Exclusivity and exhaustivity of disjunction(s): a cross-linguistic study.[1]

Andreea C. NICOLAE — *Leibniz-Centre General Linguistics*
Aliona PETRENCO — *Humboldt University*
Anastasia TSILIA — *Massachusetts Institute of Technology*
Paul MARTY — *University of Malta*

Abstract. Most natural languages have more than one linguistic form available to express disjunction. One of these forms is often reported by native speakers to be more exclusive than the other(s) and, in recent years, it has been claimed that some languages may in fact have dedicated exclusive disjunctions. In this paper, we report on a series of verification studies investigating the robustness of the exclusivity inference associated with different disjunction markers within and across five different languages and extend this investigation to another, related type of inference, namely the exhaustivity inference. In our results, we found that complex disjunctions were generally more likely to be interpreted exclusively than simplex ones and that, in some languages, further differences exist among the complex disjunctions. Exhaustivity inferences were much less robust and, by contrast, showed little-to-no difference among disjunction types. We lay out possible directions for interpreting these results.

Keywords: disjunction, exclusivity, exhaustivity, complexity, alternatives, cross-linguistic semantics

1. Introduction

Disjunctive sentences like (1) are ambiguous between an inclusive and an exclusive interpretation. Most, if not all extant accounts of this phenomenon assume that plain disjunctions like English *or* encode an inclusive meaning, yielding the literal interpretation in (1a). In positive sentences like (1), this inclusive meaning can be strengthened to an exclusive one via scalar inferencing, yielding the enriched interpretation in (1b).

(1) Asher will order beer or wine.
   a. Asher will order beer or wine (possibly both). *Inclusive*
   b. Asher will order beer or wine, but not both. *Exclusive*

English, like many other languages, has yet another way of expressing disjunction: in addition to plain *or*, we also find the morphologically complex disjunction *either*. . . *or*; similarly, in German, we find a plain disjunction, *oder*, and a more complex one, *entweder*. . . *oder*. Many languages show in fact a three-way and even four-way distinction, with multiple simplex and complex disjunctive forms available. For instance, in Russian, we find *ili*, *ili*. . . *ili* and *libo*. . . *libo*, in Hungarian *vagy*, *vagy*. . . *vagy* and *akár*. . . *akár*, in French *ou*, *ou*. . . *ou*, *ou bien*. . . *ou bien* and *soit*. . . *soit*, in Romanian *sau*, *ori*, *ori*. . . *ori* and *fie*. . . *fie*. The multiplicity of disjunctive particles in these languages raises an immediate question: do all these particles convey the same meaning and if not, what are the dimensions of variation?

[1]The authors are grateful to the audience at Sinn und Bedeutung in Bochum, the semantics colloquium in Göttingen, the workshop on Logic, Grammar and Meaning in Milan, the Brown Bag lunch series in Berlin and the Nihil workshop in Amsterdam, where different incarnations of this material has been presented. We are particularly thankful to Maria Aloni, Nina Haslinger, Clemens Mayr, Uli Sauerland, Viola Schmitt and Yasu Sudo for their invaluable feedback. This research was supported by the DFG grant NI-1850/2-1, awarded to A. Nicolae.

 In: Baumann, Geraldine, Daniel Gutzmann, Jonas Koopman, Kristina Liefke , Agata Renans, and Tatjana Scheffler (eds.) 2024. Proceedings of Sinn und Bedeutung 28. Bochum: Ruhr-University Bochum, 1098-1113.

An intuition commonly reported in both the expert and non-expert literature is that the different forms available for expressing disjunction within a language relate to the extent to which they associate with an exclusive interpretation. Typically, authors of logic textbooks use the more complex disjunction(s) to exemplify the meaning of the logical exclusive operator XOR, in line with the paraphrases that linguistically naive speakers often provide for these complex forms. Similar intuitions are found in the expert literature where, for some languages, complex disjunctions have been claimed to unambiguously convey an exclusive interpretation. For instance, Spector (2014: p.13-18) claims that, in French, the reiterated disjunction *soit... soit*, unlike the simplex disjunction *ou*, obligatorily gives rise to an exclusive inference like the one in (1b) in non-embedded contexts. Szabolcsi (2015: p.194-197) extends this claim to other disjunctions with reiterated particles such as French *ou... ou*, Russian *ili... ili* or Hungarian *vagy... vagy*.[2] Thus, according to the literature, some languages ought to have dedicated 'exclusive' disjunctions which obligatorily trigger the (otherwise optional) exclusive inference associated with disjunction. Whether or not this claim is empirically correct remains an open question which has not been systematically investigated across languages using quantitative methods.

A weaker claim, closer to what Spector (2014) ultimately endorses, is that complex disjunctions obligatorily trigger strengthening, but that this strengthening need not be to exclusivity. In support of this claim, Spector observes for instance that sentences like (2), where the complex disjunction *soit... soit* is embedded in the scope of a universal quantifier, need not yield the strong exclusivity inference in (2a); rather, it can yield the weaker inference in (2b), which leaves open the possibility that some guests ordered both beer and wine.

(2) Chaque invité a pris soit de la bière soit du vin.
'Every guest ordered SOIT beer SOIT wine'
a. Every guest ordered one or the other but not both.
b. It's not the case that every guest ordered both.

Building on this observation, we can then ask whether this weaker claim generally holds of complex disjunctions. That is, do complex disjunctions generally give rise to strengthened meanings, irrespective of the nature of the strengthened meaning? Note that, while Spector's observation pertains to the occurrence of *soit... soit* in the scope of a universal quantifier, the claim of interest extends in theory to unembedded environments, raising the question of whether the use of complex disjunctions in these environments may force other forms of non-exclusive enrichment. To answer this question, we thus need to consider other inferences generally associated with unembedded disjunctions. One such inference is the *exhaustivity* inference.[3] This inference, less extensively discussed in the literature on disjunction, makes reference to relevant alternatives to the mentioned disjuncts, rather than to their conjunction, and

[2]Szabolcsi (2015: p.197) also claims that, in this regard, reiterated complex disjunctions should be distinguished from non-reiterated complex disjunctions like English *either... or*, which, she argues, retain both their inclusive and exclusive flavors. As far as we know, this claim has not yet been put to the test.

[3]Another prominent type of inferences associated with unembedded disjunction are ignorance inference, e.g., the inference from (1) that the speaker doesn't know which of the two Asher ordered (i.e., both disjuncts are living possibilities in the speaker's mind). For space reason, we do not discuss these inferences in this paper; in fact, the verification studies we report on below were specifically designed to factor out the potential effect of these inferences on participants' judgments. We refer the reader to Degano et al. 2023 for a recent experimental investigation of ignorance inferences and to Nicolae 2017 for an argument that these inferences should count towards a requirement of obligatory strengthening.

says that they are not true (Gotzner et al., 2020). In the case of the sentence in (1), repeated below in (3), this inference says Asher will not order anything *besides* beer or wine, as illustrated in (3a). Importantly, we note that this inference does not carry any commitment as to whether he will order both drinks, namely the exclusivity component. Similarly, the exclusive inference does not carry any commitment as to whether Asher won't order anything besides beer or wine.

(3) Asher will order beer or wine.
   a. Asher will order beer or wine and nothing else. *Exhaustive*
   b. Asher will order beer or wine, but not both. *Exclusive*

In the remainder of the paper, we present a series of verification studies investigating the robustness of the exclusivity and exhaustivity inferences associated with different disjunction markers within and across five different languages.

2. Experiments

In the following, we present a series of studies investigating the robustness of different inferences across different disjunction markers, both within and across five languages: English, French, Romanian, Russian and Greek. For each language, we chose three of the most commonly used disjunctive markers, one simplex and two complex (with the sole of exception being English which only employs one type of complex disjunction). The two inferences under investigation were the exclusivity and the exhaustivity (ad-hoc) inferences. The three factors – language, disjunction type and inference type – were manipulated between-subjects. The disjunctive constructions tested in each language are schematically described in Table 1.

	D1	D2	D3
English	A *or* B	*either* A *or* B	n/a
French	A *ou* B	*ou bien* A *ou bien* B	*soit* A *soit* B
Romanian	A *sau* B	*fie* A *fie* B	*ori* A *ori* B
Russian	A *ili* B	*libo* A *libo* B	*ili* A *ili* B
Greek	A *i* B	*i* A *i* B	*ite* A *ite* B

Table 1: Disjunctive constructions tested in all five languages; D1 are simplex disjunctions whereas D2 and D3 are all complex.

2.1. Participants

Participants were recruited online using Prolific (minimum prior approval rate: 90%; nationality, country of birth and first language were controlled for, depending on the language being tested). Participants were paid approximately £1.7 for their participation (£8/hr). In total, 564 subjects took part in the Exclusivity studies and 533 in the Exhaustivity studies (see details in Table 2), yielding between 30 and 45 subjects per disjunction in each group. All participants gave written informed consent prior to experimentation. All data were collected and stored in accordance with the provisions of Data Protection Act 2018.

	Exclusivity	Exhaustivity
English	90	89
French	127	119
Romanian	111	106
Russian	107	94
Greek	129	128
Total	564	533

Table 2: Number of participants recruited for both sets of studies.

2.2. Materials and design

The experiments were run as online surveys. At the beginning of the survey, participants were given general instructions (translated by native speakers into the corresponding languages). They were told that they would witness a guessing game between two friends, Kate and Henry. The game was described as follows:

> *Instructions* – Kate and Henry are two friends who like playing games. In this experiment you will witness one of their games. The rules are as follows: Kate draws two pictures and doesn't show them to Henry. The first picture depicts a situation and comes with a sentence describing it. The second picture depicts a follow-up scene. She shows Henry the first picture, depicting the situation, and asks him to make a guess about what's going to happen. Then, Kate presents the second picture with the follow-up scene. Your task will be to judge whether Henry's guess was right by clicking the 'yes' or 'no' button.

Each trial consisted of a scenario unfolding over three scenes, where the test sentences appeared in the second scene. The structure of the scenarios was the same across all trials: the first scene set the stage of a story by displaying a picture together with a short sentence describing a future event; the second scene showed a character making a guess about what was going to happen next in that story in relation to the relevant event; finally, the third and last scene revealed the outcome of the story by means of a novel picture accompanied by the lead-up 'Here's what happened'. The participants moved from one scene onto the next by clicking a button at the bottom of the page; the picture(s) from the previous scene(s) remained on the page as the scenario progressed, such that the final scene consisted of all 3 pictures, as shown in Figure 1.

In the test trials, the character's guesses involved disjunctive sentences of the form *[Pronoun] will [verb] [(D) A D B]* such as *She will bring (either) a bouquet or balloons*. The [pronoun] term always agreed with the subject of the sentence displayed in the first scene; the [verb] term was an action verb; the disjunctive phrase [(D) A D B] involved a simplex or complex disjunction type connecting two common nouns (A, B) denoting inanimate, concrete objects.

Test sentences were presented with one of three possible story outcomes obtained by manipulating the contents of the final scene picture; these constituted the three conditions of interest, namely TRUE, FALSE and TARGET. The TRUE and FALSE conditions were constant across experiments, while the TARGET condition differed. In the TRUE and FALSE conditions, the final scene made the disjunctive sentences true and false, respectively, independently of the type of

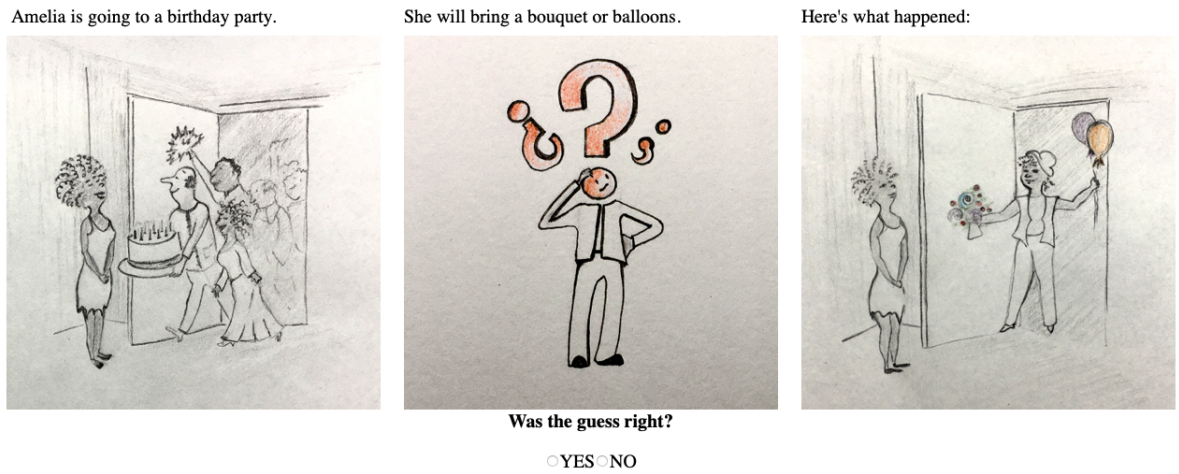

Figure 1: Example of scenario used in the TARGET trial for the Exclusivity studies. Scenarios unfolded before the participants, one scene at a time.

inference being tested; this was achieved by making the disjunction true via the truth of one of the disjuncts, or false via the falsity of both disjunct (see details in (4)). The TARGET condition, on the other hand, differed across the two experiments since it varied according to the inference type being tested.[4] In the Exclusivity studies, which tested for presence of the exclusivity inference, both objects mentioned in the guess appeared in the final image. Such an outcome made the test disjunctive sentence false if the exclusivity inference was present (expected answer: 'No'), but true if it was absent (expected answer: 'Yes'). In the Exhaustivity studies , which tested for the presence of the ad-hoc/exhaustivity inference, only one of the objects mentioned in the guess appeared in the final image, but crucially also an additional, unmentioned, object. Such an outcome made the test disjunctive sentence false if the exhaustive inference was present (i.e., participants would be expected to select 'No' to the question), but true if it was absent (i.e., participants would be expected to select 'Yes' to the question). Note that by only presenting one of the two objects mentioned in the disjunctive sentence we avoided having participants judge the sentence based on its exclusivity inference potential.

(4) Possible outcomes for target sentences *'(either) A or B'*
   a. TRUE: A
   b. FALSE: C
   c. TARGET$_{exclusive}$: A and B
   d. TARGET$_{exhaustive}$: A and C

Target sentences were tested in all three conditions, with three iterations of each condition, yielding 9 test items. 18 non-disjunctive filler items were added in order to make the target items less visible across the experiment: 6 true, 6 false and 6 open to interpretation. Participants started the experiment with two practice trials and then completed the 27 test trials, presented to them in a randomized order.

[4]Two of the three target items had to be changed in the Exhaustivity studies due to the lack of easily accessible and salient third alternatives beyond the two mentioned in the target sentence. The Exhaustivity studies crucially relied on there being such alternatives to the disjuncts, something that the target items in the Exclusivity studies didn't necessitate.

Inference type was a between-subject factor such that no participant saw a test sentence in both types of target conditions shown in (4). This constitutes the only difference between the Exclusivity and the Exhaustivity studies. Within each experiment, disjunction type was also manipulated and this too was a between-subject factor. This was done so as not to encourage implicit, comparative judgments between disjunctive constructions.[5] All materials created for the English version were adapted and translated into French, Romanian, Russian and Greek by linguistically-trained native speakers.

2.3. Data preparation

Data preparation and analysis were carried out in the R statistical environment (R Core Team, 2023) using the Hmisc (Harrell, 2023), lme4 (Bates et al., 2015), and car (Fox and Weisberg, 2019) packages for the R statistics program. Responses from 37 subjects in the Exclusivity studies (6.5% of the sample) and from 43 subjects in the Exhaustivity studies (8% of the sample) were removed prior to analyses because their performance to TRUE and FALSE controls did not reach the pre-established threshold of 80% accuracy.

2.4. Results

Responses to the test items are summarized in Figure 2. In both experiments, the rate of 'No' responses (i.e., 'wrong guess') was lowest in the TRUE conditions (all Ms$<5\%$), highest in the FALSE conditions (all Ms$>90\%$) and somewhat intermediate in the TARGET conditions. Recall that, in the TARGET conditions, this measure stands proxy for the rate of exclusive/exhaustive interpretations, meaning that the higher the rate of 'wrong guess' responses, the more exclusive/exhaustive inferences being drawn. In our statistical analyses, we assessed, for each inference type in each language, whether responses in the TARGET conditions differ as a function of the disjunction type; we report the results of these analyses below.

2.4.1. Exclusivity studies

In the TARGET conditions, every disjunction in the five languages tested received an intermediate rejection rate, i.e., in-between those observed for their TRUE and FALSE baselines. These results are expected only if the disjunctions of interest are assumed to be ambiguous between an inclusive and an exclusive reading. The mean rejection rates for D2 and D3 were relatively uniform across languages, with 8 out of 9 instances in the 60-75% range, while the rates for D1 showed more variations, ranging from 20% in Romanian to 54% in Greek.

For each language, we fitted a GLMER model (logit link function), predicting responses in the TARGET conditions from the fixed effect of disjunction (dummy coded). Each model included by-participant and by-item random variance for the intercept, which was the maximal random effect structure supported by the data.[6] Each of these models was compared to a null model missing only the fixed effect of disjunction. The model with the fixed effect of disjunction was

[5]Nicolae and Sauerland (2016) have shown that speakers' judgements of exclusivity are affected when presented with multiple disjunction markers within the same experiment.

[6]The model for French triggered a singular fit warning due to the by-item random variance for the intercept being estimated very near zero. As a sanity check, this model was refitted without the random intercept for items. The values of the coefficients of the refitted model were the same as before. While this warning only arose for this model, we note that the estimated variance for the item random effect was relatively small in all models.

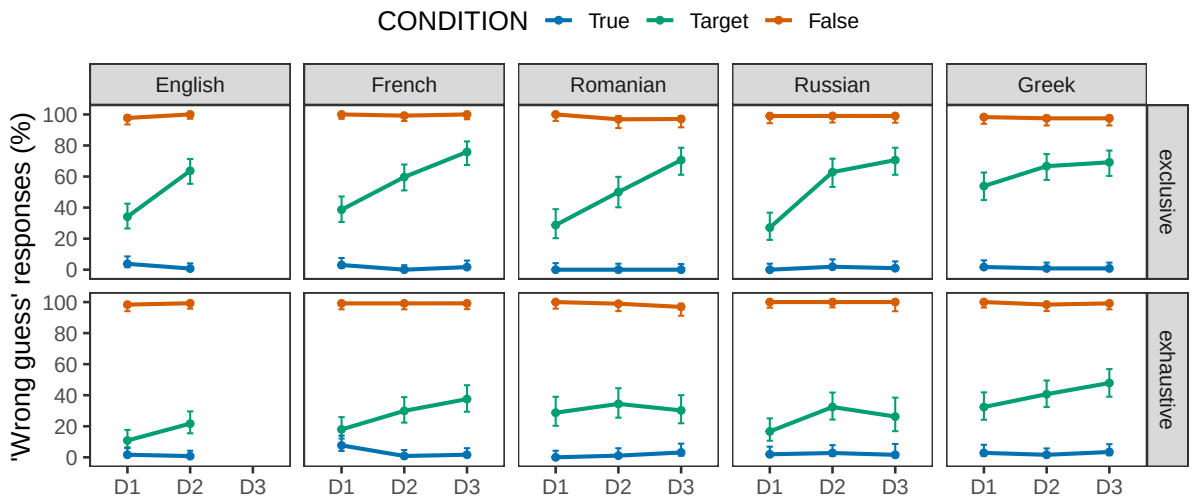

Figure 2: Mean rejection rate (i.e., proportion of 'wrong guess' responses) to the test trials by inference type, language, disjunctive marker and picture condition. Error bars represent 95% binomial confidence intervals.

found to provide a significantly better fit to the data compared to the null model for English ($\chi^2_1 = 25.26$, $p < .001$), French ($\chi^2_2 = 21.06$, $p < .001$), Romanian ($\chi^2_2 = 34.64$, $p < .001$), Russian ($\chi^2_2 = 36.51$, $p < .001$) but not for Greek ($\chi^2_2 = 4.64$, $p = 0.09$), where the mean rejection rate for D1 was only marginally lower than those for D2 and D3. In all other languages with reiterated disjunctions (French, Romanian and Russian), both D2 and D3 yielded significantly higher rejection rates than D1 (all βs> 3.27, all ps$< .05$). Further reliable contrasts were found between D2 and D3 in French ($\beta = 2.55$, $p = .05$) and Romanian ($\beta = 7.23$, $p < .05$), showing that distinct reiterated disjunctions in these languages prompt exclusive interpretations to a different extent. No such contrast was found in Russian ($\beta = 0.59$, $p = 0.7$).

2.4.2. Exhaustivity studies

All disjunctions received an intermediate rejection rate in the TARGET conditions, except for the simplex disjunctions in English and French. Nevertheless, the mean rejection rates in these conditions were relatively low across languages, with 13 out 14 instances in the 10-40% range (Greek D3: 48%). Thus, as can be seen in Figure 2, the rate to which exhaustive inferences were drawn was lower than the rate to which exclusive inferences were drawn across the board.

As before, for each language we fitted a GLMER model predicting responses in the TARGET conditions from the fixed effect of disjunction. Each model included by-participant and by-item random variance for the intercept.[7] Each of these models was compared to a null model missing only the fixed effect of disjunction. The model with the fixed effect of disjunction was found to provide a significantly better fit to the data compared to the null model only for English and English only (English: $\chi^2_1 = 5.12$, $p < .05$; French: $\chi^2_2 = 5.38$, $p = .07$; Romanian: $\chi^2_2 = 0.97$, $p = .61$; Russian: $\chi^2_2 = 2.66$, $p = .26$; Greek: $\chi^2_2 = 3.39$, $p = 0.18$).

[7]As in the Exclusivity studies, we ran into a singular fit warning due to the by-item random variance for the intercept being estimated at zero. In this experiment, this was the case for both French and Romanian.

3. Discussion

The findings of these experiments can be summarized as follows:

- All the disjunctions tested in this study yielded ambiguity patterns showing that, no matter how 'exclusive' they feel, they all allow an inclusive interpretation.
- Complex disjunctions generally yielded higher rates of exclusive interpretations than simplex ones across languages.
- Speakers' propensity to interpret a disjunction exclusively varies substantially: (i) there is wide cross-linguistic variation in how exclusive simplex disjunctions are interpreted (e.g., Romanian vs. Greek), and (ii) further contrasts may exist among complex disjunctions within the same language (e.g., in French and Romanian).
- Exhaustivity (ad-hoc) inferences arose cross-linguistically but were much less derived than exclusivity inferences.

In the remainder of this section we will discuss the implications of our results for current theories of implicatures.

3.1. Comparison of inference strengths: exhaustive versus exclusive

We begin with a short discussion of the comparison between exclusive and exhaustive inferences. To reiterate, our results indicate that exhaustive inferences were derived less often than exclusive inferences in our studies. We believe that this finding can be explained in reference to the nature of the different types of alternative involved in the derivation of these inferences. Consider again the example from earlier, repeated below in (5). Deriving the exhaustive inference associated with this sentence requires alternatives like those in (5a), all of which involve generating ad-hoc competitors to the disjuncts, i.e., competitors constructed from contextual, rather than conventional linguistic factors. As it is easy to verify, these alternatives can be negated altogether without giving rise to a contradiction, yielding the inference in (5b).

(5) Asher will order (either) beer or wine.

a. *Alternatives:* { Asher will order [lemonade]. / Asher will order [whiskey]. / Asher will order beer and [lemonade]. / ⋮ }

b. *Exhaustive inference:* Asher will order nothing else besides beer and wine.

Exclusivity inferences, on the other hand, are generally assumed to arise from the more basic lexical competition between 'or' and its scalemate, the logically stronger connective 'and'. In this case then, the competitors of interest need not be set up by the context for the competition to arise: this competition directly arises due to the conventional semantic content of the relevant connectives. Thus, the results we obtained could be a by-product of this difference in the make-up of both types of inference. Specifically, it is possible that the set-up of our studies made it so that constructing novel ad hoc competitors to the disjuncts on trial-to-trial basis was far more demanding than simply retrieving the invariant lexical competitor to the disjunctive marker, hence the lower rates of exhaustivity inference that we observed.

3.2. Variation in inference strength of exclusivity

Our findings disconfirm the claim that reiterated disjunctions in languages like French, Russian or Romanian are dedicated 'exclusive' disjunctions categorically distinct from simplex ones. Crucially, however, these findings remain largely in line with the layman's intuition and support the weaker claim that complex disjunctions are more strongly associated with an exclusive interpretation than simplex ones. In the following we will offer some thoughts on what could be driving this tendency and how we might begin to formalize such contrasts.

In principle, this cross-linguistic tendency to interpret complex disjunctions exclusively more so than simplex disjunctions could be explained in reference to cost-benefit principles like Horn's 1984 *R Principle*: since it would be more economical for speakers to use a simpler form to convey the literal, inclusive meaning of disjunction, the use of a more complex disjunction can be taken as signaling the intent of the speaker to depart somehow from that literal meaning, e.g., to convey the enriched, exclusive meaning. This is, in fact, what laid the groundwork for the proposal put forward in Nicolae and Sauerland 2016 (henceforth N&S).

On N&S's proposal, simplex and complex disjunctions compete with each other. Their proposal is motivated by the finding that, when presented with both *or* and *either or* (or *oder* and *entweder oder* in the German variant) in the same experimental session, participants rated the complex disjunction as more exclusive than the simplex one, whereas no such contrast was observed when the two forms were tested in isolation.[8] The crux of their proposal is that the simplex disjunction does not compete with conjunction but rather with the complex disjunction, which itself receives its strengthened meaning via competition with conjunction. Crucial to their account is the assumption that assertively used sentences contain not only an exhaustification operator, but also a covert doxastic operator which is adjoined at LF (cf. Meyer (2013); see also also Kratzer and Shimoyama (2002), Chierchia (2006) and Alonso-Ovalle and Menéndez-Benito (2010) for related proposals). This operator, generally referred to as the K-operator, can be thought of as the necessity modal, with the semantics in (6) (following Gazdar (1979), a.o.).

(6) $[\![\Box_x \text{ p}]\!] = \lambda w.\forall w' \in \text{Dox}(x)(w) : p(w')$
$w' \in Dox(x)(w)$ *iff given the beliefs of x in w, w' could be the actual world.*

Given this operator, as well as the exhaustification operator *exh* responsible for deriving scalar implicatures (Chierchia et al., 2012), N&S propose the following LF for *either. . . or*:

(7) **LF for *either–or*:** $\Box exh[p \vee q]$ (N&S: ex. 21)
a. $Alt(p \vee q) = \{p \vee q, p \wedge q\}$
b. $[\![\Box exh[p \vee q]]\!] = \Box[p \vee q] \wedge \Box\neg[p \wedge q]$

Assuming the meaning above for *either–or*, they propose that *or* takes as its alternative this stronger meaning under the LF in (8), delivering the weaker meaning in (8b).

(8) **LF for *or*:** $exh\Box[p \vee q]$ (N&S: ex. 22)
a. $Alt(\Box[p \vee q]) = \{\Box[p \vee q], \Box exh[p \vee q]\}$
$= \{\Box[p \vee q], \Box[p \vee q] \wedge \Box\neg[p \wedge q]\}$

[8] There were two experiments per language, and each involved giving ratings on a 7-point scale; in one experiment, participants had to judge the extent to which a disjunctive sentence *A or B* suggests *not A and B*; in the other, they had to judge whether one could conclude *only one* given the disjunctive statement.

b. $[\![exh\Box[p \vee q]]\!] = \Box[p \vee q] \wedge \neg[\Box(p \vee q) \wedge \Box\neg(p \wedge q)]$
$= \Box[p \vee q] \wedge \neg\Box\neg[p \wedge q]$

This proposal can account for the simplex-complex two-way distinction, especially in experimental setups where the two forms are pinned against one another, like the ones which N&S aim to account for. When it comes to setups like the one in the present study, where the *or/either or* contrast was between- rather than within-participants, the idea that *or* would be strengthened with respect to *either... or* rather than *and* becomes less appealing. One point against it comes from the observation that alternatives which are structurally more complex than the asserted sentence are generally not considered when calculating implicatures, unless the particular linguistic structure has been made salient in the discourse (Katzir, 2007). Since participants in the simplex conditions were not presented with the complex variant(s) during the survey, the argument goes that they should not have been able to strengthen *or* (and its cross-linguistic equivalents) via negation of the complex disjunction *either... or* (and its equivalents); in other words, participants in the simplex disjunction condition would only be expected to strengthen via negation of the stronger conjunctive alternative. The question thus remains, why are participants more likely to interpret a complex disjunction as exclusive than a simplex one?[9]

In our attempt to better understand what might be behind this difference in robustness between different disjunction markers, consider the finding from van Tiel et al. (2016) (building on Baker et al. 2009; Doran et al. 2012) that some scalar elements are more likely to give rise to a scalar implicature than others, with *cheap/free, sometimes/always, some/all, possible/certain* being at the high-end of the strength scale and *ugly/hideous, silly/ridiculous, tired/exhausted, content/happy* at the low-end with fewest scalar inferences being drawn. Among other factors, van Tiel et al. (2016) show that (part of) the variability observed is predicated by the boundedness of the scalemate involved, namely whether or not it corresponds to an end-of-scale expression, i.e., given a lexical scale $<\alpha, \beta>$, the distinctness of α and β is greater if β denotes an end point on the dimension over which it quantifies.

So could boundedness also explain the contrasts that we observed? One obvious concern here is that, in our case, we are dealing with the same inference, at least superficially, derived from the use of two logically equivalent elements. However, if the story advocated for by N&S is to be adopted, and the two scalar items, *or* and *either... or*, appeal to different alternatives, then boundedness might be a relevant notion afterall. Since *either... or* has *and* as an alternative, an end-of-scale expression, whereas *or* has *either... or* as an alternative, which is not bounded as far as its linguistic meaning goes, the fact that *either or* triggers a stronger scalar implicature than *or* can be explained by the account put forward by van Tiel et al. (2016). Nevertheless, as discussed above, we believe that the account in N&S does not readily extend to the experimental design we employed. Thus, in the remainder of this paper, we would like to sketch two alternative accounts, which may ultimately prove to be related to one another.

3.2.1. Cues to local exhaustification

The first account revolves around cues to local exhaustification. It builds on the observation that complex disjunctions usually facilitate, if not favor, a contrastive focus configuration. Thus

[9]We note here that N&S's account also falls short of an explanation as to why complex disjunctions may be perceived as more exhaustive than simplex disjunctions since their account crucially builds on the interaction between the *and*-alternative and the two disjunctive forms.

for instance, in declarative sentences, English *or* does not easily allow focus on each individual disjunct, unlike *either or*, as exemplified by the contrast in (9).[10]

(9) a. ??ASHER$_F$ or BILL$_F$ will visit Paris.
b. Either ASHER$_F$ or BILL$_F$ will visit Paris.

We propose that this configuration more readily calls for an interpretation where each disjunct is interpreted exhaustively, a reading along the lines of *Only Asher, or only Bill will visit Paris*. This can be achieved by taking *exh* to adjoin locally to each of the disjuncts, as in (10a)/(11a).[11] Depending on what the relevant alternatives are, notated here as subscripts on the respective *exh* operators, the result of this exhaustification process may yield the exclusive interpretation in (10b) or the exhaustive one in (11b) (or both).

(10) Complex: **Disj** A **Disj** B
a. $[exh_{\{A,B\}}(A) \vee exh_{\{A,B\}}(B)]$
b. $(A \wedge \neg B) \vee (B \wedge \neg A)$

(11) Complex: **Disj** A **Disj** B
a. $[exh_{\{A,C\}}(A) \vee exh_{\{B,C\}}(B)]$
b. $(A \wedge \neg C) \vee (B \wedge \neg C)$

On the assumption that contrastive focus in disjunction is a reliable cue to exhaustification, we would expect that disjunction involving narrow focus on the disjuncts should be associated with strengthened meanings more often than disjunction involving, say, broad focus. There are two possible ways of implementing this: (i) take *exh* to be optional and have its insertion be dependent on prosodic prominence, or (ii) take *exh* to be obligatory, and assume that prosodic prominence is associated with an increase in access to relevant alternatives. Such a proposal could even be taken a step further in order to account for differences among complex disjunctions. Specifically, we could argue that prosodic prominence is gradient and this gradience is an indicator of the inference strength. While this proposal is somewhat speculative, we believe that a production study looking into the prosodic prominence associated with different disjunction markers could be conducted to test this hypothesis.[12]

3.2.2. Cues to (levels of) uncertainty

Whereas the previous account was couched in terms of (strength of) cues to local exhaustification, the account we present in this section takes inference strength to correlate with variation in listener's certainty about the intended inference. Here too we identify two possible ways of couching this variation, and we discuss each of them in turn below.

[10] We note that this contrast is much less pronounced in post-verbal position, as in (i):
(i) a. Anushka will visit PARIS$_F$ or BERLIN$_F$.
b. Anushka will visit either PARIS$_F$ or BERLIN$_F$.
With simplex disjunctions, it is also possible to place the focus on the disjunctive marker itself, in which case the exclusive inference becomes quite strong. However, uttering a disjunctive statement with pitch accent on the disjunction only seems fully felicitous as a correction to a conjunctive statement.

[11] While we don't go into the details here, we do believe that the most likely underlying representation is one involving ellipsis, and thus clausal disjunction. Under this view then, the *exh* operator acts at the clausal level.

[12] There is currently a debate in the literature as to what should count when evaluating prosodic prominence which is why we remain agnostic.

On the Gricean approach to implicature calculation, a listener first considers relevant alternatives which the speaker could have uttered. In response to a weak utterance, a listener assumes that the speaker is uncertain about the truth value of stronger, more informative, alternatives, given than the speaker did not utter these. This step, on its own, only derives the weak inference (cf. *a primary implicature*) that the speaker is uncertain about the truth of stronger alternatives. It has been claimed, however, that a further step can be taken in order to derive the stronger inference of certainty regarding the falsity of stronger alternatives (cf. *a secondary implicature*). This step involves the additional assumption that the speaker is knowledgeable, or opinionated, with respect to the truth of alternative propositions (cf. *the epistemic step*) (Grice, 1967; Horn, 1972; Gazdar, 1979; Sauerland, 2004). It is not unnatural to suppose that the use of marked forms is meant to indicate a higher level of opinionatedness on the part of the speaker. This would then amount to higher rates of secondary implicatures for complex disjunctions. Note that within such an account, opinionatedness would be taken to be probabilistic. While this remains speculative for now, future studies could look into such possible correlations between perception of speaker expertise and rate of strengthening.[13]

The proposal we just sketched is neo-Gricean. Grammatical versions of this account handle the opinionantedness component via the K operator introduced previously in the context of N&S's proposal. Specifically, the distinction between primary and secondary implicatures is viewed as a scope interaction between K/□and *exh*, such that *exh*>□ delivers a primary implicature and □>*exh* a secondary one. We illustrated this point for the exclusivity inference(s) in (12).[14]

(12) a. **Strong exclusive interpretation:** $\Box\neg(p \wedge q)$
exclusive in every possible world under consideration.
b. **Weaker exclusive interpretation:** $\neg\Box(p \wedge q)$
exclusive in some of the possible worlds under consideration.

The two inferences above differ in terms of how strong the requirement for exclusivity is, with variation in strength being analyzed as a function of how many possible worlds satisfy the exclusivity requirement. Assuming that robustness of inference can be seen a reflection of strength of inference, as shown above, the problem is that this only gives us two levels of variation and it is unclear how it would be able to account for the three-way variation observed in languages like French and Romanian. A possible extension would be to appeal to a degree-based probabilistic semantics of modality, building on Swanson 2016; Yalcin 2007, 2010; Lassiter 2014, 2020; Moss 2015; Santorio and Romoli 2017.

The idea, in a nutshell, is to think of modals as measures of probability, thus allowing us to map propositions to a value on a probability scale. This would allow us to model the strength of the exclusivity inference in terms of the degree to which it is likely that the *not both* inference holds. Simplifying greatly, we can imagine that the covert modal posited for assertively-used sentences have variable strength, such that a disjunctive sentence can in fact be interpreted as conveying a degree, possibly not 100%, of certainty that the disjunctive statement holds.

[13] On this hypothesis, we could also imagine that disjunctions associated with a higher, more formal register (e.g. French *soit soit*) are also those more likely to give rise to exclusivity: if someone uses a disjunctive marker from a higher register, it gives the impression that they are more expert on the topic, hence more opinionated. We would like to thank Federica Longo for her suggestion to consider register as a relevant factor in modeling strength of implicatures.

[14] We assume the same system could be at play for ad-hoc inferences as well.

Assuming exhaustification can then proceed normally, the strengthened interpretation would amount to the interpretation in (13).[15]

(13) *n%* likely that *p or q* and *n%* likely not *p and q*

Depending on the strength of the modal, we could then envision it taking on different values depending on how strongly a given participant views the likelihood conveyed by the disjunctive statement, and in turn, the negation of its conjunctive inference. On this view, the higher the likelihood, the stronger the exclusivity inference. Do note that an issue with the account as presented so far is that it assigns the same *n%* to both the assertive and the implicated components, whereas intuitively it seems that the certainty level should only vary with respect to the implicated component, something that the neo-Gricean proposal presented above could capture. This issue is not insignificant but we nevertheless leave it as an open issue here.[16]

We have suggested that a possible implementation of the variability in strength of exclusivity could be achieved by adopting a degree-based probabilistic semantics of the covert modal operator.[17] We believe this can easily be extended to cases such as the ones in our experimental set-up which involved the future marker *will*, by re-analyzing it in terms of the speaker's belief in how likely a certain outcome is.

Summing up, the general line of reasoning we pursued here takes the disjunctive marker to affect what we take the speaker's epistemic state to be (albeit in ways we still don't fully understand) — be it because it modulates the strength of the K operator or because it modulates the likelihood of the opinionatedness assumption.

4. Concluding remarks

The results of our experiments showed that all disjunctions in the five languages we tested are ambiguous between an inclusive and an exclusive interpretation and that they may, but need not, differ in terms of how exclusive they are. These findings constitute a rebuttal of the categorical view whereby particular disjunctions are exclusive across the board. We sketched instead two non-categorical approaches that could explain the observed optionality in strength, building on the intuition that multiple aspects enter into the calculation, with prosodic marking and opinionatedness being two of the main factors we consider relevant. While in the previous section we discussed their roles in isolation, it is clear that they can work in concord, with prosodic marking being taken to relate to the activation of alternatives, and opinionantedness to the extent to which one can confidently exclude the activated alternatives.

Another question that arose from the experimental data presented here regards the multiplicity of disjunction particles. In languages like Russian and Greek, in contrast to languages like French and Romanian, we do not see gradual effects of exclusivity all the way, raising the following question: why would a language have three or more ways of expressing disjunction if only one or two gradients of exclusivity tend to be expressed? Could it be that differ-

[15] This interpretation assumes that *exh* occurs under the modal operator. It is not clear to us at this point how to tell apart the interpretations that arise from the two scope possibilities given this degree-semantics for the modal.

[16] But see Mandelkern and Dorst (2022) for a view that assertions should more generally be seen as weak.

[17] A similar approach could, in principle, also derive variability in strength of the exhaustivity inference. Given our results, however, any complete theory would need to also take into account the nature of the alternatives involved and the ease of retrieval.

ent disjunctions are responsible for different inferences? To begin answering this question, we tested another type of inference, namely the exhaustivity inference. This inference was overall much less robust than the exclusivity inference, and crucially, not remarkably distinguishable amongst the different disjunctive types, although a tendency for higher rates of exhaustivity was observed for complex disjunctions. We argued that this tendency, which parallels the significant result obtained with exclusivity inferences, is supported by the view that prosodic prominence (associated with complex disjunctions) cues hearers to interpret utterances on their stronger, exhaustified, parses involving local strengthening of the disjuncts. This tendency for complexity to lead to increased exhaustiveness favours the type of explanation we advanced here, whereby [**Disj** A **Disj** B] puts the focus on the independent disjuncts, biasing towards substitution alternatives $Alt = \{A, B, C, \dots\}$.

Further investigation into the realm of meaning variation among disjunctions is undoubtedly called for. We already have evidence from the domain of existential quantifiers that indefinites come in different epistemic varieties (see, e.g., work by Alonso-Ovalle and Menéndez-Benito 2010, Aloni and Port 2010, Fălăuş 2014, to name only a few). And even from the domain of disjunctions we have evidence that such specialized disjunctions do occur. For example, Ivlieva (2016) notes that some complex Russian disjunctions (*to li… to li* and *ne to… ne to*) give rise to obligatory, non-cancellable ignorance inferences, as shown by the contrast in (14). This is particularly striking because this inference persists even under existential modals, an environment where disjunctions normally give rise to free choice permission inferences and ignorance is obviated.

(14) Ty možeš vzjat' **to li** jabloko, **to li** apel'sin **/ne to** jabloko, **ne to** apel'sin
You may take *to li* an orange *to li* an apple/ *ne to* an orange *ne to* an apple
$\not\rightsquigarrow$ you may take an orange and you may take an apple
$\rightsquigarrow$ it is either an orange or an apple that you're allowed to take

A more detailed investigation is needed but what seems to be the case is that certain inferences are more likely to be lexicalized, with ignorance and free choice being such inferences, to the exclusion of exclusivity inferences (Maria Aloni p.c.). Our results indicate that exhaustive inferences most likely fall in the same category as exclusivity inferences in their resistance to lexicalization. A proper understanding of this pattern will have to be left for another time, but we believe the *Neglect Zero* approach advocated by Aloni (2022) may pave the way towards a solution.

Future work on this topic could also look at the specifics of the morphological makeup of complex disjunctions and what points of variation are observed there. For example, one dimension of variation could relate to the number of morphemes in a given disjunction (e.g. two in *ou bien* versus only one in *soit*). This distinction cuts both within complex disjunctions as well as between simplex and complex, with simplex *i* and complex *ili* being a prime example since *ili* is morphologically made up of the disjunctive marker *i* and the question particle *li*. An even more specific dimension of variation could be formulated in terms of morphological containment, with both *i* vs *ili* and *ou* vs *ou bien* acting as prime examples, since the complex variants are built off of the simplex variants. Suffice it to say, the possible levels of variation are numerous and coming up with any concrete hierarchy of markedness requires significantly more empirical work.

References

Aloni, M. (2022, June). Logic and conversation: The case of free choice. *Semantics and Pragmatics 15*(5), 1–60.

Aloni, M. and A. Port (2010). Epistemic indefinites crosslinguistically. In *Proceedings of NELS 41*.

Alonso-Ovalle, L. and P. Menéndez-Benito (2010). Modal indefinites. *Natural Language Semantics 18*(1), 1–31.

Baker, R., R. Doran, Y. McNabb, M. Larson, and G. Ward (2009). On the non-unified nature of scalar implicature: An empirical investigation. *International Review of Pragmatics 1*(2), 211 – 248.

Bates, D., M. Mächler, B. Bolker, and S. Walker (2015). Fitting linear mixed-effects models using lme4. *Journal of Statistical Software 67*(1), 1–48.

Chierchia, G. (2006). Broaden your views: Implicatures of domain widening and the 'logicality' of language. *Linguistic Inquiry 37*(4), 535–590.

Chierchia, G., D. Fox, and B. Spector (2012). Scalar implicatures as a grammatical phenomenon. In C. Maienborn, P. Portner, and K. von Heusinger (Eds.), *Semantics: An International Handbook of Natural Language Meaning* (Berlin & Boston: de Gruyter ed.), Volume 3, pp. 2297–2332. New York, NY: Mouton de Gruyter.

Degano, M., S. Ramotowska, P. Marty, M. Aloni, R. Breheny, J. Romoli, and Y. Sudo (2023). The ups and downs of ignorance. under review.

Doran, R. B., G. Ward, M. Larson, Y. McNabb, and R. Baker (2012). A novel experimental paradigm for distinguishing between what is said and what is implicated. *Language 88*, 124–154.

Fox, J. and S. Weisberg (2019). *An R Companion to Applied Regression* (Third ed.). Thousand Oaks CA: Sage.

Fălăuş, A. (2014). (Partially) Free Choice of Alternatives. *Linguistics and Philosophy 37*(2), 121–173.

Gazdar, G. (1979). *Pragmatics: Implicature, Presupposition, and Logical Form*. New York, N.Y.: Academic Press.

Gotzner, N., D. Barner, and S. Crain (2020). Disjunction triggers exhaustivity implicatures in 4- to 5-year-olds: Investigating the role of access to alternatives. *Journal of Semantics 37*, 219–245.

Grice, P. (1967). Logic and conversation. Unpublished lecture notes from William James Lectures at Harvard, 1967.

Harrell, F. (2023). *Package 'Hmisc'*. R package version 5.1-0.

Horn, L. (1984). Towards a new taxonomy for pragmatic inference: Q-and R-based implicature. *Meaning, form and use in context*.

Horn, L. R. (1972). *On the semantic properties of logical operators in English*. Ph. D. thesis, University of California Los Angeles.

Ivlieva, N. (2016). Epistemic disjunction and obligatory ignorance. Handout at 'Disjunction days'.

Katzir, R. (2007). Structurally defined alternatives. *Linguistics and Philosophy 30*(6), 669–690.

Kratzer, A. and J. Shimoyama (2002). Indeterminate pronouns: The view from Japanese. In Y. Otso (Ed.), *Tokyo Conference on Psycholinguistics*, Volume 3, pp. 1–25.

Lassiter, D. (2014, 07). Epistemic Comparison, Models of Uncertainty, and the Disjunction

Puzzle. *Journal of Semantics 32*(4), 649–684.
Lassiter, D. (2020). *Graded Modality*, pp. 1–25. John Wiley & Sons, Ltd.
Mandelkern, M. and K. Dorst (2022). Assertion is weak. *Philosophers' Imprint 22*(n/a).
Meyer, M.-C. (2013). *Ignorance and grammar*. Ph. D. thesis, Massachusetts Institute of Technology, Cambridge, MA.
Moss, S. (2015, March). On the semantics and pragmatics of epistemic vocabulary. *Semantics and Pragmatics 8*(5), 1–81.
Nicolae, A. C. (2017). Deriving the positive polarity behavior of plain disjunction. *Semantics and Pragmatics 10*(5), 1–21.
Nicolae, A. C. and U. Sauerland (2016). A contest of strength: *or* versus *either or*. In N. Bade, P. Berezovskaya, and A. Schöller (Eds.), *Sinn und Bedeutung 20*, pp. 551–568.
R Core Team (2023). *R: A Language and Environment for Statistical Computing*. Vienna, Austria: R Foundation for Statistical Computing.
Santorio, P. and J. Romoli (2017). Probability and implicatures: A unified account of the scalar effects of disjunction under modals. *Semantics and Pragmatics 10*(13), 1–61.
Sauerland, U. (2004). Scalar implicatures in complex sentences. *Linguistics and Philosophy 27*(3), 367–391.
Spector, B. (2014). Global positive polarity items and obligatory exhaustivity. *Semantics and Pragmatics 7*(11), 1–61.
Swanson, E. (2016). The application of constraint semantics to the language of subjective uncertainty. *Journal of Philosophical Logic 45*(2), 121–146.
Szabolcsi, A. (2015). What do quantifier particles do? *Linguistics and Philosophy 38*(2), 159–204.
van Tiel, B., E. Van Miltenburg, N. Zevakhina, and B. Geurts (2016). Scalar diversity. *Journal of Semantics 33*(1), 137–175.
Yalcin, S. (2007). Epistemic modals. *Mind 116*(464), 983–1026.
Yalcin, S. (2010). Probability operators. *Philosophy Compass 5*(11), 916–937.