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An experimental Investigation of Antipresuppositions

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An experimental Investigation of Antipresuppositions

Abstract
The aim of this paper is to assess whether inferences resulting from violating the principle Maximize Presupposition behave differently from presuppositions and implicatures in processing, thus testing predictions of theories which separate those inferences out from these more well-studied aspects of meaning (Percus 2006, Sauerland 2008). We present data from a picture selection task and a visual world eye-tracking study on the English indefinite/definite determiner. Based on the findings we argue that 1) the epistemic status of anti-uniqueness inferences is much weaker than the uniqueness presupposition of the definite or implicature raised by the indefinite, and 2) drawing these inferences requires more effort than not drawing it or calculating presuppositions or implicatures.

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An experimental Investigation of Antipresuppositions

Nadine Bade and Florian Schwarz

1 Introduction

The aim of this paper is to assess whether inferences resulting from violating the principle *Maximize Presupposition* behave differently from presuppositions and implicatures in processing, thus testing predictions of theories which separate those inferences out from these more well-studied aspects of meaning (Percus 2006, Sauerland 2008). We present data from a picture selection task and a visual world eye-tracking study on the English indefinite/definite determiner. Based on the findings we argue that 1) the epistemic status of anti-uniqueness inferences is much weaker than the uniqueness presupposition of the definite or implicature raised by the indefinite, and 2) drawing these inferences requires more effort than not drawing it or calculating presuppositions or implicatures.

2 Theoretical Background

Presupposition triggers are obligatory when their presupposition is fulfilled in the context, see (1).

(1) a. John came to the party. Bill came, # (too).
b. Jenna went ice skating yesterday. She went # (again) today.
c. John knows / # believes Paris is in France.
d. The/ # A sun is shining.
e. The father/ # The fathers of the victim arrived at the crime scene.

A subset of these data, including the competition between definite and indefinite determiner in (1d), can be accounted for by assuming a principle **Maximize Presupposition** (Heim 1991). This is a general pragmatic principle accounting for the insertion of presupposition triggers, see below.

Maximize Presupposition (*MP!*) (Heim 1991) Make your contribution presuppose as much as possible!

More sophisticated versions of *Maximize Presupposition* assume that certain items are ordered on a scale of presuppositional strength (Percus 2006, Sauerland 2008, Chemla 2008), see (2).[1]

(2) {the, a} , {know, believe} , {too, ∅}, {again, ∅} , {both, all}

The oddness of (3a) under a ***MP!*** approach is the result of pragmatic reasoning: since there is a presuppositionally stronger competitor, (3b), the hearer assumes, upon hearing (3a), that the presupposition of this stronger alternative is false. The result is an inference that it is not certain that there is exactly one father of the victim. This inference goes against common knowledge and thus makes the sentence odd.

(3) a. #A father of the victim arrived at the crime scene.
b. The father of the victim arrived at the crime scene.

Whereas the mechanism for deriving the inference is the same as the one for the derivation of implicatures ***MP!*** cannot be subsumed under the maxim of quantity. This is due to the observation that the two sentences in (3a) are identical on the level of assertion.[2] As a result neither one of the

[1] There is disagreement, however, which items are parts of lexical scales and thus subject to this ordering. According to Sauerland (2008) only items with well defined lexical alternatives are managed by ***MP!*** , see Bade (2016) for discussion of the potentially limited empirical scope of ***MP!***

[2] Of course, one need not assume that. If competition is on the level of assertion, however, the inferences at hand are considered implicatures, which is not consistent with their different behaviour.

two is more informative than the other. This is a welcome result since ***MP!*** based inferences differ from implicatures and presuppositions in important respects.

First, inferences based on ***MP!*** project since the competition with the presuppositional item is unaffected by operators such as negation, questions and conditionals, see (4).

(4) a. #A father/fathers of the victim did not arrive at the crime scene.
b. #If a father/fathers of the victim arrived at the crime scene...
c. #Did a father/fathers of the victim arrive at the crime scene?

This is predicted as the presupposition of the competitor projects through all these operators. Furthermore, items which are already the strongest item on a Horn-scale seem to enter competition with presuppositionally stronger items, see the oddness of the sentences in (4).

(5) a. #Not all arms of John are broken.
b. #If all arms of John are broken...
c. #Are all arms of John broken?

If one assumes "both" to be a competitor for the universal quantifier on the level of presuppositions, the oddness of these sentences can be explained parallel to the case of "the" above. Second, ***MP!*** based inferences are epistemically weaker than presuppositions, and implicatures (Heim 1991, Sauerland 2008), consider (6a) as opposed to (6b).

(6) a. Robert caught a 6ft long catfish.
b. Robert caught the 6ft long catfish.

Whereas the speaker must be certain that there is a unique 6ft long catfish to utter (6b) s/he does not have to be certain that there is more than one when uttering (6a). (6a) only warrants the inference that the speaker is not certain that there is a unique 6ft long catfish, without strengthening to the speaker being certain that there not a unique 6ft long catfish.

Given these theoretical assumptions inferences arising as a result of a violation of ***MP!*** have a special status, which differs both from presuppositions and implicatures. They are weak inferences, which resist strengthening, and project. As a result, ***MP!*** based inferences should also show a processing pattern which is different from those usually associated with implicatures and presuppositions. Before spelling out more detailed predictions, we lay out the general approach of our study.

3 Experimental Evidence

3.1 Idea and Method

The aim of the study was to gain insights into the interpretation of indefinite sentences like (7a) with definite ones like (7b) in contexts where they enter a competition based on ***MP!*** . Specifically, we were interested in the derivation of different inferences associated with these sentences and the time course of their processing. (7a) has both an implicature that there is exactly one gray cat on the third floor and an ***MP!*** based inference (usually referred to as the "antiuniqueness" inference or "antipresupposition" of the indefinite) that there is more than one cat on the third floor in the given context. (7b) in turn has the presupposition that there is exactly one cat on the third floor.

(7) a. A cat on the third floor is gray.
$\rightsquigarrow$ There is more than one cat on the third floor.
$\rightsquigarrow$ There is exactly one gray cat on the third floor.
b. The cat on the third floor is gray.
$\rightsquigarrow$ There is exactly one cat on the third floor.

The method we chose to test the availability of these inferences and how fast they can be accessed was a visual-world eye-tracking experiment using auditory stimuli.

3.2 Material and Design

We had a toal of four conditions, one with the indefinite and definite determiners respectively, and one with a numeral, which was either focused or not, see examples in (8).

(8) a. A shirt in Benjamin's closet is blue. INDEFINITE
b. The shirt in Benjamin's closet is blue. DEFINITE
c. One shirt in Benjamin's closet is blue. NUMERAL
d. ONE shirt in Benjamin's closet is blue. NUMERALF

For the three picture conditions two of three different pictures types were paired with each other and presented with a third distractor picture. The picture types had different properties, specified below. The pictures were always depicting kids with their containers containing different colored items.

Picture type 1 SAMECOLOR contained three of the relevant items, all of which had the color given in the sentence, see example in Figure 1. The antiuniqueness inference of the indefinite is verified in this case, however implicature of the indefinite and presupposition of the definite are falsified. The second picture type SINGLEITEM contained one item of the relevant sort which had the color described. This picture makes the presupposition of the definite true. Accordingly, the antiuniqueness inference of the indefinite is falsified, the implicature is true as well, see an example in Figure 2. The third picture type DIFFCOLOR contained three items of the relevant kind, only one of which had the described color. This makes this picture the perfect competitor for the sentence with the indefinite according to theoretical assumptions. This is because both the antiuniqueness inference as well as the implicature of the indefinite are true in this picture. The presupposition of the definite is false, see example in Figure 3 below. The properties of the pictures are summarized in Table 1.

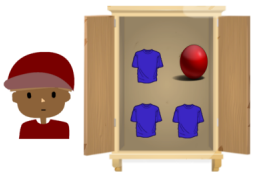


Figure 1: SAMECOLOR

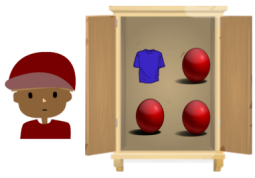


Figure 2: SINGLEITEM

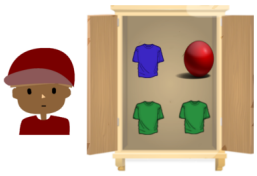


Figure 3: DIFFCOLOR

Inference	**SAMECOLOR**	**SINGLEITEM**	**DIFFCOLOR**
Anti-PSP	TRUE	FALSE	TRUE
PSP	FALSE	TRUE	FALSE
Implicature	FALSE	TRUE	TRUE

Table 1: Summary of picture properties.

There were three different picture conditions pairing two of the three picture types with a fourth distractor type containing no relevant items, see picture conditions in (9) and in figures 4 to 6.

(9) **Conditions A - C**
a. A: type 1, type 2, type 4
b. B: type 2, type 3, type 4
c. C: type 1, type 3, type 4

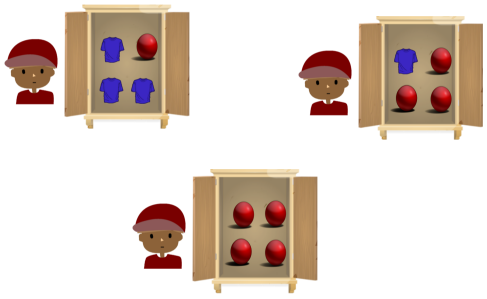


Figure 4: Condition A.

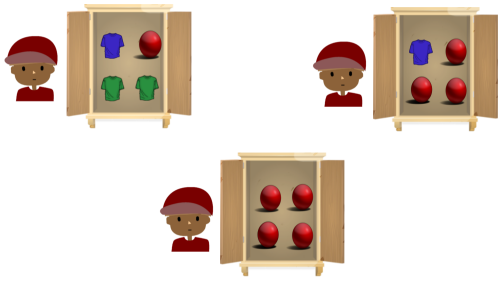


Figure 5: Condition B.

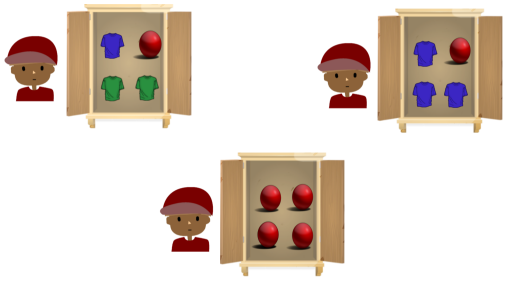


Figure 6: Condition C.

The four level factor DETERMINER was crossed with the three level factor PICTURE, resulting in a 4x3 design and 12 experimental conditions in total. DETERMINER was treated as a between-group factor, i.e. each participant only heard one determiner type. The conditions were distributed over 12 lists in a Latin square design. We had 18 critical items and 30 filler items, which were designed to counterbalance the picture choices for the critical items. Specifically, we included fillers like in (10a) to force the choice of SAMECOLOR pictures, and fillers like in (10b) and (10c) to force choices of the distractor picture.

(10) a. There are three blue shirts in Benjamin's closet.
b. There are no shirts in Benjamin's closet.
c. There are only red balls in Benjamin's closet.

Based on our theoretical assumptions we labeled the picture types given in Table 2 *target choices* for indefinite and definite, respectively.

condition	definite	indefinite
A	SINGLEITEM	SAMECOLOR
B	SINGLEITEM	DIFFCOLOR
C	DIFFCOLOR	DIFFCOLOR

Table 2: Target choices.

The 18 critical item were recorded in all 4 determiner conditions. They were cut using the software PRAAT so that only the determiner changed and the rest of the sentence remained the same across determiner conditions. Half of the time the recordings of the indefinite sentences were chosen as the basis for cutting, the other half the sentences with the definite were used. This was done to minimize differences in intonation between conditions so that we could make sure that only the determiner played a role for the picture chosen.

3.3 Procedure and Participants

120 students of the University of Pennsylvania participated in the experiment. They were recruited through the SONA system and received course credit for their participation. After consenting to participate they read instructions on a computer screen. They went through two practice trials to get familiar with the task. They heard a sentence and saw three different pictures on screen at the same time. They were instructed to choose the picture they heard described by clicking on it. While doing the task their eye movements were recorded using an EyeLink 1000 by SR Research. 18 trials that exhibited more than 30% track-loss in the time window from the noun to the adjective were removed for purposes of analysis.

3.4 Predictions

We will now turn to the predictions for the different picture conditions. For reasons of simplicity, we will lay out predictions for the definite and indefinite and will not discuss numerals and focused numerals separately. We assume the basic pattern to be the same for simple indefinites and numerals.[3]

Picture condition A contained the two critical picture types SAMECOLOR and SINGLEITEM, see figures 7a and 7b below.

(11) {A /The /One /ONE} shirt in Benjamin's closet is blue.



(a) Type 1 SAMECOLOR (b) Type 2 SINGLEITEM

Figure 7: Condition A.

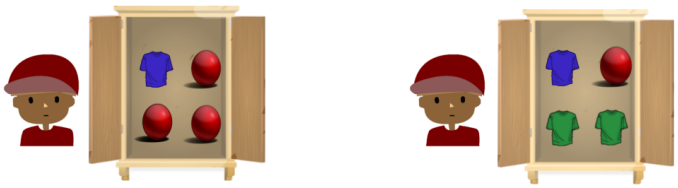
We predict type SINGLEITEM do be chosen for the definite due to its presupposition, whereas

[3]One reason to include numerals was to be able to compare the results to German data, where indefinite and numeral have the same form. We wanted to make sure that German "ein" behaves like a proper indefinite in the relevant aspects. We expected the difference between "one", which can be focused, and "a" to mainly play a role for implicature computation, since focus placement is predicted to change the rate of implicatures. Since this is not the main issue of the present discussion, we will not discuss numerals in any detail here.

type SAMECOLOR should be chosen for the indefinite due to its anti-presupposition. In addition, the target choice should be quicker for the definite than for the indefinite, given previous evidence that presuppositions are available immediately, whereas anti-presuppositions are the result of complex reasoning based on the presupposition of the competitor.

Picture condition B contained picture types SINGLEITEM and DIFFCOLOR, see Fig. 8a and 8b below.

(12) {A /The /One /ONE} shirt in Benjamin's closet is blue.



(a) Type 2 SINGLEITEM (b) Type 3 DIFFCOLOR

Figure 8: Condition B.

Again, SINGLEITEM should be chosen for the definite condition. DIFFCOLOR is predicted to be the target choice for the indefinite. Not only its implicature but also its antiuniqueness anti-presupposition are verified. Identifying and picking the target should be quicker for the definite than for the indefinite, for the same reasons specified above.

The third picture condition contained SAMECOLOR and DIFFCOLOR, see 9a and 9b below.



(a) Type 1 SAMECOLOR (b) Type 3 DIFFCOLOR

Figure 9: Condition C.

There is no picture verifying the uniqueness presupposition of the definite in condition C. However, based on previous findings (Schwarz 2013) we assume that due to the possibility of restricting the domain for the definite, which is easier in the DIFFCOLOR picture, DIFFCOLOR would be the target choice for the definite. The same should be true for the indefinite, given that anti-presupposition and implicature are verified. Possibly, the target choices are equally slow for definite and indefinite in this condition, given the additional effort for computing inferences in the indefinite case and finding the appropriate domain restriction for the definite case.

3.5 Results

We will first report the rates of target choices we found for each condition and determiner. The predictions for condition A are borne out for the definite. The vast majority of the time participants chose the SINGLEITEM picture for the definite since it verifies the presupposition. Surprisingly, the same pattern arose for the indefinite, suggesting that the anti-uniqueness inference did not play a role at all in picture choices. The false implicature seems to keep participants from being able to choose

the SAMECOLOR picture. This is also in line with the target choices being quick, as implicatures should be processed early and immediately influence choice of picture (Huang and Snedeker 2009).

determiner	SAMECOLOR	SINGLEITEM	**RT**
the	6%	94%	3230
A	2%	98%	3180
one	5%	95%	3288
ONE	3%	97%	3290

Table 3: Picture choices by determiner condition A.

The predictions were also borne out for the definite in condition B. SINGLEITEM picture was chose almost all of the time, as it verifies the presupposition. Contrary to our predictions, however, DIFFCOLOR was not the picture most often chosen for sentences with the indefinite. While significantly more frequent than for definites ($\beta = -0.43$, $SE = 0.13$, $z = 3.35$, $p < .001$),[4] DIFFCOLOR choices were merely at 23%. They were significantly more frequent yet for numerals (for *one*: $\beta = 0.32$, $SE = 0.14$, $z = 2.34$, $p < .05$), but even so remain only at about chance level. Again, anti-uniqueness does not seem to be a strong factor for picture choice. However, two things are noteworthy: first, target choices for the indefinite are significantly slower than for the definite ($\beta = -879.6$, $SE = 355.1$, $t = -2.48$) suggesting that additional processing costs were incurred compared to the definite in this condition, in contrast to condition A. Second, competitor choices for indefinites were significantly slower in this picture condition than they were in condition A ($\beta = 547.9$, $SE = 80.6$, $5 = 6.80$). This suggests that the competing picture had a part in the decision process.

determiner	DIFFCOLOR	SINGLEITEM	**RT**
the	5%	95%	3443
A	23%	77%	3809
one	44.2%	57.4%	3902
ONE	44.5%	55.5%	3868

Table 4: Picture choices by determiner condition B.

Our predictions for condition C were completely borne out. DIFFCOLOR picture was chosen for the definite due to facilitated domain restriction, and for the indefinite since it verified both its anti-uniqueness inference and implicature. There were significantly more target choices for the indefinite in condition C than there were in B and A (B: $\beta = 5.60$, $SE = 0.32$, $z = 17.36$, $p < .001$; A: $\beta = 8.66$, $SE = 0.42$, $z = 20.60$, $p < .001$). Target choices were equally quick for all determiners.

determiner	DIFFCOLOR	SAMECOLOR	**RT**
the	86%	14%	3593
A	99.3%	0.7%	3347
one	100%	0%	3233
ONE	98%	2%	3228

Table 5: Picture choices by determiner condition C.

Next, we will report the data from eye-movements we collected. For graphing the results, we created windows of 50 ms and plotted the percentage of looks (fixations) to critical regions (target, competitor, distractor). The figures below report *Target Advantage* scores, i.e., looks to target minus the looks to competitor. For statistical analysis, we computed linear mixed effect models for log-transformed scores in R, using $|t| > 2$ as an indication of significance. Critical regions for the computation of inferences started with the onset of the noun, and the onset of the PP, and the onset

[4] Response patterns where analyzed using logistic mixed effect models with the glmer function in R.

of the AP, as indicated by the vertical lines in (13). The PP itself is never informative and thus we expect the calculation of inferences to start upon hearing the noun itself.

(13) A | shirt | in Benjamin's closet is | blue.

The first time window we looked at was thus 500-700 ms after onset of the noun, which is right before the PP onset, indicated as the first vertical black line in the graph below. Neither PICTURE CONDITION nor DETERMINER have an impact on target advantage in this time window.

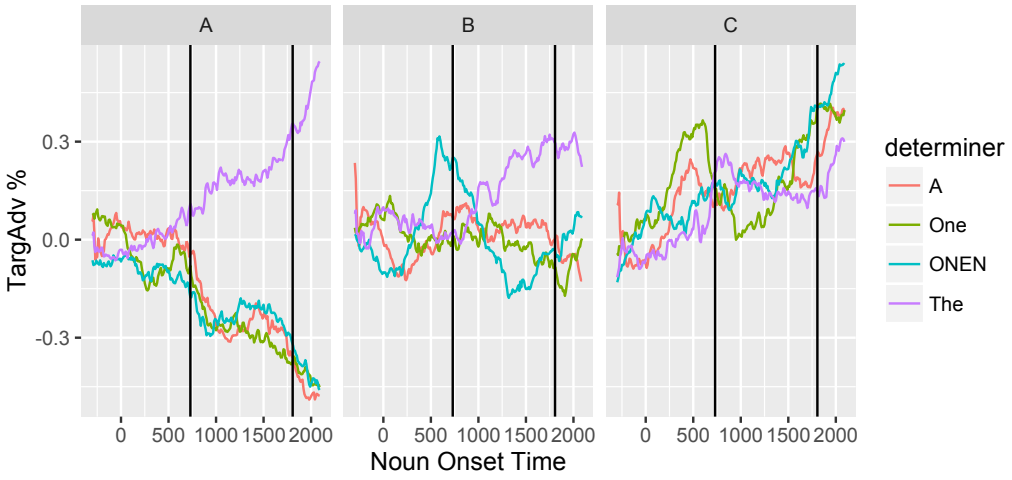


Figure 10: Target advantage all determiners by condition.

Interesting patterns start to show up in the second time window we looked at, 700-900 ms after noun onset and thus right after the PP onset. There was a significant effect of PICTURE CONDITION for "a" versus "the": for the definite there is a difference only between conditions A and C ($\beta = 3.76$, $SE = 0.95$, $t = 3.95$), for the indefinite between conditions A and B ($\beta = 2.31$, $SE = 0.94$, $t = 2.44$) as well as A and C ($\beta = 2.58$, $SE = 0.94$, $t = 2.75$), with significantly more looks to the target in conditions B and C than in A, see Figure 11. This is surely due to the fact that what was originally labelled target in condition A did not play a role in the decision at all. Looks are going to the competitor for the indefinite in condition A early on, compare the upper left graph in Figure 10. In addition, response becomes significant as a predictor of TargetAdvantage for indefinite "a" ($\beta = -3.47$, $SE = 1.73$, $t = -2.01$) but not for "the", i.e. ultimate target choice influenced the looks to the target for the indefinite early on. Moreover, there is a marginal effect of DETERMINER ("the" versus "a") in condition B, if choice was the target ($\beta = -3.31$, $SE = 1.79$, $t = 1.85$): there are more looks to the target for the definite than there are for the indefinite at this point.

The third time window we looked at was 900-1100ms after noun onset, which is right after the PP onset. We see highly significant effects of PICTURE CONDITION for both definite and indefinite DETERMINER ("A"-A vs. B: $\beta = 3.53$, $SE = .97$, $t = 3.62$; "A"-A vs. C: $\beta = 5.17$, $SE = .97$, $t = 5.32$; "The"-A vs. B: $\beta = 3.75$, $SE = .98$, $t = 3.85$; "The"-A vs. C: $\beta = 4.41$, $SE = .97$, $t = 4.53$). Most importantly, there is a marginally significant interaction between time window two and three and DETERMINER ("a" versus "the") in condition B if the choice was the target ($\beta = 4.17$, $SE = 2.13$, $t = 1.96$). There is a higher target advantage for the indefinite than for the definite in the first time window, whereas in the second time window the target advantage for the definite is higher, see the effect highlighted by the two blue boxes (indicating time windows) in Figure 12 below.

3.6 Discussion

The results confirm the weak epistemic status of ***MP!*** based inferences. In condition B, where the implicature of the indefinite did not play a role, choices were only rarely influenced by the anti-uniqueness inference of the indefinite. In line with what is predicted the reaction time data suggest,



Figure 11: Target advantage all conditions by determiner.

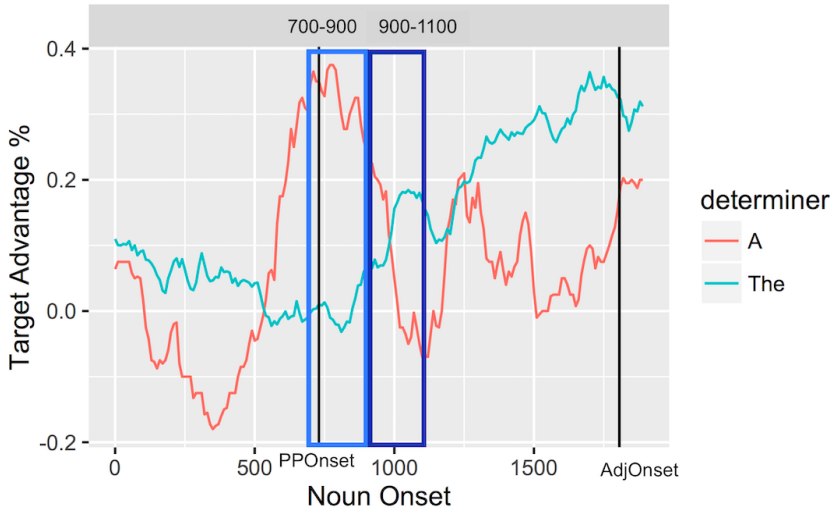


Figure 12: Target advantage condition B if choice = target.

however, that, if computed, ***MP!*** based inferences require more time than presuppositions. In addition, the eye-tracking data suggest that the time course of the computation of these inferences is different from the one of presuppositions. The competitor picture seems to play a role in computing ***MP!*** based inference, as shown by relatively late looks to the competitor for the indefinite compared

to the definite when target is ultimately chosen. This speaks in favour of an approach to ***MP!*** that works with alternatives. Yet it seems that comparing the indefinite to its presuppositional alternative is not as automatic as lexical competition triggered for implicatures, i.e. most of the time the target sentences seemed to be interpreted as lacking an anti-uniqueness inference.

This could mean that indefinites are about novelty not antiuniqueness after all (Heim 1983), and that the observed oddness effects are due to "anti-familiarity" inferences. However, it may also be that the indefinite is simply ambiguous between an existential and a modifier with a presupposition of existence in subject position (see Heim 2012 for discussion). And possibly only one of them enters competition with the definite. Some evidence for this view comes from the differences between indefinites and numerals we observed. Anti-uniqueness inferences were computed to a higher degree for numerals than for indefinites and they displayed a different eye movement pattern. This might be due to the fact that a simple existential interpretation is less likely for numerals, which suggest that the number of items is at-issue, however existence is not. Not much is known about the factors that influence when the interpretation of the indefinite depends on the competition with the definite. The standard examples discussed for ***MP!*** suggest that stereo-typicality of the uniqueness plays a role. Recently, it has been suggested that strength of the inference might depend on whether the speaker is an *Authority* (Rouillard and Schwarz 2017). The knowledge state of the speaker is not made sufficiently clear in our experiments. Further research is needed to understand what factors trigger ***MP!*** based competition. Our results suggest that theories distinguishing these inferences from implicatures and presuppositions are on the right track. The reliability of the inference as well as the time course of its computation differ from the one we observe for presuppositions and implicatures alike. To get a better understanding of these inferences, more reliable factors for their derivation need to be established.

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