sex onto grammatical gender and often made erroneous inferences (e.g., inferring that giraffes (feminine in German) in general have a biological property that is only possessed by female animals), especially when they were under time pressure. This result suggests that although German speakers must be consciously aware that grammatical gender is not directly linked to the biological sex of the referent, they do link biological sex and grammatical gender under certain circumstances. In particular, this effect is likely to occur when the target has a biological sex and when participants must determine the biological sex of the target.

What about children? Do children also (erroneously) use grammatical gender when drawing inferences about the sex-specific properties of animals? If the overgeneralized gender-sex mapping observed in German-speaking adults is acquired in the process of syntactic bootstrapping (i.e., children's assumption that grammatical classes reflect conceptual classes), as argued by Vigliocco et al. (2005), we should also see this mapping in young children who have already learned the grammatical gender system.

2. The present study

In this study, we explored the question of gender-sex mapping in children by comparing German-speaking preschool-aged children with children of the same age who speak Japanese, which does not have a gender system. It has been demonstrated that children as young as 3 years of age accurately assign nouns to gender classes in German (MacWhinney, 1978; Mills, 1985, 1986; Szagun, 2004; Szagun & Steinbrink, 2004). Thus, it is of great interest to determine whether prior to formal instruction in school, young children differ in their reasoning about animals' biological sex and in their inferences about the animals' biological sex-specific properties, depending on whether the children speak a language with or without a grammatical gender system.

As noted earlier, the effects of grammatical gender are less likely to be seen in languages with more than two gender classes because the concept-grammar mapping is irregular and hence not transparent in these languages. However, although German has three gender classes, both articles and pronouns correspond to the grammatical gender class of the animal instead of its biological sex, unless the animal's biological sex is pragmatically important. Furthermore, the majority of basic-level animal names in German belong to either the masculine or the feminine gender class.[1] In this sense, the concept-grammar mapping seems to be evident even to German speakers, at least for nouns referring to humans and animals (Imai et al., 2010a).

In the literature concerning the relation between language and thought, researchers have often asked whether the given influence of language is observed in purely non-linguistic thought or only within the realm of language use. In the former case, the effect is considered to be evidence of linguistic relativity (or the Whorfian hypothesis). In the latter case, the effect is considered only to be evidence of ''thinking for speaking'' (e.g., Slobin, 1987, 1996). In light of this distinction, our research concerns ''thinking for speaking'' but not ''linguistic relativity'' in two ways: (1) performing the task clearly involves language; (2) for German children, the gender-marking article was presented with the target noun. However, for speakers of languages with grammatical gender, marking gender by articles or pronouns is the *norm* rather than the exception in everyday discourse. If we found that children linked the grammatical gender of an animal's name to its biological sex (even though the two are orthogonal) and applied this link when making inferences about the sex-specific properties of animals (even though the children consciously knew that they should not do so), this result would suggest that grammatical particles, such as gender-marking articles, may affect how German-speaking children reason, which is in itself an extremely important

question for cognitive science, regardless of whether it is characterized as evidence of linguistic relativity.

2.1. Study 1

The first study was conducted to examine whether grammatical gender affects German-speaking children's inferences about sex-specific biological properties. The task used in this study is a property inference task that required children to make a (uncertain) judgment about whether a sex-specific property given in a premise applies to a given animal. Specifically, we told the children that an unknown internal property was shared by all male animals or all female animals. We used the terms ''daddy animals'' and ''mommy animals'' to indicate the animals' biological sex. We then asked the children whether the animal shown in the picture would have that property. For example, the experimenter said, ''*Alle Papa-Tiere haben BROMA innen drin. Hat der*$_{[MASC]}$ *Pinguin BROMA innen drin*?'' (''All daddy animals have BROMA inside. Does the penguin have BROMA inside?''). Children were asked to reply with ''yes'' or ''no.'' If there is a relationship between grammatical gender and children's inferences about an unknown property, German-speaking children should be more willing to infer that the property given in the premise holds for the target animal when the target animal's grammatical gender corresponded to the biological sex mentioned in the premise than when the target's grammatical gender did not match the sex given in the premise. This asymmetry was not expected to occur in Japanese children.

2.1.1. Methods

2.1.1.1. Participants: Sixteen native German-speaking 5-year-olds (8 girls and 8 boys; mean age: 5.6, ranging from 5.1 to 5.11), living in Berlin, and 16 native Japanese-speaking 5-year-olds (10 girls and 6 boys; mean age: 5.4, ranging from 5.0 to 5.8), living in a suburban city in the Greater Tokyo area, participated in this study. The demographic properties of the German and Japanese children were comparable.

2.1.1.2. Materials: We selected 12 animals from a range of kinds (mammals, reptiles, birds, and insects) as experimental stimuli that both German and Japanese children would be familiar with (listed in Table 1). Among the 12 basic-level names of the animals, 6 were grammatically feminine and 6 were grammatically masculine in German. The selection of animals was made on the basis of the results of masculinity-femininity ratings conducted with 29 Japanese adults, who rated 42 basic-level animal names on an eleven-point rating scale (ranging from very female to very male, with zero indicating neutral with respect to femininity/masculinity). Half of the animals were grammatically feminine in German, the other half grammatically masculine. We selected six grammatically feminine and masculine animals each, whose rating scores were the closest to zero.

Black-and-white drawings of animals were used as the experimental stimuli. The drawings of the animals were either taken from Snodgrass and Vanderwart (1980) or were supplemented by structurally similar pictures. Additionally, we selected 12 pictures of either animals or artifacts for both the practice and the control trials. All pictures were scaled to

Table 1
Stimuli used in Studies 1 and 2

Grammatical gender in German	
Feminine	Masculine
Bee	Worm
Duck	Frog
Mouse	Chimpanzee
Owl	Dolphin
Seal	Penguin
Spider	Leopard

the same size. The children saw the pictures of the animals on the screen of a 15″ laptop monitor against a black background.

Although previous reports suggest that German children of this age have an almost adult-like knowledge about gender class assignment for the nouns they use (Szagun, 2004; Szagun & Steinbrink, 2004), we conducted a pre-study to ascertain that German preschool-age children would be able to correctly assign grammatical gender to the selected animals. Ten 5-year-olds (mean age: 5.6, ranging from 5.2 to 5.11), who did not participate in either of the main studies, were shown pictures of the selected animals and were asked to describe each animal's mood as happy, angry, or sad. Moods were indicated by one of three face icons (i.e., one with a happy, one with a sad, and one with an angry expression) placed above each animal. The children were instructed to reply in a full sentence, which required them to assign a gender to the animal's name (e.g., ''The mouse [German: *die*$_{[FEM]}$ *Maus*] is happy''). The children's performance was close to perfect (99%).

2.1.1.3. Procedure: The children of both language groups were tested individually in a quiet room in their preschool. The entire experiment consisted of 8 practice trials, 4 control trials, and 12 experimental trials. The practice items were used to familiarize the children with the experimental procedure. Prior to the practice trials, children were first told that there are mommies and daddies for animals, just as there are mommies and daddies for humans. Additionally, children were told that animals, just like humans, have certain things inside (e.g., blood) and that these properties can differ between biological genders (e.g., ''mommy animals can have a baby inside their body'').

In the first two practice trials, we asked children simple questions to ensure that they could say ''yes'' or ''no'' according to the question. For example, they were shown a picture of a cat and asked whether it was a dog. After confirming that the children were clearly able to indicate both ''yes'' and ''no,'' we proceeded to the next two practice trials to ensure that the children were able to draw inferences concerning familiar biological properties and to indicate the answer by saying ''yes'' or ''no.'' Here, the children were shown a picture of a familiar animal or a non-animal object and were told that the object shown in the picture had a particular property. For example, in one trial, children were told that all trees have leaves and were then asked whether the kangaroo shown in the picture also had leaves. In another trial, children were told that all birds can fly and were asked

whether a sparrow could fly. Lastly, another four practice trials were conducted to familiarize the children with the task of giving answers to questions about sex-specific properties. The children were shown pictures of animals whose sex can be clearly indicated by their appearance (e.g., a male lion [with a mane], a milk cow). They were then asked, for example, whether the animal (e.g., the male lion) in the picture could have babies. The target animals were selected so that the grammatical gender was orthogonal to the correct response and hence could not serve as a cue for answering the question. After confirming that the children understood the procedure and were able to indicate ''yes'' or ''no'' according to the question, we moved on to the main experiment.

The experiment consisted of 12 experimental trials and 4 control trials. The experimental and control trials were intermixed and were presented in a random order. The 12 experimental items consisted of 6 grammatically feminine and 6 grammatically masculine animals, which had not been used in the practice trials (see Table 1). Four control items were included to prevent the children from falling into a pattern of answering ''yes'' or ''no'' consistently without processing the questions carefully. The controls consisted of two pictures of artifacts and two pictures of animals, which had not been used in the experimental or practice trials.

In each experimental trial, children were taught a novel internal biological property specific to either female or male animals (e.g., ''All mommy animals have IDOFORM inside.'' [German: *Alle Mama-Tiere haben IDOFORM innen drin*.]). The female or male assignment of the property to each target object was counterbalanced across participants. Then a picture was presented, and the child was asked whether the animal shown would have this property (e.g., ''Look here! Does the owl also have IDOFORM inside?'' [German: *Schau mal! Hat die*$_{[FEM]}$ *Eule auch IDOFORM innen drin*?]). In each trial, a different (unknown) property was used. Note that the target noun was accompanied by the gender-marking article because this construction is a natural way to indicate a generic animal name in German (e.g., Behrens, 2005); however, the gender-marking article did not appear in the noun phrase of the premise (i.e., mommy/daddy animals) or in the property (e.g., IDOFORM). In the control trials, the experimenter taught the children a novel property that was shared by *all animals*, saying, for example, ''All animals have QUONTIN inside.'' The experimenter then asked the children whether the object shown in the picture was likely to have this property. In two of the control trials, the children were shown a picture of an animal and hence were expected to give a ''yes'' response. In the other two control trials, an artifact object was presented, and the children were expected to reply ''no'' to the experimenter's question.

It should be noted that the *all-animals* premises do not logically exclude the possibility that non-animate entities also have the property. Nevertheless, in everyday contexts, even adults are likely to draw an inference that an artifact object does not have the property in this case. We thus considered the ''no'' response for the artifact items to be a ''heuristically correct'' response.

During the experimental trials, the children were encouraged and praised for whatever response they gave but were not given explicit feedback on whether their answer was ''correct.'' All children were tested individually in a quiet room in their preschool. The testing time was between 10 and 20 min.

2.1.2. Results and discussion

All children successfully gave correct (i.e., heuristically reasonable) responses in at least three of the four control trials. Thus, the data from all children were included in the analyses. We categorized the children's responses in the experimental trials into four response categories: consistent ''yes'' answers (i.e., saying ''yes'' when the grammatical gender of the animal and the biological sex specified in the premise matched), consistent ''no'' answers (saying ''no'' when the grammatical gender of the animal and the biological sex specified in the premise did not match), inconsistent ''yes'' answers (saying ''yes'' when the grammatical gender of the animal and the biological sex specified in the premise did not match), and inconsistent ''no'' answers (saying ''no'' when the grammatical gender of the animal and the biological sex specified in the premise matched).

We checked whether Japanese- and German-speaking children differed with respect to the distribution of their ''yes'' and ''no'' responses. Both Japanese and German children applied the property to the target animal (i.e., replying ''yes'') in about 7 out of 12 cases in the experimental trials ($M = 7.31$ and $M = 7.19$, respectively). Thus, Japanese and German children did not differ in their overall willingness to give ''yes'' responses, $t(30) = .124$, $p > .5$.

We thus merged the four response types into two types according to whether the response was in correspondence with the animal's grammatical gender class in German: gender-consistent responses (the consistent ''yes'' answers and the consistent ''no'' answers) and gender-inconsistent responses (the inconsistent ''yes'' answers and the inconsistent ''no'' answers) for the subsequent analysis. Both subject and item analyses were computed. The two kinds of analyses are indicated by subscripts: the subscript $_1$ refers to the subject analysis and the subscript $_2$ refers to the item analysis.

As shown in Fig. 1, German preschoolers gave more gender-consistent responses than expected by chance (50%), 63.6%, $t_1(15) = 4.615$, $d = 1.15$, $p < .01$, $t_2(11) = 4.733$, $p < .01$, whereas the gender-consistent answers of their Japanese peers did not differ from the chance level, 47.4%, $t_1(15) = -0.863$, $d = -0.22$, $p > .4$, $t_2(11) = 4.615$, $p > .4$. More important, a comparison between the two groups revealed that the rate of gender-consistent responses was significantly higher for German (63.6%) than for Japanese children (47.4%), $t_1(30) = 3.837$, $d = 1.356$, $p < .01$; $t_2(11) = 2.898$, $p = .015$.

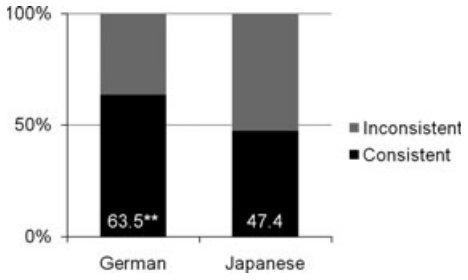

Fig. 1. Percentages of gender-consistent and gender-inconsistent responses by German and Japanese children in Study 1. **Proportion significantly above chance level (50%), $p < .01$.

As these results indicate, German-speaking children showed a strong asymmetry in their willingness to project the property onto the target animal in accordance with a match (or mismatch) between the sex specified in the premise and the target animal's grammatical gender. This result suggests that grammatical gender affects the way German children make inferences about the sex-specific biological properties of animals. This asymmetry in the responses was not found in Japanese children. However, an important question remains: Does this difference between German and Japanese children warrant the conclusion that the two groups of children actually differ in their ways of drawing inferences about the sex-specific properties of animals?

One may wonder whether the cross-linguistic difference between the two groups of children could be attributed to a difference in their general willingness to draw inferences from a premise rather than to the influence of grammatical gender. We think this alternative interpretation is unlikely for two reasons. First, as reported above, German and Japanese children did not differ in their willingness to draw inferences when asked about biological properties that were common to ''all animals'' (in the control trials) instead of ''all mommy (or daddy) animals.'' Second, the children of the two language groups did not differ in their overall proportions of ''yes'' responses in the experimental trials.

However, it is interesting to go a step further and ask whether German and Japanese children use different sources of cues as a basis for their inferences. On what basis did Japanese and German children determine whether a given target animal was likely to have the sex-specific property indicated in the premise? Previous research has demonstrated that young children's notions of animals differ from those of adults. Although children may have been taught that *all* animals have a certain biological property, they tend to think that only certain kinds of animals have that property (e.g., Carey, 1985; Gutheil, Vera, & Keil, 1998). One possibility is that Japanese children's pattern of inferences about sex-specific properties (i.e., how likely they are to think that the target animal has the property) directly mirrors their pattern of inferences about properties common to all animals because they have no other valid cue for generalizing sex-specific properties. In contrast, German children might have based their inferences on the animal's grammatical gender rather than on their judgment of how likely the target animal was to share the property that all animals were supposed to have.

We tested these possibilities in Study 2: We examined whether German and Japanese children's patterns of inferences about sex-specific properties were related to their patterns of inferences about whether the same target animal has a property that is shared by all animals.

We expected Japanese children's inferences about sex-specific properties for a given animal to reflect their inferences about properties shared by all animals. If this is the case, their willingness to draw inferences about properties common to all animals should be highly correlated to their willingness to draw inferences about sex-specific properties. In contrast, German-speaking children's inferences about sex-specific properties may be more strongly related to the target animal's grammatical gender. Thus, their willingness to draw inferences about properties that are common to all animals should not be correlated with their willingness to draw inferences about sex-specific properties. If this is the case, then children speaking a language with grammatical gender reason differently about sex-specific

biological properties in animals compared with children speaking a language without a grammatical gender system.

Therefore, we asked German-speaking and Japanese-speaking children to draw inferences about animal-general properties and examined how closely the pattern of children's inferences about the animal-general properties was related to their pattern of inferences about the sex-specific animal properties in Study 1.

2.2. Study 2

In Study 2, using the same animals as in Study 1, German-speaking and Japanese-speaking children were taught a novel biological property. They were told that this property was shared by *all animals.* We then asked the children whether this property was also a property of the target. For example, the children were told that all animals have QUONTIN inside. They were then asked whether the target animal would have QUONTIN inside. The target was either one of the animals used in Study 1 or an inanimate object. Here, ''yes'' answers were correct for all animal targets. Inanimate objects (e.g., a *table*) were included to balance affirmative and negative responses. The premise that all animals have a certain property does not logically exclude the possibility that inanimate objects also have that property, but this is what children usually understand (e.g., Markovits, 2000). We thus expected the children in Study 2 to say ''no'' when asked to draw inferences about non-animal objects.

2.2.1. Methods

2.2.1.1. Participants: Sixteen native German-speaking 5-year-olds (8 girls and 8 boys; mean age: 5.6, ranging from 5.0 to 5.11) from Berlin and 19 native Japanese-speaking 5-year-olds (8 girls and 11 boys; mean age: 5.6, ranging from 5.2 to 5.11) from a suburban city in the Greater Tokyo area participated in this study; their demographic background was the same as that of the children in the previous study. None of the children had participated in Study 1.

2.2.1.2. Materials: The stimulus materials consisted of 24 black-and-white line drawings. Twelve of them depicted the animals that were used in the experimental trials of Study 1. Another 12 drawings of non-animal objects (artifacts and plants) were taken from Snodgrass and Vanderwart (1980).

2.2.1.3. Procedure: As in Study 1, practice trials were conducted prior to the experimental session to ensure that the children could clearly indicate both ''yes'' and ''no.'' The materials and the procedure of the practice trials in this study were identical to those of the practice trials in Study 1. During the experimental session, the children were taught a novel biological property that applied to all animals (e.g., ''All animals have IDOFORM inside'') and were then asked whether the property could be applied to a specific animal (e.g., ''Does the owl have IDOFORM inside?'') or to a non-animal object (e.g., ''Does the table have IDOFORM inside?''). In each trial, a different (unknown) property was used. Associations of the property with an animal or a non-animal were counterbalanced across subjects. The

trials with animal targets and non-animal targets were intermixed and were presented in a random order. As in Study 1, no feedback was provided on whether children's responses were correct or incorrect. They were praised and encouraged regardless of their responses.

2.2.2. Results and discussion

First, we found that German and Japanese children did not differ in their overall willingness to judge that the target object had the novel biological property given in the premise. For animal items, both German and Japanese children tended to think that the target had the property given in the premise, which stated that the property was shared by all animals (i.e., they said ''yes''). However, the proportions of ''yes'' responses were not perfect: German, 77.6%; Japanese, 81.1%. There was no significant difference between the German and Japanese children, $t_1(33) = 0.473$, $p > .4$; $t_2(11) = 0.802$, $p > .4$. For non-animal items, children from both language groups strongly avoided applying the property to the target object (i.e., they said ''no''): German, 92.7%; Japanese, 91.2%. The percentages of rejections did not differ significantly between the two language groups, $t_1(33) = 0.339$, $p > .4$, $t_2(11) = 0.462$, $p > .4$.

To examine whether German and Japanese children used different cognitive bases when making inferences about sex-specific properties, we correlated the patterns of ''yes'' responses for the animal items in Studies 1 and 2 for each language group. Correlation coefficients are shown in Table 2. In the German group, as expected, children's judgments about animal-general properties (Study 2) were not related to their judgments about sex-specific properties in Study 1 ($\tau = .176$, $p > .4$). Instead, German children's judgments about sex-specific properties were significantly correlated with the correspondence between the grammatical gender of the animal name and the biological sex specified in the premise ($\tau = .571$, $p < .01$). In sharp contrast, and as expected, Japanese children's pattern of inferences about sex-specific properties in Study 1 was indeed significantly correlated with their pattern of inferences about animal-general properties in Study 2 ($\tau = .531$, $p < .05$). The correspondence between the grammatical gender of the animal name in German and the biological sex specified in the premise did not affect Japanese children's inferences ($\tau = .090$, $p > .4$).

Our findings suggest that Japanese children's willingness (or unwillingness) to apply sex-specific properties to specific animals reflected their pattern of inference for properties common to all animals. In contrast, German children relied on the grammatical gender of the animal for their inferences about sex-specific biological properties.

Table 2
Coefficients for correlations between inferences about sex-specific properties and inferences about animal-general properties, as well as gender class

	Inferences About Sex-Specific Properties (Study 1)	
	German	Japanese
Grammatical gender of German animal name	$\tau = .571$**	$\tau = .090$
Inferences about animal-general properties (Study 2)	$\tau = .176$	$\tau = .531$*

3. General discussion

The results of this study suggest that there is a relation between grammatical gender and German-speaking children's reasoning about sex-specific properties. In a property inference task, we found that grammatical gender affected German preschoolers' inferences about sex-specific biological properties. German preschoolers were more likely to judge that the target animal possessed a sex-specific property when the grammatical gender of the animal matched the biological sex specified in the premise than when there was no correspondence between grammatical gender and biological sex. Furthermore, we found that German-speaking and Japanese-speaking children used different bases for drawing inferences about the sex-specific properties of animals. While German-speaking children relied on the target animal's grammatical gender class, Japanese children's inferences reflected how likely they thought it was that the animal had properties shared by *all animals*.

3.1. The influence of the gender system on property inference

Our findings suggest that 5-year-old German children utilize grammatical gender as a cue for reasoning about sex-specific biological properties. This in turn suggests that German-speaking children are unconsciously biased to think, for example, that all giraffes are likely to have female properties simply because the noun '*giraffe'* is grammatically feminine. This ''misconception'' may have arisen from a relatively small number of cases in the lexicon in which gender class and biological sex do overlap, as is the case for human beings. This account is consistent with Vigliocco et al.'s (2005) *sex and gender hypothesis*, which holds that young children speaking a gender language notice the correspondence between nouns referring to human biological sex and the grammatical gender of these nouns, which leads them to link biological sex and grammatical gender conceptually. Children may then overextend this principle to (non-human) animals because these animals are sexuated entities like humans, although generic animal names include both sexes.

The relation between grammatical gender and children's inferences about the sex-specific properties of animals is also consistent with previous research investigating the interplay between language and conceptual development. Young children build their knowledge, including biological concepts, largely through spontaneous inferences and in doing so, they recruit a variety of cues, including perceptual and taxonomic similarity, as well as linguistic cues (e.g., Carey, 1985; Gelman & Markman, 1986; Inagaki & Hatano, 1996, 2003; Waxman & Markow, 1995). For example, in the domain of biology, Inagaki and Hatano (1996) showed that preschoolers' spontaneous classification of living things included only humans and animals but not plants. However, when asked to make inferences about biological properties that could be applied to both animals and plants (e.g., *need nutrients* or *become bigger*), preschoolers extended their conceptions of living things to include plants. The same linguistic treatment of animals and plants (i.e., applying the same predicate for animals and plants) may thus serve as a basis for children to recognize the commonality between animals and plants. Likewise, Gelman and Markman (1986) found that 4-year-olds predominantly based their inferences about biological properties on the perceptual similarity

of animals. However, when categories were labeled prior to the inference task, the basis of children's induction shifted to taxonomic relations. Using the same linguistic forms thus invited the children to detect the similarities among category members, which subsequently served as their basis for inferences about biological properties.

By analogy, our research suggests that the grammatical gender class membership of animals may serve as a cue for German-speaking children's inferences about animal properties, especially when children reason about whether a property that is said to hold for a general class also applies to a specific object. In contrast to previous studies (e.g., Sera et al., 2002; Vigliocco et al., 2005), the present research revealed a gender effect in German, a language with three gender classes. This finding suggests that a relation between grammatical gender and the speakers' reasoning about animals may not be limited to languages with only two gender classes. The difference between previous studies and ours may be attributed to the nature of the experimental task. Tasks that directly require participants to make inferences about sex-specific biological properties may be more likely to trigger the linkage between grammatical gender and biological sex within the domain of animals than are tasks that do so by indirect means (e.g., by asking about entities without a biological sex).

3.2. Limitations and implications for theories of language and thought

The present research suggests that German children utilize grammatical gender as a cue for making inferences about sex-specific animal properties. These results may thus be seen as support for the hypothesis that certain linguistic structures affect people's ways of thinking about certain entities (for an overview, see Gentner & Goldin-Meadow, 2003).

However, we do not intend to claim that German and Japanese children are fundamentally different in their conceptual representations of animals, nor do we claim that any differences found between German and Japanese children should be attributed to language alone. For example, German and Japanese children may well differ with respect to the animals that they consider typical, and this disparity would largely be due to cultural differences. Furthermore, because our task was heavily language-based, we are aware that our findings may be seen as evidence of ''thinking for speaking'' only (e.g., Slobin, 1987, 1996), which theoretically frames the conceptual influence of language only within the realm of language use (e.g., paying attention to and encoding a particular aspect of the world in order to talk about events and objects). Some researchers may also be concerned that it is not fair to compare German-speaking children and Japanese-speaking children because German children heard the gender-marking article with the noun, whereas Japanese children did not.

Despite these limitations, the critical issue may not be whether the effect of grammatical gender should be characterized as evidence of ''thinking for speaking'' or ''linguistic relativity.'' We do, after all, reason primarily with language. In other words, it is altogether natural for us to make inferences based on language. Furthermore, for speakers of languages with grammatical gender, explicit gender marking by articles or pronouns is the *norm* rather than the exception in everyday discourse. The results of the two experiments indicate that German-speaking children and Japanese-speaking children made inferences about

sex-specific properties on different bases; the former could use the grammatical gender of an animal's name as a cue, whereas the latter could not. We conclude that grammatical gender has non-trivial consequences for inferences about sex-specific properties in German-speaking children, regardless of whether this finding can be characterized as evidence of linguistic relativity.

Recent neurological studies in color perception suggest that language is automatically accessed and, as a consequence, crosslinguistic differences are found in brain activity even in ''purely'' perceptual tasks (e.g., Tan et al., 2008; Thierry, Athanasopoulos, Wiggett, Dering, & Kuipers, 2009). In light of this finding, perhaps there is no ''purely non-linguistic'' context for humans in natural settings. Framing the investigation of the relation between language and thought only around the traditional approach to linguistic relativity—that is, focusing only on differences in *non-linguistic* cognitive functions—may cloud our understanding of the role of language in thought or even in the nature of human cognition.

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Note

1. Although there are three gender classes in German, in the animal domain, the grammatical gender class of most animal terms is either masculine or feminine. Animals with neuter gender, mostly belonging to the domain of companion animals (e.g., horse [German: das Pferd]), are typically specified into males and females by distinct names (e.g., mare, stallion [German: die Stute, der Hengst]) (Zubin & Köpcke, 1986).

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