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Authors

Djalal, Farah

Voorspoels, Wouter

Heyman, Tom

et al.

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Language Informativity: Is starfish more of a fish in English than in Dutch?

Farah M. Djatal (farahmutiasari.djalal@kuleuven.be)

Wouter Voorspoels (wouter.voorspoels@kuleuven.be)

Tom Heyman (tom.heyman@kuleuven.be)

Gert Storms (gert.storms@kuleuven.be)

Faculty of Psychology and Educational Sciences, University of Leuven,
Tiensestraat 102, 3000 Leuven, Belgium

Abstract

Two studies examined how lexical information contained in words affects people's category representations. Some words are lexically suggestive regarding the taxonomic position of their referent (e.g., *bumblebee*, *starfish*). However, this information differs from language to language (e.g., in Dutch the equivalent words hold no taxonomic information: *hommel*, *vlinder*). Three language groups, Dutch, English, and Indonesian speakers, were tested in similarity and typicality judgment tasks. The results show that the lexical information affects only the users of the language (e.g., Dutch speakers rated Dutch-informative items, both in similarity and typicality tasks, higher than English and Indonesian speakers). Results are discussed in light of theories of concept representation and the language relativity hypothesis.

Keywords: lexical; similarity; typicality; cognitive; concepts

Introduction

In concept research, the meaning of a word is generally related to the properties of the (category of) objects it refers to. These properties cover a broad range, such as physical, contextual and taxonomic properties. This information is activated when people have need of the word meaning, for instance when they have to interpret the word in a sentence, or make concept-dependent judgements, such as similarity (how similar are salmon and trout) or categorization decisions (is this novel object a fish?). A number of theories propose that categorization follows a feature-based approach, meaning that people tend to put objects in the same category the more properties they have in common (e.g., Clark, 1973; Nelson, 1974; Mervis, 1987). For instance, an object that grows in soil and has branches and leaves is called a tree. Consequently, all objects that share the same features will be called a tree as well.

Language, however, is generally not considered merely a system of signifiers that map on classes of objects with certain (physical) properties. Indeed, it also entails a particular way of carving up the world and manners of thinking about reality, subtly encoding cultural knowledge, and metaphors that describe ways of viewing natural phenomena (e.g., Lakoff & Johnson, 1980). It is often claimed that, when learning a language, one does not only learn what the different words in a language refer to, but also these more subtle aspects. In other words, learning a particular language may have particular effects on thinking

about and perceiving the world (e.g., Casasanto, 2016; Lucy, 2014).

The idea that language shapes thought and perception has some interesting consequences, which become tangible when considering the myriad of languages that can be found in the world. According to language relativity, as two languages are structurally different, their respective speakers should differ in how they think, act and perceive in objectively similar situations. This hypothesis has been examined and confirmed in a number of cognitive domains. The effects on cognition of particular manners of classification have been documented in domains such as color (e.g., Thierry, Athanasopoulos, Wiggett, Dering, & Kuipers, 2009), causation (e.g., Fausey & Boroditsky 2011), and space and motion (e.g., Slobin, 1996). Also, it has been shown that grammatical categories such as gender and tense have effects on cognitive tasks (e.g., Boroditsky, Schmidt, & Phillips, 2003), and language specific metaphors that describe abstract domains such as time, musical pitch and mathematical and number terminology have been shown influential in cognitive tasks in these domains (e.g., Casasanto, 2008; Dolscheid, Shayan, Majid, & Casasanto, 2013).

Considering the evidence available at the moment, the question is not so much whether language can influence thought, but how, in which domains and to what extent this is the case. In the present study, we examine whether the representation of categories in a taxonomically structured domain are under influence of the vocabulary that a language provides for the domains. In some cases, the name that a language provides for a category of objects sometimes holds information regarding its position in the taxonomic structure. For example sunflower is a type of flower, a bumblebee is closely related to bees, a goldfish is a type of fish and a blackbird is a type of bird. Clearly, in English, the names are more than just arbitrary signifiers, containing what we will refer to as "lexical information": Information regarding the referent of a word that follows from the word itself, generally because the name is a combination of constituents of which at least one has a meaning in the language. The obvious question from a language relativistic point of view then is whether the availability of lexical information in a name influences the representation of the category it refers to. To the extent that languages differ in

terms of lexical information, one may find representational differences for everyday categories such as bumblebees or cauliflowers¹. From the perspective of the dominant theories in concept representation (e.g., exemplar theory, Smith & Medin, 1981; family resemblance, Rosch & Mervis, 1975; prototype theory, Hampton, 1995), we do not expect category labels to have any influence in how the category is represented. Although some theories consider the labels to be features that matter (e.g., the rational model of categorization; Anderson, 1991), the labels are considered arbitrary, and thus their meaning is not taken into account. To examine whether a word's lexical information influences the representation of the object category it refers to, we look at objects for which one language has a head noun that is informative as to the object's position in a broader taxonomy, whereas the equivalent in another language does not entail such information. The word bumblebee, for instance, is informative in English, but not in Dutch, where no reference to bee is made in the word (*hommel*) or in Bahasa (i.e., the Indonesian language; *kumbang*). Conversely, *inktvís* (squid) is suggestive in Dutch (i.e., the word *vis* in Dutch means fish) but not in English (squid) or Bahasa (*cumi-cumi*).

If the representation of object categories is influenced by lexical information, we expect that people's judgments regarding the objects will subtly vary across language groups in a systematic way, particularly when the judgments rely on the representations of the categories. For example, as starfish in English contains a category suggestion, but not in Dutch, we expect English participants to judge a starfish to be more similar to a goldfish than Dutch participants, as starfish in Dutch does not hold the same category suggestion (*zeester*). Moreover, we expect English participants to judge starfish as more typical for the fish category than Dutch participants. Similarity and typicality are fundamental notions in concept representation research, and directly related to how people represent classes of objects. As such, they form a perfect arena to test whether lexical information influences representation.

Study 1: Similarity

In the first study, we examined how lexical information included in object names can influence people's judgments of similarity between two objects that share lexical category information in their name (e.g., the Dutch pair *walvis* and *inktvís*; in English, respectively, whale and squid) and whether the three language groups, English, Dutch, and Indonesian speakers, give higher similarity ratings for pairs of items that are lexically informative in their own language.

¹ Obviously, a cauliflower is not a flower. Some names provide useful taxonomic information, but sometimes the information can be misleading. Another example: the word whale in Dutch (*walvis*) wrongly implies that the animal belongs in the fish category. We will consider both cases.

Method

Participants Sixty English speakers (44 females and 16 males, mean age: 21 years and 10 months), 74 Dutch speakers (59 females and 15 males, mean age: 18 years and 3 months), and 60 Indonesian speakers (33 females and 27 males, mean age: 24 years and 6 months) were tested. Two Indonesian participants were excluded from the analyses as there was no variability in their answers. The Dutch speakers were students who got credits in exchange for participation, the Indonesian participants were students who live and study in Indonesia, and the English speakers were recruited online using Amazon Mechanical Turk.

Material² A list of 70 questions was presented in a web survey. Each question contained a pair of words that shared the same lexical information in one of the three languages. In 16 word pairs the words were informative in Dutch but not in English nor in Bahasa (e.g., *wasbeer* and *beer* [raccoon and bear]; *aardappel* and *sinaasappel* [potato and orange]), 16 word pairs were informative in Bahasa but not in English nor in Dutch (e.g., *ikan hiu* and *ikan pari* [shark and stingrays]; *burung hantu* and *burung kakaktua* [owl and cockatoo]), and 16 word pairs were informative in English (e.g., bumblebee and bee; catfish and jellyfish), but not in Dutch nor Bahasa. As fillers, eight word pairs were informative in all three languages and 14 word pairs were uninformative in all the three languages.

Procedure Dutch and Indonesian participants were given a link to an online survey, whereas the English speakers participated via Mechanical Turk. In the survey, each word pair was presented in the format: "How similar are X and Y?". Participants answered on a 10-point rating scale ranging from 1 (not at all similar) to 10 (extremely similar). The survey took about 5 to 7 minutes. All items were translated into the three languages and all three groups of participants received the survey in their own languages. Thus, with the exception of the filler items, items that were informative in one language were uninformative in the other two languages. Each participant was randomly assigned to one of four randomized orders of the items sets.

Results and Discussion

First, the consistency of the similarity judgments within each language group was computed using the split-half method combined with the Spearman-Brown formula. The reliability estimates for English, Dutch, and Indonesian speakers were, respectively, .80, .89, and .90, indicating a high agreement among participants of the same language group in the similarity judgment task. Next, we computed average similarity scores by first calculating by-participant

² In a pilot study, different participants from the three language groups were asked to judge the familiarity of all the objects' names on a 10-point scale. The results revealed that participants were relatively familiar with all items.

conditional means and then collapsing across participants (see the upper panel of Figure 1).

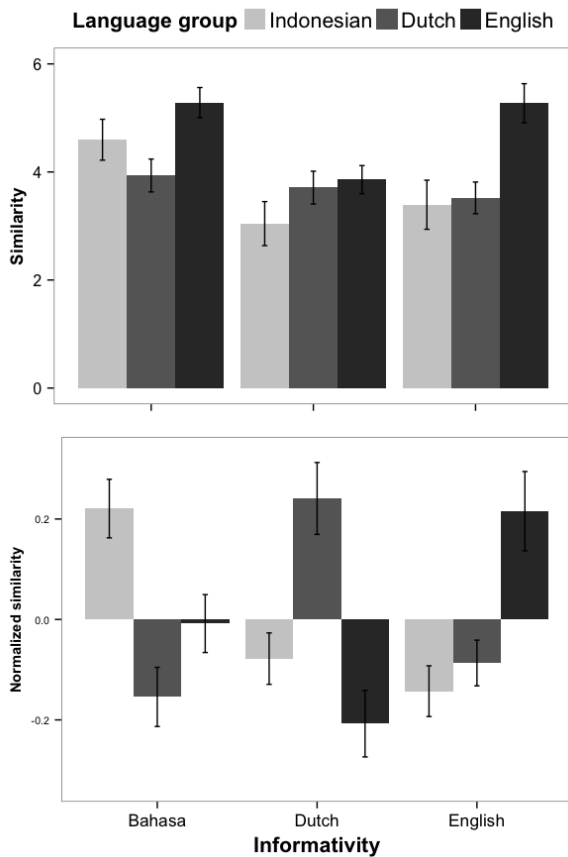


Figure 1: Averaged raw (upper panel) and z-transformed (lower panel) similarity scores in each condition with 95% confidence intervals. The z-transformed values reflect the effect of lexical informativity, controlled for differences between language groups and item groups.

In order to test the hypothesis that people’s similarity judgments are influenced by the lexical information in the objects’ names, mixed effect analyses were performed on the similarity judgment scores. In the analyses, the language group (English, Dutch, and Indonesian speakers) and the language informativity were included as fixed effects, whereas participants and items were included as random effects such that a maximal random structure was created (Barr, Levy, Scheepers, & Tilly, 2013). The crucial test of the linguistic relativity hypothesis concerns the interaction between language group and language informativity: If lexical information influences the similarity judgments, we expect that two categories are judged more similar by speakers of the language in which the categories’ names are informative. To test for this interaction, a model that includes the interaction term was compared with a model that does not. The analyses were carried out in R (version 3.1.2) using the lme4 package (Bates, Maechler, Bolker, & Walker, 2014). As predicted, the analyses revealed a

significant language group \times language informativity interaction ($\chi^2(4) = 34.49, p < .001$), suggesting that similarity judgments can be influenced by lexical information. However, the interpretation of the interaction is not that straightforward, because baseline similarity scores differed in the three language groups. This is best exemplified by a separate analyses of the filler data, which showed a strong effect of language group ($\chi^2(2) = 26.60, p < .001$). Remember, fillers were either uninformative or informative in all three languages, so this finding entails that the three language groups have diverging baselines.

To aid the interpretation of the language group \times language informativity interaction, we transformed the similarities into z-scores for every participant separately, after which by-participant conditional means were calculated. Collapsing across participants then yields the average similarity scores shown in the lower panel of Figure 1 (some are negative as a result of the by-participant z-transformation). Figure 1 suggests that items informative in a certain language receive relatively higher similarity ratings from the speakers of that language. Additional contrast analyses performed on the untransformed similarity data confirmed this ($\beta = 0.86, SE = 0.26, Z = 3.25, p = .001$, for Bahasa; $\beta = 1.17, SE = 0.25, Z = 4.66, p < .001$, for Dutch; and $\beta = 1.07, SE = 0.23, Z = 4.73, p < .001$, for English)³. These results are consistent with the hypothesis that each language group judges similarity higher for item pairs that are lexically informative in their own language.

In general, it is assumed that people judge similarity based on features that objects have in common. However, this study shows that lexical information may also affect similarity judgments between two objects, even when it concerns objects that are rather perceptual in nature. Note that the participants were most likely not aware of the purpose of the study, as nothing in the instructions hinted at the research question of interest, and the item list contained a relatively large number of fillers. This finding suggests that the particular language, and the implicit cultural knowledge it carries, can influence people’s judgments.

Study 2: Typicality

In Study 2, we examine whether lexical information that is included in objects’ names could affect people’s typicality judgments. Typicality refers to the graded membership structure of concepts, and is considered a crucial variable in natural language concept research (see, e.g., Rosch & Mervis, 1975). Similar to Study 1, items that are informative either in English, Dutch or Bahasa were presented in order to investigate whether language users rate typicality higher for words that are informative in their own language.

³ The statistical model is the same as in the previous analyses, except that Helmert coding was used to extract the relevant comparisons. Furthermore, to obtain p-values, we treated the *t*-statistic as a *z*-statistic following Barr and colleagues (2013, p. 266). The data and the scripts of the mixed effects analyses can be found on osf.io/tfqhw.

Method

Participants Sixty one English speakers (46 females and 15 males, mean age: 22 years and 4.5 months), 60 Dutch speakers (48 females and 12 males, mean age: 18 years and 5 months), and 67 Indonesian speakers (41 females and 25 males, mean age: 24 years and 8 months) participated in the second study. One participant was excluded since she was originally from Malaysia and spoke Malay as her mother tongue. None of them participated in Study 1, nor were they aware of the purpose of this study. The Dutch speakers were students who got credits in exchange for participation, the Indonesian participants were students who live and study in Indonesia, and the English speakers were recruited online using Mechanical Turk.

Materials A list of 46 questions was presented to the participants in a website survey. Six items were most informative in English (e.g., ladybird, eggplant, jellyfish), six items were most informative in Dutch (e.g., *kikkervisje*, *inktvvis*, *stinkdier* [tadpole, squid, skunk]), and another six items were most informative in Bahasa (e.g., *ikan hiu*, *burung hantu*, *burung kakaktua* [shark, owl, cockatoo]). The remaining items were fillers, consisting of eight items that were informative in all three languages (English, Dutch, and Bahasa), and 20 items that were not informative in any of the three languages.

Procedure All questions were of the following format: “How typical is x for the category of X?”. All informative items (x) were paired with the category name (X) that was included in the objects’ name. For example: “How typical is a goldfish for the category of fish?”. Participants were asked to answer on a 10-point scale rating, ranging for 1 (extremely atypical) to 10 (extremely typical). The survey took about 3 to 5 minutes. All participants were tested in their own language and received one out of three sets of questions, which only differed in the order of the items.

Results and Discussion

The consistency of the typicality judgments in each language group was computed using the same method as in Study 1 (i.e., split-half method combined with the Spearman-Brown formula). The results were, for English, Dutch, and Indonesian speakers, respectively, .91, .91, and .97. These results indicate a very high consistency between subjects in each language group (see the upper panel of Figure 2 for the average typicality scores in each condition). Mixed effects analyses were then performed on the typicality judgment scores in order to investigate whether lexical information included in objects’ names could affect people’s typicality judgments. The analyses were run in the exact same manner as in Study 1. Again, the effect of interest in this study, the interaction between language group and language informativity, was statistically significant ($\chi^2(4) = 13.08, p = .011$).

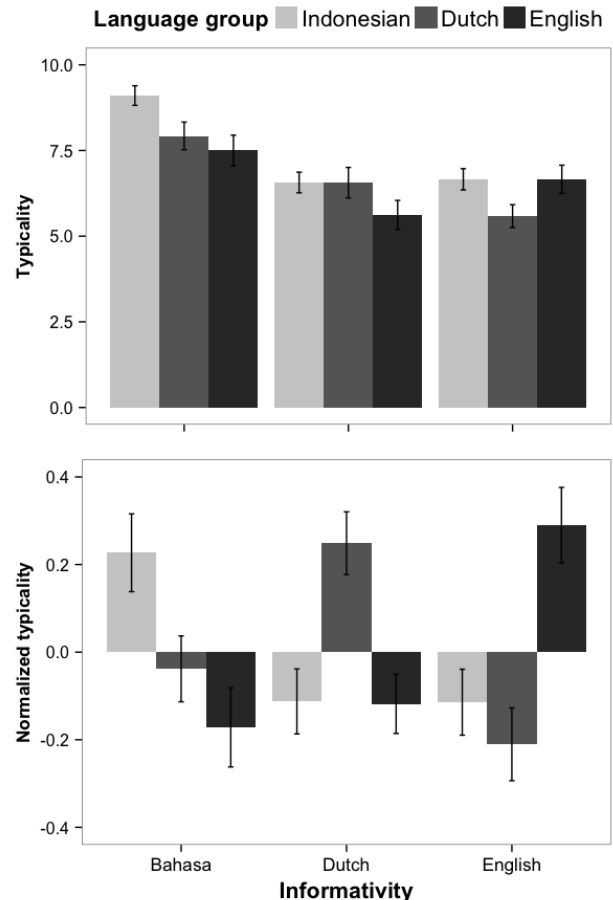


Figure 2: Averaged raw (upper panel) and z-transformed (lower panel) typicality scores in each condition with 95% confidence intervals. The z-transformed values reflect the effect of lexical informativity, controlled for differences between language groups and item groups.

As in Study 1, the interpretation of the interaction gets clouded by cross-cultural differences in baseline (typicality) judgements. More specifically, analyses of the filler data showed a main effect of language group once again ($\chi^2(2) = 7.96, p = .019$). Analogous to Study 1, we first transformed the typicality judgments into z-scores per participant, then we calculated by-participant conditional means, and finally we collapsed across participants to obtain the average typicality scores shown in the lower panel of Figure 2. The pattern of results looks very similar to those displayed in Figure 1. That is, items informative in a certain language receive relatively higher typicality ratings from the speakers of that language. Additional contrast analyses performed on the untransformed typicality data are in line with this, although the effect did not reach statistical significance for Bahasa ($\beta = 0.89, SE = 0.57, Z = 1.54, p = .123$, for Bahasa; $\beta = 1.19, SE = 0.49, Z = 2.42, p = .015$, for Dutch; and $\beta = 1.52, SE = 0.43, Z = 3.57, p < .001$, for English).

The results of Study 2 suggest that in all three language groups, participants rated typicality higher for items that were informative in their respective languages. Similar to

Study 1, these results are consistent with the hypothesis that people are influenced by lexical information in giving typicality judgments, even if sometimes the lexical information provided is misleading (e.g., starfish and *inktvís* [squid] rated as more typical members of category fish for, respectively, English and Dutch speakers). Again, it seems that not only non-lexical features are considered when making these judgments – as is the general assumption of models of concept representation – but also suggestive information that is available in the linguistic name of an object.

General Discussion

Two studies were conducted to investigate the influence of lexical information on semantic tasks related to taxonomic concept representation. In Study 1, evidence was found that participants rated similarity higher for item pairs that were informative in their language, as well as in Study 2, where the participants judged typicality higher when the items' name was suggestive of a particular taxonomic position in their mother tongue. Interestingly, these findings suggest that language has some influence on how categories are represented simply by means of the particular names that are used. Not only does this finding have consequences for models of concept representation and categorization, it is also interesting to consider it in light of the discussion concerning the influence language can have on thought.

More than features?

Both the similarity and typicality judgment task showed that even if the information contained in the objects' names was misleading, people are tempted to use this information to categorize the object. While this is an interesting finding as such, the obvious question is which cognitive processes underlie the observed effect of lexical information. Broadly speaking, the effect can be driven either by the representation that is influenced by the label, or the response processes underlying the judgment.

At a representational level, it is possible that some features of the informative constituent of the label are automatically transferred to the representation of the category the label refers to. For example, the representation of 'star fish' in English speakers may automatically include some features of fish, by virtue of the label. When making a judgment of similarity or typicality, these features, although not experientially acquired, will make the categories more similar, or typical: a starfish will be considered more typical of fish and more similar to goldfish because of these transferred features. Alternatively, it may be merely because of the label. According to the rational model of categorization, labels are just another feature, without any special status. Thus, according to this approach, a similarity or typicality judgment also relies on the label, and shared labels or partly shared labels are expected to influence the judgment.

The effect could also reside at the response level. Given that in both experiments, informative trials presented

participants with two labels that share a constituent, it is possible that participants were influenced by the mere commonality in the labels. This explanation would imply that whatever the label, independent of it being informative or not, commonality between labels will influence judgments of typicality and similarity (for example, this would imply that English speakers judge a **beer** and a **beehive** more similar than Dutch speakers). While this is not our preferred interpretation, it cannot be refuted on the basis of the two experiments presented here.

To examine this hypothesis, an additional ongoing study is conducted using pairs of items in which an item with lexical information is paired with an item that is considered to be a typical member of the category mentioned in the name of the first item (e.g., salmon and jellyfish and salmon). As in the present studies, critical items are only informative in one language. In this way, the idea that people make an inference about the likely relation between the words (e.g., share the ending '-fish') can be controlled.

Importantly, while we cannot conclude to either explanation, our results do not in any way contradict the basic idea that similarity drives categorization, nor that perceptual, contextual and relational features are important. In general, people do categorize objects based on these features and then compare them with the other members or the prototype of the category. However, relying on features – in the traditional sense – may not tell the complete story. As demonstrated in Djalal, Ameel, Heyman, and Storms (2016), there is no clear-cut correspondence between the generated features and the prediction of category membership, and thus it should not come as a surprise that sometimes information of a different nature is relied upon.

Language shapes thought?

The present study provides evidence for language specific characteristics being influential in two fundamental cognitive tasks that have been extensively shown to rely on concept representation. The leap to concluding that the labels in a language can influence meanings should not be made without care, however. For one, as explained in the previous section, the effect may reside at the response level.

Here, we consider another possible explanation that points to a particularly subtle way of how language can shape behaviour in certain tasks. Perhaps the effect of label informativity depends on uncertainty. When people cannot form a sufficiently detailed image of the object a word is referring to, they may rely on other sources of information, one of which is the knowledge encoded in the labels of the language. For example, when people are uncertain as to whether a squid is a fish (a boundary case at least for some people), Dutch speakers may indeed rely on the "cultural knowledge" present in their language (in which the word for squid makes reference to fish) as a source of information, whereas English and Bahasa speakers do not have this knowledge available. While most objects used in the present studies were relatively familiar to participants, this interpretation requires further examination.

While not a mere response effect, relying on language in this way is presumably not what is understood when theorizing about language and thought. However, the question is whether the potential relation with an individual's knowledge would make the observed effect less interesting. Perhaps one of the most basic ways in which culture, and language, are influential in a person's behaviour and thought, is the mere fact that she can rely on knowledge that is encoded in the culture, without the need for first-hand experience.

In sum, the present findings in the domain of concept representation are consistent with the (abstract) hypothesis that language shapes thought, but more importantly, they point to a number of hypotheses as to the cognitive processes or representational differences involved in the behavioural effects.

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