On the anti-exhaustive inference of *ya*

Andreea C. Nicolae
Leibniz-Zentrum Allgemeine
Sprachwissenschaft, Berlin, Germany
nicolae@leibniz-zas.de

Yasutada Sudo
University College London
London, UK
y.sudo@ucl.ac.uk

Muyi Yang
Osaka University
Osaka, Japan
muyi.yang.ym@gmail.com

Abstract

Sudo 2014 analyzes the connective *ya* in Japanese as an inclusive disjunction that triggers two scalar inferences, (i) a conjunctive inference and (ii) an anti-exhaustive inference, based on alternatives involving other connectives. Sauerland et al. 2017 propose a competing analysis of (i) that is based on domain alternatives, but they make no claim about (ii). We report on an experiment with an inference task whose results indicate that *ya* does indeed trigger (ii) but it is not as robust as (i). We argue that this is problematic for Sudo's (2014) analysis, but at the same time shows that Sauerland et al.'s (2017) analysis needs to be augmented with a mechanism for generating (ii). In order to account for the difference in robustness, we propose that (i) is a grammatically derived scalar inference, while (ii) is a pragmatically derived scalar inference.

1 Introduction

Japanese has a connective *ya*, which is often used to list examples (as Kuno 1973, p. 114 remarks). For instance, (1), is roughly translated with '... and ..., for example'.

(1) Taroo-wa amerika-ya furansu-ni itta.
Taro-TOP USA-YA France-to went
'Taro went to the USA and France, for example.'

Sudo 2014 proposes that the lexical meaning of *ya* is simply an inclusive disjunction but it is strengthened by two scalar inferences (SIs): (i) a conjunctive inference and (ii) an anti-exhaustive inference. Concretely, according to Sudo 2014, the semantics of (1) is as in (2), but it also involves two SIs, (2-a) and (2-b).

(2) Taro went to the USA $\vee$ Taro went to France
a. $\rightsquigarrow$ Taro went to both the USA and France. CONJUNCTIVE
b. $\rightsquigarrow$ Taro went to at least one more country. ANTI-EXHAUSTIVE

According to this idea, the underlying semantics of *ya* is disjunctive, despite the fact that the overall meaning entails conjunction, e.g., (1) entails that Taro went to both the USA and France. The strongest evidence for this comes from *ya* in quantified sentences like (3), which does not entail that every friend went to both countries, but only that every friend went to at least one of them (cf. Smith and Kobayashi 2018).

(3) dono tomodachi-mo amerika-ya furansu-ni itta.
which friend-MO USA-YA France-to went
'Every friend went to USA or France, for example.'

Importantly, the conjunctive counterpart of (3) formed with the conjunctive connective *to* in place of *ya*, as in (4), does entail that every friend went to both countries. This suggests that the universal quantifier *dono NP* is read distributively and the relevant reading of (3) is not a cumulative reading with respect to a conjunctive object.

(4) dono tomodachi-mo amerika-to furansu-ni itta.
which friend-MO USA-YA France-to went
'Every friend went to the USA and France, for example.'

There are two competing proposals about how the two SIs of *ya* are derived: Sudo 2014 analyzes both of them as (higher-order) SIs that arise in competition with the conjunctive and disjunctive alternatives. Sauerland et al. 2017, on the other hand, focus on the conjunctive inference and derive it with domain alternatives (cf. Bowler 2014; Singh et al. 2016).

In this paper, we report on an experiment with an inference task that compared the two SIs of *ya* between them as well as with the exhaustive inference of the conjunctive connective *to* and the anti-conjunctive, alternatively, the exclusive inference of the disjunctive connective *ka*. The latter two inferences are illustrated by (5) and (6), respectively.

(5) Taroo-wa amerika-to furansu-ni itta.
Taro-TOP USA-TO France-to went
'Taro went to the USA and France.'
⇝ Taro did not go to other countries EXHAUSTIVE

(6) Taroo-wa amerika-ka furansu-ni itta.
Taro-TOP USA-KA France-to went
'Taro went to the USA or France.'
⇝ Taro did not go to both countries ANTI-CONJUNCTIVE

The results indicate that *ya* does trigger an anti-exhaustive inference but it is not as robust as the other three inferences we tested, which were all very robust. We argue that these experimental findings are problematic for Sudo's (2014) analysis, which derives the two SIs of *ya* by the same mechanism, whereby failing to capture their difference in robustness. The results also show that Sauerland et al.'s (2017) analysis needs to be augmented with a mechanism for generating the anti-exhaustive inference. To explain the difference in robustness, we propose a hybrid account where the conjunctive inference of *ya* is a *grammatically* derived SI, as proposed by these previous studies, but its anti-exhaustive inference is a *pragmatically* derived SI (see Marty et al. 2021; Marty et al. 2024c for similar ideas).

2 Experiment

The goals of our experiment were to show that *ya* has an anti-exhaustive inference and to compare its robustness with its conjunctive inference, as well as with other inferences that are related to these two inferences, namely the exhaustive inference of the cojunctive connective *to* and the anti-conjuctive inference of the disjunctive connective *ka* (The latter also typically triggers an exhaustive inference but we did not test it).

2.1 Material

Our experiment employed a version of the inference task. The inference task has not only been extensively used to investigate various types of SIs, but also is known to yield more robust results than other experimental tasks (Geurts and Pouscoulous 2009; Ronai and Xiang 2021; Marty et al. 2024b), therefore making it the ideal task for purposes of showing the existence of an SI.

In order to further boost the robustness of the target inferences, following Ronai and Xiang's (2021) findings, we included a *wh*-question in each trial and presented the test sentence as an answer to it, as illustrated by the following example stimulus. (Note that nouns in Japanese are generally number-neutral.)

(7) Shota: Takuya-wa donna petto-o katteru no?
Takuya-TOP what.kind pet-ACC have Q
'Shota: What kind of pet does Takuya have?'

Misaki: neko-ya kame-da yo.
cat-YA turtle-COP PRT
'Misaki: A cat(s) and a turtle(s)'.

In addition to the existence of the anti-exhaustive inference, we are also interested in its quality. Intuitively, the anti-exhaustive inference of *ya* feels weaker than the conjunctive inference, as previously suggested by Sudo 2014, fn. 2, and we hypothesized that this is because the anti-exhaustive inference is by default perceived as a primary implicature, rather than a secondary implicature, in the sense of Sauerland 2004. For example, in the case of (1), the anti-exhaustive inference is '$\neg B_s$(Taro went to only USA and France)', rather than 'B_s(¬Taro went to only USA and France)'. In order to test this hypothesis, we prepared two types of probe questions, PRIMARY and SECONDARY. For (7), for example, the English translations of the two probe questions are as in (8). (We used the epistemic possibility modal *kamoshirenai* to phrase the PRIMARY question.)

(8) a. Can you conclude the following from this?: Misaki thinks that Takuya might have a pet(s) different from a cat(s) or a turtle(s). PRIMARY
b. Can you conclude the following from this?: Misaki thinks that Takuya has a pet(s) different from a cat(s) or a turtle(s). SECONDARY

Both questions were answered by pressing a button labeled *Hai* 'Yes' or *Iie* 'No'.

One caveat is in order: if an inference is perceived as a primary implicature, the PRIMARY question should be accepted, while the SECONDARY question rejected. If an inference is perceived as a secondary implicature, the SECONDARY question should be accepted, but whether the PRIMARY question will be rejected depends on whether the probe question itself is read with an implicature implying ignorance.

2.2 Procedure

The experiment consisted of 4 types of INFERENCE (ANTI-EXHAUSTIVE, CONJUNCTIVE, EXHAUSTIVE, ANTI-CONJUNCTIVE) × 2 types of PROBE (PRIMARY, SECONDARY) = 8 experimental conditions. Both factors were tested within participants. Each experimental condition had 4 items, meaning there were 32 target items in total. They were presented in a random order together with 32 filler items on Gorilla Experiment Builder (`www.gorilla.sc`; Anwyl-Irvine et al. 2020). The experiment was pre-registered on the Open Science Framework at `https://osf.io/mtu7z`.

We employed 39 self-claimed Japanese native speakers on CrowdWorks (`crowdworks.jp`) (see Majima et al. 2017 for comparisons with other services for the purposes of behavioral research). They were all paid 350–385 yen, including the platform fee. Two of them were excluded from analysis as they failed to reach a pre-established threshold accuracy of 80% for filler items (Their accuracy rates were 56.2% and 68.8%, suggesting that their answers were largely random). For the remaining 37 participants, the mean accuracy rate was 93.3%.

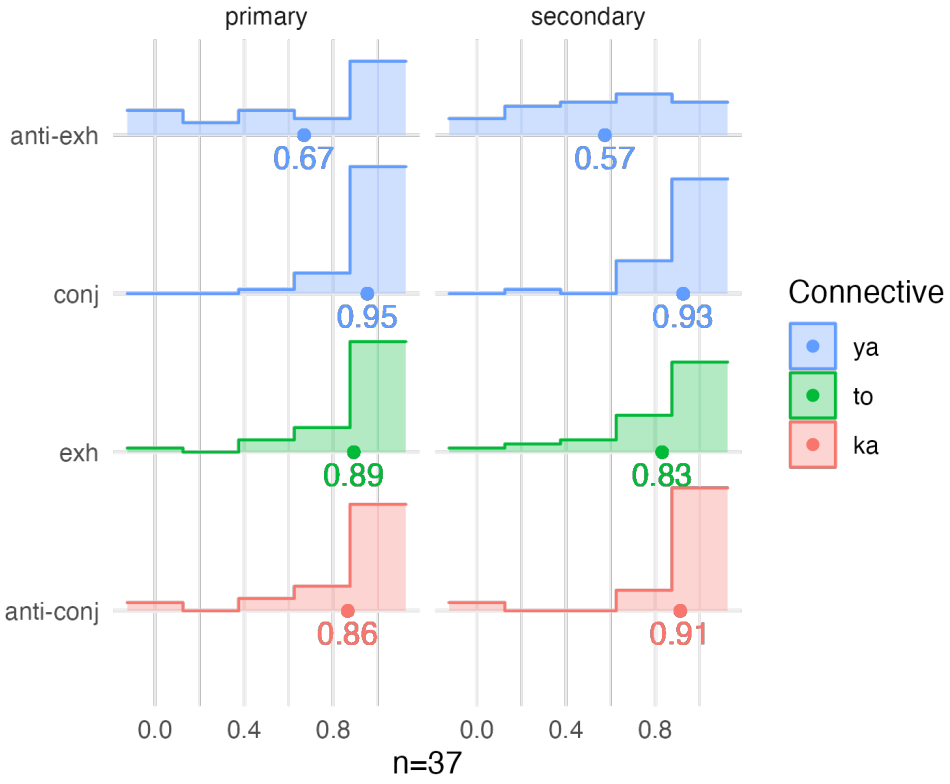

Figure 1: Proportions of *Yes* answers in experimental conditions. The histograms represent by-participant proportions across 4 items in the respective experimental conditions.

2.3 Results

The results are summarized in Figure 1. We fitted a mixed-effects logistic regression model using the `lme4` package (Bates et al. 2015) for `R` (R Core Team 2024) with INFERENCE and PROBE as fixed effect factors, with both factors treatment coded with ANTI-EXHAUSTIVITE and PRIMARY as reference levels, respectively. The model revealed a significant simple effect of INFERENCE with respect to each non-reference level, a significant simple effect of PROBE, and a significant interaction with respect to the anti-conjunctive inference of *ka* (see Table 1 for details).

2.4 Discussion

The experimental results show that the anti-exhaustive inference of *ya* is much less robust than the other three inference types, and is characterized more aptly as a primary implicature. The significant interaction effect with respect to the anti-conjunctive inference of *ka* suggests that the latter is more likely to be perceived as a secondary implicature, while the non-significant interaction effects with the other inference types could well be due to the ceiling effect.

We take these results as evidence for the anti-exhautive inference, because were it not for it, the simple effect of PROBE and the significant interaction effect would not be explained. This in turn means that Sauerland et al.'s (2017) account is incomplete, as it is entirely silent about this inference.

At the same time, the low robustness of the anti-exhaustive inference poses a serious challenge for Sudo's (2014) account, according to which it is an SI of the same kind as the other three inferences tested in our experiment. In particular, it proposes to derive the anti-exhaustive and conjunctive inferences of *ya* with a single operator.

Fixed effects	β	s.e.	z	p
Intercept	1.22	0.47	2.57	0.010*
$\text{INFERENCE}_{\text{CONJ}}$	3.41	1.13	3.01	0.003**
$\text{INFERENCE}_{\text{EXH}}$	1.89	0.77	2.44	0.014*
$\text{INFERENCE}_{\text{ANTICONJ}}$	4.39	1.87	2.35	0.019*
PROBE	−0.74	0.34	−2.19	0.028*
$\text{INFERENCE}_{\text{CONJ}}\times\text{PROBE}$	0.20	0.68	0.30	0.767
$\text{INFERENCE}_{\text{EXH}}\times\text{PROBE}$	0.07	0.53	0.13	0.900
$\text{INFERENCE}_{\text{ANTICONJ}}\times\text{PROBE}$	1.83	0.73	2.51	0.012*

Random effects	σ^2	σ	ρ		
By-participant					
Intercept	4.25	2.06			
$\text{INFERENCE}_{\text{CONJ}}$	6.57	2.56	−0.77		
$\text{INFERENCE}_{\text{EXH}}$	9.15	3.03	−0.84	0.80	
$\text{INFERENCE}_{\text{ANTICONJ}}$	24.29	4.93	−0.29	0.19	0.41
By-item					
α	1.07	1.03			
$\text{INFERENCE}_{\text{CONJ}}$	2.12	1.46	−0.46		
$\text{INFERENCE}_{\text{EXH}}$	1.86	1.36	−0.97	0.63	
$\text{INFERENCE}_{\text{ANTICONJ}}$	1.20	1.10	−0.63	−0.04	0.59

Table 1: Parameter estimates of the mixed-effects logistic regression model.

While the experimental design has some room for improvement, e.g., the effect of *Probe* came out as relatively small, overall, it is a reasonable conclusion that a novel account of the anti-exhaustive inference is called for. To this end, we will sketch a novel 'hybrid' account in what follows.

3 A hybrid account

Firstly, it should be noticed that our experimental results are compatible with both Sudo's (2014) and Sauerland et al.'s (2017) account of the conjunctive inference of *ya* as a grammatically derived SI. We therefore remain neutral as to which analysis of the conjunctive inference is on the right track, but we crucially follow them in assuming that the conjunctive inference is a grammatically derived SI.

Turning now to the anti-exhaustive inference, as we discussed above, we reject Sudo's (2014) idea that the anti-exhaustive inference is also an SI of the same kind. Instead, we propose that it is a *pragmatically* derived SI.

Marty et al. (2021, 2024) recently suggested a similar hybrid account for SIs generated by *or* vs. negated *and*. In their experiments with truth-value judgment tasks, they observed that the SIs of sentences with *or* occurring in various modal constructions are generally much more robust than those of sentences containing negated *and* instead, despite the fact that the contents of the sentences are quite similar, if the SIs are taken into consideration. To account for this, they suggest that *or* generates a scalar inference with some grammatical mechanism (e.g., EXH), while a scalar inference for negated *and* is due to pragmatic reasoning in the spirit of (neo-)Gricean Pragmatics. If pragmatic reasoning is contingent on various contextual factors, as is commonly assumed, it is not surprising that pragmatically derived SIs come out not so

robustly in experimental settings. Assuming that grammatically derived scalar inferences are more reliably present (although in principle also optional), we can account for the observed difference in robustness.

Applying this idea to the two scalar inferences of *ya*, we analyze its conjunctive inference as a grammatically derived SI, and its anti-exhaustive inference as a pragmatically derived SI. This analysis not only accounts for the difference in robustness in the same way as Marty et al.'s account of *or* vs. negated *and*, but it also naturally follows from it that the anti-exhaustive inference is more likely to be perceived as a primary implicature, on the assumption that pragmatically derived SIs are born as primary implicatures and only optionally strengthen to secondary implicatures with further reasoning (see, e.g., Gazdar 1979; Soames 1982; Sauerland 2004).

In order for this hybrid account to explain the full set of observations from our experiment, some auxiliary assumptions are necessary. Firstly, it is crucial that the conjunctive inference is analyzed as a *grammatically* derived SI. Secondly, we have to assume that the exhaustive inference of *to* and the anti-conjunctive inference of *ka* are likewise both grammatically derived SIs, as they were both much more robust than the anti-exhaustive inference of *ya* in our results. Thirdly, the pragmatic mechanism that derives the anti-exhaustive inference should (i) reason about an alternative expression which has an exhaustive inference and (ii) derive the inference that the speaker couldn't utter it while respecting the conversational maxims. This crucial alternative can be the conjunctive alternative with its exhaustive inference (which is a grammatically derived SI in our account) for *ya* in positive contexts and the disjunctive alternative with its exhaustive inference for *ya* in negative contexts. This account of the anti-exhaustive inference is very similar to Sudo's (2014), except that the core mechanism that 'negates' the alternative is pragmatic reasoning, rather than a grammatical operator.

4 Outlook

While variation in robustness among different scalar expressions ('scalar diversity') has recently garnered a lot of attention in the experimental literature (e.g., Tiel et al. 2016; Ronai and Xiang 2021; Marty et al. 2024a; Nicolae et al. 2024a; Nicolae et al. 2024b), the theoretical understanding of the variation is arguably still rudimentary. We certainly do not think everything about scalar diversity, which is a continuum, is to be accounted for in terms of the dichotomy of grammatical vs. pragmatic inferences, but if we (and Marty et al. 2021; Marty et al. 2024c) are right, at least part of the diversity should be.

Furthermore, our hybrid account makes experimentally testable predictions that go beyond robustness alone, e.g., that pragmatic inferences are more likely to be perceived as primary implicatures and are more sensitive to the speaker's epistemic state, etc., which are left for future research.

Acknowledgements. A.N. received support from the DFG grant NI-1850/2-1 and the ERC Synergy Grant 856421. The work has also been partly supported by JSPS Core-to-Core Program (#JPJSCCA20210001; PI: Yoichi Miyamoto).

References

Anwyl-Irvine, Alexander L. et al. (2020). "Gorilla in our midst: An online behavioral experiment builder". In: *Behavior Research Methods* 52, pp. 388–407. DOI: 10.3758/s13428-019-01237-x.

Bates, Douglas et al. (2015). "Fitting Linear Mixed-Effects Models Using lme4". In: *Journal of Statistical Software* 67.1, pp. 1–48. DOI: 10.18637/jss.v067.i01.

Bowler, Margit (2014). "Conjunction and disjunction in a language without 'and'". In: *Proceedings of SALT 24*. Ed. by Todd Snider, Sarah D'Antonio, and Mia Weigand. LSA and CLC, pp. 137–155. DOI: 10.3765/salt.v24i0.2422.

Gazdar, Gerald (1979). *Pragmatics: Implicature, Presupposition, and Logical Form*. Academic Press.

Geurts, Bart and Nausicaa Pouscoulous (2009). "Embedded Implicatures?!?" In: *Semantics and Pragmatics* 2.4, pp. 1–34. DOI: 10.3765/sp.2.4.

Kuno, Susumu (1973). *The Structure of the Japanese Language*. Cambridge, MA: MIT Press.

Majima, Yoshimasa et al. (2017). "Conducting online behavioral research using crowdsourcing services in Japan". In: *Frontiers in Psychology* 8.378. DOI: 10.3389/fpsyg.2017.00378.

Marty, Paul et al. (2021). "Negative Free Choice". In: *Semantics and Pragmatics* 14.13, pp. 1–54. DOI: 10.3765/sp.14.13.

— (2024a). "On the salience of linguistic alternatives in the inference task for scalar implicature". Talk at Experiments in Linguistic Meaning (ELM) 3, University of Pennsylvania.

— (2024b). "Probing the probe: why inference tasks may inflate response rates for Scalar Implicature". Ms.

— (2024c). "What makes linguistic inferences robust?" In: *Journal of Semantics* 41.1, pp. 1–52. DOI: 10.1093/jos/ffad010.

Nicolae, Andreea C. et al. (2024a). "Do languages have exclusive disjunctions?" In: *Open Mind*.

— (2024b). "Exclusivity and exhaustivity of disjunction(s): A cross-linguistic study". To appear in *Sinn und Bedeutung (SuB) 28*.

R Core Team (2024). *R: A Language and Environment for Statistical Computing*. R Foundation for Statistical Computing. Vienna, Austria. URL: https://www.R-project.org/.

Ronai, Eszter and Ming Xiang (2021). "Exploring the connection between Question Under Discussion and scalar diversity". In: *Proceedings of the Linguistic Society of America* 6.1, pp. 649–662. DOI: 10.3765/plsa.v6i1.5001.

Sauerland, Uli (2004). "Scalar implicatures in complex sentences". In: *Linguistics and Philosophy* 27.3, pp. 367–391. DOI: 10.1023/B:LING.0000023378.71748.db.

Sauerland, Uli et al. (2017). "Tracking down disjunction". In: *New Frontiers in Artificial Intelligence: JSAI-isAI 2015 Workshops, LENLS, JURISIN, AAA, HAT-MASH, TSDAA, ASD-HR, and SKL, Kanagawa, Japan, November 16–18, 2015, revised selected papers*. Ed. by Mihoko Otake et al. Springer, pp. 109–121. DOI: 10.1007/978-3-319-50953-29.

Singh, Raj et al. (2016). "Children interpret disjunction as conjunction: Consequences for theories of implicature and child development". In: *Natural Language Semantics* 24, pp. 305–352. DOI: 10.1007/s11050-016-9126-3.

Smith, Ryan Walter and Ryoichiro Kobayashi (2018). "Alternating conj/disjunctions: the case of Japanese *-toka* and *tari*". In: *Proceedings of Sinn und Bedeutung 22*. Ed. by Uli Sauerland and Stephanie Solt. ZAS. Berlin: ZASPiL, pp. 393–406.

Soames, Scott (1982). "How presuppositions are inheritied: A solution to the projection problem". In: *Linguistic Inquiry* 13.3, pp. 483–545.

Sudo, Yasutada (2014). "An anti-exhaustive, polarity sensitive connective in Japanese and higher-order scalar implicatures". Talk at TEAL-9.

Tiel, Bob van et al. (2016). "Scalar diversity". In: *Journal of Semantics* 33.1, pp. 137–175. DOI: 10.1093/jos/ffu017.