Inferring Generic Meaning From Pragmatic Reference Failure

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Abstract

Generic sentences (e.g., "birds lay eggs") express generalizations about kinds, in contrast to non-generic sentences that express facts about specific individuals or sets of individuals (e.g., "all birds lay eggs"). Although generics are pervasive in natural language, there is no unique linguistic marker of genericity, making the identification of generics a challenge. We investigate the morphosyntactic cues that listeners use to identify whether a sentence should receive a generic interpretation or not. We find that two factors – the definiteness of a sentence's subject NP and the tense of the sentence – are extremely important in guiding intuitions about whether a sentence should receive a generic interpretation. We argue that the importance of these factors can be explained by taking generic interpretations to arise due to a failure to ground expressions as referring to specific entities or events.

Keywords: Psycholinguistics; pragmatics; generics

Introduction

Generic sentences express generalizations about kinds and are an important tool for the transmission of knowledge (Gelman, 2003). A key difference between generic and non-generic statements is that generics allow for exceptions: "birds fly" expresses a generalization about the kind *bird* and is true despite the fact that some birds do not fly, while "all birds fly" is false, because, e.g., emus do not fly (Prasada, 2000). Despite their importance, generics are not consistently marked by any particular lexical, morphological, or syntactic convention. This presents a challenge for speakers who intend to communicate generic meanings and listeners who must correctly interpret speakers' intended meaning.

Prior work suggests that morphosyntactic features, pragmatic factors, and world knowledge all serve as cues that guide the interpretation of sentences as generic or not. In English, the subject noun phase (NP) of a generic sentence is often a bare plural ("birds fly"), but it can also be an indefinite singular ("a bird has feathers") or definite singular ("the bird is a warm-blooded animal"). In contrast, definite plural subject NPs ("the birds have beaks") are generally thought to force non-generic interpretations. Tense and aspect also as cues to generic meaning; simple present tense sentences ("birds fly") are more associated with generic meanings than, e.g., present progressive ("birds are flying overhead") or past tense ("birds flew by my window") sentences (Carlson, 1977; Krifka et al., 1995; Lyons, 1977).

Pragmatics and world knowledge also influence a sentence's interpretation as generic or non-generic. For example, if a unique bird is present in the context of an utterance of a sentence with the subject NP "the bird," this NP is likely to be interpreted as referring to the bird in the context, giving rise to a non-generic interpretation. World knowledge about properties shared by members of a kind may influence the interpretation of potentially generic sentences. For instance, the sentence "a bird does not fly" is likely to be interpreted as being about some particular bird, given world knowledge that, in general, birds fly.

Previous experimental work has confirmed the influence of these three factors—morphosyntax, pragmatic context, and world knowledge—on the interpretation of sentences as generic. Adults and children can both use the definiteness of subject NPs, as well as tense and aspect, to identify generics, and prefer generic interpretations when the subject NP has no available referent in context (Gelman & Raman, 2003; Cimpian, Meltzer, & Markman, 2011). By age 3, children are less likely to assign a generic interpretation to a sentence when its subject NP has a possible referent in the preceding linguistic context and can also use knowledge about the generalizability of properties to kinds in identifying generics (Cimpian & Markman, 2008). World knowledge about whether the subject of a sentence is animate or inanimate also affects interpretations of genericity (Brandone & Gelman, 2009).

In the current paper, we propose that these findings can be synthesized under a single explanation: generic interpretations are driven by a failure to find reference for entities or events described by the sentence in question. We hypothesize that listeners consider two possible interpretations of potentially generic statements: the speaker is either trying to be informative about a particular entity or set of entities, or else the speaker is trying to be informative about a kind. If reference to the particular fails conspicuously, then kind reference becomes likely.

This hypothesis—which we refer to as the "pragmatic reference failure hypothesis"—is inspired by the finding that the referential status of subject NPs in a particular context affects judgements of genericity (Gelman & Raman, 2003). It also provides a candidate explanation for morphosyntactic effects. Like referential context, features like tense and definiteness influence the probability that a speaker was referring to a specific entity. The definite determiner presupposes the existence of a unique, salient entity in the common ground, suggesting that the speaker intends to refer to a particular entity. Certain tenses and aspects, such as simple past and progressive aspect, also have a referential character that English simple present tense lacks.

In the current investigation, we build on the prior work described above by assessing the impact of morphosyntactic factors on adults' judgments about genericity across a wide variety of sentences. Most previous work on the identifica-

tion of generics has focused on children's abilities, perhaps stemming from an assumption that children face challenges in identifying generics that are less relevant for adults. However, research on the probabilistic nature of language comprehension suggests that adults face a similar problem (Levy, 2008; Frank & Goodman, 2012). In the case of identifying generics, we take adults to reason about the likelihood that an utterance is generic given morphosyntactic features of the sentence, features of the context, and the their own world knowledge. The current study also differs from previous work in that we collect naturalistic examples of generic and non-generic sentences generated by study participants, rather than rely on artificially constructed examples. This allows us to consider a realistic representation of genericity in natural language. In this way, we follow recent work on the interpretation of naturally-occurring uses of quantifiers involved in scalar implicature patterns, rather than constructed examples of scalar implicatures (Degen, 2015).

The paper is organized as follows. We first introduce an experimental paradigm that allows us to gather a large number of naturalistic examples of generic and non-generic sentences from study participants. We then collect judgments from a second, independent set of participants, as to whether these sentences should receive generic or non-generic interpretations (Experiment 1). We next use several machine learning techniques to identify which factors are most useful in classifying sentences as generic or not. We find that just two factors—definiteness of the subject NP and tense—prove extremely successful in classifying sentences. Finally, we validate the importance of tense for generic interpretation with human subjects (Experiment 2). Taken together, the results of these experiments show that judgments of whether a sentence is generic or non-generic can largely be explained by considering whether the sentence can be referentially grounded.

Experiment 1

It has previously been argued that the number and definiteness of a sentence's subject NP influence its interpretation as generic or non-generic. Previous work investigating these cues to genericity have generally fixed the number of the subject NP as either singular (Cimpian et al., 2011) or plural (Gelman & Raman, 2003) and only manipulated definiteness. In Experiment 1, we considered the effects of number, definiteness, animacy, and their interaction on the interpretation of generics. A set of participants performed a sentence completion task in which the subject NP was provided. A second set of participants then classified these sentences as generic or non-generic.

Method

Participants We recruited two sets of participants through Amazon's Mechanical Turk website to complete two independent tasks. We restricted participants to individuals within the United States and paid all participants 50 cents. The sets consisted of 100 and 94 participants, respectively. The first task took approximately 14 minutes to complete, while the second task took approximately 6 minutes. We excluded from the analysis 4 participants from the first set and 6 participants from the second set who indicated that their native language was not English.

Stimuli In task 1, the first set of participants was presented with a sequence of NPs followed by a single-line text box. Participants were instructed to "write a sentence starting with the phrase below." The NPs were generated from a set of 48 nouns, split evenly between animates and inanimates. For each participant, each noun was randomly assigned morphosyntactic features using a 2×2 factorial design crossing number (singular, plural) with definiteness (definite, indefinite). Full NPs were created from the base noun and the randomly chosen number and definiteness features. For example, if the noun "panda" received values *plural* and *definite*, the full NP would be "the pandas."

The sentences produced by self-reported native English speakers were then split into random sets of approximately 50 sentences each. For task 2, each set of sentences was presented to one individual from the second set of participants. For a sentence whose subject NP was *noun*, participants indicated whether they thought the sentence was about "*nouns*," "a specific *noun*" (for sentences with singular subject NPs), or "a specific group of *nouns*" (for sentences with plural subject NPs).[1]

Procedure In task 1, we first presented participants with four example NPs. After providing a sentence completion for each example item, participants were shown an example sentence completion that they could have written for the given NP. These example sentences were constructed to favor non-generic interpretations for all NP types. Next, all 48 subject NPs were presented in pseudorandom order, counterbalanced so that no two consecutive NPs matched in both number and definiteness. We required each sentence completion to be at least six characters in length. After providing sentence completions for all NPs, participants reported their native language.

In task 2, participants were instructed that they would be viewing a sequence of approximately 50 sentences that had been produced by other Mechanical Turk workers. Participants began by judging 4 example sentences constructed by us for which the participants received feedback. The remaining sentences were presented in random order. After completing task 2, participants reported their native language. We measured reaction times for each item, measured from the time the item was presented until the time a response was submitted. Reaction times were used to exclude from the analysis responses in whose reaction times were greater than 2 standard deviations from the mean, but were not further analyzed.

[1] Participants included in task 1 also judged whether the sentences they produced were generic or non-generic in a similar manner. Their responses are not reported here, but were similar to the results obtained in task 2 ($r = 0.67$). We also ran a separate rating experiment using the phrasing "*nouns* in general" for the generic question, and found consistent ratings ($r = 0.99$, Fleiss' $\kappa = 0.81$).

Table 1: Example Productions from Experiment 1.

Definiteness	Number	Genericity	Examples
Indefinite	Singular	Generic	"An elephant is large.", "A car is a form of transportation."
Indefinite	Singular	Non-generic	"A dolphin swam alongside the boat.", "A guitar kept me up all night."
Indefinite	Plural	Generic	"Foxes chase rabbits.", "Computers have made communication easier."
Indefinite	Plural	Non-generic	"Owls were perched in the barn.", "Marbles rolled all over the floor."
Definite	Singular	Generic	"The peacock is a noisy bird.", "The chair has four legs."
Definite	Singular	Non-generic	"The pigeon landed on the car.", "The trumpet was out of tune."
Definite	Plural	Generic	"The kangaroos jump a lot.", "The guitars are stringed instruments."
Definite	Plural	Non-generic	"The pandas ate bamboo.", "The fences were strong."

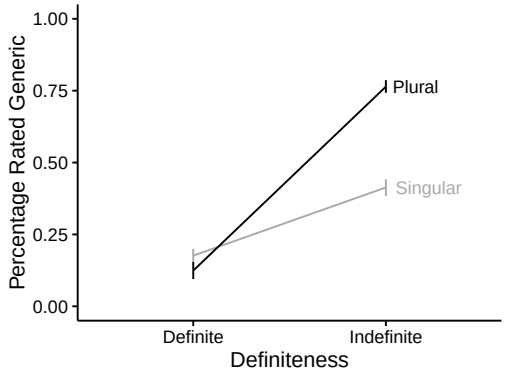

Figure 1: Percentage of sentences rated generic in Experiment 1 by definiteness and number. Error bars show 95% confidence intervals.

Results and Discussion

Both definiteness and number affected judgments (Figure 1). Sentences with indefinite subject NPs—especially bare plural subjects—were more likely to be rated generic (see Table 1 for examples). We fit a logistic mixed-effects model to predict a sentence's classification as generic or non-generic from the interaction between definiteness, number, and animacy of the subject NP.[2] The model identified significant main effects of definiteness such that sentences with indefinite subject NPs were more likely to be rated generic ($\beta = 3.29, z = 14.41, p < 0.001$) and animacy such that sentences with inanimate subjects were less likely to be rated generic ($\beta = -1.29, z = -3.33, p < 0.001$). There were also significant interactions between animacy and definiteness such that sentences with inanimate, indefinite subjects were more likely to be rated generic ($\beta = 0.86, z = 2.52, p < 0.05$) and between definiteness and number such that sentences with indefinite, singular subjects were less likely to be rated generic ($\beta = -1.84, z = -7.59, p < 0.001$).

The results are consistent with previous findings that indefinite singulars and bare plurals facilitate generic interpretations compared to definite singulars and definite plurals, respectively (Cimpian et al., 2011; Gelman & Raman, 2003). The interaction between definiteness and plurality reveals a superadditive effect by which indefinite, bare plurals were rated more generic than would be predicted by the main effects of definiteness and plurality. This is unsurprising, as bare plurals are often taken to be the canonical subject type for English generics. The effect of animacy is also consistent with previous findings that both children and adults produce more generic statements when describing animals than when describing artifacts (Brandone & Gelman, 2009).

Comparing the effect sizes across significant predictors, we find that definiteness had the greatest influence on participants' responses. This finding is straightforwardly interpretable in terms of the pragmatic reference failure hypothesis, which states that generic interpretation arises from reference failure. Since the definite determiner *the*, unlike indefinite determiners, presupposes the existence of a unique, salient entity in the common ground, it follows that definite subject NPs are more likely to refer to some particular entity. Therefore, sentences with definite subjects are less likely to have an intended generic interpretation.

Note, however, that there were sentences with definite subject NPs that were judged generic. Thus, we cannot conclude that sentences with definite subject NPs categorically receive non-generic interpretations. Rather, we argue that the presuppositions of the definite determiner are most easily satisfied if the NP can be grounded in a concrete referent present in the common ground. In principle, these presuppositions can be satisfied by taking the NP to be kind-referring, but such an interpretation requires an additional interpretative step to conclude that the speaker does not intend to refer to particular individual in the common ground.

One unexpected finding is that across all subject NP types, including plural definites, sentences were occasionally judged to be generic. This seems to clash with the general view that definite plurals do not allow for generic interpretations in English. This result forced us consider whether our methodology measured some property other than genericity. However, inspection of definite plurals that were judged generic suggested that these ratings were at least *prima facie* appropriate (Table 1). Moreover, recent work has suggested that sentences with definite plural subject NPs in En-

[2]All data and code can be viewed at `https://github.com/langcog/generic_ref`.

glish can receive generic interpretations, at least in certain circumstances (Farkas & de Swart, 2007), but that such uses may come with additional social meaning (Acton, 2014).

Classifying Generics

In Experiment 1, we directly manipulated the definiteness, number, and animacy features of subject NPs and observed how these manipulations influenced genericity judgments. However, the sentences produced in Experiment 1 varied with respect to many morphosyntactic, lexical, and semantic respects that we did not directly control. It is plausible that these factors also contributed to judgments about the classification of sentences as generic or not. To probe the influence of these factors on participants' responses, we extracted additional linguistic features from the sentences produced in Experiment 1 and then employed a number of classification techniques to determine which were most important in determining whether a sentence would be judged generic.

Method

We first used the Stanford part-of-speech (POS) tagger (Toutanova, Klein, Manning, & Singer, 2003) to obtain POS tags and tense/aspect features for verbs for all sentences judged in Experiment 1. Using these POS tags, we automatically extracted the following features for each sentence: tense, aspect, presence of main verb *be* or *have*, and presence of a modal. We also calculated the total sentence length minus the length of the subject NP for each sentence.

We next split the sentences from Experiment 1 into training and test sets, with the training set consisting of 75% of all sentences produced. Using the training set, we trained a variety of models to classify sentences as generic or non-generic. All models included definiteness, number, and animacy of the subject NP, the factors extracted using POS tags, and sentence length as predictors. Models included generalized linear models, basic decision trees, boosted decision trees, and random forests. Model parameters were optimized using 10-fold cross-validation on the training set. The models were then evaluated against the 25% held-out test set.

Results & Discussion

All models achieved classification accuracy on the test set between 85% and 87%. The most straightforwardly interpretable of these methods was a basic decision tree pruned to have three terminal nodes (Figure 2). This decision tree considers only the definiteness of the subject NP and the tense of the sentence and achieved a test accuracy of 86.7%.

To assess the reliability of human judgments (and hence the theoretical ceiling for the classifiers), an independent set of participants re-rated the sentences in the held-out test set. The experimental details were the same as those for task 2 of Experiment 1. We recruited 41 participants, all of whom reported that their native language was English. The agreement between these judgments and those collected in Experiment 1 was substantial: the judgments were in agreement 87.8% of the time, virtually identical to the accuracy of the machine classification techniques we employed (Cohen's $\kappa = 0.73$).

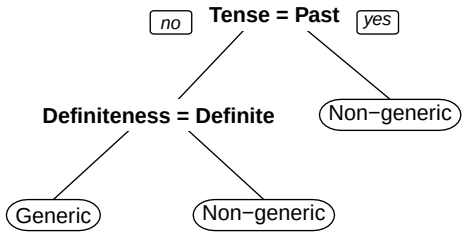

Figure 2: Decision tree with three terminal nodes for classification of sentences as generic or non-generic.

The most striking finding in our attempt to classify sentences as generic was that the vast majority of factors considered did not prove useful in this classification task. In the end, we were able to achieve human-level accuracy in the classification task using only the definiteness of a sentence's subject NP and the tense of the sentence. As discussed in the context of the results of Experiment 1, the definite article presupposes the existence of a unique, salient entity. Thus, a listener can infer that the speaker intended to refer to some particular individual, rather than a kind.

The importance of tense can be understood in a similar manner. Partee (1973) observes from the interaction of tense and negation that the past tense in English has a referential character. "I didn't turn off the stove," neither means that there is no time in the past when the speaker turned off the stove (which is false) nor that there is any time in the past when the speaker did not turn off the stove (which is trivially true). Rather, the speaker refers to a specific interval of time during which he/she did not turn off the stove. In general, English simple past tense clauses refer to particular intervals of time during which particular events occurred (Heim, 1994). In contrast, the vast majority (92%) of non-past sentences produced in Experiment 1 used simple present tense, which is employed in English to express habits or ongoing states, rather than strictly temporally delimited events. While kinds are unlikely to participate in specific events, habits or states may express general properties of kinds.

We propose that the influence of definiteness and tense on the interpretation of sentences as generic or non-generic can be explained by the pragmatic reference failure hypothesis. Listeners attempt to referentially ground the expressions in particular entities or events. Failure to identify referents for these expressions gives rise to generic interpretations.

Experiment 2

The results of the classification task described above suggest that tense plays a critical role in guiding judgments as

to whether a sentence should be interpreted as generic. In order to confirm this finding, we ran an experiment in which we directly manipulated the tense of sentences to see if this would change interpreters' judgments about genericity. This experiment is partial replication of Cimpian et al. (2011), in particular their findings regarding the role of tense in guiding generic interpretations. However, our study differs from previous work in that we compare the magnitude of the effect of tense to those of other effects. In addition, we consider whether tense meaningfully interacts with other factors in driving generic interpretations.

Method

Participants Recruitment details were similar to those of task 2 in Experiment 1. We recruited a total of 50 participants, all of whom were self-reported native English speakers.

Stimuli We chose a set of 48 sentences produced in Experiment 1, one for each base noun used in the experiment. All subject NP types, crossing definiteness, number, and animacy, were equally represented in this set. None of the selected sentences contained main verb *be* or *have*, a modal, or a passive construction. The selected sentences were evenly split between those with simple present and simple past tense verbs. In several cases, sentences produced in Experiment 1 were slightly altered to avoid awkward phrasing or to change the definiteness or number feature of the subject NP to ensure that all pairs of number and definiteness features were equally represented.

Once all 48 sentences were collected, we created alternate versions of each sentence in which the tense of the main verb was changed from simple present to simple past or vice versa.

Procedure The procedure was similar to that of part 2 in Experiment 1. Participants began by judging four example sentences. After this, participants viewed all 48 sentences in random order and indicated whether the sentence was about "*nouns*" or "a specific *noun*/group of *nouns*." Half of sentences judged by each participant contained simple present tense verbs, while half contained simple past tense verbs. Items were presented in random order; the order of tenses was also randomized.

Results and Discussion

The effects of definiteness and number of the subject NP were broadly similar to the effects found in Experiment 1. In addition, the tense manipulation greatly influenced judgments, with present tense sentences being more likely to be judged generic across all subject NP types (Figure 3).

We fit a logistic mixed-effects model to predict sentences' genericity classifications from the interaction of tense, definiteness, number, and animacy. The model revealed only two significant effects; sentences with indefinite subject NPs were more likely to be judged generic ($\beta = 2.81, z = 3.04, p < 0.01$), as were present tense sentences ($\beta = 2.31, z = 3.26, p < 0.01$). The effects of tense and definiteness are similar in magnitude and provide further confirmation of the findings of the classification task.

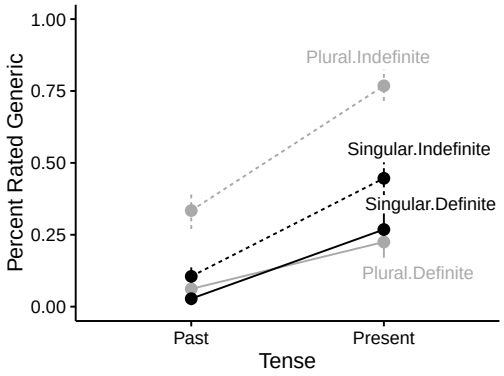

Figure 3: Percentage of sentences rated generic in Experiment 2 by tense, definiteness, and number. Error bars show 95% confidence intervals.

Note also that the consistency of the effect of tense across all subject NP types further confirms that definite subject NPs are not precluded from expressing generic meanings. Rather, as discussed above, it is more difficult to arrive at a generic interpretation of a sentence with a definite subject NP. However, this difficulty can be overcome if other factors, such as tense, support a generic interpretation.

General Discussion

We set out to explore the question of what gives rise to generic interpretations of sentences. The results here replicate previous findings about cues to genericity: Indefinite subject NPs support generic interpretations more than definite subject NPs (Cimpian et al., 2011; Gelman & Raman, 2003), present tense sentences are more likely to be judged generic than past tense sentences (Cimpian et al., 2011), and sentences with animate subjects tend to be more generic than those with inanimate subjects (Brandone & Gelman, 2009). Overall, we found that the most important factors for identifying generic statements were the definiteness of the sentence's subject NP and the tense of the sentence. We have argued that the importance of these two factors can be explained by viewing generic interpretations as the result of listeners' failure to ground expressions as referring to particular entities or events.

As noted above, there are exceptions to the generalizations discussed here. Even past tense sentences with definite plural subjects may be interpreted generically in certain cases (e.g. "The dinosaurs went extinct.") How can we account for such cases? Judgments regarding generic or non-generic meanings must be viewed as graded inferences about speakers' intentions. The factors that we have discussed here influence the likelihood that listeners will interpret a sentence as generic or not, but none of these factors can be viewed as categorically creating or precluding a generic interpretation.

We leave open for future research the question of the extent to which the pragmatic reference failure hypothesis is generalizable to cover generic interpretations in other lan-

guages. Some existing work supports the idea that tense and aspect influence genericity judgments in Spanish in a similar manner as reported here (Pérez-Leroux, Munn, Schmitt, & DeIrish, 2004). However, the role of definiteness in signaling generic and non-generic meanings is not expected to be the same across languages. For example, Romance languages canonically express genericity with sentences whose subjects are definite plural NPs, the subject NP type that is least associated with generic meanings in English. The theoretical linguistics literature offers several potential explanation for this cross-linguistic difference. It has been argued that languages that canonically express genericity with definite plural subjects do so because determiner-less NPs, like English bare plurals, cannot occupy arguments positions in these languages (Chierchia, 1998). Alternatively, languages may simply differ in whether their definite determiners may lexicalize reference to kinds or not (Dayal, 2004).

Our explanation regarding the source of generic interpretations has the potential to explain other factors that have previously been shown to serve as cues to generic meaning. For example, although we did not find aspect to play a crucial role in classifying sentences as generic or not, previous work has found that both children and adults are more likely to interpret present progressive sentences as non-generic than simple present sentences (Cimpian et al., 2011). Our failure to identify aspect as a crucial cue to generic meaning is possibly due to the fact that only 6.8% of the sentences produced in Experiment 1 used progressive or perfect aspect. However, our hypothesis is amenable to taking aspect to play a role in determining generic meaning. Present progressive sentences in English refer to events that are occurring at the speech time. A listener can infer from a sentence using the present progressive that a speaker intended to refer to a particular event.

Our proposal also straightforwardly explains previous findings that the contextual availability of a referent for the subject NP of a sentence makes it more likely that the sentence will be judged non-generic (Gelman & Raman, 2003). The presence of a referent for the subject NP greatly reduces the difficulty on the part of a listener to referentially ground this expression. We therefore predict that in such cases, listeners will be more likely to arrive at a non-generic interpretation.

We look forward to future work that tests the extension of the pragmatic reference failure hypothesis to explain additional factors influencing generic and non-generic interpretations and to explain cues to generic meaning in languages other than English.

Acknowledgments

Thanks to Daniel Lassiter, Rose Schneider, and the members of the Language and Cognition Lab. We gratefully acknowledge the support of NSF BCS Grant 1456077.

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