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INFLUENCE OF GRAMMATICAL GENDER ON DEDUCTIVE REASONING ABOUT SEX-SPECIFIC PROPERTIES OF ANIMALS

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Abstract

Grammatical gender is independent of biological sex for the majority of animal names (e.g., a male giraffe is grammatically treated as feminine). However, there is apparent semantic *motivation* for grammatical gender classes, especially in mapping human terms to gender classes. This research investigated whether this apparent motivation in mapping between grammar and biological sex affects deductive inference in German speakers. We identified two contexts in which speakers unconsciously over-generalize the grammar-semantics mapping to make inappropriate deductive inferences about sex-specific biological properties. They tended to erroneously accept deductions when the sex in the premise and the grammatical gender of the target animal agreed. The sex-gender agreement affected the inference even when the sex of the target was explicitly indicated (e.g., die_[FEM] männliche (male) Giraffe). Experiment 2 further suggested that these effects occur only when the gender-marking article accompanied the noun. Implications of the results for linguistic relativity is discussed.

Keywords: Add your choice of indexing terms or keywords; kindly use a semi-colon; between each term.

Introduction

Many languages of the world have a system of grammatical gender, where nouns are assigned to one of the limited number of gender classes (Corbett & Fraser, 2000). Unlike languages that mark gender only semantically (e.g., English), languages with grammatical gender assign gender to all nouns regardless of whether or not referents have a biological sex. The link between gender assignment and conceptual properties of non-human referents has widely been said to be arbitrary (Aikhenvald, 2000; Fox, 1990), as grammatical gender is not relevant to biological sex for a majority of words. For example, in German, the word *giraffe* is grammatically feminine and *elephant* is masculine, but it is not the case that all giraffes are female or that all elephants are male. Nonetheless, the feminine article *die* (_[FEM]) must be applied when one refers to a grammatically feminine noun and the feminine pronoun *sie* must be used as an anaphoric reference, whether the referent is biologically female or male (e.g., *die männliche (male) Giraffe*). Here,

an interesting question is to what extent speakers are able to separate the biological sex of an animal from its grammatical gender. From the perspective of a speaker of language without grammatical gender, it appears confusing that one has to use the feminine article and the female pronoun even when the giraffe is actually male. Of course, speakers of a language with the grammatical gender system must know that grammatical gender does not directly reflect biological sex. However, are the speakers completely immune to the influence of grammatical gender when they draw inferences about the animal's sex-specific biological properties? It is possible that the few cases of semantic correspondence between grammatical gender and biological sex may have resulted in an overgeneralization during the process of language acquisition. In German, for example, salient female terms such as *woman*, *lady*, *mother* are grammatically feminine, while salient male terms such as *man*, *boy*, *father*, are grammatically masculine (*Natural Sex Principle*, cf. Zubin & Koepcke, 1986).

Thus, speakers may falsely generalize this *exceptional* mapping between gender class and biological sex to words for animated entities in general. This assumption is consistent with Vigliocco and colleagues' (Vigliocco, Vinson, Paganelli, & Dworzynski, 2005) *sex-and-gender-hypothesis*, which proposes that a conceptual influence of grammatical gender originates in speakers' first noticing the correspondence between grammatical classes and corresponding conceptual classes. In other words, acknowledging the link between biological sex and the grammatical gender class in the case of some salient human-specific terms leads speakers to develop a general anticipation that even non-human animals from the same grammatical gender class are more similar to one another than animals from different grammatical gender classes.

Most of the previous research has asked whether and to what extent grammatical gender influences speakers' concepts of entities in terms of typically feminine/masculine attributes assigned to those entities. Konishi (1993) looked at how Spanish and German speakers construe femininity or masculinity of non-animal objects by having them give gender-related ratings of various nouns on a potency scale

(e.g., weak vs. strong; tender vs. vigorous): German speakers rated *moon* (grammatically masculine in German and feminine in Spanish) to be higher on the scale of masculinity than *sun* (masculine in Spanish and feminine in German), while Spanish speakers showed the reverse pattern. Sera and colleagues (Sera, Berge, & del Castillo Pintado, 1994; Sera, Elieff, Forbes, Burch, Rodriguez, & Dubois, 2002) asked Spanish and French speakers to assign either a female or a male voice to artifact objects and reported that the judgments tended to agree with the grammatical gender of the objects (see also Boroditsky, Schmidt, & Phillips, 2003; Flaherty, 2001). However, to our knowledge, the question of whether speakers of a language with grammatical gender are at all influenced by grammatical gender when they make inferences about biological sex-specific properties of animals has not been addressed in the literature.

Importantly, Vigliocco et al. (2005) suggested that the relation between grammatical gender and speakers' concepts is weaker for languages with more than two gender classes, such as German. Using an odd-one-out categorization task, they in fact found an effect of grammatical gender on Italian speakers' construal of similarity among animals, but not on German speakers'. However, unlike judgments of abstract similarity among objects, inference about biological sex-specific properties is more directly linked to grammatical gender categories, and hence we might expect the influence of grammatical gender in German speakers in this case.

It is hard to imagine that German speakers are not aware of the motivated link between grammatical gender and biological sex, as human males are clearly mapped to the masculine gender and human females are mapped to the feminine gender. Yet, when thinking about animals at the level of generic species (dog, cat, giraffe, etc.), speakers have to separate grammatical gender and biological sex. Of course, adults speaking a language with grammatical gender must *consciously* understand that grammatical gender of basic-level animal names is independent of animals' biological sex. However, it may still be possible that their inference is still affected by the overgeneralization of the syntax-semantics mappings: For example, they may make a false deductive conclusion that grammatically feminine (or masculine) animals *in general* have a female (or male)-specific biological property.

Deductive reasoning plays a core role in human inference and learning, along with inductive reasoning (cf. Murphy, 2002). If grammatical gender affects deductive reasoning about biological properties even though people consciously understand that grammatical gender is independent of biological sex of animals, this will be taken as support for linguistic relativity.

Provided that such an effect is seen, however, it is important to be able to distinguish two possible mechanisms behind it. The effect may arise within the realm of syntactic processing but not at the conceptual representation of animal kinds. In other words, the effect may be seen only

when a speaker processes the gender-marking article or pronoun. The alternative possibility is that the overgeneralized syntax-semantic mapping penetrates into the conceptual level of generic-level animal kinds. If this is the case, the effect should be seen even when generic-level animal names are presented without the gender-marking article.

The present study

We tested German and Japanese speakers on deductive inferences about sex-specific animal properties. The Japanese speakers' performance served as a baseline because Japanese is a language without grammatical gender. We designed two experiments in such a way that we could identify at what level of processing the relation between grammatical gender and deductive reasoning is found, if it is found at all. In the first experiment, target words for deduction were presented in the singular form with their associated articles marking the gender class of each word. (In German, article + noun phrase can refer to a generic meaning.) In the second experiment, the target words were presented in plural form without any marking of gender class. Participants were asked to indicate whether the deductive conclusion would hold true or not; they were instructed to give a "No" response in cases in which the conclusion was logically indeterminable, in addition to the cases in which deduction would be clearly false.

Five conditions were set up within participants. The *Generic Animal Condition* was designed to test whether German speakers were more likely to draw a erroneous deductive conclusion when the sex specified for the biological property given in the premise and the grammatical gender class of the target animal's basic-level name were consistent (e.g., female – feminine) than when they were inconsistent (e.g., female – masculine). Here, the deductive conclusion is logically indeterminable, as the biological sex of the target animal is unknown, and thus, "No" is the correct answer. Nevertheless, German speakers may experience difficulties rejecting the deductive conclusion when the grammatical gender of the target animal agrees with the biological sex specified in the premise. In contrast, it should be easy for Japanese speakers to reject the deduction in this ambiguous case.

In order to test for possible baseline differences in deductive reasoning across the two language groups, we included the *Generic-Animal Control Condition*. Here, participants were to judge the correctness of the deductive conclusion about a property true for all animals regardless of their sex, while the targets were exactly the same as in the *Generic-Animal* condition.

The *Sex-specified Animal Condition* was set up to test whether grammatical gender affects deductive inference in German speakers even when the sex of the animal is explicitly specified in the conclusion. Here, unlike the *Generic Animal* condition, the target animal's sex was explicitly specified by the gender-specifying adjective and the specified sex and the grammatical gender of the target

animal was either consistent or inconsistent. Here, the deductive inference should of course be made based on the agreement between the sex in the premise and the target animal's sex indicated by the adjective. It is interesting to see if consistency between grammatical gender and sex affects German speakers' judgments in this obvious case.

The *Sex-specified Animal Control Condition* was included to rule out an alternative explanation for the potential gender effect in the *Sex-specified Animal Condition*. Provided that the expected effect was obtained, it may also have arisen from the difference in the difficulty in simply processing of the two types of (i.e., grammatical gender-sex specifying adjective matching and mismatching) noun phrases. To disambiguate the two possibilities, the conclusions in this condition were the same as those in the *Sex-specified Animal Condition*, but the property in the premise was not sex-specific. Finding the gender effect in German speakers in this control condition would indicate that the effect arises at the level of local phrase processing rather than during the deductive reasoning. In contrast, if there is no gender effect in this control condition, but the effect is found in the *Sex-specified Animal condition*, where the property in the premise is also sex-specific, this suggests that the grammatical gender affects deductive reasoning about a sex-specific property, even when the target animal's sex is explicitly given.

Finally, the *Artifact Condition* was included to examine whether German speakers' deductive reasoning about non-animate entities was affected by grammatical gender. The target object was an artifact whose grammatical gender was either consistent or inconsistent with the sex specified in the premise. The conclusion was logically determinable and should always be rejected. This condition allows us to see how pervasive the influence of grammatical gender on deductive inference about sex-specific biological properties: If the motivated sex-gender mapping is applied even in the realm of entities without sex, this would suggest that the influence of grammatical gender is overarching in German speakers.

Experiment 1

In this experiment, we tested whether there is a relation between grammatical gender and speakers' deductive reasoning about a sex-specific biological property when the grammatical gender of the target object was explicitly invoked by the gender-marking article.

Method

Participants

Twenty-one native German-speaking undergraduates from Zurich and 17 native Japanese-speaking undergraduates from Tokyo, both from a wide variety of majors, participated for payment.

Design and Materials

As described earlier, there were five within-subjects conditions: *Generic Animal*, *Generic Animal Control*, *Sex-specified Animal*, *Sex-specified Animal Control*, and *Artifact*. In each trial across the five conditions, the premise sentence containing a blank property X was shown, and followed by the target object. In the *Generic Animal*, *Sex-specified Animal*, and *Artifact* conditions, the premise stated that the property X was sex-specific. It said: "All and only male (or female) animal had X inside." In the two *Control* conditions, the premise statement was sex-general: "All and only animals had X inside." Prior to the experiment, the participants were told that X was an internal and important property.

In the *Generic Animal Condition*, 36 generic level animal names (half grammatically feminine, half masculine in German) that were commonly known to speakers of both languages, were used as targets. Each animal appeared once in the sex-gender consistent trials and once in the inconsistent trials, yielding a total of 72 trials in this condition. As described earlier, the correct response was "No" for all trials, as the deduction was not logically determinable. The same 36 animal names were used in the *Generic Animal Control Condition*, in which the property given in the premise sentence was general to all animals. Here, of course, the correct response was "Yes" for all trials.

In the *Sex-specified Animal Condition*, 18 animal names (half grammatically feminine, half masculine) that were not used in the *Generic Animal Condition* were presented twice, once in a consistent and once in an inconsistent trial. Here, the sex specified in the premise and the grammatical gender of the target animal always matched, but the specified sex and the grammatical gender of the target animal was either *consistent* ("die_[FEM] weibliche (female) Maus (mouse)") or *inconsistent* ("die männliche (male) Mous") for the "all and only female animals have X inside" premise). The same targets were used for the *Sex-specified Animal Control Condition*, but here, the property in the premise was not sex-specific (e.g., "all and only animals has X inside").

In the *Artifact Condition*, the premise concerned a sex-specific animal property, as in the other two main conditions, but 28 artifact names (half grammatically feminine, half masculine) served as targets. All artifact names appeared once in a sex-gender consistent and once in an inconsistent trial. The "No" response was correct for all trials.

Altogether, there were 208 trials including 90 trials with potential "Yes" responses and 118 trials with potential "No" responses.

Procedure

In each trial, a fixation cross appeared on the screen for one second. The premise statement was then shown for 1.5 seconds, followed by a blank screen for 0.5 seconds. For German participants, the name of the target object accompanied by the gender article was then presented until the participant made a response. For Japanese participants, the target object name was presented alone, without a classifier, as this was judged to be the most natural way of

presentation The participants were asked to indicate whether the deductive conclusion would hold true for the target by pressing a designated key for “Yes” or “No”. After the response, the screen remained blank for 1.5 seconds and the next trial was then started. The presentation order of the 208 trials of all conditions was completely randomized within and across participants.

Results and Discussion

We report the results separately for each condition.

Generic Animal Condition Here, we only analyze the error responses (i.e., Yes responses, see Figure 1). Response times were not submitted to the analysis because of the high error rates in German speakers. As expected, there was a significant Language (German vs. Japanese) X Consistency (sex-gender consistent vs. inconsistent) interaction effect, $F_1(1,31)=9.1$, $F_2(1,90)=98.8$, both $p<.01$). Paired t-tests were performed on subject (t_1) and item means (t_2) contrasting the performance in consistent and inconsistent trials across the different conditions. German speakers were more likely to erroneously accept a deductive conclusion when the sex in the premise and the grammatical gender of the target were consistent (53.4%) than when they were inconsistent (29.9%), $t_1(16) = 3.133$, $d = .626$, $p = .006$, $t_2(35) = 13.447$, $d = 2.898$, $p < .000$. No such difference was found in Japanese participants (17.0% vs. 17.2%), $t_1(15) = -.102$, $p = .920$, $t_2(35) = -.166$, $p = .869$. However, the performance in German speakers in the Control condition showed that they were in general no poorer in deductive reasoning than Japanese speakers (German:92.5%; Japanese:83.5%), $t_1(31) = 1.821$, $p = .078$; $t_2(70) = 4.597$, $d = .969$, $p < .000$. These results suggest that the grammatical gender effect seen in the Generic Animal condition was not a reflection of generally poor deductive inference on the part of German speakers.

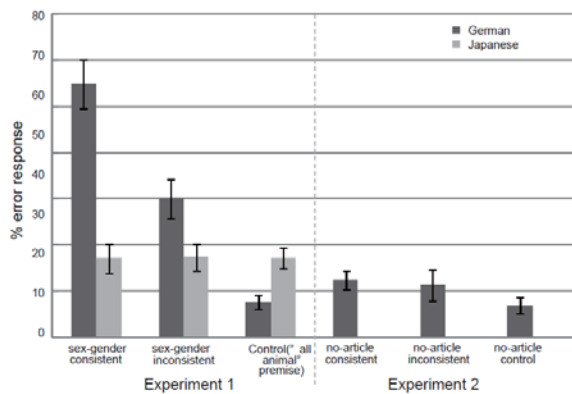


Figure 1. Percentages of error responses in the *Generic Animal Condition* (with sex specific premises) of Experiments 1 and 2 and in the *Generic Animal Control Condition* (with sex-general premises) in Experiment 1.

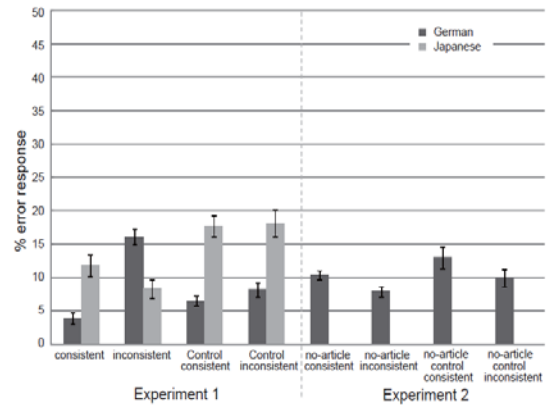


Figure 2. Percentages of error responses in the *Sex-specified Animal Condition* (with sex-specific premises) and the *Sex-specified Animal Control Condition* (with sex-general premises) in Experiments 1 and 2.

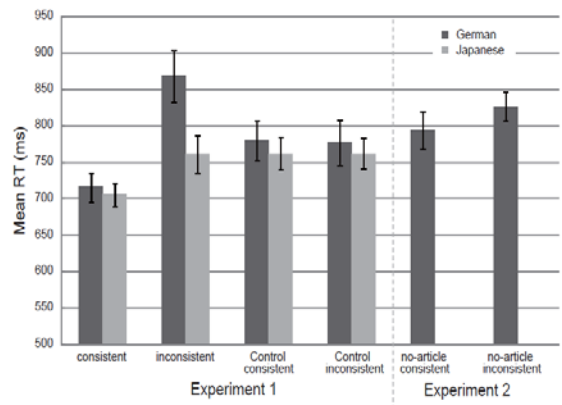


Figure 3. Response times (in milliseconds) for correct responses in the *Sex-specified Animal Condition* (with sex-specific premises) in Experiment 1 and the *Sex-specified Animal Control Condition* (with sex-general premises) in Experiments 1 and 2.

Sex-specified Animal Condition In this condition, both the error rates and response times were submitted to analyses. Again, a significant Language X Consistency interaction effect on the error rates was found, $F_1(1,31) = 8.5$, $F_2(1,34) = 8.9$, both $ps<.01$. Unlike the *Generic Animal Condition*, the correct/error deduction was logically determinable according to the agreement or disagreement between the *sex* in the premise and the specified *sex* of the target animal. Here, the inconsistent trials, in which the sex specified by the adjective and grammatical gender in the target were inconsistent (e.g., *die männliche Giraffe*), were expected to be more difficult than the consistent trials (*die weibliche Giraffe*). Indeed, German speakers were more likely to draw erroneous deductions in the inconsistent trials (16.1%) than in the consistent trials (3.9%), $t_1(16) = 2.917$, $d = .878$, p

= .010, $t_2(17) = 2.735$, $d = .766$, $p = .014$ (Figure 2). No such difference was found in Japanese participants (11.8% vs. 8.3%), $t_1(15) = -1.274$, $p = .222$, $t_2(17) = -1.514$, $p = .148$. A similar pattern was found for response times. German speakers were slower in drawing deductive inferences in the inconsistent case (868ms) than in the consistent case (716ms), $t_1(16) = 3.442$, $d = .574$, $p = .003$, $t_2(17) = 4.986$, $d = 1.522$, $p < .000$, while no such difference was found in Japanese responses (706ms and 761ms), $t_1(15) = 1.342$, $p = .199$, $t_2(17) = 1.969$, $d = .559$, $p = .065$ (Figure 3). In the Control condition, there was no Language X Consistency effect on either accuracy, $F_1(1,31) = 0.3$, $F_2(1,34) = 1$, or response times, $F_1(1, 31) = 0.01$, $F_2(1,34) = 0.6$.

Thus, even when the biological sex of an animal was explicitly indicated, grammatical gender affected German speakers' inferences about sex-specific animal properties. The fact that German speakers' performance did not differ from that of Japanese speakers in the Control condition (where the premise was not sex-specific) indicates that the sex-gender consistency effect here emerged in the process of deductive reasoning rather than from mere disturbance of the local level processing of the target phrase due to gender-sex mismatch.

Artifact Condition In the *Artifact Condition*, no Language X Consistency effect was found, $F_1(1,31)=1.2$, $F_2(1,26)=0.9$, both $ps > .1$. In neither language group did sex-gender consistent and inconsistent trials differ with respect to the error rates (German: 3.8% vs. 0.4%; Japanese: 1.3% vs. 0.4%) nor response times (German: 729ms vs. 727ms; Japanese: 601ms vs. 623ms). Thus, the influence of grammatical gender on sex-specific biological properties found in the animal domain did not extend to the artifact domain.

The results of Experiment 1 showed that German speakers were not immune to the motivated (but logically orthogonal) gender-sex mapping when they make deductive inferences about sex-specific properties of animals. When the biological sex specified in the premise agreed with grammatical gender of the target animal, they often made a false deduction that a sex-specific biological property holds for the target animal in general even though its biological sex was unspecified. German speakers experienced difficulty in rejecting the deductive conclusion even when the target animal's sex was explicitly indicated otherwise by a sex-specifying adjective, when the biological sex specified for the property and grammatical gender of the target animal agreed.

These results naturally lead to a question of whether the same effects are obtained when the target animal name is presented without the article. If German speakers' representation of animals per se is affected by grammatical gender, the same effects should be observed without explicit invocation of the article. Alternatively, the gender effects in Experiment 1 may vanish when the animal name is presented without the gender article. If so, this would

indicate that the gender effect arises at the level of grammatical processing, but not at the level of the representation of animals. Experiment 2 was conducted to disambiguate these two possibilities.

Experiment 2

Method

Participants

Twenty-nine German-speaking undergraduates from Zurich participated in this study. None of them had participated in Experiment 1.

Design, Materials, and Procedure

The design, materials and procedure of Experiment 2 were identical to those in Experiment 1 with one exception: All target words were presented in plural form without articles marking grammatical gender. In the *Generic Animal Condition*, for example, the target “die _[FEM] Maus (mouse)” was now presented as Mäuse (mice) and in the *Sex-specified Animal Condition*, “die männliche (male) Maus” was now presented as “männliche Mäuse”.

Results

In stark contrast to Experiment 1, we found no significant difference between the gender-sex consistent and inconsistent trials in any of the conditions on the error rates or response times (for t_1 and t_2 : all $ps > .1$; see Figures 1-3). When the performance of German speakers in this experiment was compared to that of Japanese speakers in Experiment 1, in no condition (including the *Generic Animal* and *Sex-Specified Animal* conditions) was there any Language X Consistency effect.

The results of Experiment 2 indicate that the grammatical gender effects found in Experiment 1 arise only when the speakers see the target animal name with the gender-marking article. This suggests that it was the *gender article* that affected German speakers' deductive reasoning about sex-specific animal properties; the effect did not arise because German speakers' representation of animals per se was changed by gender grammar.

General Discussion

Grammatical gender *in principle* is independent of biological sex, as grammatical gender is assigned to non-sexuated entities as well as to sexuated ones. This is even true for a majority of (basic-level) animal names. At the same time, there is apparent semantic *motivation* for grammatical gender classes, especially in mapping human terms to gender classes. This research investigated whether this mapping between grammar and biological sex is over-generalized in deductive inference--a core domain of human reasoning. We identified two contexts in which German speakers unconsciously over-generalize this grammar-semantics mapping to make erroneous deductive inferences.

First, German speakers tended to erroneously accept deductions when the sex specified in the premise and the grammatical gender of the basic-level name of the target animal agreed. Second, the sex-gender agreement affected the inference even when the sex of the target animal was explicitly indicated: German speakers experienced difficulty in rejecting the deduction when, for example, asked to judge whether a female-specific property would be true for “die_[FEM] männliche Maus (male mouse)”. Experiment 2 further suggests that these effects occur only when the gender-marking article was processed. Thus, German speakers seem to project biological sex onto gender-marking articles but not onto the conceptual representation of animals per se. Furthermore, this mapping does not go so far as to affect inferences when the targets are non-sexuated entities.

Researchers investigating the relation between the speakers’ conceptual representation of objects and gender grammar have mostly approached the question in light of *whether* masculine or feminine images were projected on objects according to the grammatical gender of the name. This research examined the relation between gender grammar and cognitive processes more directly, asking how speakers handle the semantic motivation of gender classes on one hand and the fact that grammatical gender is independent of biological sex in animal terms on the other hand. The finding that German speakers could not help projecting biological sex on gender-marking articles (when they should not) can be taken as some evidence for linguistic relativity (Gentner & Goldin-Meadow, 2003, for an overview). On the other hand, our findings cannot be interpreted to be support for a strong version of linguistic relativity hypothesis, as the effect was not obtained without explicit invocation of the grammatical gender. Some researchers may argue that the gender effect here is only support for thinking for speaking (Slobin, 1996) but not for linguistic relativity per se, because the effect was obtained in a task using language (see also Vigliocco et al., 2005). Nevertheless, the influence of grammatical gender we found in this research should not be seen as trivial. For speakers of languages with grammatical gender, explicit gender marking by articles or pronouns is the *norm* rather than the exception in everyday discourse. If these speakers of languages unconsciously link the grammatical gender of an animal’s name to its biological sex (even though the two are orthogonal), and if this link is strong enough to serve as a basis for inferences about sex-specific properties of animals, then we may conclude that grammatical gender has non-trivial cognitive consequences for these speakers, be it characterized as a “true” linguistic relativity effect or not. This research is important for the literature of language and thought in that it specifies how (i.e., the mechanism) and in what contexts gender grammar might affect cognitive processes rather than simply providing evidence for linguistic relativity (see also Imai & Saalbach, 2010)

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