Higher-order scalar implicatures of 'ya' in Japanese

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TEAL 9
September 25, 2014

1 Anti-exhaustivity and polarity sensitivity

- Japanese has a number of different connectives (Kuno 1973) (we'll concentrate on nominal connectives).[1]
  - Familiar conjunctive ('**to**') and disjunctive connective ('**ka**'):

    (1) 太郎は[$_{DP}$ コーヒー**と**紅茶を]飲んだ (conjunction)
    Tarō-wa [kōhī **to** kōcha] -o nonda
    Taro-top [coffee and tea] -acc drank
    'Taro drank coffee and tea.'

    (2) 太郎は[$_{DP}$ コーヒー**か**紅茶を]飲んだ (disjunction)
    Tarō-wa [kōhī **ka** kōcha] -o nonda
    Taro-top [coffee or tea] -acc drank
    'Taro drank coffee or tea.'

  - This talk is about '**ya**':

    (3) 太郎は[$_{DP}$ コーヒー**や**紅茶を]飲んだ
    Tarō-wa [kōhī **ya** kōcha] -o nonda
    Taro-top [coffee ya tea] -acc drank
    'Taro drank things like coffee and tea.'

  - See §4 for more connectives.

- Two semantic properties of 'ya': (i) **anti-exhaustivity** and (ii) **polarity sensitivity**

1.1 Anti-exhaustivity

- (3) entails (4a) and (4b) and seems to also say (4c):[2]

  (4) a. Taro drank coffee.
  b. Taro drank tea.
  c. **Taro drank something else too.** ⇐ '**anti-exhaustive inference**'

[1] 'Ka' and 'to' can appear on each conjoined DP (although 'to' sounds a bit stilted when repeated), while 'ya' cannot. I have no explanation for this different, but doubling does not seem to have clear semantic effects.

[2] Makoto Kanazawa (p.c.) suggested to me that the anti-exhaustivity inference might be modalized, e.g. `it's possible that Taro drank something else too'. But (3) seems to say something stronger than the following sentence, which does not exclude the possibility that Taro only drank coffee and tea.

(i) 太郎は少なくとも[$_{DP}$ コーヒーと紅茶を]飲んだ
Tarō-wa sukunakutomo [kōhī **to** kōcha] -o nonda
Taro-top at.least [coffee to tea] -acc drank
'Taro at least drank coffee and tea.'

According to the account put forward here, the anti-exhaustive inference is correlated with the exhaustive inference of the conjunctive alternative formed with 'to'. It might be that the exhaustive inference is somehow weaker or modalized. As the judgments are not particularly clear, I will leave this issue for future research.

- The conjunctive sentence (1) only entails (4a) and (4b), and tends to implicate that (4c) is false (**exhaustive inference**; more on this later).

1.2 Polarity sensitivity

- In U(pward)E(ntailing) contexts like (3), 'ya' is interpreted conjunctively.
- In D(ownward)E(ntailing) contexts like (5) and (6), it is interpreted disjunctively (it probably has conjunctive readings too).

(5) [$_{CP}$ 太郎が[$_{DP}$ コーヒー**や**紅茶を]飲んだ]とは思えない (negative attitude)
[Tarō-ga [kōhī **ya** kōcha]-o nonda] to-wa omo-e-nai
[Taro-nom [coffee ya tea]-acc drank] C-top think-can-neg
'It's hardly believable that Taro drank things like coffee and tea.'

(6) [$_{CP}$ もし太郎が[$_{DP}$ コーヒー**や**紅茶を]飲めば]、夜眠れないだろう (cond. antecedent)
[Tarō-ga [kōhī **ya** kōcha]-o nom-eba] yoru nemur-e-nai darō
[Taro-nom [coffee ya tea]-acc drink-if] night sleep-can-neg infer
'If Taro drinks things like coffee and tea, he won't be able to sleep at night.'

- Compare these to the conjunctive counterparts:

(7) [$_{CP}$ 太郎が[$_{DP}$ コーヒー**と**紅茶を]飲んだ]とは思えない (negative attitude)
[Tarō-ga [kōhī **to** kōcha]-o nonda] to-wa omo-e-nai
[Taro-nom [coffee and tea]-acc drank] C-top think-can-neg
'It's hardly believable that Taro drank coffee and tea.'

(8) [$_{CP}$ もし太郎が[$_{DP}$ コーヒー**と**紅茶を]飲めば]、夜眠れないだろう (cond. antecedent)
[Tarō-ga [kōhī **to** kōcha]-o nom-eba] yoru nemur-e-nai darō
[Taro-nom [coffee and tea]-acc drink-if] night sleep-can-neg infer
'If Taro drinks coffee and tea, he won't be able to sleep at night.'

Since 'to' does not have wide scope conjunctive readings in (7) and (8), it is unlikely that 'ya' can in (5) and (6). So 'ya' receives a disjunctive reading there.

- NB: in other DE environments 'と' also gives rise to conjunctive readings (due to wide scope, plurality, etc.; cf. Szabolcsi & Haddican 2004).

(9) *clause-mate negation*
a. 太郎は[$_{DP}$ コーヒー**や**紅茶を]飲まなかった
Tarō-wa [kōhī **ya** kōcha (***ya**)] -o nom-anak-atta
Taro-top [coffee ya tea (ya)] -acc drink-neg-past
'Taro didn't drink things like coffee and tea.'
b. 太郎は[$_{DP}$ コーヒー**と**紅茶を]飲まなかった
Tarō-wa [kōhī **to** kōcha (***ya**)] -o nom-anak-atta
Taro-top [coffee and tea (ya)] -acc drink-neg-past
'Taro didn't drink coffee and tea.'

(10) *restrictor of universal quantifier*
a. [$_{DP}$ コーヒー**や**紅茶]を飲んだどの学生も気分が悪くなった
[kōhī **ya** kōcha]-o nonda dono gakusē-mo kibun-ga waruk unatta
[coffee ya tea]-acc drank which student-∀ got sick

'Every student who drank things like coffee and tea got sick'

b. [$_{DP}$ コーヒー**と**紅茶]を飲んだどの学生も気分が悪くなった

[kōhī **to** kōcha]-o nonda dono gakusē-mo kibun-ga waruk unatta
[coffee and tea]-acc drank which student-∀ got sick

'Every student who coffee and tea got sick'

1.3 Outline

§2 : Analysis

- 'Ya' is a disjunction.
- The conjunctive interpretation in UE contexts is due to a **scalar implicature** (SI).
- The anti-exhaustive inference is also a SI.

§3 Plurality

§4 Other connectives

§A Previous studies on polarity sensitive connectives in Child English and Walpiri

2 Analysis

- **Claim 1**: 'ya' is a disjunction.
- **Claim 2**: the conjunctive meaning in UE contexts and anti-exhaustive inferences are due to SIs:
  - The relevant alternatives are 'to' (conjunction) and 'ka' (disjunction).
  - Crucially these alternatives are assumed to have SIs of their own.
  - So the SIs of 'ya' are **higher-order** (cf. Spector 2007).

2.1 Rough idea

- What SIs do the conjunctive and disjunctive alternatives have?
  - The disjunctive sentence (2) implicates that Taro did not drink both.
  - The conjunctive sentence (1) has an **exhaustive inference** that Taro only drank coffee and tea. We analyse this as a SI.
- 'Ya' is an inclusive disjunction '$\vee$' and involves as LIs the negations of these two alternatives with their SIs.
- For (3):

(3) 太郎は[$_{DP}$ コーヒー**や**紅茶(***や**)を]飲んだ

Tarō-wa [kōhī **ya** kōcha (***ya**)] -o nonda
Taro-top [coffee ya tea (ya)] -acc drank

'Taro drank things like coffee and tea.'

- Plain meaning:
  Taro drank coffee $\lor$ Taro drank tea
- SI from the disjunctive alternative 'ka':
  $\neg(\text{Taro drank coffee} \lor \text{Taro drank tea} \land \underbrace{\text{Taro did not drink both}}_{\text{SI}})$
- SI from the conjunctive alternative 'to':
  $\neg(\text{Taro drank coffee} \land \text{Taro drank tea} \land \underbrace{\text{Taro drank nothing else}}_{\text{SI}})$

Taken together:

- Taro drank coffee $\lor$ Taro drank tea
- $\neg$(Taro did not drink both) = Taro did drink both (conjunctive reading)
- $\neg$(Taro drank nothing else) = Taro drank something else (anti-exhaustivity)

• What about DE contexts? For (6), (11a) and (11b) are the alternatives.

(6) [$_{CP}$ もし太郎が[$_{DP}$ コーヒー**や**紅茶を]飲めば]、夜眠れないだろう
[Tarō-ga [kōhī **ya** kōcha]-o nom-eba] yoru nemur-e-nai darō
[Taro-nom [coffee ya tea]-acc drink-if] night sleep-can-neg infer
'If Taro drinks things like coffee and tea, he won't be able to sleep at night.'

(11) a. [$_{CP}$ もし太郎が[$_{DP}$ コーヒー**か**紅茶を]飲めば]、夜眠れないだろう
[Tarō-ga [kōhī **ka** kōcha]-o nom-eba] yoru nemur-e-nai darō
[Taro-nom [coffee or tea]-acc drink-if] night sleep-can-neg infer
'If Taro drinks coffee or tea, he won't be able to sleep at night.'
b. [$_{CP}$ もし太郎が[$_{DP}$ コーヒー**と**紅茶を]飲めば]、夜眠れないだろう =(8)
[Tarō-ga [kōhī **to** kōcha]-o nom-eba] yoru nemur-e-nai darō
[Taro-nom [coffee and tea]-acc drink-if] night sleep-can-neg infer
'If Taro drinks coffee and tea, he won't be able to sleep at night.'

This time, the disjunctive alternative has an exhaustive inference, and the conjunctive alternative has an (indirect) SI:

- Plain meaning:
  [Taro drank coffee $\lor$ Taro drank tea] $\Rightarrow$ [Taro cannot sleep]
- SI from the disjunctive alternative with 'to':
  $$\neg\left(\begin{array}{l}\text{[Taro drank coffee} \lor \text{Taro drank tea]} \Rightarrow \text{[Taro cannot sleep]}\\ \land\ \underbrace{\text{there's nothing else } x \text{ s.t. [Taro drank } x\text{]} \Rightarrow \text{[Taro cannot sleep]}}_{\text{SI}}\end{array}\right)$$
- SI from the conjunctive alternative with 'to':
  $$\neg\left(\begin{array}{l}\text{[Taro drank coffee} \land \text{Taro drank tea]} \Rightarrow \text{[Taro cannot sleep]}\\ \land\ \underbrace{\neg(\text{[Taro drank coffee} \lor \text{Taro drank tea]} \Rightarrow \text{[Taro cannot sleep]})}_{\text{SI}}\end{array}\right)$$

Taken together:

- [Taro drank coffee $\lor$ Taro drank tea] $\Rightarrow$ [Taro cannot sleep]
- $\neg$(there's nothing else x s.t. [Taro drank x]$\Rightarrow$[Taro cannot sleep])
  = there's something else x s.t. [Taro drank x]$\Rightarrow$[Taro cannot sleep]
- (the SI from the conjunctive alternative is identical to the plain meaning)

The result is a disjunctive reading with an anti-exhaustive inference.

2.2 Formalisation: the exhaustivity operator

- I adopt the 'grammatical theory of SI' (Chierchia 2004, 2006, 2013, Chierchia, Fox & Spector 2012, Fox 2007, Groenendijk & Stokhof 1984, van Rooij & Schulz 2004, Spector 2003, 2007, etc.).
- In particular, we use Fox's (2007) version of the exhaustivity operator (exh).

(12) a. $[\![\text{exh}_A(\phi)]\!] = [\![\phi]\!] \wedge \forall\psi \in IE(\phi, A) \neg[\![\psi]\!]$

b. $IE(\phi, A) := \bigcap \left\{ A' \subseteq A \;\middle|\; \begin{array}{l} A' \text{ is a maximal set s.t.} \\ \{\neg p \mid p \in A'\} \cup \{\phi\} \text{ is consistent} \end{array} \right\}$

IE stands for 'innocently excludable'. (for the most part, innocently excludable alternatives are the same as non-weaker alternatives; it only matters for disjunction).

- **Assumption 1**: the alternatives for 'ya' already involve exh:

(13) $Alt(A \text{ ya } B) = \left\{ \begin{array}{l} \text{exh}_{\text{StrAlt}(A \text{ ka } B) \cup \text{CtxAlt}(A \text{ ka } B)}(A \text{ ka } B), \\ \text{exh}_{\text{StrAlt}(A \text{ to } B) \cup \text{CtxAlt}(A \text{ to } B)}(A \text{ to } B) \end{array} \right\} \cup \{ A \text{ ya } B \}$

- **Assumption 2**: two kinds of alternatives
  - **Structural alternatives:** derived morphosyntactically (Katzir 2007, Fox & Katzir 2011)

    (14) $\text{StrAlt}(A \text{ ka } B) = \text{StrAlt}(A \text{ to } B) = \{ A, B, A \text{ ka } B, A \text{ to } B \}$

  - **Contextual alternatives:** derived with contextually relevant disjuncts/conjuncts:

    (15) a. $\text{CtxAlt}(A \text{ ka } B) = \{ A, B, A \text{ ka } B, A \text{ ka } B \text{ ka } C, A \text{ ka } B \text{ ka } D, A \text{ ka } B \text{ ka } C \text{ ka } D, \ldots \}$

    b. $\text{CtxAlt}(A \text{ to } B) = \{ A, B, A \text{ to } B, A \text{ to } B \text{ to } C, A \text{ to } B \text{ to } D, A \text{ to } B \text{ to } C \text{ to } D, \ldots \}$

2.3 UE contexts

- To simplify, assume that the contextual alternatives are formed by A, B and C.
- Exhaustified disjunction:

  (16) $[\![\text{exh}_{\text{StrAlt}(A \text{ ka } B) \cup \text{CtxAlt}(A \text{ ka } B)}(A \text{ ka } B)]\!] = A \vee B \wedge \neg(A \wedge B)$

  - Plain meaning: $A \vee B$
  - Since contextual alternatives are entailed by the plain meaning, they cannot be negated.
  - The only innocently excludable alternative is the conjunctive alternative 'A to B'.

- Exhaustified conjunction

  (17) $[\![\text{exh}_{\text{StrAlt}(A \text{ to } B) \cup \text{CtxAlt}(A \text{ to } B)}(A \text{ to } B)]\!] = A \wedge B \wedge \neg(A \wedge B \wedge C)$

  - Plain meaning: $A \wedge B$
  - Since the structural alternatives are entailed by the plain meaning, they cannot be negated.
  - The contextual alternatives are all innocently excludable.

- 'A ya B' has the negations of these as SIs.

  (18) $[\![\text{exh}_{Alt(A \text{ ya } B)}(A \text{ ya } B)]\!]$
  $\Leftrightarrow (A \vee B) \wedge \neg[\![\text{exh}(A \text{ ka } B)]\!] \wedge \neg[\![\text{exh}(A \text{ to } B)]\!]$
  $\Leftrightarrow (A \vee B) \wedge \neg(A \vee B \wedge \neg(A \wedge B)) \wedge \neg(A \wedge B \wedge \neg(A \wedge B \wedge C))$
  $\Leftrightarrow (A \vee B) \wedge (A \wedge B) \wedge (A \wedge B \wedge C)$
  $\Leftrightarrow A \wedge B \wedge C$

- If there are more contextual alternatives, the anti-exhaustivity will be disjunctive:

(19) $[\![\text{exh}_{Alt(A\ \text{ya}\ B)}(A\ \text{ya}\ B)]\!]$
$\Leftrightarrow (A \vee B) \wedge \neg(A \vee B \wedge \neg(A \wedge B)) \wedge \neg(A \wedge B \wedge \neg(A \wedge B \wedge C) \wedge \neg(A \wedge B \wedge D) \wedge \dots)$
$\Leftrightarrow A \wedge B \wedge (C \vee D \vee \dots)$

2.4 DE contexts

- Let f be a DE-operator.
- Exhaustified disjunction:

(20) $[\![\text{exh}_{\text{StrAlt}(f(A\ \text{ka}\ B)) \cup \text{CtxAlt}(f(A\ \text{ka}\ B))}(f(A\ \text{ka}\ B))]\!] = f(A \vee B) \wedge \neg(f(A \vee B \vee C))$

  - Plain meaning: $f(A \vee B)$
  - The structural alternatives are entailed by the plain meaning, so non-excludable.
  - The contextual alternatives are stronger and excludable.

- Exhaustified conjunction

(21) $[\![\text{exh}_{\text{StrAlt}(f(A\ \text{to}\ B)) \cup \text{CtxAlt}(f(A\ \text{to}\ B))}(f(A\ \text{to}\ B))]\!] = f(A \wedge B) \wedge \neg(f(A \vee B))$

  - Plain meaning: $f(A \wedge B)$
  - Since the contextual alternatives are all entailed, so non-excludable.
  - The structural alternatives are stronger: the only innocently excludable one is the disjunctive alternative $f(A\ \text{ka}\ B)$.

- For '$f(A\ \text{ya}\ B)$':

(22) $[\![\text{exh}_{Alt(f(A\ \text{ya}\ B))}(f(A\ \text{ya}\ B))]\!]$
$\Leftrightarrow f(A \vee B) \wedge \neg[\![\text{exh}(f(A\ \text{ka}\ B))]\!] \wedge \neg[\![\text{exh}(f(A\ \text{to}\ B))]\!]$
$\Leftrightarrow f(A \vee B) \wedge \neg(f(A \vee B) \wedge \neg(f(A \vee B \vee C))) \wedge \neg(f(A \wedge B) \wedge \neg(f(A \vee B)))$
$\Leftrightarrow f(A \vee B) \wedge f(A \vee B \vee C) \wedge f(A \wedge B)$
$\Leftrightarrow f(A \vee B \vee C)$

2.5 Some complications regarding quantified sentences

- At first, we seem to make the wrong prediction for existentially quantified sentences:

(23) $[\![\text{exh}_{Alt(\exists x(A\ \text{ya}\ B)}(\exists x(A\ \text{ya}\ B))]\!]$
$\Leftrightarrow \exists x(A \vee B) \wedge \neg[\![\text{exh}(\exists x(A\ \text{ka}\ B))]\!] \wedge \neg[\![\text{exh}(\exists x(A\ \text{to}\ B))]\!]$
$\Leftrightarrow \exists x(A \vee B) \wedge \neg(\exists x(A \vee B) \wedge \neg(\exists x(A \wedge B))) \wedge \neg(\exists x(A \wedge B) \wedge \neg(\exists x(A \wedge B \wedge C)))$
$\Leftrightarrow \exists x(A \wedge B) \wedge \neg\exists x(A \wedge B \wedge C)$

The conjunctive inference is on the right track, but the anti-exhaustive inference that no one did all of the contextual alternatives is not attested.

(24) 誰かが[$_{DP}$ コーヒー**や**紅茶を]飲んだ

dareka-ga [kōhī **ya** kōcha] -o nonda
someone-nom [coffee ya tea] -acc drank
'Someone drank things like coffee and tea.'

This does not entail that no one drank all of the drinks.

- But notice that generally exh cannot take scope above an indefinite. E.g. (25) does not implicate that no one drank both.

  (25) Someone drank coffee or tea.

  For whatever reason, the distribution of exh is constrained, and the correct inference is generated with the following parse.

  (26) $[\![\exists x(\text{exh}(A \text{ ya } B))]\!] \Leftrightarrow \exists x(A \wedge B \wedge C)$

- For universally quantified sentences, both options seem to be possible.

  (27) Everyone drank coffee or tea.

  If exh takes narrow scope, the SI is that no one drank both. If exh takes wide scope, SI is that not everyone drank both.

- Both scope possibilities are attested with 'ya'.

  (28) みんなが[$_{\text{DP}}$ コーヒー**や**紅茶を]飲んだ

  minna-ga [kōhī **ya** kōcha] -o nonda
  everyone-nom [coffee ya tea] -acc drank
  'Eveyrone drank things like coffee and tea.'

  (29)
  $$\begin{aligned}&[\![\text{exh}_{Alt(\forall x(A \text{ ya } B))}(\forall x(A \text{ ya } B))]\!]\\ &\Leftrightarrow \forall x(A \vee B) \wedge \neg[\![\text{exh}(\forall x(A \text{ ka } B))]\!] \wedge \neg[\![\text{exh}(\forall x(A \text{ to } B))]\!]\\ &\Leftrightarrow \forall x(A \vee B) \wedge \neg(\forall x(A \vee B) \wedge \neg(\forall x(A \wedge B))) \wedge \neg(\forall x(A \wedge B) \wedge \neg(\forall x(A \wedge B \wedge C)))\\ &\Leftrightarrow \forall x(A \wedge B) \wedge \neg\forall x(A \wedge B \wedge C)\end{aligned}$$

  (30) $[\![\forall x(\text{exh}(A \text{ ya } B))]\!] \Leftrightarrow \forall x(A \wedge B \wedge C)$

3 Plurality

- Based on (31), Kuno (1973:114) claims that 'ya' does not have collective readings:

  (31) [ジョンやメアリー]が結婚した

  [John **ya** Mary]-ga kekkonshita
  [John ya Mary]-nom married
  `People like John and Mary got married.'

  This cannot mean that John and Mary married each other (collective reading). It's only interpretation is distributive that involves multiple weddings.

- But this data is confounded by the anti-exhaustivie inference: 'marry' can only be true of a pair of individuals.

- If the predicate is compatible with pluralities consisting of three or more individuals, the collective reading is available. For instance, the following sentences are true in situations with only one relevant event.

  (32) [フランクやマーティン]が一緒に研究をした

  [Frank **ya** Martin]-ga isshoni kenkyuu-o shita
  [Frank ya Martin]-nom together research-acc did
  'People like Frank and Martin did research together.'

(33) 太郎は[本や雑誌]を束ねた

Tarō-wa [hon **ya** zasshi]-o tabaneta
Taro-top [book ya magazine]-acc bundled
'Taro bundled up things like books and magazines.'

And these sentences have anti-exhaustive inferences that there are more individuals/things involved in the event.

- Cumulative readings are also attested.

(34) この人たちは[フランスやドイツ]から来た

kono hito-tachi-wa [furansu **ya** doitsu]-kara kita
this person-assoc.pl-top [France ya Germany]-from came
'These people came from places like France and Germany.'

- To account for non-distributive readings, I adopt Winter's (2001) theory of nominal coordination, where plural forming connectives are analysed with generalised boolean meet ($\sqcap$) and type-shifting (**collectivity raising**).

3.1 Winter on nominal coordination

- Winter's (2001) ideas:
  - No non-boolean 'and';
  - Collective readings are due to a type-shifting operation;
  - 'Atom predicates' like 'run' are of type (et), while 'set predicates' like 'meet' and 'work together' are of type $((et)t)$.
- Proper names denote Montagovian individuals of type $((et)t)$.

(35) $[\![\text{John}]\!] = \lambda P_{(et)}.P(j)$ $\quad [\![\text{Mary}]\!] = \lambda P_{(et)}.P(m)$

- 'And' denotes generalised boolean meet ($\sqcap$)

(36) $$\sqcap_\tau = \begin{cases} \wedge & \text{if } \tau = t \\ \lambda X_{(\sigma_1\sigma_2)}.\lambda Y_{(\sigma_1\sigma_2)}.\ \lambda Z_{\sigma_1}.X(Z) \sqcap_{\sigma_2} Y(Z) & \text{if } \tau = (\sigma_1\sigma_2) \end{cases}$$

- Simply conjoining two proper names will yield a distributive universal quantifier:

(37) $[\![\text{John and Mary}]\!] = [\lambda P_{(et)}.P(j)] \sqcap_{((et)t)} [\lambda P_{(et)}.P(m)] = \lambda P_{(et)}.P(j) \wedge P(m)$

- Winter proposes a type-shifting operation (**collectivity raising**) to obtain a collective reading. It involves two operations.[3,4]
  - **Minimal sort** (min): $\lambda Q_{(et)t}.\lambda P_{(et)}.\ Q(P) \wedge \forall P' \in Q[P' \Rightarrow P \rightarrow B = A]$

(38) $\text{min}([\![\text{John and Mary}]\!]) = \text{min}(\lambda P_{(et)}.P(j) \wedge P(m))$
$= \lambda P_{(et)}.P(j) \wedge P(m) \wedge \forall P'[[P'(j) \wedge P'(m) \wedge P' \Rightarrow P] \rightarrow P = P']$
$= \lambda P_{(et)}.P = [\lambda x.\ x = j \vee x = m]$

  - In set talk: $\text{min}([\![\text{John and Mary}]\!]) \approx (\lambda P_{(et)}.P = \{j, m\}) \approx \{\{j, m\}\}$

[3]Winter (2001) defines generalised versions of these operations. also he generalises $\mathcal{E}$ with choice functions. We ignore these complications here for the sake of simplicity.
[4]One of winter's arguments for $\mathcal{E}$ involves a collective reading with a disjunction: ''Mary and (either) Sue or John met''.

  - ⟦John and Mary⟧ is a principal filter generated by $\{j, m\}$, and min returns the singleton containing this generator.

  – **Existential raising** ($\mathcal{E}$): $\lambda P_{((et)t)}.\lambda Q_{((et)t)}.\ \exists X_{(et)}[P(X) \wedge Q(X)]$

- **Collectivity raising** ($\mathcal{C}$): $\lambda Q_{((et)t)}.\ \mathcal{E}(\min(Q))$

(39) ⟦John and Mary met⟧
$\Leftrightarrow \mathcal{C}(⟦\text{John and Mary}⟧)(\textbf{met})$
$\Leftrightarrow \mathcal{E}(\min(⟦\text{John and Mary}⟧))(\textbf{met})$
$\Leftrightarrow \mathcal{E}(\lambda P_{(et)}.P = \{j, m\})(\textbf{met})$
$\Leftrightarrow \exists X_{(et)}[X = \{j, m\} \wedge \textbf{met}(X)]$
$\Leftrightarrow \textbf{met}(\{j, m\})$

- 'Or' denotes generalised boolean join ($\sqcup$):

(40) $$\sqcup_\tau = \begin{cases} \vee & \text{if } \tau = t \\ \lambda X_{(\sigma_1\sigma_2)}.\lambda Y_{(\sigma_1\sigma_2)}.\ \lambda Z_{\sigma_1}.X(Z) \sqcup_{\sigma_2} Y(Z) & \text{if } \tau = (\sigma_1\sigma_2) \end{cases}$$

(41) $⟦\text{John or Mary}⟧ = \lambda P_{(et)}.\ P(j) \vee P(m)$

(42) $\min(⟦\text{John or Mary}⟧)$
$= \lambda P_{(et)}.\ [P = [\lambda x.x = j]] \vee [P = [\lambda x.x = m]]$
$\approx \lambda P_{(et)}.\ P = \{j\} \vee P = \{m\}$
$\approx \{\{j\}, \{m\}\}$

Applying collectivity raising to this doesn't yield any new reading.

3.2 Generalising exh

- 'Ya' denotes generalised boolean join, just like 'or' and 'ka', but involves higher-order SIs.[5]
- If exh applies before min, we can derive the correct meaning. We'll show: (with j being the only contextual alternative)

(43) $\min(⟦\text{exh(Frank ya Martin)}⟧) = \{\{f, m, j\}\}$

- In order to apply exh at the DP level, we generalise it as follows:

(44) $⟦\text{exh}_A(f)⟧ = ⟦f⟧ \sqcap \bigsqcap_{g \in IE(f,A)} -g$

(45) $$-_\tau = \begin{cases} \neg & \text{if } \tau = t \\ \lambda X_{(\sigma_1\sigma_2)}.\ \lambda Z_{\sigma_1}.\ -_{\sigma_2}(X(Z)) & \text{if } \tau = (\sigma_1\sigma_2) \end{cases}$$

(46) $$IE(f, A) := \bigcap \left\{ A' \subseteq A \;\middle|\; \begin{array}{l} A' \text{ is a maximal set s.t.} \\ \bigsqcap(\{-g \mid g \in A'\} \cup \{f\}) \neq \bot \end{array} \right\}$$

(47) $$\bot_\tau = \begin{cases} 0 & \text{if } \tau = t \\ \lambda X_{\sigma_1}.\bot_{\sigma_2} & \text{if } \tau = (\sigma_1\sigma_2) \end{cases}$$

- Alternatives for 'Frank ya Martin':

(48) $\{$ Frank ya Martin, $\text{exh}_{A_{\text{ka}}}$(Frank ka Martin), $\text{exh}_{A_{\text{to}}}$(Frank to Martin) $\}$

[5] Winter (2001) does not talk about SIs at all, but 'or' should have one, e.g. "Mary and (either) Sue or John met" should implicate that Mary did not meet both of them. This might not be trivial to derive in Winter's theory.

3.3 Conjunctive alternative

- Conjunctive alternative: '$\text{exh}_{A_{\text{to}}}$(Frank to Martin)'

(49) $[\![\text{Frank}]\!] = \lambda P_{(et)}.P(f)$ $\quad [\![\text{Martin}]\!] = \lambda P_{(et)}.P(m)$ $\quad [\![\text{Jeroen}]\!] = \lambda P_{(et)}.P(j)$

(50) $[\![\text{Frank to Martin}]\!] = \lambda P_{(et)}.P(f) \wedge P(m)$

(51) $Alt_{\text{to}} = \text{StrAlt(Frank to Martin)} \cup \text{CtxAlt(Frank to Martin)}$
$= \left\{ \begin{array}{l} \text{Frank, Martin, Frank ka Martin, Frank to Martin,} \\ \text{Frank to Martin to Jeroen} \end{array} \right\}$

- The structural alternatives are not innocently excludable:

(52) a. $[\![\text{Frank to Martin}]\!] \sqcap -[\![\text{Frank}]\!]$
$= \lambda P_{(et)}.\ P(f) \wedge P(m) \wedge \neg P(f)$
$= \lambda P_{(et)}.\ 0$
$= \bot_{((et)t)}$

b. $[\![\text{Frank to Martin}]\!] \sqcap -[\![\text{Martin}]\!]$
$= \lambda P_{(et)}.\ P(f) \wedge P(m) \wedge \neg P(m)$
$= \lambda P_{(et)}.\ 0$
$= \bot_{((et)t)}$

c. $[\![\text{Frank to Martin}]\!] \sqcap -[\![\text{Frank ka Martin}]\!]$
$= \lambda P_{(et)}.\ P(f) \wedge P(m) \wedge \neg P(f) \wedge \neg P(m)$
$= \lambda P_{(et)}.\ 0$
$= \bot_{((et)t)}$

- The contextual alternative is innocently excludable:

(53) $[\![\text{Frank to Martin}]\!] \sqcap -[\![\text{Frank to Martin to Jeroen}]\!]$
$= \lambda P_{(et)}.\ P(f) \wedge P(m) \wedge \neg(P(f) \wedge P(m) \wedge P(j))$
$= \lambda P_{(et)}.\ P(f) \wedge P(m) \wedge \neg P(j)$

- Therefore, the conjunctive alternative has the following meaning:

(54) $[\![\text{exh}_{A_{\text{to}}}\text{(Frank to Martin)}]\!] = \lambda P_{(et)}.\ P(f) \wedge P(m) \wedge \neg P(j)$

- NB: applying min to this effaces the effects of exh, because the minimum set containing f and m is the same as the minimum set containing f and m but not j.

(55) $\text{min}([\![\text{Frank to Martin}]\!]) = \text{min}([\![\text{exh}_{A_{\text{と}}}\text{(Frank to Martin)}]\!]) \approx \{\{f, m\}\}$

This is compatible with the fact that the following sentence does not have an exhaustive inference that f, m and j did not do research together (see §3.6).

(56) フランク**と**マーティンが一緒に研究をした

[Frank **to** Martin]-ga isshoni kenkyuu-o shita
[Frank to Martin]-nom together research-acc did
'Frank and Martin did research together.'

3.4 Disjunctive alternative

- Disjunctive alternative: '$\text{exh}_{A_{\text{ka}}}$(Frank ka Martin)'

(57) $[\![\text{Frank ka Martin}]\!] = \lambda P_{(et)}.P(f) \vee P(m)$

(58) $Alt_{か} = \text{StrAlt}(\text{Frank ka Martin}) \cup \text{CtxAlt}(\text{Frank ka Martin})$
$= \left\{ \begin{array}{l} \text{Frank}, \text{Martin}, \text{Frank ka Martin}, \text{Frank to Martin}, \\ \text{Frank ka Martin ka Jeroen} \end{array} \right\}$

- The conjunctive alternative is innocently excludable.

(59) $[\![\text{Frank ka Martin}]\!] \sqcap -[\![\text{Frank to Martin}]\!]$
$= \lambda P_{(et)}.\ P(f) \vee P(m) \wedge \neg(P(f) \wedge P(m))$

- The contextual alternative is not innocently excludable.

(60) $[\![\text{Frank ya Martin}]\!] \sqcap -[\![\text{Frank ya Martin ya Jeroen}]\!]$
$= \lambda P_{(et)}.\ P(f) \vee P(m) \wedge \neg(P(f) \vee P(m) \vee P(j))$
$= \lambda P_{(et)}.\ 0$
$= \bot_{((et)t)}$

- Therefore, the disjunctive alternative has the following meaning:

(61) $[\![\text{exh}_{A_{\text{ya}}}(\text{Frank ya Martin})]\!] = \lambda P_{(et)}.\ P(f) \vee P(m) \wedge \neg P(j)$

- But again, min removes the effect of exh, because the set of minimum sets containing f or m are the same as the set of minimum sets containing f or m not j:

(62) $\text{min}([\![\text{Frank ya Martin}]\!]) = \text{min}([\![\text{exh}_{A_{\text{ya}}}(\text{Frank ya Martin})]\!]) \approx \{ \{ f \}, \{ m \} \}$

3.5 Higher-order implicatures with pluralities

- As we have just seen, exh has no effects for the conjunctive and disjunctive alternatives. But we will see that it does for 'ya' (the reasoning is the same as in the propositional case).

(63) $A_{\text{ya}} = \{ \text{Frank ya Martin}, \text{exh}_{A_{\text{ka}}}(\text{Frank ka Martin}), \text{exh}_{A_{\text{to}}}(\text{Frank to Martin}) \}$

(64) $[\![\text{exh}_{A_{\text{ya}}}(\text{Frank ya Martin})]\!]$
$= [\![\text{Frank ya Martin}]\!] \sqcap -([\![\text{exh}_{A_{\text{ka}}}(\text{Frank ka Martin})]\!]) \sqcap -([\![\text{exh}_{A_{\text{to}}}(\text{Frank to Martin})]\!])$
$= [\![\text{Frank}]\!] \sqcup [\![\text{Martin}]\!]$
$\quad \sqcap -(([\![\text{Frank}]\!] \sqcup [\![\text{Martin}]\!]) \sqcap -([\![\text{Frank}]\!] \sqcap [\![\text{Martin}]\!]))$
$\quad \sqcap -(([\![\text{Frank}]\!] \sqcap [\![\text{Martin}]\!]) \sqcap -([\![\text{Frank}]\!] \sqcap [\![\text{Martin}]\!] \sqcap [\![\text{Jeroen}]\!]))$
$= [\![\text{Frank}]\!] \sqcap [\![\text{Martin}]\!] \sqcap [\![\text{Jeroen}]\!]$
$= \lambda P_{(et)}.\ P(f) \wedge P(m) \wedge P(j)$
$= \{ P \mid \{ f, m, j \} \in P \}$

- min returns the minimal set $\{ \{ f, m, j \} \}$:

(65) $\text{min}([\![\text{exh}_{A_{\text{ya}}}(\text{Frank ya Martin})]\!]) \approx \{ \{ f, m, j \} \}$

- This explains the reading of (32) that f, m and j did research together:

(32) フランク**や**マーティンが一緒に研究をした
[Frank **ya** Martin]-ga isshoni kenkyuu-o shita
[Frank ya Martin]-nom together research-acc did
'people like Frank and Martin did research together.'

3.6 Non-existent readings?

- Applying exh above min has no effects for the disjunctive and conjunctive alternatives.

(66) a. $\text{min}([\![\text{Frank}]\!]) \approx \lambda P_{(et)}.\ P = \{f\}$
b. $\text{min}([\![\text{Martin}]\!]) \approx \lambda P_{(et)}.\ P = \{m\}$
c. $\text{min}([\![\text{Frank ka Martin}]\!]) \approx \lambda P_{(et)}.\ P = \{f\} \vee P = \{m\}$
d. $\text{min}([\![\text{Frank to Martin}]\!]) \approx \lambda P_{(et)}.\ P = \{f, m\}$

(67) $$\left[\!\!\left[\text{exh}_{A'_{\text{ka}}}\right]\!\!\right](\text{min}([\![\text{Frank ka Martin}]\!])) \\ = [\lambda P_{(et)}.\ P = \{f\} \vee P = \{m\}] \sqcap -[\lambda P_{(et)}.\ P = \{f, m\}] \\ = [\lambda P_{(et)}.\ P = \{f\} \vee P = \{m\}]$$

(68) $$\left[\!\!\left[\text{exh}_{A'_{\text{to}}}\right]\!\!\right](\text{min}([\![\text{Frank to Martin}]\!])) \\ = [\lambda P_{(et)}.\ P = \{f, m\}] \sqcap -[\lambda P_{(et)}.\ P = \{f\}] \sqcap -[\lambda P_{(et)}.\ P = \{m\}] \\ \sqcap -[\lambda P_{(et)}.\ P = \{f\} \vee P = \{m\}] \\ = [\lambda P_{(et)}.\ P = \{f, m\}]$$

- But then we predict a purely disjunctive meaning for 'ya', equivalent to (67), which is unattested.

(69) $$\left[\!\!\left[\text{exh}_{A'_{\text{ya}}}\right]\!\!\right](\text{min}([\![\text{Frank ya Martin}]\!])) \\ = [\lambda P_{(et)}.\ P = \{f\} \vee P = \{m\}] \wedge -[\lambda P_{(et)}.\ P = \{f, m\}] \\ = [\lambda P_{(et)}.\ P = \{f\} \vee P = \{m\}]$$

- It's reasonable to assume that (locally) vacuous application of exh is generally prohibited. With this assumption the above disjunctive and conjunctive alternatives are banned.
- Another possibility to consider is to apply exh above $\mathcal{E}$ (i.e. above $\mathcal{C}$).

(70) a. $\mathcal{C}([\![\text{Frank}]\!]) \approx \lambda P_{((et)t)}.\ P(\{f\})$
b. $\mathcal{C}([\![\text{Martin}]\!]) \approx \lambda P_{((et)t)}.\ P(\{m\})$
c. $\mathcal{C}([\![\text{Frank ka Martin}]\!]) \approx \lambda P_{((et)t)}.\ P(\{f\}) \vee P(\{m\})$
d. $\mathcal{C}([\![\text{Frank to Martin}]\!]) \approx \lambda P_{((et)t)}.\ P(\{f, m\})$

Applying exh to (70d),

(71) $$\left[\!\!\left[\text{exh}_{A''_{\text{to}}}\right]\!\!\right](\mathcal{C}([\![\text{Frank to Martin}]\!])) \\ \approx \lambda P_{((et)t)}.\ P(\{f, m\}) \wedge \neg P(\{f\}) \wedge \neg P(\{m\}) \wedge \neg P(\{f, m, j\})$$

So (56) under this parse should mean that Frank and Martin did research together, but Frank, Martin and Jeroen did not do research together. Having this as a possible reading of (56) is not harmful.

4 Other connectives

- Another exhaustive connective: 'ni'

(72) 太郎は[$_{\text{DP}}$ コーヒー**に**紅茶(***に**)を]飲んだ

Tarō-wa [kōhī ni kōcha (*ni)]-o nonda
Taro-top [coffee ni tea (ni)]-acc drank
'Taro drank coffee and tea'

- Other anti-exhaustive connectives: 'toka', 'yara'

(73) a. 太郎は[$_{DP}$ コーヒー**とか**紅茶(**とか**)を]飲んだ
Tarō-wa [kōhī toka kōcha (toka)]-o nonda
Taro-top [coffee toka tea (toka)]-acc drank
'Taro drank things like coffee and tea'

b. 太郎は[$_{DP}$ コーヒー**やら**紅茶(**やら**)を]飲んだ
Tarō-wa [kōhī yara kōcha (yara)]-o nonda
Taro-top [coffee yara tea (yara)]-acc drank
'Taro drank things like coffee and tea'

These items also show polarity sensitivity. But unlike 'ya', 'toka' and 'yara' can be attached to a single DP.

(74) a. 太郎は[$_{DP}$ コーヒー**とか**を]飲んだ
Tarō-wa [kōhī toka]-o nonda
Taro-top [coffee toka]-acc drank
'Taro drank things like coffee'

b. 太郎は[$_{DP}$ コーヒー**やら**を]飲んだ
Tarō-wa [kōhī yara]-o nonda
Taro-top [coffee yara]-acc drank
'Taro drank things like coffee'

They are (hopefully) amenable to the same analysis.

- '**Non-exhaustive**' connective: 'mo'

(75) 太郎は[$_{DP}$ コーヒー**も**紅茶*(**も**)(*を)]飲んだ
Tarō-wa [kōhī **mo** kōcha *(**mo**)] nonda
Taro-top [coffee mo tea (mo)] drank
'Taro drank things like coffee and tea.'

This sentence has conjunctive reading that is neutral with respect to exhaustivity. So (75) does not exclude the possibility that Taro drank something else, but does not entail it, unlike the version with 'ya'.

'Mo' shows polarity sensitivity under negation but not in conditionals:

(76) [$_{CP}$ 太郎が[$_{DP}$ コーヒー**も**紅茶**も**]飲んだ]とは思わない (disjunctive reading)
[Tarō-ga [kōhī **mo** kōcha **mo**] nonda] to-wa omo-e-nai
[Taro-nom [coffee mo tea mo] drank] C-top think-can-neg
'It's hardly believable that Taro drank coffee or tea.'

(77) [$_{CP}$ 太郎が[$_{DP}$ コーヒー**も**紅茶**も**]飲めば]夜眠れないだろう (conjunctive reading)
[Tarō-ga [kōhī **mo** kōcha **mo**] nom-eba] yoru nemur-e-nai darō
[Taro-nom [coffee mo tea mo] drink-if] night sleep-can-neg infer
'If Taro drinks coffee and tea, he won't be able to sleep at night.'

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Appendix: Polarity sensitive connectives in other languages

- Previous studies on polarity sensitive connectives:
  - Singh, Wexler, Astle, Kamawar & Fox (2013) on child English 'or'
  - Bowler (2014) on Walpiri 'manu'

  In these languages the disjunctive connective shows similar polarity sensitivity.

  - in UE contexts, conjunctive interpretations.
  - in DE contexts, disjunctive interpretations.
- They claim that in these languages, the conjunctive alternative is not accessed, i.e.

$$Alt(A \text{ or } B) = \{ A, B, A \text{ or } B \}$$

- With recursive application of exh, a conjunctive meaning arises in UE contexts

(78) $\llbracket \text{exh}_{A}(\text{exh}_{\{A,B,A \text{ or } B\}}(A \text{ or } B)) \rrbracket$
$\Leftrightarrow \llbracket \text{exh}_{\{A,B,A \text{ or } B\}}(A \text{ or } B) \rrbracket \wedge \neg \llbracket \text{exh}_{\{A,B,A \text{ or } B\}}(A) \rrbracket \wedge \neg \llbracket \text{exh}_{\{A,B,A \text{ or } B\}}(B) \rrbracket$
$\Leftrightarrow (A \vee B) \wedge \neg(A \wedge \neg B) \wedge \neg(B \wedge \neg A)$
$\Leftrightarrow (A \vee B) \wedge (A \rightarrow B) \wedge (B \rightarrow A)$
$\Leftrightarrow (A \wedge B)$

- $\mathcal{A} = \{ \text{exh}_{\{A,B,A \text{ or } B\}}(A), \text{exh}_{\{A,B,A \text{ or } B\}}(B), \text{exh}_{\{A,B,A \text{ or } B\}}(A \text{ or } B) \}$
- $[\![\text{exh}_{\{A,B,A \text{ or } B\}}(A \text{ or } B)]\!] = A \vee B$
- $[\![\text{exh}_{\{A,B,A \text{ or } B\}}(A)]\!] = A \wedge \neg B$
- $[\![\text{exh}_{\{A,B,A \text{ or } B\}}(B)]\!] = B \wedge \neg A$

• This works for child English and Walpiri, but it is not adequate for 'ya'.
  - Walpiri lacks conjunctive connectives altogether, so it makes sense to say that the conjunctive alternative is absent. But Japanese does have 'to'.
  - There's some evidence that children do not access 'lexical alternatives' (e.g. 'and' for 'or'). but Japanese adult speaks should be able to access it. in fact, they do for 'ka'. Although we could still stipulate 'to' is not an alternative to 'ya', it is ad hoc.
  - Anti-exhaustivity would require a separate explanation.