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Grammatical gender in German: A case for linguistic relativity?

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The "principle of linguistic relativity" holds that, by way of grammatical categorization, language affects the conceptual representations of its speakers. Formal gender systems are a case in point, albeit a particularly controversial one: Previous studies obtained broadly diverging data, thus giving rise to conflicting conclusions. To a large extent, this incoherence is related to task differences and methodological problems. Here, a priming design is presented that avoids previous problems, as it prevents participants from employing gender information in a strategic manner. Four experiments with German native speakers show priming effects of the prime's grammatical gender on animate and nonanimate targets, an effect for the prime's biological gender on animate targets, but no effect for the prime's biological gender on nonanimate targets, and thus speak against an effect of language on thought for German gender.

Keywords: Grammatical gender; Cognition; Language; Linguistic relativity; Priming; German.

Does the grammatical gender of nouns affect the conceptual representation of the respective objects? In other words: Do speakers of German consider the sun (*Sonne*) as more female than the moon (*Mond*), simply because the former has feminine grammatical gender (*die Sonne*) and the latter masculine (*der Mond*)?

This question is closely linked to the discussion on whether language affects thought. While there has been ample and unambiguous evidence for linguistic impacts on cognition on a general level since at least the 1930s (e.g., Carmichael, Hogan, & Walter, 1932; and see Kuhnmünch & Beller, 2005; Loftus & Palmer, 1974), the so-called "Whorfian effects" have been subject to a controversial debate for more than half a century. Whorf reasoned that language organizes the "kaleidoscopic flux of impressions" (1956, p. 213) from the outside world by imposing categorization principles through its grammar, and the way in which this is done differs considerably across languages. His *principle of linguistic relativity* holds that this imprint of grammar should lead users of markedly different grammars to "arrive at somewhat different views of the world" (Whorf, 1956, p. 221; see also Gentner &

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Goldin-Meadow, 2003; Gumperz & Levinson, 1996; Lucy, 1992; Sapir, 1921).

Several domains have been scrutinized for such effects of language on cognition, none of which have yielded unequivocal results, among them colour discrimination (Regier, Kay, & Cook, 2005; Roberson, Davies, & Davidoff, 2000), spatial representations (Levinson, Kita, Haun, & Rasch, 2002; Li & Gleitman, 2002), and temporal perspectives (Boroditsky, 2001; Chen, 2007; January & Kako, 2007; cf. Bender, Beller, & Bennardo, 2010, for a discussion). In an attempt to integrate negative and positive findings, Boroditsky, Schmidt, and Phillips (2003) suggested that linguistic impacts on thought may be more powerful for more abstract domains (i.e., domains that are not so reliant on sensory experience) and raised grammatical gender as a particularly abstract case, due to the perceived arbitrariness of gender assignment to objects.

Gender and its possible impacts

Most Indo-European languages (including English and German) have gender systems, albeit to a varying degree. Genders are defined as classes of nouns that entail morphosyntactic agreement in associated words (cf. Hockett, 1958, p. 231). For instance, in *den einen schwarzen Hund* ("the one black dog"; accusative), determiner, numeral, and adjective take specific endings, which are characteristic for the masculine gender of *Hund*. Depending on how gender is assigned within a given language, two types of gender systems are distinguished: In *semantic* gender systems, the gender of a noun can be derived from its meaning, with English being a case in point, although English does have some exceptions to the general rule (such as feminine ships). *Formal* systems, on the other hand, extend gender categories beyond nouns for sexuated referents, and they do so according to morphological or phonological rules. In these cases, gender depends on the form of the noun.

The two most debated genders in the psychological literature are masculine and feminine, due to their apparent connotation of biological gender (or sex). After all, the class that happens to encompass the word for "man" was termed "masculine", and the class that happens to encompass the word for "woman" was termed "feminine". However, while the gender distinction may coincide with a distinction of sex, it need not do so. In fact, gender languages distinguish between up to 20 genders, and in some languages (even of the Germanic branch, such as Dutch or Swedish), one *common gender* unites what in other languages is either *masculine* or *feminine* (for detailed discussions of gender and its variations, see Comrie, 1999; Corbett, 1991).[1]

For centuries, philosophers and linguists have therefore used the term "gender" in its original sense, which—going back to Latin *genus* (German: *Genus*)—simply referred to "kind, sort". Although these "kinds" rarely reflect sex differences neatly, people may feel invited by the very term "gender" to draw a connection between gender and sex, and researchers interested in the principle of linguistic relativity repeatedly put forward the assumption that speakers of gender languages may include gender information—and hence notions related to the respective sex—in their conceptual representation of objects (Boroditsky et al., 2003; Flaherty, 2001; Konishi, 1993; Sera, Berge, & Castillo Pintado, 1994).

However, whether the grammatical gender assigned to a noun really rubs off on its semantic content, has been controversially discussed: For Romance languages like Spanish or Italian, respective effects have been reported by at least five groups of researchers (Boroditsky et al., 2003; Flaherty, 2001; Koch, Zimmermann, & Garcia-Retamero, 2007; Konishi, 1993; Sera et al., 1994, 2002), while mixed findings were obtained by Vigliocco's team (Bowers, Vigliocco, Stadthagen, & Vinson, 1999; Kousta, Vinson, & Vigliocco, 2008; Vigliocco, Vinson, Paganelli, & Dworzynski, 2005). For German, the picture is

[1] To minimize confusion between the two, the term "sex" will be used in the following for the biological gender of animates, and the term "gender" for the grammatical category (cf. Comrie, 1999).

even more obfuscated. Here, gender effects on object conceptualization have been observed by some (Boroditsky et al., 2003; Konishi, 1993; Mills, 1986; Phillips & Boroditsky, 2003), but not by others (Koch et al., 2007; Sera et al., 2002; Vigliocco, Vinson, Indefrey, Levelt, & Hellwig, 2004; Vigliocco et al., 2005). On a different level, studies focusing on gender retrieval in language production replicate similar differences between Romance languages and German (Kousta et al., 2008; Vigliocco et al., 2004). One possible explanation for such a cross-linguistic difference is that the Romance languages, with only two genders, allow for a closer association between gender and sex than German, with its three genders (Sera et al., 2002).

More importantly, however, methodological differences also account for a good deal of the incoherent results. An early approach was to ask participants to rate targets according to the semantic differential (Osgood, Suci, & Tannenbaum, 1957), with potent ratings indicating a male conceptualization (Konishi, 1993). Other researchers explicitly asked participants to assess how masculine or feminine the targets are, or to assign a male or female voice to them (Sera et al., 1994, 2002). Without a rationale for answering questions like "How masculine (or potent) is a bridge?", a strategy that suggests itself in this kind of task is to draw on the grammatical gender. In the triadic judgement task (Vigliocco et al., 2005), participants had to rate the similarity of targets (either words or pictures of either animals or artifacts). A small effect of gender (limited to animals in the word condition) was found for Italian, but not for German. As in previous studies, the effect in Italian might have been due to employing gender strategically, whereas the null result for German could have been brought about by participants simply sticking to the task and focusing on semantic similarity.

In order to prevent such strategies, several alternatives were devised. Bowers and colleagues (1999) asked their (Spanish-speaking) participants to decide, for a range of words, as compared to pictures, whether they require the masculine or feminine determiner. From the observed advantage for words, they concluded that grammatical gender is not directly linked to the corresponding concept. However, the question remains open of whether a semantic notion of gender derived from the grammatical category is linked to the concept.

In contrast, Boroditsky reports significant effects also for German. Boroditsky and Schmidt (2000), for instance, asked (German- and Spanish-speaking) participants to memorize pairs of nouns and names, with half of the pairs having the same gender/sex and the other half having diverging gender/sex. In the recall phase, participants had to indicate the sex of the name paired to each noun, and they did better for consistent pairs than for inconsistent ones. By its very nature, however, this task favours the consistent condition: Even with no memory at all, a simple heuristic like "take the same gender" would result in consistent pairs (which would all be answered correctly) leading over inconsistent ones (all incorrectly; for related results and their discussion, see Boroditsky et al., 2003; Foundalis, 2002; Koch et al., 2007; Phillips & Boroditsky, 2003).

So far, the research attempts that are least subject to participants' strategies are tasks that elicit semantic substitution errors (Kousta et al., 2008; Vigliocco et al., 2004). However, there is some debate on how to interpret the respective results, depending on the underlying model for gender retrieval. Summarizing findings for an effect of gender on conceptual representations, Kousta et al. therefore concluded that the evidence is still ambiguous and is complicated by methodological problems. In particular, studies were often designed so as to favour either a semantic or a purely grammatical decision. Consequently, results diverged greatly, with an apparent effect of gender on conceptualization in the former group and no such effect in the latter.

The main goal of our study was to tackle this issue in a nonconfounded and unambiguous way for the particular case of German gender. We therefore combined a lexical decision task with a priming design and worked with native speakers of German. The basic idea was to present grammatical and semantic primes and to ask

participants to decide whether the target was a word (Experiment 1) or which gender it had (Experiments 2 to 4).

Our design departs from the traditional procedure in that it does not contrast two languages, but rather two classes of words (i.e., masculine and feminine nouns) within one language. This procedure should enable us to assess whether or not there is an effect of noun class (i.e., gender) on the semantic level (for possible implications of this procedure, see also the discussion). Before describing these experiments in more detail, we provide some background information on the gender system in German.

The German gender system

All nouns in German have one of three grammatical genders: masculine (with 39% of all nouns), feminine (35%), and neuter (26%; Schwichtenberg & Schiller, 2004). A small number of words have shifting gender assignment, basically due to some regional variance. For practical reasons, neuter was not considered in our study.[2]

Gender assignment in German is quite complex. For some groups of nouns, gender is largely derived from meaning and thus is assigned through semantic rules. For instance, the gender of nouns referring to people largely reflects their sex; in addition, most fruits are feminine (except for apples and peaches), and most alcoholic beverages are masculine (except beer; Dudenredaktion, 2005, p. 160; and see Schwichtenberg & Schiller, 2004). However, the vast majority of assignment rules are formal. Of these, a small proportion are based on morphological aspects (e.g., nouns with the suffixes "-ung", "-heit", or "-keit" tend to be feminine), whereas most are based on phonological aspects (e.g., nouns ending in "-e" tend to be feminine). Each of these rules has various exceptions, however. For instance, nouns ending in "-e" may also be masculine (as in the case of *Friede*, "peace", or *Käse*, "cheese") and are often masculine when denoting people (such as *Junge*, "boy", or *Psychologe*, "psychologist"). Given that these phonological rules describe tendencies rather than perfect matching, they might be better labelled stochastic rules or regularities (cf. Köpcke & Zubin, 1983).

And yet, most people are convinced that gender assignment in German is arbitrary. At least the linguistically untrained native speakers participating in our studies regularly insisted that regularities for gender assignment do not exist (apart from a few well-known morphological regularities such as that nouns suffixed by "-chen" change into neuter). A popular example of this perceived arbitrariness is the triplet *das Messer, die Gabel, der Löffel* ("the$_{neu}$ knife, the$_{fem}$ fork, the$_{mas}$ spoon"). Similarly, Corbett (1991, p. 92) reports that even simple assignment rules do not operate on a conscious level and continues to characterize German as a particular complex case. It is thus not surprising that it took years of meticulous research to identify and document the respective regularities (for pioneering work in this regard, see e.g., Köpcke & Zubin, 1983, 1984; Zubin & Köpcke, 1986; for more recent experiments, see Hohlfeld, 2006; Schwichtenberg & Schiller, 2004).

But do people make use of these regularities when assigning gender? In order to test this, several experiments examined how native speakers assign gender to nonwords, which were constructed according to these regularities (Hohlfeld, 2006; Köpcke & Zubin, 1983; Schwichtenberg & Schiller, 2004). While these studies revealed that most native speakers do follow at least some of these regularities when assigning gender to new words, Hohlfeld (2006) cautions against generalizing these findings. Based on her studies, in which gender had to be

[2] We are primarily interested in whether the grammatical gender of nouns affects the conceptual representation of the respective objects; hence, we restricted our material to the two genders that might be linked to sex (neuter is not). This restriction should have no consequences for people's decisions in the tasks, and it should not be critical for generalizing the findings. As reported above, the observed differences in gender impact on thought between German and Romance languages have been explained through their differences in gender systems (Sera et al., 2002; Vigliocco et al., 2005). Accordingly, the two genders in Romance languages facilitate a sex-to-gender mapping during learning, whereas the three genders in German do not. In this sense, neuter is crucial only for the difficulty with which associations are acquired during the lifetime; it is not relevant for performance in our task.

assigned to transparent nouns (i.e., nouns conforming to gender-marking regularities) and nontransparent nouns, she concludes that the default route to gender assignment is the lexical route. The form-based route, on the other hand, is only used when no lexical entry is accessible, as in the case of nonwords.

Since people are not aware (or are unsure) of their intuitions regarding gender assignment, what they typically do in order to assess the gender of a noun is combine it with a definite determiner and test their agreement. For instance, *Löffel* is masculine if *der Löffel* sounds "right"—an intuition that is largely derived from the lexical entry. This strategy is emphasized by the standard volumes on German language (Dudenredaktion, 1996, 2005), which indicate gender simply by giving the appropriate definite determiner.

When examining whether the grammatical categorization of a noun as either masculine or feminine really does rub off on its semantic content, two groups of nouns need to be distinguished: nouns that denote sexuated entities and nouns that denote nonsexuated entities (our selection thus encompasses nouns that denote animates and nouns that denote objects, in the following simply labelled as "animate nouns" and "object nouns"). Both animate and object nouns have grammatical gender. In contrast to objects, however, animates also have a biological gender (sex), and this can be congruent or incongruent with the grammatical gender of the respective noun. In our experiments, we worked with grammatical and semantic primes (i.e., primes that conveyed information on grammatical and biological gender, respectively) and with targets that had only grammatical gender or both types of gender. When people access lexical knowledge, both semantic and syntactic properties become available almost simultaneously, yet with a tiny advantage for the semantic property over the syntactic property (Müller & Hagoort, 2006). Sex is part of the semantic meaning of a noun that denotes a sexuated referent (e.g., "aunt"), whereas grammatical gender is part of the syntactic properties (in German: *die Tante*, "the$_{fem}$ aunt"). The concrete predictions for each target group are illustrated in Figure 1.

In tasks that require access to lexical knowledge, each of the targets should be primed by grammatical primes, even in the case of nonwords (albeit perhaps somewhat more weakly) as the phonological form "invites" assumptions about its grammatical gender to a certain extent. In addition, animate nouns should also be primed by semantic primes (cf. Figure 1a). The crucial question is whether object nouns that are actually devoid of sex do also respond to semantic priming. If the grammatical gender of such a noun rubs off on its semantic content (thus "inducing" a sense of sex), it should respond to semantic priming (Figure 1b), albeit perhaps somewhat more weakly as the induced sex might be less salient. If the grammatical gender does not rub off on the semantic content of the noun (whose meaning would thus remain devoid of sex), the noun should not respond to semantic priming (Figure 1c). In other words: If a noun's gender is

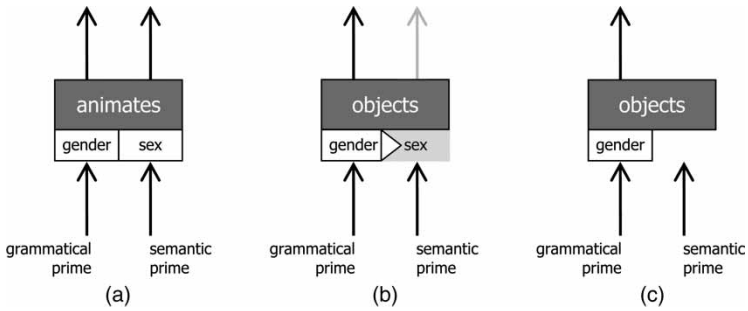

Figure 1. *Possible effects of priming on the decision tasks: (a) for animate nouns, and for object nouns if (b) grammatical gender affects object conceptualization or (c) does not affect object conceptualization.*

seeping into its semantic meaning, then object nouns should be sensitive to priming biological gender in a similar way to animate nouns. If, however, a noun's gender is available as grammatical information only, then object nouns should be insensitive to priming biological gender.

EXPERIMENT 1

In order to prevent participants from employing gender-related heuristics, the first experiment used a lexical decision task for which gender was entirely irrelevant: Participants had to decide as quickly as possible whether a target was a word or a nonword. Targets were either masculine or feminine, and, prior to each decision, a prime was presented that conveyed gender information. In order to determine whether a target is a valid word, people need to access lexical knowledge (given that the target is not obviously a nonword due to an unusual letter combination). As mentioned above, this lexical knowledge encompasses both the meaning of the word and syntactic properties such as gender. A host of studies demonstrated that gender priming affects performance in lexical decision tasks; yet, these effects are basically due to inhibition in incongruent trials rather than facilitation in congruent trials (Friederici & Jacobsen, 1999; Jescheniak, 1999; Perdijk, Spalek, & Schriefers, 2007; Schriefers & Jescheniak, 1999). In accordance with these findings, we reasoned that consistent trials in our experiment should be accomplished faster and/or with fewer errors than inconsistent trials.

Method

Participants

A total of 40 native speakers of German (13 male and 27 female; age $M = 23.6$ years, range 18 to 40 years, $SD = 4.6$) from the Freiburg area participated in this experiment. They were rewarded with up to 5.04 euros, contingent on the number of correct decisions in the task.

Materials and design

Sixty quadruples—each consisting of a masculine word, a semantically similar feminine word, and a corresponding pair of nonwords (i.e., anagrams of the two words)—were used as targets (e.g., *Kasten*, "box", masculine; *Kiste*, "box", feminine; *Staken*, nonword rated as masculine by 93.3% of the participants in a pretest, see below; *Stike*, nonword rated as feminine by 94.9%). Semantic similarity within a word pair was important to prevent a possible interference with gender-related differences between natural objects and artifacts (as reported by Mullen, 1990; Sera et al., 1994). Each item had fewer than three syllables and not more than eight letters; composite terms, loan words, and nouns referring to animates were excluded. Furthermore, nouns whose gender is marked by morphological regularities (e.g., the suffix "-heit" indicates feminine gender) were excluded because this type of regularity is the one most likely to be known to native speakers.[3]

Nonwords were constructed so as to consist of exactly the same letters as their word counterparts, yet composed in a way that renders them as "German-looking" as possible. This was necessary to ensure that participants had to access lexical knowledge in the task at hand.

All items had been pretested by 32 male and 32 female native speakers, who had to assign either the definite masculine or feminine determiner (*der* or *die*, respectively) to any of the items, both words and nonwords. To be included, agreement on gender assignment had to be higher than 75% for nonwords and higher than 95% for words. Finally, the four lists of masculine and feminine words and masculine and feminine nonwords

[3] While we took care to exclude nouns that mark gender morphologically in order to prevent the task from becoming too simple, it was not necessary to exclude *any* regularities. As we were not interested in how people identify gender (i.e., by way of retrieval or assignment), but rather in whether grammatical properties affect the semantic level, it would not be of critical importance if our participants were aware of the phonological regularities. Such an awareness would only have facilitated the task in general, independent of priming, and would hence have rendered our assessment of possible effects more conservative (N.B., in the case of grammatical priming only).

were checked for similarity with regard to average word length, frequency of usage of the words (according to the Celex database), and the agreement in gender assignment, and no significant differences were found.

For the primes, we used four different instantiations of the possessive pronoun for third person singular. As in English, this pronoun in German is sensitive to the sex of the possessor, with distinct forms for male and female.[4] In contrast to its English relative, however, the German possessive pronoun is also sensitive to the gender of the possessed object, requiring different forms for masculine versus feminine objects (cf. Table 1). This set of pronouns thus combines information on semantic sex and grammatical gender and thereby allows a double dissociation: The decision on the target should be affected by the prime's grammatical form if the target's gender is available together with the word as syntactic information; it should be affected by the prime's content if gender is also available in a semantic sense; and it should be affected in a mixed manner if gender is available in both ways.

Items were presented in a within-subject design, with four factors: *sex of prime* (male vs. female), *gender of prime* (masculine vs. feminine), *gender of target* (masculine vs. feminine), and *status of target* (word vs. nonword).

Procedure

Primes and targets were displayed in the center of a 48.3-cm CRT screen with 100-Hz refresh rate. They subtended about 2° of visual angle horizontally and 0.5° vertically. Participants were tested individually. A short instruction was given on the screen, followed by a set of practice items with trial-wise feedback for correct and false responses. No such feedback was provided in the subsequent test trials. Targets in the test trials were worked on in four blocks of 60 target items each, with the four items of each quadruple distributed over the four blocks and with masculine and feminine words and nonwords occurring in a random order otherwise. Each target item was preceded by one of the four primes randomly assigned, with a stimulus onset asynchrony (SOA) of 200 ms. Responses were given with one of two computer mice, one for the left hand and one for the right hand. Half of the participants were instructed to indicate words with the right mouse and nonwords with the left, while the other half received the reverse response mapping.

Table 1. *Gender and sex information of the four primes used in Experiment 1*

	Sex (semantic)	
Gender (grammatical)	*Male (*his*)*	*Female (*her*)*
Masculine	*sein*	*ihr*
Feminine	*seine*	*ihre*

Results and discussion

The accuracy data (proportion of correct scores) were arcsine transformed. Response latencies that were outliers in each individual's distribution of latencies—as identified by Tukey's criterion (i.e., latencies that were below the first quartile minus 1.5 times the interquartile range or above the third quartile plus 1.5 times the interquartile range; Clark-Carter, 2004, chap. 9)—were excluded. Separate analyses of variance for reaction times and accuracies were conducted, with four within-subject factors: sex of prime (male vs. female), gender of prime (masculine vs. feminine), gender of target (masculine vs. feminine), and status of target (word vs. nonword). These analyses indicated that words were identified faster than nonwords and that priming effects depended on the status of target. We therefore conducted separate analyses for words and nonwords.

[4] More precisely, pronouns are sensitive to the grammatical gender of the possessor. However, animates (and particularly persons) can be regarded as the "prototypical" possessors, which should activate a connotation of sex. This was supported by a post hoc test ($n = 20$), in which we checked how reliably the different types of primes were identified as male or female. The possessive pronouns *ihr(e)* and *sein(e)* proved to be only slightly weaker (88.75%) than the pictograms (90%) used in Experiment 4 and the nouns *Frau/Mann* (100%). This overlap is picked up in the discussion.

Apart from some effects that reflect features of the material (i.e., masculine words were identified faster and more accurately than feminine words, which tend to have more syllables, and female primes led to a faster identification of nonwords than male primes, which have one letter more), the analyses also yielded significant priming effects of the gender of the primes in the reaction time for nonwords, $F(1, 39) = 19.603$; $p < .001$; $\eta_p^2 = .335$, and in the accuracy for words, $F(1, 39) = 4.920$; $p = .032$; $\eta_p^2 = .112$, but no significant effects of the sex of the primes were found in any of the conditions, all $F(1, 39) < 2.065$; $p > .159$; $\eta_p^2 < .050$ (cf. Tables 2 and 3 and Figure 2).

This pattern of results suggests that the gender of a noun is available as grammatical information only and does not rub off on its semantic content or the conceptual representation of its referent. The case of the nonwords provides particularly strong evidence for this assumption: As nonwords, by definition, lack a semantic content, any effect of gender on their processing must be grammatical in nature. The effect of grammatical priming as opposed to semantic priming is also remarkable as the differences in grammatical primes were more subtle (*sein* vs. *seine*) than those in the semantic primes (*sein* vs. *ihr*).

Table 2. *Mean priming effects on the reaction time*

	Grammatical priming				*Semantic priming*				*Grammatical priming*				*Semantic priming*			
Exp.	*M*	*MSE*	*t*	*p*	*M*	*MSE*	*t*	*p*	*M*	*MSE*	*t*	*p*	*M*	*MSE*	*t*	*p*
	Anagrams (nonwords)												*Objects (words)*			
1	9.43	2.13	4.43	**.000**	−1.24	2.20	−0.56	.576	−2.66	2.08	−1.28	.208	0.875	2.39	0.04	.971
	Animates												*Objects*			
2	10.40	5.08	2.05	**.050**	11.74	5.36	2.19	**.037**	17.33	8.06	2.15	**.039**	6.58	13.69	0.480	.634
3	33.63	7.43	4.53	**.000**	12.42	7.54	1.65	.112	21.52	6.09	3.54	**.002**	0.32	5.44	0.058	.954
4	18.45	4.53	4.08	**.000**	11.68	4.23	2.76	**.009**	17.90	5.71	3.13	**.003**	3.89	5.75	0.676	.503
2–4	20.13	3.28	6.14	**.000**	11.90	3.13	3.80	**.000**	18.55	3.90	4.76	**.000**	3.97	5.37	0.739	.462

Note: Reaction time in ms. Tested for a difference from zero. Degrees of freedom: $df = 39$ in Experiment 1, $df = 28$ (animates) and 31 (objects) in Experiment 2, $df = 25$ (animates) and 21 (objects) in Experiment 3, $df = 40$ (animates) and 39 (objects) in Experiment 4; joined analysis of Experiments 2 to 4, $df = 95$ (animates) and 93 (objects). Positive values for *M* indicate an acceleration (ms) through priming. Probabilities of $p \leq .05$ are printed in bold.

Table 3. *Mean priming effects on accuracy*

	Grammatical priming				*Semantic priming*				*Grammatical priming*				*Semantic priming*			
Exp.	*M*	*MSE*	*t*	*p*	*M*	*MSE*	*t*	*p*	*M*	*MSE*	*t*	*p*	*M*	*MSE*	*t*	*p*
	Anagrams (nonwords)												*Objects (words)*			
1	−4.70	17.93	−0.26	.795	4.96	17.06	0.29	.773	62.25	28.06	2.22	**.032**	−31.73	22.08	−1.44	.159
	Animates												*Objects*			
2	76.19	30.70	2.48	**.019**	42.10	29.91	1.41	.170	63.63	27.15	2.34	**.026**	17.42	30.32	0.575	.570
3	77.46	29.52	2.62	**.015**	24.42	44.68	0.547	.590	125.64	31.90	3.94	**.001**	−15.05	28.94	−0.520	.609
4	97.30	22.60	4.31	**.000**	6.17	29.84	0.207	.837	51.84	25.50	2.03	**.049**	4.20	25.50	0.165	.870
2–4	85.55	15.46	5.54	**.000**	21.97	19.61	1.12	.265	73.12	16.21	4.51	**.000**	4.20	16.32	0.257	.798

Note: Accuracy (arcsine transformed). Tested for a difference from zero. Degrees of freedom: $df = 39$ in Experiment 1, $df = 28$ (animates) and 31 (objects) in Experiment 2, $df = 25$ (animates) and 21 (objects) in Experiment 3, $df = 40$ (animates) and 39 (objects) in Experiment 4; joined analysis of Experiments 2 to 4, $df = 95$ (animates) and 93 (objects). Positive values for *M* indicate an increase in accurate responses through priming. Probabilities of $p \leq .05$ are printed in bold.

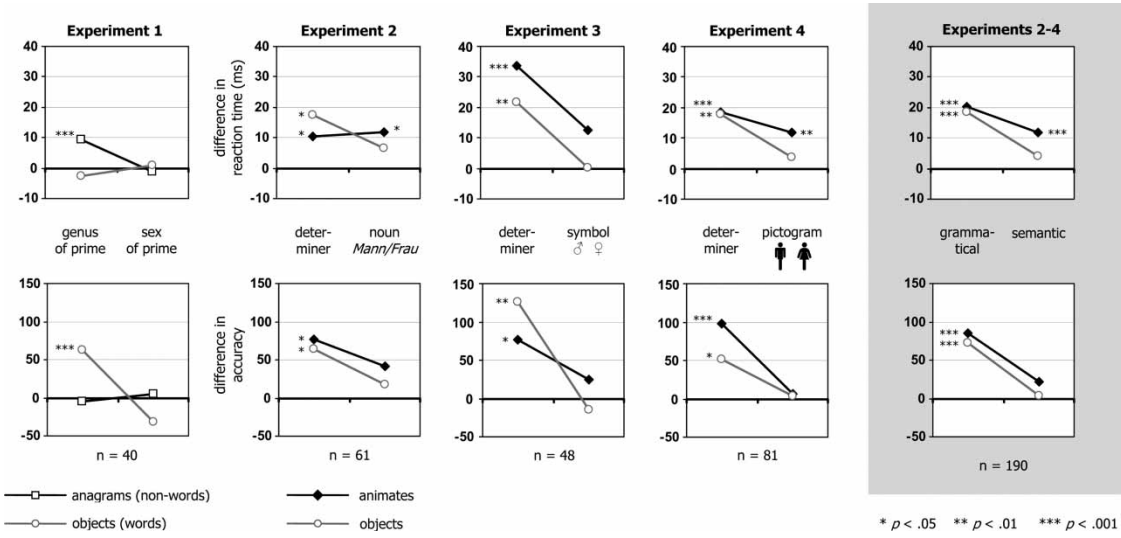

Figure 2. *Priming effects in Experiments 1 to 4, in terms of reaction time and accuracy; the diagrams on grey background give the results of the joined analysis of Experiments 2 to 4.*

In addition, the observed priming effect for the nonwords hints at the possibility that this grammatical information may not (or may not always) be stored, but may rather be assigned, and most likely so according to some assignment regularities.

However, Experiment 1 raises three possible concerns. First, as the task itself was not at all related to any kind of gender, the semantic aspects of gender inherent in the primes may not have been sufficiently salient to be elicited. Second, although biological sex is the prototypical semantic content associated with *sein(e)* versus *ihr(e)*, these possessive pronouns do also refer to nonsexuated possessors and thus may not be sufficiently strong as semantic primes (cf. Footnote 4). And finally, the overall priming effects were not very strong. While this is consistent with other findings in the field (cf. Schriefers & Jescheniak, 1999), there is good reason to assume that this could have been aggravated by the primes used. The possessive pronouns were chosen because they combine information on semantic sex and grammatical gender, thus allowing for a double dissociation. However, they are not as strongly linked to gender as the definite determiners, which occur much more frequently in everyday speech and are the prime indicators of a noun's grammatical gender in German (as discussed in the introduction). In order to address these concerns, we modified Experiment 1 by using different sets of primes and by adopting a gender decision task instead of a lexical decision task.

EXPERIMENTS 2, 3, AND 4

In the following experiments, participants were explicitly asked to identify the target's gender. Although this implies a focus on grammatical gender (identifying the sex of nonsexuated objects makes little sense), decisions should be inhibited not only by grammatically inconsistent trials, but also by semantically inconsistent trials if gender and sex are conceptually linked.

Method

Participants

A total of 190 native speakers of German (77 male and 113 female; age $M = 22.9$ years, range 17 to 45 years, $SD = 4.1$) from the Freiburg area

participated in these studies (61 in Experiment 2, 48 in Experiment 3, and 81 in Experiment 4). They were rewarded with up to 3.78 euros, contingent on the number of correct decisions in the task.

Materials and design

Due to the modified task (gender instead of lexical decision), we had to modify the targets accordingly: Nonwords were dropped and were replaced by words denoting animates (e.g., *Onkel*, "uncle", masculine; *Tante*, "aunt", feminine). Criteria for including animate nouns were the same as those for the words in Experiment 1, except that we had to include several nouns for which gender could be assigned according to morphological regularities (e.g., *Gräfin*, "countess"; *Raufbold*, "ruffian"). In addition, biological and grammatical gender for the animates had to be congruent (which ruled out words like *Mädchen*, "girl", neuter, or *Katze*, "cat", typically used in a generic sense, although feminine). In other words, object targets possessed grammatical gender only, while animate targets possessed both biological and grammatical gender.

The new sets of primes included the definite determiners *der* (masculine) and *die* (feminine) for priming grammatical gender in all three experiments and varying pairs for priming biological gender, one in each experiment: the words for man and woman, *Mann* and *Frau* (in Experiment 2); the biological symbols for indicating sex, ♂ ♀ (in Experiment 3); and the pictograms used for restrooms, 🚹 🚺 (in Experiment 4), respectively. These pairs differ substantially with regard to the gender information they convey: The nouns combine grammatical and biological gender, whereas symbols and pictograms indicate biological gender only. The latter two further differ with regard to abstractness: The symbols are as arbitrary as words are, whereas the pictograms resemble the entities for which they stand.

Although the main purpose of varying the semantic primes was to test whether our findings could be generalized across different types of material, it is possible to make distinct predictions for each pair of primes: As the nouns combine both grammatical and biological gender and are in the same (i.e., verbal) format as the targets are, they should have stronger effects than the other two. In addition, pictograms should have stronger effects than the symbols, as they can be recognized immediately, whereas the meaning of the symbols first needs to be decoded.

The presentation was the same as that in Experiment 1, except that type of target (objects vs. animates) was treated as a between-subjects factor: type of prime, gender/sex of prime, and gender of target varied within subjects.

Procedure

The procedure was the same as that in Experiment 1, with the exception that targets in the critical test trial were worked on in two blocks of 60 items each, with masculine and feminine words (either objects or animates) in random order (three warm-up trials were provided at the beginning of each block).

Results and discussion

For each experiment, separate analyses of variance for reaction times and accuracies were conducted, with one between-subject factor (type of target: animate vs. object) and three within-subject factors: type of prime (grammatical vs. semantic), gender/sex of prime (grammatical: masculine vs. feminine; semantic: male vs. female), and gender of target (masculine vs. feminine). These analyses revealed differences between the types of targets (animates vs. objects), indicating that words denoting animates as targets were answered faster than those denoting objects, which could be due to the fact that the animate nouns used here combine grammatical and biological gender information in a congruent manner. If people take biological gender into account when deciding on the grammatical gender of a noun, objects are disadvantaged by not having a biological gender.

The analyses also indicated that priming effects depend on the type of prime for reaction times and accuracies. To further quantify these priming effects, we calculated the mean priming effect for the two types of primes (grammatical vs. semantic) on the two types of targets (objects vs. animates),

both separately for each experiment and jointly for the three experiments; *t* tests were employed to check whether each priming effect was significantly different from zero (for an overview of the results, see Tables 2 and 3 and Figure 2). As can be seen, priming effects occur consistently with the grammatical primes, both for objects and for animates (and in terms of both reaction times and accuracy). The semantic primes, on the other hand, have significant effects on reaction times for animates only (in two of the three experiments). Crucially, for objects, all priming effects of semantic primes are far from being significant (all $t < 0.677$, $p > .500$).

A comparison of the different pairs of semantic primes reveals that, as predicted, the priming effects of the symbols (Experiment 3) were the weakest. The main reason for this could be that their meaning had to be decoded, and this was aggravated by the fact that not all participants were sufficiently familiar with their meaning to be reliably primed: A post hoc test ($n = 20$) indicated that only 75% categorized them correctly under time pressure (as compared to 90% both for the determiners and for the pictograms, and 100% for the nouns *Mann/Frau*). Interestingly, however, the pictograms (Experiment 4) had somewhat stronger effects than the nouns *Mann/Frau* (Experiment 2), even though the pictograms were not in the same format as the targets (pictorial vs. verbal) and contained less information than the nouns (sex only vs. sex and gender). The slight advantage of the pictograms could be due to the fact that the gender information they did convey could be recognized immediately.

GENERAL DISCUSSION

Across experiments, our study reveals priming effects of grammatical—but not biological—gender on nonanimate target nouns. In principle, nonsignificant results do not justify conclusive inferences to be drawn regarding the nonexistence of an effect. However, the consistency of this pattern across two types of tasks and four different pairs of primes does lend some support to the conclusion that performance in lexical tasks on objects is not sensitive to priming biological gender. Priming grammatical gender, on the other hand, did have effects, and it even had effects on nonwords that lack any semantic content. A possible concern that the semantic primes chosen for the study may simply not have been effective is ruled out by the fact that, at least in two cases, these primes did affect the decisions on words for animates. Taken together, this pattern of findings indicates that the semantic content of a noun denoting an object is not affected by its grammatical gender.

This conclusion concurs with theoretical accounts of the German gender system as basically formal (Corbett, 1991). Other than *semantic gender systems* like English, *formal gender systems* extend the gender categories beyond nouns for sexuated referents in a nonsystematic manner, which renders formal gender systems arbitrary in terms of semantics. This is not to say that no regularities exist according to which gender could be imputed, but rather that these regularities need not be semantic. As reported in the introduction, a host of regularities were indeed identified (most of which are phonological), which account for roughly three quarters of the nouns in German. Although native speakers appear to be largely unaware of these regularities, they seem to be guided by them when assigning gender to new words, but less so when identifying the gender of nouns they already know (Hohlfeld, 2006). More importantly, these regularities are not used to furnish the semantics of object nouns with a sense of sex. That is, the gender of a noun is available (and indeed probably stored) as a syntactic property only, yet not seeping into its semantic content.

Our findings are also compatible with reports on cross-linguistic differences (Koch et al., 2007; Sera et al., 2002; Vigliocco et al., 2005), but not with findings on respective effects in German (Boroditsky & Schmidt, 2000; Boroditsky et al., 2003; Konishi, 1993; Phillips & Boroditsky, 2003). As argued above, however, these latter discrepancies can be attributed to differences in tasks: Unlike previous studies, our priming tasks

prevented participants from drawing on gender information in a strategic manner. One might argue that, for this very reason, our study failed to adequately assess how people *think* of the objects under consideration. After all, the grammatical gender of the noun could affect how these objects are conceptualized (i.e., as somewhat more male or female) without affecting the semantics of the nouns that refer to them. For two reasons, though, such an argument is not convincing. First, it is not the case that our tasks can be accomplished without access to semantics. In the lexical as well as in the gender decision task, participants needed to access lexical knowledge. Such knowledge, however, includes both semantic and syntactic properties (e.g., Müller & Hagoort, 2006). For an animate noun such as "aunt" or "stallion", sex is a crucial part of its semantic content or meaning. As a consequence, these nouns are affected by both grammatical and semantic primes. And second, if grammatical gender has an effect on conceptualization, this should be reflected on the semantic level. When lexical knowledge is accessed, gender is directly available and should thus, if at all, affect the semantic content of a noun before it can reach a higher level such as the conceptual representation of the respective object. Consequently, if affected by its gender, an object noun should respond to semantic priming (as is the case with the animate nouns). If an object noun does not respond to semantic priming, inclusion of a gender-based sex notion into the semantic content of the noun is quite unlikely. Of course, people could still construct connotations to gender on a higher level, say, when they have to decide whether a bridge is more elegant or more powerful or when they recall children's books depicting the sun as female and the moon as male. But in this case, associations of all kinds might be at work, which would prevent the unequivocal identification of purely linguistic effects.

A different concern with results from priming studies like ours could be that the findings might simply reflect patterns of association rather than aspects of conceptual or semantic representation. Given the agreement rules for determiners (or possessives) and the nouns that follow them, one might assume strong patterns of co-occurrence that, as a consequence, would then cause facilitation effects by way of gender priming. However, three arguments contradict this interpretation. First, while it seems safe to assume that definite determiners co-occur with nouns rather frequently—in fact, they might be the words that co-occur most frequently with almost any given noun—the reversal does not hold: The number of words with which a determiner can co-occur is tremendous. Facilitation effects of semantic primes on animate nouns (which constitute just a tiny subsection of the group of nouns in general) should thus, in any case, be stronger than facilitation effects of determiners on nouns. Yet, the opposite is the case: Semantic priming effects are always weaker. Second, while it seems safe to assume that the nouns *Mann* and *Frau* co-occur with animate nouns to a considerable extent, this is rather unlikely for pictograms and symbols. Facilitation effects of *Mann/Frau* should thus be stronger than facilitation effects of pictograms (or symbols). However, pictograms yielded priming effects at least as strong as those of the nouns *Mann/Frau*. And third, if the effects were brought about by co-occurrence, they should indeed be facilitation effects. However, reviews of previous priming studies reveal that the relative difference in task performance is due not so much to a *facilitation* effect in the gender-consistent trials, but rather to *inhibition* in the gender-inconsistent trials (e.g., Friederici & Jacobsen, 1999). Therefore, it is not plausible to assume that the pattern we found in our experiments can be simply reduced to patterns of co-occurrence and hence association. Instead, it is more likely that the priming effects of grammatical gender are brought about by monitoring processes in language processing (which hamper the accomplishment of the actual task when identifying an incongruence), whereas the priming effects for animate nouns are brought about by activation of shared semantic properties such as sex (Harley, 2008).

Our study differs from many others in that it focused on one single language. Examinations of linguistic relativity typically involve either a

comparison of different languages (e.g., Sera et al., 2002; Vigliocco et al., 2005) or the performance of bilingual speakers under different conditions (Kousta et al., 2008). In any case, however, the presumptions are, first, that linguistic structures should somehow affect the conceptual level beyond "thinking for speaking" (Slobin, 1996), and, second, that this should be done differently in different languages. Cross-linguistic comparisons are not required for testing the first presumption. If, as Whorf himself defines his principle of linguistic relativity, linguistic structure prestructures thought within each single language (Whorf, 1956, p. 213f.), it should be sufficient to examine whether thought is indeed prestructured, for instance in our case whether masculine words are conceived of as more male than feminine words (and vice versa). If no evidence for this first presumption is found—as was the case in our study—testing the second is redundant for this particular case. Yet, as pointed out earlier, cross-linguistic differences in the mapping complexity of the gender systems may account for differences in the strength of respective effects (Sera et al., 2002). Our results for German gender should thus not be generalized to other gender languages, and extending this research, for instance, to the Romance languages with their two-gender systems would certainly help to clarify issues.

It is also important to note that—while our results speak against an impact of language on thought with regard to grammatical gender, at least in German—this does not rule out that language may have such an impact in other domains. So far, the most convincing evidence (albeit disputed, e.g., by Li, Abarbanell, & Papafragou, 2005; Li & Gleitman, 2002) for such an impact comes from the domain of space and, more precisely, from research on spatial descriptions. In order to provide coherent descriptions, people need to adopt a specific perspective or *frame of reference*. This frame of reference is linguistically encoded (e.g., by employing phrases such as "in front of") and conceptually meaningful (i.e., giving rise to a specific conceptual representation of the spatial constellation). As has been repeatedly demonstrated, cultural differences with regard to which frame of reference is preferred entail consequences for the conceptual representations (e.g., Haun, Rapold, Call, Janzen, & Levinson, 2006; Haun, Rapold, Janzen, & Levinson, 2011; Levinson, 2003; Levinson & Wilkins, 2006; Majid, Bowerman, Kita, Haun, & Levinson, 2004). Gender assignment of nouns, on the other hand, appears to constitute a purely syntactic or abstract property that lacks conceptual involvement, at least in a formal system like German.

There is some debate as to the domains in which effects of language on thought are most likely to be detected (cf. Boroditsky et al., 2003): One suggestion is to focus on categories with fuzzy boundaries (such as colour discrimination) rather than on categories with strict boundaries (such as sex). Another is to focus on abstract domains (such as gender) rather than on concrete domains (such as colour). Our findings suggest that, while abstract domains are less constrained by sensory experiences and may thus provide more leeway for an impact of linguistic categories on conceptualization and thinking, some linguistic categories are so abstract that they simply lack a conceptual representation. German gender seems to be one of these categories.

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REFERENCES

Bender, A., Beller, S., & Bennardo, G. (2010). Temporal frames of reference: Conceptual analysis and empirical evidence from German, English, Mandarin Chinese, and Tongan. *Journal of Cognition and Culture*, *10,* 283–307.

Boroditsky, L. (2001). Does language shape thought? English and Mandarin speakers' conceptions of time. *Cognitive Psychology*, *43,* 1–22.

Boroditsky, L., & Schmidt, L. A. (2000). Sex, syntax, and semantics. In L. R. Gleitman & A. K. Joshi (Eds.), *Proceedings of the 22nd Annual Conference of*

the Cognitive Science Society (pp. 42–47). Mahwah, NJ: Lawrence Erlbaum Associates.

Boroditsky, L., Schmidt, L. A., & Phillips, W. (2003). Sex, syntax, and semantics. In D. Gentner & S. Goldin-Meadow (Eds.), *Language in mind* (pp. 61–79). Cambridge, MA: MIT Press.

Bowers, J. S., Vigliocco, G., Stadthagen, H., & Vinson, D. (1999). Distinguishing language from thought: Experimental evidence that syntax is lexically rather than conceptually represented. *Psychological Science*, *10,* 310–315.

Carmichael, L., Hogan, H. P., & Walter, A. A. (1932). An experimental study of the effect of language on the reproduction of visually presented forms. *Journal of Experimental Psychology*, *15,* 73–86.

Chen, J.-Y. (2007). Do Chinese and English speakers think about time differently? Failure of replicating Boroditsky (2001). *Cognition*, *104,* 427–436.

Clark-Carter, D. (2004). *Quantitative psychological research: A student's handbook*. New York, NY: Psychology Press.

Comrie, B. (1999). Grammatical gender systems: A linguist's assessment. *Journal of Psycholinguistic Research*, *28,* 457–466.

Corbett, G. G. (1991). *Gender*. Cambridge, UK: Cambridge University Press.

Dudenredaktion. (Ed.). (1996). *Duden 1: Rechtschreibung der deutschen Sprache* [Duden 1: Orthography of the German Language]. Mannheim, Germany: Dudenverlag.

Dudenredaktion. (Ed.). (2005). *Duden 4: Die Grammatik* [Duden 4: The grammer]. Mannheim, Germany: Dudenverlag.

Flaherty, M. (2001). How a language gender system creeps into perception. *Journal of Cross-Cultural Psychology*, *32,* 18–31.

Foundalis, H. E. (2002). Evolution of gender in Indo-European languages. In W. D. Gray & C. D. Schunn (Eds.), *Proceedings of the 24th Annual Conference of the Cognitive Science Society* (pp. 304–309). Mahwah, NJ: Lawrence Erlbaum Associates.

Friederici, A. D., & Jacobsen, T. (1999). Processing grammatical gender during language comprehension. *Journal of Psycholinguistic Research*, *28,* 467–484.

Gentner, D., & Goldin-Meadow, S. (Eds.). (2003). *Language in mind*. Cambridge, MA: MIT Press.

Gumperz, J. J., & Levinson, S. C. (Eds.). (1996). *Rethinking linguistic relativity*. Cambridge, MA: Cambridge University Press.

Harley, T. A. (2008). *The psychology of language*. Hove, UK: Psychology Press.

Haun, D. B. M., Rapold, C. J., Call, J., Janzen, G., & Levinson, S. C. (2006). Cognitive cladistics and cultural override in hominid spatial cognition. *Proceedings of the National Academy of Sciences*, *103,* 17568–17573.

Haun, D. B. M., Rapold, C. J., Janzen, G., & Levinson, S. C. (2011). Plasticity of human spatial cognition: Spatial language and cognition covary across cultures. *Cognition*, *119,* 70–80.

Hockett, C. F. (1958). *A course in modern linguistics*. New York, NY: Macmillan.

Hohlfeld, A. (2006). Accessing grammatical gender in German: The impact of gender-marking regularities. *Applied Psycholinguistics*, *27,* 127–142.

January, D., & Kako, E. (2007). Re-evaluating evidence for linguistic relativity: Reply to Boroditsky (2001). *Cognition*, *104,* 417–426.

Jescheniak, J. D. (1999). Gender priming in picture naming: Modality and baseline effects. *Journal of Psycholinguistic Research*, *28,* 729–737.

Koch, S. C., Zimmermann, F., & Garcia-Retamero, R. (2007). El sol–die Sonne: Hat das grammatische Geschlecht von Objekten Implikationen für deren semantischen Gehalt? [El sol–die Sonne (the sun): Does the grammatical gender assigned to objects have semantic implications]. *Psychologische Rundschau*, *58,* 171–182.

Konishi, T. (1993). The semantics of grammatical gender: A cross-cultural study. *Journal of Psycholinguistic Research*, *22,* 519–534.

Köpcke, K.-M., & Zubin, D. A. (1983). Die kognitive Organisation der Genuszuweisung zu den einsilbigen Nomen der deutschen Gegenwartssprache [The cognitive organization of gender assignment to the monosyllabic nonus of the German present-day language]. *Zeitschrift für germanistische Linguistik*, *11,* 166–182.

Köpcke, K.-M., & Zubin, D. A. (1984). Sechs Prinzipien für die Genuszuweisung im Deutschen: Ein Beitrag zur natürlichen Klassifikation [Six principles of gender assignment in German: A contribution to natural classification]. *Linguistische Berichte*, *93,* 26–50.

Kousta, S.-T., Vinson, D. P., & Vigliocco, G. (2008). Investigating linguistic relativity through bilingualism: The case of grammatical gender. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *34,* 843–858.

Kuhnmünch, G., & Beller, S. (2005). Distinguishing between causes and enabling conditions—through

mental models or linguistic cues? *Cognitive Science*, *29,* 1077–1090.

Levinson, S. C. (2003). *Space in language and cognition*. Cambridge, UK: Cambridge University Press.

Levinson, S. C., Kita, S., Haun, D. B. M., & Rasch, B. H. (2002). Returning the tables: Language affects spatial reasoning. *Cognition*, *84,* 155–188.

Levinson, S. C., & Wilkins, D. P. (Eds.). (2006). *Grammars of space*. Cambridge, UK: Cambridge University Press.

Li, P., Abarbanell, L., & Papafragou, A. (2005). Spatial reasoning skills in Tenejapan Mayans. In B. G. Bara et al. (Ed.), *Proceedings of the 27th Annual Conference of the Cognitive Science Society* (pp. 1272–1277). Mahwah, NJ: Lawrence Erlbaum Associates.

Li, P., & Gleitman, L. (2002). Turning the tables: Language and spatial reasoning. *Cognition*, *83,* 265–294.

Loftus, E. F., & Palmer, J. C. (1974). Reconstruction of automobile destruction: An example of the interaction between language and memory. *Journal of Verbal Learning and Verbal Behavior*, *13,* 585–589.

Lucy, J. A. (1992). *Language diversity and thought: A reformulation of the linguistic relativity hypothesis*. Cambridge, UK: Cambridge University Press.

Majid, A., Bowerman, M., Kita, S., Haun, D. B. M., & Levinson, S. C. (2004). Can language restructure cognition? The case for space. *Trends in Cognitive Sciences*, *8,* 108–114.

Mills, A. E. (1986). *The acquisition of gender: A study of English and German*. London, UK: Springer-Verlag.

Mullen, M. K. (1990). Children's classifications of nature and artifact pictures into female and male categories. *Sex Roles*, *23,* 577–587.

Müller, O., & Hagoort, P. (2006). Access to lexical information in language comprehension: Semantics before syntax. *Journal of Cognitive Neuroscience*, *18,* 84–96.

Osgood, C. E., Suci, G. J., & Tannenbaum, P. H. (1957). *The measurement of meaning*. Urbana, IL: University of Illinois Press.

Perdijk, K., Spalek, K., & Schriefers, H. (2007). Syntactic and strategic forces in picture naming: Gender retrieval in blocked priming experiments. *Language and Cognitive Processes*, *22,* 501–526.

Phillips, W., & Boroditsky, L. (2003). Can quirks of grammar affect the way you think? Grammatical gender and object concepts. In R. Alterman & D. Kirsh (Eds.), *Proceedings of the 25th Annual Meeting of the Cognitive Science Society* (pp. 928–933). Mahwah, NJ: Lawrence Erlbaum Associates.

Regier, T., Kay, P., & Cook, R. S. (2005). Focal colors are universal after all. *Proceedings of the National Academy of Sciences*, *102,* 8386–8391.

Roberson, D., Davies, I., & Davidoff, J. (2000). Colour categories are not universal: Replications and new evidence from a stone age culture. *Journal of Experimental Psychology: General*, *129,* 369–398.

Sapir, E. (1921). *Language*. New York, NY: Harcourt, Brace & World.

Schriefers, H., & Jescheniak, J. D. (1999). Representation and processing of grammatical gender in language production: A review. *Journal of Psycholinguistic Research*, *28,* 575–600.

Schwichtenberg, B., & Schiller, N. O. (2004). Semantic gender assignment regularities in German. *Brain and Language*, *90,* 326–337.

Sera, M. D., Berge, C. A. H., & Castillo Pintado, J. (1994). Grammatical and conceptual forces in the attribution of gender by English and Spanish speakers. *Cognitive Development*, *9,* 261–292.

Sera, M. D., Elieff, C., Forbes, J., Burch, M. C., Rodríguez, W., & Dubois, D. P. (2002). When language affects cognition and when it does not: An analysis of grammatical gender and classification. *Journal of Experimental Psychology: General*, *131,* 377–397.

Slobin, D. I. (1996). From "thought and language" to "thinking for speaking". In J. J. Gumperz & S. C. Levinson (Eds.), *Rethinking linguistic relativity* (pp. 70–96). Cambridge, UK: Cambridge University Press.

Vigliocco, G., Vinson, D. P., Indefrey, P., Levelt, W. J. M., & Hellwig, F. (2004). The role of grammatical gender and semantics in German word production. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *30,* 483–497.

Vigliocco, G., Vinson, D. P., Paganelli, F., & Dworzynski, K. (2005). Grammatical gender effects on cognition: Implications for language learning and language use. *Journal of Experimental Psychology: General*, *134,* 501–520.

Whorf, B. L. (1956). *Language, thought and reality*. Cambridge, MA: MIT Press.

Zubin, D. A., & Köpcke, K.-M. (1986). Gender and folk-taxonomy: The indexical relation between grammatical gender and lexical categorization. In C. Craik (Ed.), *Noun classes and categorizations* (pp. 139–180). Amsterdam, The Netherlands: John Benjamins.