An experimental investigation of implicature and homogeneity approaches to free choice*

Lyn Tieu
University of Toronto

Cory Bill
Leibniz-ZAS

Jacopo Romoli
Heinrich-Heine Universität Düsseldorf

Abstract A sentence containing disjunction in the scope of a possibility modal, such as *Angie is allowed to buy the boat or the car*, gives rise to the FREE CHOICE inference that Angie can freely choose between the two. This inference poses a well-known puzzle, in that it is not predicted by a standard treatment of modals and disjunction (e.g., Kamp 1974). To complicate things further, FREE CHOICE tends to disappear under negation: *Angie is not allowed to buy the boat or the car* doesn't merely convey the negation of free choice, but rather the stronger DOUBLE PROHIBITION reading that Angie cannot buy either one. There are two main approaches to the FREE CHOICE-DOUBLE PROHIBITION pattern in the literature. While they both capture the relevant data points, they make a testable, divergent prediction regarding the status of positive and negative sentences in a context in which Angie can only buy one of the two objects, e.g., the boat. In particular, the implicature-based approach (e.g., Fox 2007, Klinedinst 2007, Bar-Lev & Fox 2017, 2020) predicts that the positive sentence is true in such a context, but associated with a false implicature, while it predicts the negative sentence to be straightforwardly false. The homogeneity-based approach in Goldstein (2019) predicts both the positive and negative sentences to be equally undefined (see also Aloni 2022 and Willer 2017 for similar predictions). Investigating the contrast between these sentences in such a context therefore provides a clear way to address the debate between implicature and non-implicature accounts of FREE CHOICE. We present a set of three experiments aiming to do just this, by comparing FREE CHOICE inferences to regular implicatures, using a ternary judgment task. The results overall present a challenge for the implicature approach. We discuss how the implicature approach could be amended to account for our results, based on a recent proposal by Enguehard & Chemla (2021) on the distribution of implicatures.

Keywords: free choice, implicature, homogeneity, ternary judgment task, polarity

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1 Introduction

A sentence containing disjunction in the scope of a possibility modal, such as (1-a), gives rise to the so-called FREE CHOICE inference in (1-b), conveying that Angie is allowed to buy the boat and that she is allowed to buy the car. That is, she can *freely choose* between the two.

(1) a. Angie is allowed to buy the boat or the car.
b. ⇝ *Angie can choose between the two* FREE CHOICE

This inference poses a well-known puzzle, in that it is not predicted by standard treatments of modals and disjunction.[1] To complicate things further, FREE CHOICE tends to disappear under negation: the corresponding negative sentence in (2-a) doesn't merely convey the negation of free choice; rather, it conveys the stronger DOUBLE PROHIBITION reading, conveying that Angie cannot buy either one.

(2) a. Angie is not allowed to buy the boat or the car.
b. ⇝ *Angie is not allowed to buy either one* DOUBLE PROHIBITION

There are two main approaches to the FREE CHOICE-DOUBLE PROHIBITION pattern in the literature. One is based on deriving FREE CHOICE as an implicature, while the other either encodes it in the meaning of disjunction or the modal, or treats it as a pragmatic inference of a different kind. Both approaches can account for the basic cases above, as well as a variety of more complex data. They differ, however, with respect to a simple prediction regarding the status of sentences like (1-a) and (2-a) in a context where Angie can only buy one of the two objects, e.g., the boat. In particular, the implicature approach predicts the positive case to be a true sentence with a false implicature, while it predicts the negative case to be straightforwardly false in such a context. The non-implicature approach, on the other hand, predicts both cases to be equally undefined. Comparing these sentences in such a context, therefore, provides a clear way to address the debate between implicature and non-implicature approaches to FREE CHOICE.

We present a set of three experiments aimed at testing these predictions, using a ternary judgment task (see Katsos & Bishop 2011, Abrusan & Szendroi 2013, Križ & Chemla 2015, Tieu et al. 2017a, Renans et al. 2018, Tieu et al. 2019, among others) to target undefinedness.

Experiment 1 focused on the comparison between free choice disjunction and plain disjunction as in (3-a), the EXCLUSIVITY inference of which is less controversially analyzed as an implicature (3-b).

1 See Kamp (1974) and much subsequent work, as well as Meyer (2018) for a detailed overview of the problem.

(3) a. Angie bought the boat or the car.
b. ⇝ *Angie didn't buy both the boat and the car* IMPLICATURE

Experiment 2 compared free choice disjunction to the regular *not required to* implicature of weak modals as in (4).

(4) a. Angie is allowed to buy the boat.
b. ⇝ *Angie is not required to buy the boat* IMPLICATURE

In Experiment 3, we addressed potential confounds associated with Experiments 1 and 2, and compared free choice 'any' to the quantifier 'some'.

(5) a. Angie is allowed to buy any of the food items.
b. ⇝ *Angie can choose between the food items* FREE CHOICE

(6) a. Angie bought some of the food items.
b. ⇝ *Angie didn't buy all of the food items* IMPLICATURE

To anticipate the results, all three experiments revealed a significant interaction between inference type and polarity, suggesting free choice and scalar implicatures do not pattern in the same way with respect to polarity. Along the way, however, we also find that the interpretation of the ternary judgment task has its own challenges that need to be controlled for. We discuss the methodological implications of our study, and, on the theoretical side, how the implicature approach could be amended to account for our results, based on a recent proposal by Enguehard & Chemla (2021) on the distribution of implicatures.

The rest of the paper is organized as follows. In Section 2, we provide further background on the FREE CHOICE-DOUBLE PROHIBITION pattern, outlining the two approaches and their predictions. In Section 3, we briefly discuss some relevant previous studies. We present our experiments in Sections 4, 5, and 6, and in Section 7 we discuss the implications of the findings for theories of free choice, including how the implicature approach might be further developed to account for the results. Section 8 concludes the paper.

2 Background

2.1 Free choice

As mentioned, a sentence like (1-a) and its negation in (2-a) pose a challenge for standard treatments of modals and disjunction. To illustrate the pattern more schematically, a configuration like (7-a) gives rise to the conjunctive FREE CHOICE inference in (7-b). Its negation in (8-a) gives rise to a conjunctive DOUBLE PROHIBITION inference, which is stronger than the NEGATED FREE CHOICE inference (which

would correspond to: $\neg \Diamond B \vee \neg \Diamond C$).

(7) a. $\Diamond(B \vee C)$
b. $\Diamond B \wedge \Diamond C$ FREE CHOICE

(8) a. $\neg \Diamond (B \vee C)$
b. $\neg \Diamond B \wedge \neg \Diamond C$ DOUBLE PROHIBITION

In addition, the negated free choice reading re-emerges in cases like (9), in which a DOUBLE PROHIBITION reading of the first sentence would lead to a contradiction with the continuation. The coherence of (9) indicates that the first sentence is read with a negated free choice reading.

(9) Angie isn't allowed to buy the boat or the car. She's only allowed to buy the boat!

Relatedly, the FREE CHOICE inference can also be suspended in cases like (10), where a FREE CHOICE reading of the first sentence would lead to a contradiction with the second one. The coherence of (10) again tells us that the first sentence can be read as not entailing FREE CHOICE.

(10) Angie is allowed to buy the boat or the car. I don't remember which one.

Any approach to the FREE CHOICE-DOUBLE PROHIBITION pattern not only has to predict FREE CHOICE in the positive case and DOUBLE PROHIBITION in the negative one, but it also needs to account for the absence of such DOUBLE PROHIBITION and FREE CHOICE readings in cases like (9) and (10), respectively.[2] We turn now to the two main approaches in the literature.

2.2 Two approaches

2.2.1 The implicature approach

The most prominent approach in the literature is based on a theory of implicatures and comes in different versions (e.g., Kratzer & Shimoyama 2002, Fox 2007, Klinedinst 2007, Chemla 2010, Franke 2011, Santorio & Romoli 2017, Bar-Lev 2018, Bar-Lev & Fox 2020, Del Pinal et al. 2022). Without going into the details of the implementation, this account is based on three main ingredients: (i) a standard meaning for disjunction and possibility modals, (ii) an implicature-generating algorithm, which we can refer to as 'EXH', and (iii) a(n independently required) principle regulating the distribution of EXH, which bans or strongly disfavors EXH under

2 The puzzle, in fact, extends more generally beyond the positive/negative dichotomy, to upward- versus downward-entailing environments; see Fox (2007), among others, for discussion.

negation, as in (11) (see, among others, Chierchia et al. 2012 and Fox & Spector 2018).

(11) Do not insert EXH in a sentence *S* if the resulting meaning is weaker than that of *S*, unless forced to.

Theories differ in how they conceive of and define EXH, how many EXH operators one needs, and in which positions they must occur in order to generate FREE CHOICE. These differences will not be important for our purposes. What is relevant for us is that EXH gives rise to FREE CHOICE as an implicature.

To illustrate how this approach works, let us return to the positive case in (1-a), repeated schematically below in (12).

(12) $\Diamond(B \vee C) = \Diamond B \vee \Diamond C$ LITERAL MEANING

The literal meaning of (12) does not entail FREE CHOICE; in fact it is simply equivalent to $\Diamond B \vee \Diamond C$ (there is at least one between the boat and the car that Angie is allowed to buy).

The weak meaning in (12), when negated, immediately gives rise to the strong DOUBLE PROHIBITION reading: (13) entails $\neg \Diamond B \wedge \neg \Diamond C$ (Angie is not allowed to buy the boat and she isn't allowed to buy the car).

(13) $\neg[\Diamond(B \vee C)] = \neg \Diamond B \wedge \neg \Diamond C$ DOUBLE PROHIBITION

To generate FREE CHOICE, EXH is added to the positive sentence, generating the desired inference as an implicature.

(14) $\text{EXH}[\Diamond(B \vee C)] = \Diamond B \wedge \Diamond C$ FREE CHOICE

Moreover, the principle in (11) prevents, or makes it very hard for EXH to appear in the scope of negation, which would otherwise give rise to a NEGATED FREE CHOICE reading, (15), rather than the stronger DOUBLE PROHIBITION above in (13).

(15) $^{*}\neg[\text{EXH}[\Diamond(B \vee C)]] = \neg \Diamond B \vee \neg \Diamond C$ NEGATED FREE CHOICE

The derivations of the different meanings are schematized in Table 1.

Finally, the implicature approach can also account for the absence of FREE CHOICE and DOUBLE PROHIBITION in cases like (9) and (10). The latter can simply be a case in which EXH is not added to (12), giving rise to the weaker literal meaning that does not entail FREE CHOICE. This meaning is compatible with the continuation, where the speaker is explicit about being ignorant as to which of the boat and the car Angie is allowed to buy. (9) would be a case in which EXH does appear under negation (in the formulation of (11), EXH is allowed to appear under negation even

	LITERAL MEANING	IMPLICATURE	RESULT
POS	$\Diamond(B \vee C) = \Diamond B \vee \Diamond C$	$\text{EXH}(\Diamond(B \vee C)) = \Diamond B \wedge \Diamond C$	$\Diamond B \wedge \Diamond C$
NEG	$\neg\Diamond(B \vee C) = \neg\Diamond B \wedge \neg\Diamond C$	$^{*}\neg(\text{EXH}(\Diamond(B \vee C))) = \neg(\Diamond B \wedge \Diamond C)$	$\neg\Diamond B \wedge \neg\Diamond C$

Table 1 Derivation of the FREE CHOICE-DOUBLE PROHIBITION pattern under the implicature account.

if it leads to weakening, when this is 'forced' by the context). In this case, the potentially contradictory continuation would force EXH to appear under negation, giving rise to the NEGATED FREE CHOICE meaning in (15), which is compatible with the rest of the sentence and can therefore account for the felicity of (9).

In sum, given standard assumptions about the meanings of modals and disjunction, along with a theory of implicatures and a principle that regulates their distribution, the implicature approach can account for the FREE CHOICE-DOUBLE PROHIBITION pattern as well as cases in which these readings are absent. We turn now to the alternative, non-implicature approach.

2.2.2 A non-implicature approach: homogeneity

The implicature approach is not the only theoretical option available for explaining the FREE CHOICE-DOUBLE PROHIBITION pattern (see Zimmerman 2000, among others). Recently, a variety of alternative accounts have been proposed (e.g., Aloni 2007, Fusco 2015, Starr 2016, Willer 2017, Rothschild & Yablo 2018, Goldstein 2019, Aloni 2022). For concreteness, we focus on the HOMOGENEITY account in Goldstein (2019);[3] as far as we can see, however, the main points below apply to most of the non-implicature accounts; see also Aloni (2022) for discussion of how our results can be accounted for under her approach.

The HOMOGENEITY account is based on four ingredients: (i) a strong meaning for sentences like (1-a), which directly asserts FREE CHOICE, (ii) a homogeneity presupposition requiring that either all alternatives are possible or none of them are, (iii) an operator that has the effect of cancelling the strong FREE CHOICE meaning, and (iv) another operator that can suspend DOUBLE PROHIBITION.

To illustrate, consider the positive case in (16-a). Given (i), FREE CHOICE is directly entailed.[4] In addition, (16-a) also presupposes HOMOGENEITY, as in (16-b) (which in this case is entailed by the asserted FREE CHOICE meaning).

3 More specifically, we focus on his first account, based on alternative semantics.

4 See Goldstein (2019) for two possible ways of implementing this compositionally, by tweaking the standard meaning of modals or that of disjunction.

(16) a. $\Diamond(B \vee C) = \Diamond B \wedge \Diamond C$ FREE CHOICE
b. $\Diamond B \leftrightarrow \Diamond C$ HOMOGENEITY

While this approach directly captures FREE CHOICE by encoding it in the meaning of the positive sentence, it fails to immediately account for DOUBLE PROHIBITION. This is because in the negative case in (17-a), the asserted meaning is now simply the negation of FREE CHOICE. However, the latter, in combination with the HOMOGENEITY presupposition in (17-b) (which projects through negation), gives rise to the desired DOUBLE PROHIBITION reading in (17-c).

(17) a. $\neg \Diamond (B \vee C) = \neg(\Diamond B \wedge \Diamond C)$ NEGATED FREE CHOICE
b. $\Diamond B \leftrightarrow \Diamond C$ HOMOGENEITY
c. $\neg \Diamond B \wedge \neg \Diamond C$ DOUBLE PROHIBITION

Finally, the HOMOGENEITY approach can capture examples like (9) and (10) by introducing two additional mechanisms. The first is an operator '!' that has the effect of cancelling FREE CHOICE when merged below the modal.[5]

(18) $\Diamond(!(B \vee C)) = \Diamond B \vee \Diamond C$

The second is a local accommodation operator '$\mathcal{A}$' (invoked independently in the presupposition literature, see Beaver (2001) and Fox (2012), among others), which, when merged below negation, makes the homogeneity presupposition an entailment and prevents it from projecting. The resulting meaning is the weak one in (19).

(19) $\neg[\mathcal{A}[\Diamond(B \vee C)]] =$
$\neg[(\Diamond B \wedge \Diamond C) \wedge (\Diamond B \leftrightarrow \Diamond C)] =$
$\neg[(\Diamond B \wedge \Diamond C)] = \neg \Diamond B \vee \neg \Diamond C$ NEGATED FREE CHOICE

In sum, combining the asserted meaning and the homogeneity presupposition, the homogeneity approach can capture the basic pattern, as well as the suspension of the FREE CHOICE and DOUBLE PROHIBITION readings (through the use of two additional operators). Table 2 provides a schematic illustration of the derivations of the different meanings under this approach.

2.2.3 Summary

The two theoretical approaches we have described can account for the basic FREE CHOICE and DOUBLE PROHIBITION readings, as well as cases in which these readings

5 The operator ! essentially has the effect of double negation; we again refer the reader to Goldstein (2019) for details.

	ASSERTED MEANING	PRESUPPOSED MEANING	RESULT
POSITIVE	$\Diamond(B \vee C) = \Diamond B \wedge \Diamond C$	$\Diamond B \leftrightarrow \Diamond C$	$\Diamond B \wedge \Diamond C$
NEGATIVE	$\neg\Diamond(B \vee C) = \neg(\Diamond B \wedge \Diamond C)$	$\Diamond B \leftrightarrow \Diamond C$	$\neg\Diamond B \wedge \neg\Diamond C$

Table 2 Derivation of the FREE CHOICE-DOUBLE PROHIBITION pattern under the HOMOGENEITY account.

appear to be absent. On the empirical end of things, a variety of more complex data points have been discussed in the literature, including free choice in the scope of universal and negative existential quantifiers (Chemla 2009, Van Tiel 2012, Bar-Lev & Fox 2017, Bar-Lev 2018, Bar-Lev & Fox 2020), modified numerals (Gotzner et al. 2017, to appear), free choice beyond disjunction (Chierchia 2013, Marty et al. 2021), the interaction between free choice and presuppositions (Romoli & Santorio 2019, Marty & Romoli 2019, Del Pinal et al. 2022), as well as the processing of free choice (Chemla & Bott 2014) and its acquisition in young children (Tieu et al. 2016). The jury is still out on which of the two approaches sketched above can best account for the observed empirical landscape.[6] In what follows, we will focus on diverging predictions of the two approaches.[7]

2.3 Predictions

The two approaches we have described make similar predictions for the basic FREE CHOICE-DOUBLE PROHIBITION pattern, as well as for a variety of related data. There is one prediction where they diverge, however, which to our knowledge has been untested (although similar discussions exist in the context of plurals, see Križ 2015, Križ & Chemla 2015, Tieu et al. 2017a, Renans et al. 2018). This divergent prediction has to do with the status of the basic positive and negative cases. In particular, recall that under the implicature approach, FREE CHOICE arises as an implicature,

6 While the non-implicature approach can more straightforwardly account for certain observed differences between free choice and other implicatures, one might argue it is more stipulative in nature. In particular, while the implicature approach does not need any extra assumptions about the meanings of modals and disjunction, the non-implicature approach needs to tweak these meanings in particular ways (see Bar-Lev 2018, Romoli & Santorio 2019, and Aloni 2022 for discussion).

7 A third option is the account in Barker (2010), which encodes FREE CHOICE in the semantics while deriving DOUBLE PROHIBITION as an implicature. This approach makes the opposite prediction of the standard implicature approach: in a context in which Angie is only allowed to buy the boat, a sentence like (1-a) is predicted to be false, while its negative counterpart in (2-a) is predicted to be an implicature violation. That is, this approach predicts an asymmetry between the positive and negative free choice cases, but in the opposite direction of the corresponding disjunction cases. As we will see below, our results are also challenging for this kind of implicature approach.

	Implicature	Homogeneity
Positive	IMPLICATURE VIOLATION	PRESUPPOSITION FAILURE
Negative	FALSITY	PRESUPPOSITION FAILURE

Table 3 Predictions of the implicature and homogeneity approaches for sentences like (1-a) and (2-a), in contexts in which only one of the disjuncts is allowed.

while DOUBLE PROHIBITION is simply a part of the literal meaning.

(1-a) Angie is allowed to buy the boat or the car.
⇝ *Angie can choose between the two* IMPLICATURE

(2-a) Angie is not allowed to buy the boat or the car.
⇝ *Angie is not allowed to buy either one* LITERAL MEANING

Under the homogeneity approach, on the other hand, FREE CHOICE is part of the literal meaning, while DOUBLE PROHIBITION arises via the homogeneity presupposition. Crucially, under this approach, both the positive and negative cases are associated with the same homogeneity presupposition.

(1-a) Angie is allowed to buy the boat or the car.
⇝ *Angie can buy one iff she can buy the other* HOMOGENEITY

(2-a) Angie is not allowed to buy the boat or the car.
⇝ *Angie can buy one iff she can buy the other* HOMOGENEITY

The differences in the status of the positive and negative sentences can be brought out in a context in which only one of the disjuncts is allowed (e.g., Angie is only allowed to buy the boat). In this context, the homogeneity account predicts both the positive and negative cases to be undefined, as their presupposition is not satisfied. The implicature account, on the other hand, predicts a difference in status across the two polarities: it predicts the positive case to be a literally true sentence, but with a false implicature, while it predicts the negative case to be plainly false. The predictions are summarized in Table 3.

To sharpen the intuitions, consider the comparison with the corresponding simple disjunction case. (20-a) gives rise to an exclusivity implicature suggesting that Angie did not buy both the boat and the car. This inference disappears under negation: (21-a) does not suggest that Angie bought both the car and the boat or neither of them, which would be the negation of (20-a) with its exclusivity implicature. In other words, in a context in which Angie bought both the boat and

	Disjunction	Free choice (IMP)	Free choice (HOM)
Positive	IMP VIOLATION	IMP VIOLATION	PRESUPPOSITION FAILURE
Negative	FALSITY	FALSITY	PRESUPPOSITION FAILURE

Table 4 Predictions of the implicature and homogeneity approaches for sentences like (1-a)/(2-a) and (20-a)/(21-a), in contexts in which only one of the disjuncts is allowed (for free choice) and both of the disjuncts are true (for simple disjunction).

the car, (20-a) is predicted to be true but with a false implicature, while (21-a) is predicted to be plainly false.

(20) a. Angie bought the boat or the car.
b. ⇝ *Angie didn't buy both the boat and the car* IMPLICATURE

(21) a. Angie didn't buy the boat or the car.
b. ⇝ *Angie didn't buy either one* NEGATED LITERAL MEANING

We can state the predictions as follows: the implicature approach predicts a similar pattern for the pairs in (1-a)/(2-a) and (20-a)/(21-a), reflecting a false implicature in the positive cases and a false literal meaning in the negative cases. The homogeneity account, on the other hand, is compatible with a difference between the pairs, in that (1-a) and (2-a), unlike (20-a) and (21-a), are predicted to have the same status (they are both predicted to be undefined). These predictions can be recast as in Table 4.

Quantitatively, observing a statistical interaction between Inference Type (EXCLUSIVITY VS. FREE CHOICE) and Polarity (positive vs. negative) would present a challenge for the implicature approach, but would be entirely in line with the homogeneity approach. Testing these predictions gives us a simple way to distinguish between the two theoretical approaches. Before turning to our experiments, we will briefly outline some previous studies that the experiments build upon.

3 Previous studies

In recent years, a variety of studies have used a ternary judgment task to investigate implicatures (Katsos & Bishop 2011, Tieu et al. 2017a, Renans et al. 2018), presuppositions (Abrusan & Szendroi 2013), the interpretation of plural definites (Križ & Chemla 2015, Tieu et al. 2019, Augurzky et al. 2023), donkey pronouns (Sun et al. 2019), and counterfactuals (Marty et al. 2020). As first conceived of in Katsos & Bishop (2011) for implicatures, the idea behind the ternary judgment

task is that the lowest valued judgment (e.g., the smallest reward) is reserved for false sentences, the highest valued judgment (e.g., the biggest reward) is reserved for true and felicitous sentences, and the intermediate judgment is meant for true but infelicitous sentences, e.g., sentences with a true literal meaning but a false implicature.

Tieu et al. (2017a) made use of such a ternary judgment task to investigate the comprehension of plural noun phrases, comparing the multiplicity inference of bare plurals to the exclusivity inference of disjunction. In their study, participants saw pictures of cartoon characters deciding what to buy at the store, and heard a puppet's guesses as to what would or wouldn't happen (the so-called 'prediction' mode of the judgment task; see Tieu et al. 2017b, among others). Participants then saw the outcome and had to decide whether to reward the puppet with a small, medium, or large strawberry.

In particular, on the disjunction trials, participants heard positive and negative sentences such as (22) and (23), in contexts in which both disjuncts turned out to be true; for example, Tiger ended up buying both the apple and the banana, leaving behind a third object.

(22) Tiger will buy the apple or the banana.

(23) Tiger will not buy the apple or the banana.

In the target context in which both disjuncts turn out to be true, the positive (22) ends up being a true sentence with a false implicature, while its negative counterpart in (23) is plainly false. Participants were therefore expected to select the intermediate reward for (22), and the minimal reward corresponding to plain falsity for (23).

The results indeed revealed a clear contrast between plain falsity and implicature violation. Participants favored the intermediate reward for the positive targets, and gave mostly minimal rewards for the negative targets. This is in line with an implicature approach to the exclusivity inference, with participants mapping the intermediate reward to implicature violation and the minimal reward to falsity. This result is important because it provides a baseline against which to compare other phenomena that have also been subjected to an implicature analysis, such as the multiplicity inferences of plural noun phrases (Tieu et al. 2017a). We will use the same logic in the present study, comparing regular implicatures to free choice inferences.

In the following sections, we describe our set of three experiments. Experiment 1 focused on the comparison between free choice disjunction and plain disjunction. Experiment 2 compared free choice disjunction to the weak modal *is allowed to*. In Experiment 3, we addressed potential confounds associated with Experiments 1

and 2, and compared free choice 'any' to the quantifier 'some'. To anticipate, all three experiments revealed a significant interaction between inference type and polarity, counter to the predictions of the scalar implicature account of free choice.

4 Experiment 1

4.1 Methods

4.1.1 Participants

120 participants were recruited through Prolific and randomly assigned to the free choice (FC) (n=60) or disjunction (OR) condition (n=60). Participants were pre-screened for native language (English) and location (USA, UK). Participants were paid 1 GBP for the 6-minute study, for a pay rate of 10 GBP/hour. (The study took on average 6m10s to complete.)

4.1.2 Procedure

The procedure was the same in all three experiments that we will describe. All three experiments involved a ternary judgment task (Katsos & Bishop 2011) and were implemented using the Qualtrics platform. Participants were directed from Prolific to the experiment on the Qualtrics site.

In Experiment 1, participants were given a back story about characters who had each gone to the store. In each case, a puppet named Raffie would make a guess about what the character was allowed/not allowed to buy (FC condition) or about what the character had bought/hadn't bought (OR condition). Participants then had to decide upon seeing the pictured outcome how right the puppet had been, by selecting a reward for the puppet. Following the method in Katsos & Bishop (2011), we provided participants with three response options: a small strawberry (described in the instructions as corresponding to 'totally wrong' guesses), a large strawberry (for 'totally right' guesses), and a medium-sized strawberry (for when the puppet's guess was 'in between, not totally right but not totally wrong'). Participants indicated their response by clicking on the button that had the desired reward on it (Figure 1).

4.1.3 Materials

Each of the trials involved a display containing three objects. In the FC condition, we used a green circle around an object to indicate that the character was 'allowed' to buy the object, and a red circle with a line through it to indicate an object that a character was 'not allowed' to buy. Similarly, in the OR condition, objects that had

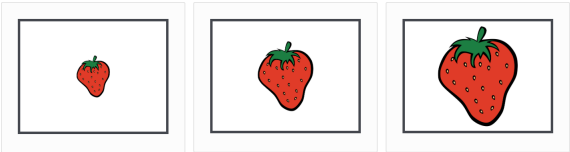

Figure 1 Response buttons for the ternary judgment task.

been purchased were circled in green, and objects that had not been bought had a red circle with a line through it (see Figure 2 for examples). The type of inference (FC vs. OR) was a between-subjects factor, so participants did not have to change how they interpreted the green and red circles – this stayed the same throughout the experiment.

In the FC condition, the critical positive and negative target sentences (e.g., (1-a) and (2-a), repeated below) were presented in contexts that falsified the free choice inference, such as Figure 2 [left], in which only one of the disjuncts is 'allowed' (i.e. Angie is only allowed to buy the boat).

(1-a) Angie is allowed to buy the boat or the car.

(2-a) Angie is not allowed to buy the boat or the car.

In the OR condition, the positive and negative target sentences (e.g., (24) and (25)) were presented as guesses, to make the disjunction felicitous. The eventual pictured outcome against which the guesses were judged (e.g., Figure 2) [right] were incompatible with the exclusivity inference (i.e. Angie ended up buying both the boat and the car).

(24) Angie will buy the boat or the car.

(25) Angie will not buy the boat or the car.

In addition to the target items, participants received clearly true and clearly false (positive and negative) control items; see Figure 3 for the FC controls and Figure 4 for the OR controls.

Finally, alongside the clearly true and clearly false FC/OR controls, we also included four controls that we will refer to as 'partial truth' controls. These involved cases where two objects were mentioned using a *conjunction*, like (26) and (27), but the pictured context only had a green circle around one of the mentioned objects (e.g., Nina was only allowed to buy the peach, or Nina only purchased the peach).

(26) Nina is allowed to buy the peach and the carrot.

(27) Nina will buy the peach and the carrot

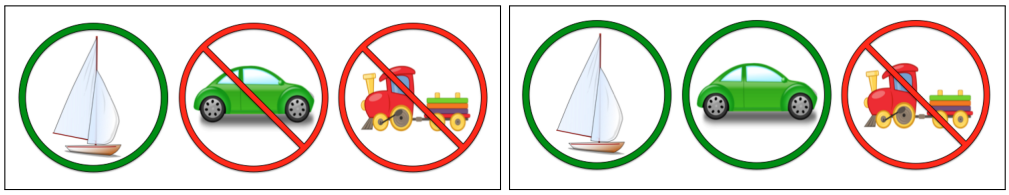

Figure 2 Example visual stimuli for FC and OR targets: the image on the left would be paired with the positive and negative FC targets in (1-a) (*Angie is allowed to buy the boat or the car*) and (2-a) (*Angie is not allowed to buy the boat or the car*); the image on the right would be paired with the positive and negative OR targets in (24) (*Angie will buy the boat or the car*) and (25) (*Angie will not buy the boat or the car*). (Actual items varied in the character's name and the pictured objects.)

Given the use of conjunction, these sentences should be uncontroversially false in the pictured contexts. Pilot experiments had revealed that some participants might be charitable in responding to the puppet's guesses, such that if the puppet turned out to be right about at least one of the mentioned objects, they would choose the intermediate reward. We reasoned that including these 'partial truth' controls would give us some measure of this tendency.

In total, participants received 2 training items, followed by a fully randomized sequence of the 8 targets (4 positive, 4 negative), 8 true/false controls (2 true and 2 false positive controls, 2 true and 2 false negative ones), and 4 partial truth controls, for a total of 20 experimental trials.[8]

4.2 Results and discussion

As can be seen in Figure 5, participants primarily gave the intermediate reward in response to both positive and negative FC targets, while they gave an asymmetric pattern of responses to the positive and negative OR targets. We fitted a mixed effects cumulative link model to responses to the targets with Inference Type, Polarity, and their interaction as fixed effects, and random by-participant slopes for Polarity. Model comparisons between the maximal model and those without each of the fixed effects revealed a significant effect of Inference Type ($\chi^2(1) = 20, p < .001$), a significant effect of Polarity ($\chi^2(1) = 119, p < .001$), and a significant interaction between Inference Type and Polarity ($\chi^2(1) = 92, p < .001$),

8 Note that every pictured context contained three objects, to avoid any potential infelicity associated with the use of a disjunctive statement to describe a context in which there are only two relevant objects (see Skordos et al. 2020 and Huang & Crain (2019) for relevant discussion).

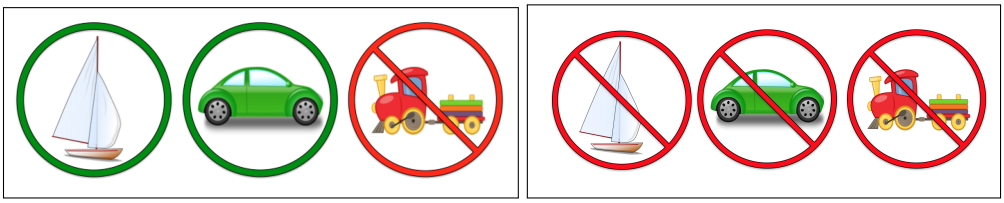

Figure 3 Example visual stimuli for the clearly true and clearly false FC controls. The positive sentence *Angie is allowed to buy the boat or the car* would be paired with the image on the left to create a true control and with the image on the right to create a false control. The negative sentence *Angie is not allowed to buy the boat or the car* would be paired with the image on the right to create a true control and with the image on the left to create a false control. (Actual items varied in the character's name and the pictured objects.)

with participants distinguishing between the two polarities more so for OR than for FC.

The interaction between Inference Type and Polarity challenges the prediction of the implicature approach, namely that the free choice inference and the exclusivity implicature should behave similarly across polarities. There are two issues, however, which may confound our interpretation of the results, and will motivate our move to Experiments 2 and 3.

The first issue has to do with participants' behaviour on the controls trials for the plain disjunction OR. Figure 6 displays the results for the FC and OR controls. Participants' responses to the FC controls were as expected, with mostly maximal rewards assigned to the clearly true controls and minimal rewards assigned to the clearly false controls. In the disjunction condition, however, the positive true and negative false controls elicited a relatively large proportion of intermediate responses. These intermediate responses are surprising: in the positive case, the context was, for example, one in which Angie bought only the boat, thus (24) should have been judged as clearly true, and in the negative case, the same context was paired with (25), which therefore should have been judged as clearly false.

We suspect that the observed intermediate responses to what should have been clearly true disjunction controls may be related to potental residual effects of the ignorance inference of disjunction (despite our best efforts to circumvent the issue by presenting the sentences in a predictive mode rather than in description mode). As for the intermediate responses to the negative controls, we speculate that they might be related to participants' preferences regarding the scope of disjunction

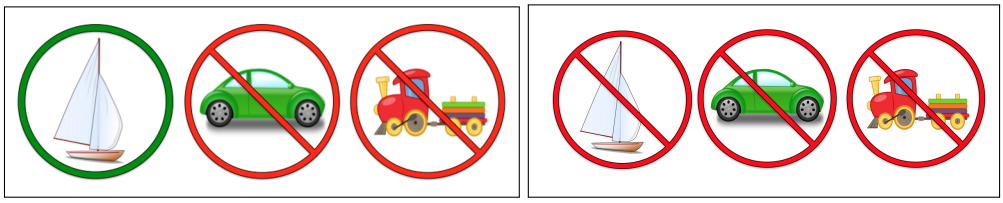

Figure 4 Example visual stimuli for the clearly true and clearly false OR controls. The positive sentence *Angie will buy the boat or the car* would be paired with the image on the left to create a true control and with the image on the right to create a false control. The negative sentence *Angie will not buy the boat or the car* would be paired with the image on the right to create a true control and with the image on the left to create a false control. (Actual items varied in the character's name and the pictured objects.)

relative to negation. Although the intended interpretation of negation scoping over disjunction should have led to a clear rejection of the control sentences, participants may have been able to access the inverse scope interpretation (which turned out to be true); participants sensitive to this ambiguity of the sentences may have thus assigned an intermediate reward to reflect the conflict between the false surface scope interpretation and the true inverse scope interpretation. Importantly, we do not observe the same kind of intermediate responses to the free choice targets, so at least at first glance, whatever factors are playing a role here are unlikely to explain participants' performance on the targets.

The second, more pressing issue, has to do with the partial truth controls we included in the experiment, in which conjunctive statements were presented in contexts that verified only one of the two conjuncts, thus rendering the sentences unambiguously false. We observed for these trials that the intermediate reward was nevertheless selected 86.3% percent of the time in the FC condition and 85.4% of the time in the OR condition. This suggests that participants may indeed have been adopting a kind of charitable response strategy: if the puppet turned out to be right about at least one of the mentioned objects, participants tended to select the intermediate reward. Importantly, on the free choice targets, one of the mentioned objects did end up being 'allowed' and one 'disallowed'. The possibility that participants could choose the intermediate reward because the puppet turned out to be right about one of the mentioned objects thus weakens our ability to conclude that the intermediate responses to the free choice targets actually reflect undefinedness of the target sentences.

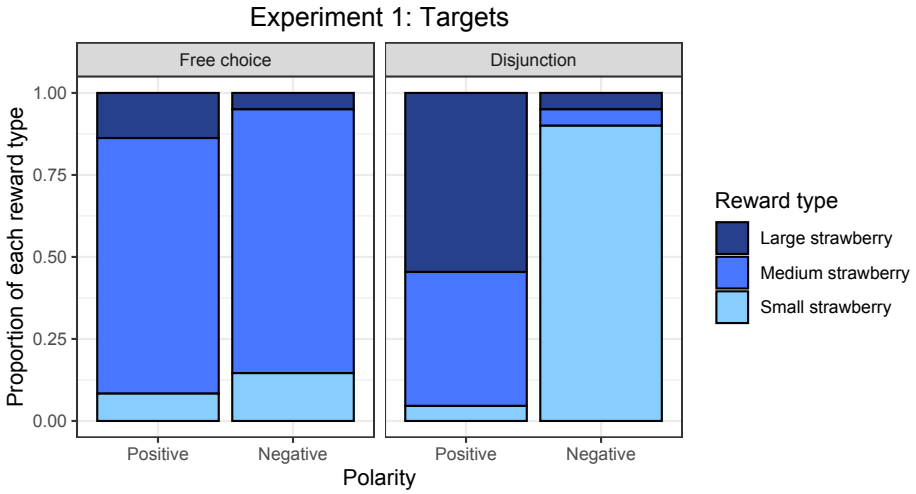

Figure 5 Experiment 1: Proportion of each reward type selected in response to free choice disjunction and plain disjunction targets.

In the next two experiments, we will address each of these issues, one at a time: in Experiment 2 we move away from plain disjunction to another inference that has been relatively uncontroversially treated as a scalar implicature, namely the inference associated with the weak modal *is allowed to*. The implicature of the modal would allow us to avoid potential issues related to ignorance inferences of the disjunction. In Experiment 3 we then attempt to circumvent the issue of a charitable 'partial truth' strategy, by moving to the free choice quantifier 'any', with corresponding displays of nine, rather than three objects.

5 Experiment 2

In Experiment 2, we compared the free choice disjunction to the deontic modal *is allowed to* without the disjunction, to investigate potential differences in the behaviour of the free choice inference and the *not required to* inference of the modal verb, with respect to polarity. Alongside the FC condition then, we also tested positive and negative deontic modal sentences like (28-a) and (29-a).

(28) a. Angie is allowed to buy the boat.
b. ⇝ *Angie is not required to buy the boat* IMPLICATURE

(29) a. Angie is not allowed to buy the boat.
b. ⇝ *Angie can't buy the boat* NEGATED LITERAL MEANING

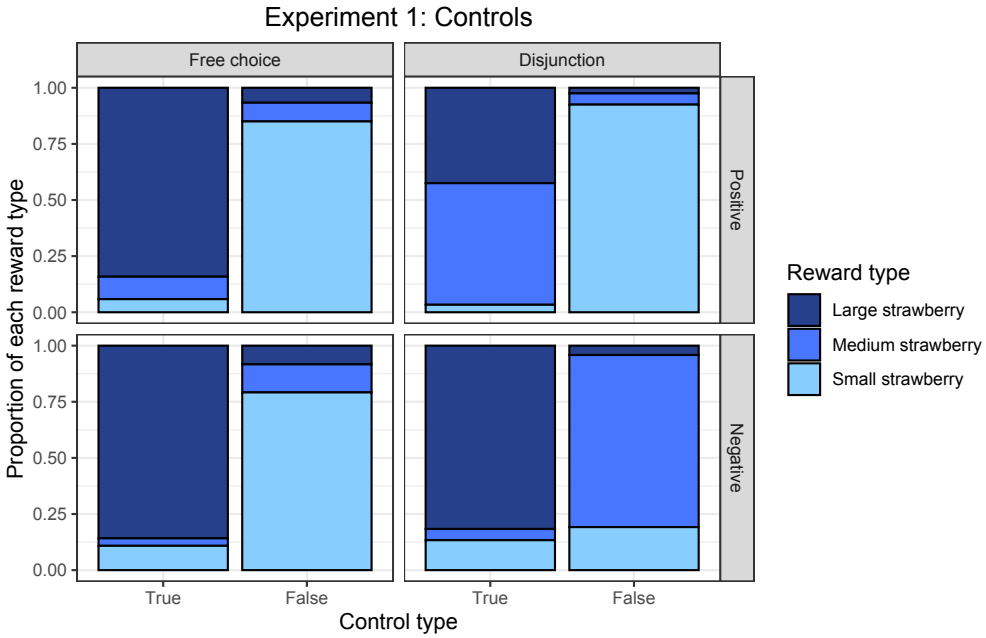

Figure 6 Experiment 1: Proportion of each reward type selected in response to clearly true and clearly false free choice and disjunction control items.

As before, the implicature approach to free choice would predict no differences between the behaviour of the two inferences with respect to negation.

5.1 Methods

5.1.1 Participants

120 participants were recruited through Prolific and randomly assigned to the free choice (FC) (n=60) or modal condition (n=60). Participants were pre-screened for native language (English) and location (USA, UK). People who had completed Experiment 1 were excluded from participating in Experiment 2. Participants were paid 1GBP for the 6-minute study, for a pay rate of 10GBP/hour. (The study took on average 5m33s to complete.)

5.1.2 Procedure

As in Experiment 1, Participants were directed from Prolific to the experiment on the Qualtrics site. The task was the same ternary judgment task with three

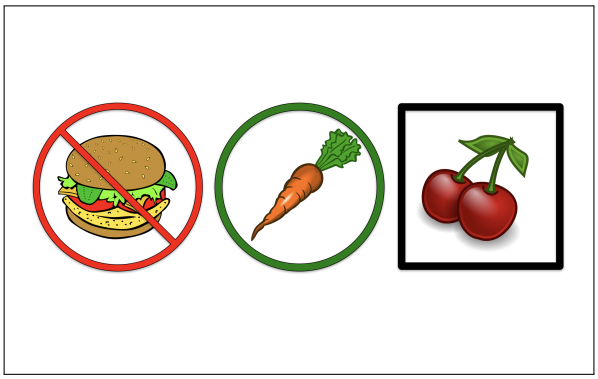

Figure 7 The instructions for Experiment 2 included this picture containing the different symbols that would be used in the experiment, along with this explanation: *Here is how we'll represent the rules. Take a look at the picture below. The red circle with the line through the hamburger means that the character is not allowed to buy the hamburger. The green circle around the carrot means that the character is allowed to buy the carrot. And the black square around the cherries means that the character has to buy the cherries.*

response options, as in Experiment 1, with the puppet's guess presented in text prior to the pictured outcome being displayed on the page.

Because we were testing the inference of the deontic modal, the three-object displays had to be able to represent not just possibility (green circle) and impossibility (red circle with a line through it), but also obligation. To do this, we introduced a black box that could outline certain objects, which participants were told meant that the character had to buy the relevant object. The relevant part of the instructions, along with the accompanying image, is provided in Figure 7.

5.1.3 Materials

The FC condition was a replication of the FC condition from Experiment 1. Participants saw all the same items that were tested in Experiment 1: 4 positive FC targets, 4 negative FC targets in contexts that falsified the free choice inference, 4 positive FC controls (2 clearly true, 2 clearly false), 4 negative FC controls (2 clearly true, 2 clearly false), and 4 clearly false conjunction controls, for a total of 20 experimental items, presented in randomized order.

The MODAL condition had the same structure with a total of 20 experimental items, but was adapted to the modal 'is allowed to'. Participants had to judge 4

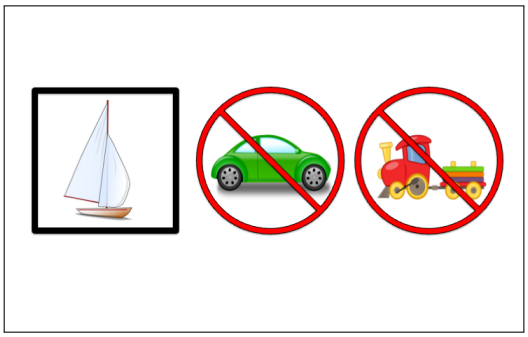

Figure 8 Example visual stimulus for the MODAL targets. This image would be paired with the positive and negative MODAL target sentences in (28-a) (*Angie is allowed to buy the boat*) and (29-a) (*Angie is not allowed to buy the boat*).

positive MODAL targets such as (28-a) and 4 negative MODAL targets such as (29-a), presented in contexts like Figure 8, which falsified the *not required to* implicature of the deontic modal.

In addition to the target items, participants received four clearly true and four clearly false (positive and negative) control items, as illustrated in Figure 9. Finally, alongside the clearly true and clearly false modal controls, we also included four 'partial truth' conjunction controls, as in the FC condition (and as in Experiment 1).

5.2 Results

As can be seen in Figure 10, participants primarily gave the intermediate reward in response to both positive and negative FC targets, while they gave an asymmetric pattern of responses to the positive and negative modal targets. We fitted a mixed effects cumulative link model to responses to the targets with Inference Type, Polarity, and their interaction as fixed effects, and random by-participant slopes for Polarity. Model comparisons between the maximal model and those without each of the fixed effects revealed a significant effect of Inference Type ($\chi^2(1) = 31, p < .001$), a significant effect of Polarity ($\chi^2(1) = 106, p < .001$), and a significant interaction between Inference Type and Polarity ($\chi^2(1) = 97, p < .001$), with participants showing a greater difference between polarities in the MODAL condition than in the FC condition.

Responses were as expected for the clearly true and clearly false controls (Figure 11). The modal condition showed none of the unexpected effects observed for the plain disjunction controls in Experiment 1.

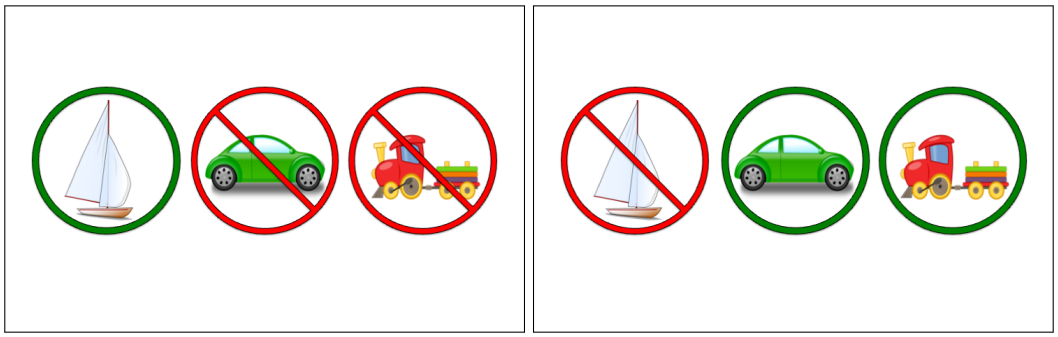

Figure 9 Example visual stimuli for the clearly true and clearly false MODAL controls. The positive sentence *Angie is allowed to buy the boat* would be paired with the image on the left to create a true control and with the image on the right to create a false control. The negative sentence *Angie isn't allowed to buy the boat* would be paired with the image on the right to create a true control and with the image on the left to create a false control. (Actual items varied in the character's name and the pictured objects.)

On the partial truth controls, however, we observed a similar effect as in Experiment 1, with participants selecting the intermediate reward for what should have been uncontroversially false conjunctive statements 90.8% of the time in the FC condition and 83.3% of the time in the MODAL condition. This suggests that in this experiment too, participants may have been adopting a charitable response strategy, whereby they were inclined to give an intermediate reward when the puppet turned out to be right about at least one of the mentioned objects.

5.3 Discussion

In sum, across Experiments 1 and 2, we found that participants primarily selected the intermediate reward for both the positive (1-a) and negative (2-a) free choice sentences in the target contexts. In contrast, when presented with simple disjunctive sentences like (24) or a simple modal statement without disjunction like (28-a) and their negative counterparts (25) and (29-a), in the corresponding contexts, participants exhibited the asymmetric pattern of responses expected on the implicature approach: a preference for the intermediate reward when the (positive) sentence was logically true but had a false implicature, and the minimal reward when the (negative) sentence was plainly false. The parallel responses to (1-a) and (2-a), combined with the observed divergent responses to the equivalent disjunctive

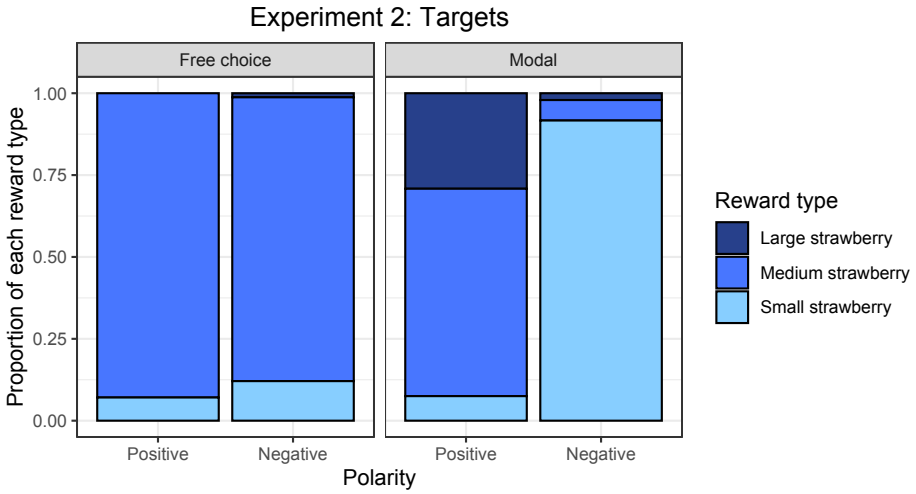

Figure 10 Experiment 2: Proportion of each reward type selected in response to free choice and modal targets.

and simple modal sentences, pose a challenge for the implicature approach.

As mentioned, however, these results can also be explained as participants having chosen the intermediate reward in an attempt to be charitable to the puppet. That is, the puppet mentioned two things (let's say, the hamburger and the carrot) and she turned out to be right about one of them (the character did end up being allowed to buy the hamburger). So, while the sentence on its free choice meaning should not be compatible with the pictured context, there is a sense in which the puppet's guess was partially right, and this could underlie the observed intermediate responses.

And indeed, corroborating the potential presence of this charitable response strategy, we observed a similar pattern of intermediate responses on our conjunction controls, where no implicature was involved at all (i.e. (26) or (27)), suggesting participants may simply have been responding charitably to the target items. This concern highlights a difficulty with the use of the ternary judgment task, insofar as there might be multiple explanations for why a participant opts for an intermediate reward. It seems particularly acute in this case, however, because we are dealing with sentences in which the puppet explicitly mentions two objects by name; when the puppet turns out to be right about one of them, it's easy to see the temptation to partially reward the puppet, and the ternary judgment scale offers just such a partial reward option.

In Experiment 3, we will move away from disjunctive free choice statements

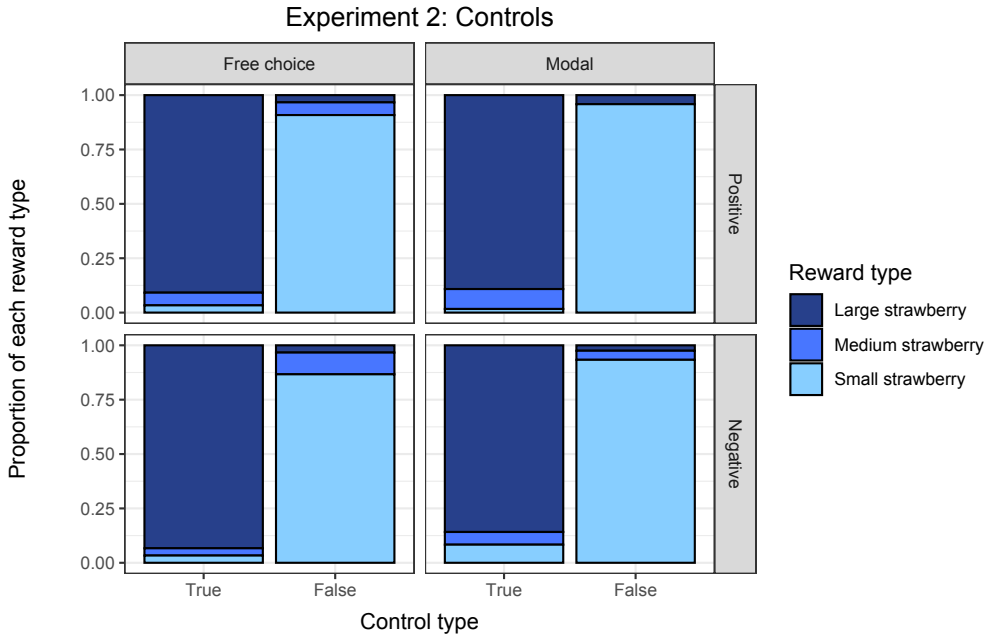

Figure 11 Experiment 2: Proportion of each reward type selected in response to clearly true and clearly false free choice and modal controls.

entirely, in an attempt to mitigate the temptation to partially reward the puppet. Instead, we will investigate the phenomenon of free choice using the quantifier 'any', and compare it to the scalar implicature of 'some'. In particular, we will use sentences like (30-a) and (31-a) and compare them to (32-a) and (33-a). The logic is the same as outlined for the first two experiments: both approaches have been extended from free choice disjunction to free choice items like *any* and their predictions extend to this domain as well (see Aloni 2007 and Chierchia 2013, among others).

(30) a. Angie is allowed to buy any of the items.
b. ⇝ *Angie can freely choose amongst all the items* FREE CHOICE

(31) a. Angie is not allowed to buy any of the items.
b. ⇝ *Angie cannot buy any of the items* NEGATED LITERAL MEANING

(32) a. Angie bought some of the items.
b. ⇝ *Angie didn't buy all of the items* IMPLICATURE

(33) a. Angie didn't buy any of the items.
b. ⇝ *Angie didn't buy any of the items* NEGATED LITERAL MEANING

The hypothesis is that the larger domain of food items (we will use displays of 9 items) will encourage fewer partial truth responses. Moreover, to further strengthen the conclusions we can draw from the data, we will use the conjunctive partial truth controls to quantify the potential use of a charitable response strategy, and ultimately to exclude all participants who exhibit this type of charitable response. A comparison of our target conditions with and without exclusion of the 'partial truth' responders will also shed light on the potential role of this strategy in explaining our results.

6 Experiment 3

6.1 Methods

6.1.1 Participants

121 participants were recruited through Prolific and randomly assigned to the free choice 'any' (n=60) or 'some' condition (n=61). Participants were pre-screened for native language (English) and location (USA, UK). People who had completed Experiments 1 or 2 were excluded from participating in Experiment 3. Participants were paid 1GBP for the 6-minute study, for a pay rate of 10GBP/hour. (The study took on average 5m54s to complete.)

6.1.2 Procedure

The procedure was the same as in Experiments 1 and 2, with participants being asked to judge a puppet's guesses against the pictured outcome, using the three-strawberry response options. As before, participants were recruited through Prolific and directed to the experiment, hosted on Qualtrics.

6.1.3 Materials

To adapt the FC condition from free choice disjunction to free choice 'any', we modified the images to contain a 3x3 display of nine objects, instead of three. This would not only make the 'any' statements more natural, but would also allow us to compare 'any' to the quantifier 'some' under the same conditions.

In the FC condition, the critical positive and negative target sentences (e.g., (30-a) and (31-a), repeated below as (34-a) and (35-a)) were presented in contexts that falsified the free choice inference, such as Figure 12, in which only four of the nine domain alternatives were actually 'allowed'.

(34) a. Angie is allowed to buy any of the items.

Figure 12 Sample image accompanying the positive and negative FC 'any' targets in (34-a) (*Angie is allowed to buy any of the items*) and (35-a) (*Angie is not allowed to buy any of the items*).

b. ⇝ *Angie can freely choose amongst the items* FREE CHOICE

(35) a. Angie is not allowed to buy any of the items.
b. ⇝ *Angie cannot buy any of the items* NEGATED LITERAL MEANING

Participants in the SOME condition saw positive 'some' and negative 'any' target sentences (e.g., (32-a) and (33-a), repeated below as (36-a) and (37-a)), accompanied by pictures which falsified the *not all* implicature of 'some' (e.g., Figure 13).

(36) a. Angie bought some of the items.
b. ⇝ *Angie didn't buy all of the items* IMPLICATURE

(37) a. Angie didn't buy any of the items.
b. ⇝ *Angie didn't buy any of the items* NEGATED LITERAL MEANING

In addition to the target items, participants received clearly true and clearly false (positive and negative) control items; see Figure 14 for the FC controls and Figure 15 for the SOME controls.

Finally, alongside the clearly true and clearly false FC/OR controls, we also

Figure 13 Sample image accompanying the positive and negative SOME targets in (36-a) (*Angie bought some of the items*) and (37-a) (*Angie didn't buy any of the items*).

included four 'partial truth' controls of the type that were included in Experiments 1 and 2. To adapt the partial truth controls to Experiment 3, the items this time involved nine pictured objects, with four of them circled ('allowed'), such that that the accompanying 'every' sentence (e.g., (38)) should be clearly false — unless participants were adopting the charitable 'partial truth' response strategy.

(38) Nina is allowed to buy every item.

In total, participants received 2 training items, followed by a fully randomized sequence of the 8 targets (4 positive, 4 negative), 12 true/false controls (as before, we included four false controls, but this time had eight true controls instead of four, to balance out the expected number of *yes*-/*no*-responses), and 4 partial truth controls, for a total of 24 experimental trials.

6.2 Results

Let us first consider the 'every' partial truth controls, which were the equivalent of the conjunction controls in Experiments 1 and 2. The first result worth noting is

Figure 14 Example visual stimuli for the clearly true and clearly false FC controls. The positive sentence *Angie is allowed to buy any of the items* would be paired with the image on the left to create a true control and with the image on the right to create a false control. The negative sentence *Angie isn't allowed to buy any of the items* would be paired with the image on the right to create a true control and with the image on the left to create a false control. (Actual items varied in the character's name and the pictured objects.)

that the move to free choice 'any' (which involved displays with more objects, and notably moving away from explicitly pronouncing two disjuncts), appears to have effectively reduced participants' recourse to the charitable response strategy. In response to the clearly false 'every' controls, 38.8% of responses in the FC condition and 21.7% of responses in the SOME condition corresponded to the intermediate reward, compared to 83–91% intermediate reward selections for the partial truth controls in Experiments 1 and 2.

To be even more conservative, for our planned analysis, we first used performance on the partial truth controls to filter out participants who appeared to consistently adopt a charitable response strategy. We eliminated from analysis participants who selected the intermediate reward on at least three out of the four

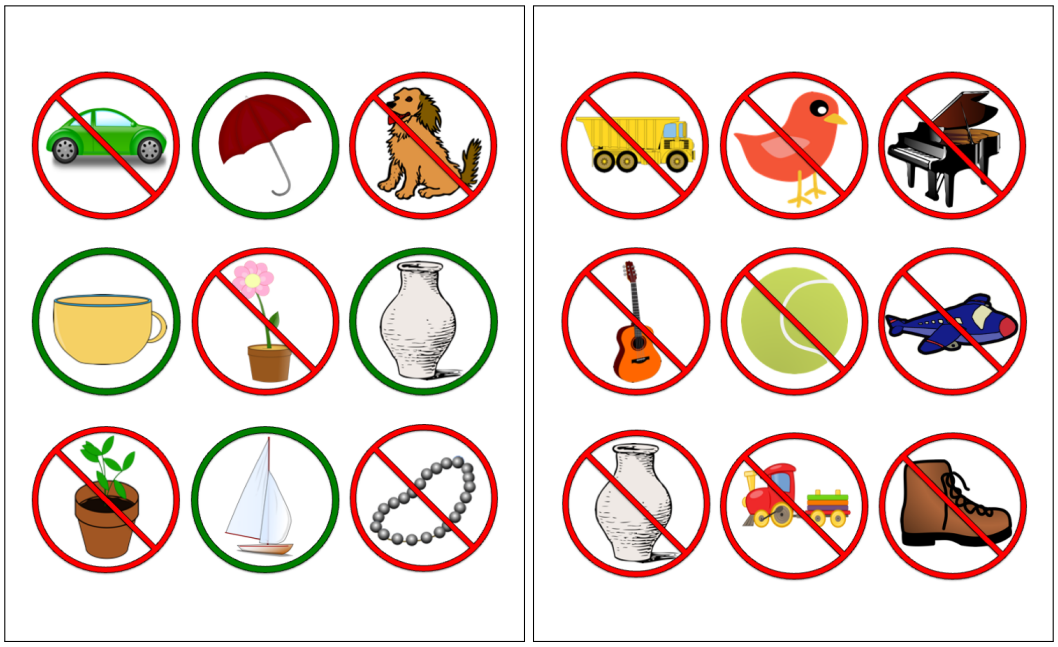

Figure 15 Example visual stimuli for the clearly true and clearly false SOME controls. The positive sentence *Angie is allowed to buy some of the items* would be paired with the image on the left to create a true control and with the image on the right to create a false control. The negative sentence *Angie isn't allowed to buy any of the items* would be paired with the image on the right to create a true control and with the image on the left to create a false control. (Actual items varied in the character's name and the pictured objects.)

partial truth controls. This criterion led to the exclusion of 47 participants, which left 74 participants (29 ANY, 45 SOME) whom we could be reasonably confident were not adopting such a charitable response strategy.

For these remaining participants, performance on the clearly true and clearly false controls was as expected, as seen in Figure 16.

As can be seen in Figure 17, participants primarily gave the minimal reward in response to both positive and negative FC targets, while they gave an asymmetric pattern of responses to the positive and negative SOME targets. We fitted a mixed effects cumulative link model to responses to the targets with Inference Type, Polarity, and their interaction as fixed effects, and random by-participant slopes for Polarity. Model comparisons between the maximal model and those without each of

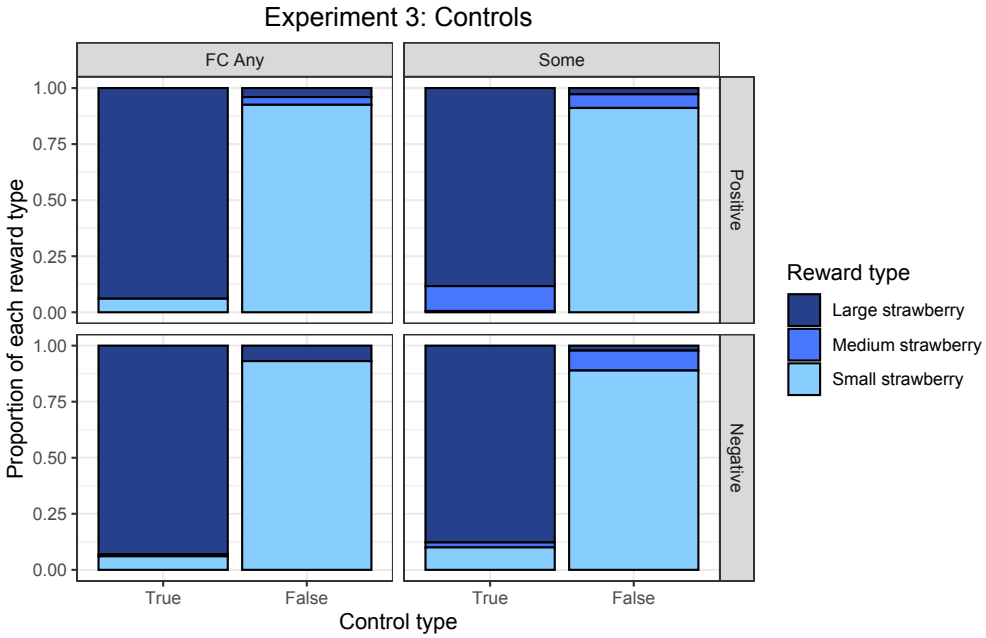

Figure 16 Experiment 3: Proportion of each reward type selected in response to free choice 'any' and 'some' controls, following exclusion of 'partial truth' responders.

the fixed effects revealed a significant effect of Inference Type ($\chi^2(1) = 4, p < .05$), a significant effect of Polarity ($\chi^2(1) = 29, p < .001$), and a significant interaction between Inference Type and Polarity ($\chi^2(1) = 5.8, p < .05$), with participants showing a greater difference between polarities in the SOME condition than in the FC condition.

6.3 Discussion

Experiment 3 replicates the finding of a difference between free choice and regular implicatures observed in Experiments 1 and 2. This time, however, we reduced the charitable interpretation strategy, and we used partial truths control to exclude participants who exhibited this strategy. The results end up being similar with or without the participant exclusions, but using the partial truth controls as a filter allows us to be more confident about our use of the ternary judgment task and the conclusions we can draw from it. Overall, we take the results across the three experiments to be more in line with the homogeneity account and more challenging for the implicature approach.

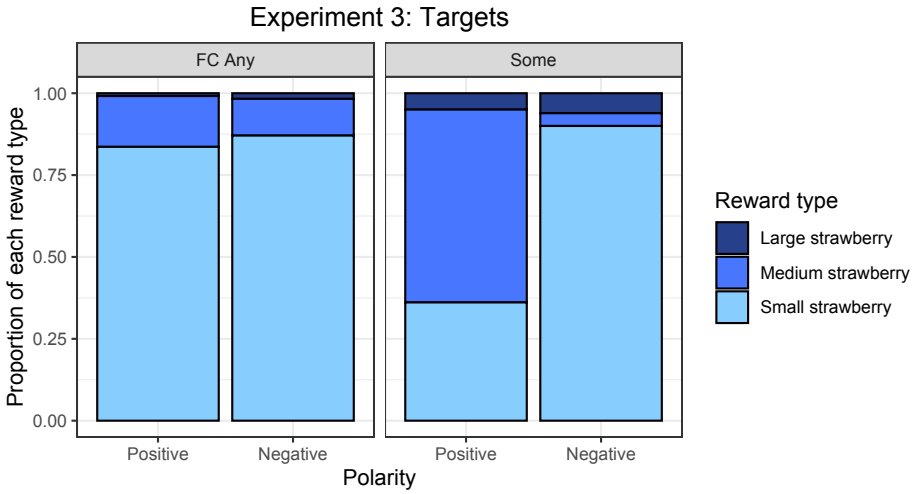

Figure 17 Experiment 3: Proportion of each reward type selected in response to free choice 'any' and 'some' targets, following exclusion of 'partial truth' responders.

7 General discussion

7.1 The challenge

Overall, the observed difference between the free choice and implicature targets, and in particular the observed interaction between Inference Type and Polarity, is challenging for the implicature account, which predicts a similar pattern across polarities for the two inference types. On the other hand, the results are straightforwardly in line with the homogeneity account, which predicts both positive and negative cases of free choice to be equally undefined in the given context, and is compatible with the observed interaction between Inference Type and Polarity.

Note that a response to the challenge against the implicature account cannot lie (entirely) in a 'scalar diversity' effect (van Tiel et al. 2016). That is, the observed interaction cannot be explained by appealing to a relative difference in the strength of the free choice and regular scalar inferences. This line of explanation would at most be able to account for the difference observed in the positive condition, but would be silent about the difference observed in the negative condition.

In addition, the nature of the *alternatives* involved in inference computation has been argued to play a role in observed differences between free choice and other inferences, in processing and acquisition (Chemla & Bott 2014, Tieu et al. 2016; see also Marty et al. 2021); however, it is not clear to us how appealing to alternatives

would be able to account for the present data. We turn next to a discussion of the methodological contribution of our study.

7.2 The ternary task and partial truths

As discussed, we set out to investigate the predictions of the two approaches by using a ternary judgment task, with the idea that the intermediate value could be straightforwardly interpreted as reflecting semantic undefinedness. Along the way, we discovered that many of our participants actually used this response option as part of what could be described as a charitable response strategy, to reward the puppet for being 'partially right'. We thus introduced conjunctive controls to be able to detect the presence of such a strategy. In Experiment 3, we both moved away from free choice disjunction, to free choice 'any', and used displays with a greater number of objects, to discourage the temptation to 'partially reward' the puppet. In this last experiment, we indeed observed less evidence for use of the charitable strategy; nevertheless, we used the conjunction controls as a filter to exclude participants who consistently employed the charitable strategy, so as to be reasonably confident that this strategy could not play a role in explaining the main findings. Nonetheless, given the degree to which we observed 'partial truth' responses in Experiments 1 and 2, we think that any future studies that use the ternary judgment task in the way we have used it here should crucially include the appropriate controls.

7.3 Amending the implicature approach

As mentioned, it is not clear how one might address the challenge to the implicature approach by appealing to the notion of scalar diversity, or to a difference in the alternatives involved in computing free choice and regular implicatures. A possible alternative direction would be to reconsider the principle regulating the distribution of implicatures.

To illustrate, consider the standard principle in (11), which strongly disfavours the appearance of EXH in the scope of negation. As with our examples, the presence of EXH in the scope of negation weakens the meaning of the overall sentence and is thus blocked. Consider now what would happen if we were to lift the ban in (11): we could then parse the negative (2-a) (repeated below), as in (39). The latter is associated with the weaker NEGATED FREE CHOICE meaning, $\neg \Diamond C \vee \neg \Diamond B$, which is true in the given target context (Angie doesn't have free choice, as she can only buy the boat).

(2-a) Angie is not allowed to buy the boat or the car.

(39) not[EXH[Angie is allowed to buy the boat or the car]]
= not[Angie can choose between the two] NEGATED FC

If (39) were a viable option, then (2-a) could be associated with a true reading in the context (in addition to that in (40) without EXH, which would give rise to a false meaning instead, as seen above).

(40) not[Angie is allowed to buy the boat or the car] DOUBLE PROHIBITION

On the basis of this, one might hypothesize that the reason people gave intermediate responses to the negative FC targets was that the target sentences were associated with two different readings, one true and one false, resulting in an intermediate status (see Bill et al. 2018 and Bar-Lev 2021 for a similar idea).

The problem with this line of explanation is that it readily extends to the negative disjunction case in (21-a), repeated below. This is because the latter could also be analyzed as in (41), giving rise to a weaker meaning, $\neg B \vee \neg C$, which is true in the given context.

(21-a) Angie didn't buy the boat or the car.

(41) not[EXH[Angie bought the boat or the car]]
not[Angie bought the boat or the car but not both] NEGATED EXCL

Therefore, simply abandoning the principle in (11) would not allow us to account for the difference between the free choice and disjunction conditions (not to mention the fact that it would leave us without an explanation for the distribution of implicatures). What's needed is to replace (11) with a principle that still disallows EXH under negation in cases like (21-a), but allows it in cases like (2-a). A recent proposal in the literature, Enguehard & Chemla (2021), has independently argued for a principle that achieves exactly this. Enguehard & Chemla (2021) argue that the standard formulation in (11) based on logical strength should be replaced by a constraint based on a notion of 'connectedness', a logical notion related to monotonicity. Roughly, the principle in (42) makes a parse strongly dispreferred if it doesn't give rise to a connected meaning.

(42) Among the parses of a sentence (with or without EXH), those that result in non-connected meanings are dispreferred/marked.

Formal details aside (for which we refer the reader to Enguehard & Chemla 2021), what is relevant here is that this proposal differs from the standard one precisely in that it predicts EXH not to be banned in the scope of negation with FREE CHOICE, while still predicting the standard asymmetry between positive and negative in the

case of simple disjunction.[9] Their argument is that it would intuitively be easier to force a NEGATED FREE CHOICE reading as in (43), than the corresponding negated exclusivity meaning in (44).[10]

(43) Angie is not allowed to buy the boat or the car. She's only allowed to buy the boat!

(44) Angie didn't buy the boat or the car. She bought both!

The intuitive difference between (43) and (44) is in line with what we observed in our experiment, in particular with respect to the comparison between the negative free choice and disjunction conditions. Under this hypothesis, participants would have found it easier to read the negative FC targets with an embedded EXH than to do the same for the corresponding negative OR targets. As a result, the former had a true reading in the context, and consequently led participants to choose the medium strawberry. This proposal presents a promising direction for making the implicature approach compatible with our results (perhaps in combination with considerations of scalar diversity, to account for the difference in the positive conditions).

8 Conclusion

A sentence containing disjunction in the scope of a possibility modal, such as *Angie is allowed to buy the boat or the car*, gives rise to the FREE CHOICE inference that Angie can freely choose between the two. As discussed, this inference is puzzling for standard treatments of modals and disjunction. In addition, FREE CHOICE tends to disappear under negation: *Angie is not allowed to buy the boat or the car* doesn't merely convey the negation of free choice, but rather the stronger DOUBLE PROHIBITION reading that Angie cannot buy either one. There are two main approaches to capturing this pattern in the literature, one of which appeals to an implicature mechanism. While both the implicature and non-implicature approaches cover the basic pattern, and more complicated related data points, they diverge in what they predict for the status of positive and negative sentences in

9 This is the case only if an anti-conjunctive inference is not derived (see Enguehard & Chemla 2021).

10 Both are actually possible with marked intonation, but the claim is that (43) is possible and relatively easy without such an intonation. As Enguehard & Chemla (2021) discuss, their proposal doesn't account for why the negated free choice reading in (43), while possibly easier to access than the corresponding negated exclusivity reading, is intuitively still more difficult than the DOUBLE PROHIBITION reading in (i).

(i) Angie is not allowed to buy the boat or the car.
⇝ *Angie is not allowed to buy either one* DOUBLE PROHIBITION

certain contexts. In this paper, we presented a set of three experiments testing these predictions.

Experiment 1 focused on the comparison between positive and negative free choice statements and positive and negative plain disjunctive statements. If the free choice inference is an implicature, we should expect it to behave like the exclusivity implicature of plain disjunction with respect to polarity. Contrary to this expectation, we observed a significant interaction between inference type (free choice vs. plain disjunction) and polarity (positive vs. negative): people distinguished the two polarities more for plain disjunction than they did for free choice. In Experiment 2, we compared positive and negative free choice to the scalar inference of the modal *is allowed to*/*is not allowed to*. Here too, we observed a significant interaction between inference type (free choice vs. modal) and polarity (positive vs. negative), with people distinguishing between the polarities for the modal but not for free choice. The findings of both Experiments 1 and 2 run counter to the predictions of the scalar implicature account.

However, while Experiments 1 and 2 provided some suggestive evidence against the implicature account, we identified a potential confound: participants might have employed a charitable response strategy, offering the intermediate reward when the puppet was right about at least one of the mentioned objects. We reasoned that this strategy might be encouraged precisely by the utterance of disjunction: the puppet specifically mentioned two objects and turned out to be 'right' about one of them, hence the intermediate reward is appropriate. Thus, in Experiment 3 we turned to an instance of free choice that does not involve explicitly pronouncing the individual disjuncts: free choice 'any', and we compared this to the scalar implicature of 'some'. And indeed, we saw less evidence of a charitable 'partial truth' strategy. Moreover, we included controls that would allow us to exclude participants who appeared to consistently rely on this strategy. With these controls in place, we nevertheless again observed a significant interaction between inference type (free choice 'any' vs. 'some') and polarity (positive vs. negative)—counter to the predictions of the implicature account.

The results of the experiments present a challenge for the implicature approach but are more straightforwardly in line with the homogeneity account. At a more general level, our results are consistent with previous findings in the literature of crucial differences between free choice and implicatures, e.g., in their processing and acquisition profiles (Chemla & Bott 2014, Tieu et al. 2016).

One could take our results as providing support for a non-implicature approach; alternatively, the findings might encourage us to refine the implicature approach, by reconsidering, for instance, the principle regulating the distribution of the EXH operator. Regardless of the theoretical choice pursued, empirically investigating the relative status of the positive and negative sentences provides a useful way to

address the debate between implicature and non-implicature approaches to free choice.

Ethics and consent

This study was approved by the University of Toronto Social Sciences, Humanities and Education Research Ethics Board (protocol no. 43403).

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Data accessibility

The design files, anonymized data, and R analysis scripts can be found at the following OSF entry: https://osf.io/56qvw/?view_only=74fee94d012642609eba8663bb78d4d3.

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Competing interests

The authors declare no competing interests.

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