

conjunctive and universal
strengthening more broadly

luka crnić

may 15, 2024

fc workshop on zoom

conjunctive and universal inferences of disjunction and indefinites

sally is allowed to eat ice cream or cake

sally is allowed to eat any dessert

$\Rightarrow \diamond(\text{sally eats ice cream}) \wedge \diamond(\text{sally eats cake})$

(e.g., aloni 2007, fox 2007, chierchia et al. 2011)

if sally eats ice cream or cake, she is happy

if sally eats any dessert, she is happy

$\Rightarrow (\text{sally eats ic} \rightarrow \text{sally is happy}) \wedge (\text{sally eats c} \rightarrow \text{sally is happy})$

(bar-lev & fox 2020)

condition

a conjunctive strengthening of a disjunctive sentence is possible only if the conjunctive meaning does not entail an excludable alternative to the sentence.

a universal strengthening of an indefinite sentence is possible only if the universal meaning does not entail an excludable alternative to the sentence.

an alternative to a sentence is excludable iff it is in all maximal sets of alternatives that can be jointly negated while the sentence is true.

(see, esp., fox 2007; cf. chemla 2009, franke 2011, etc)

satisfying the condition, standard route 1

appropriate structural properties of sentences

for example, if disjunction or an indefinite occur in the scope of an existential quantifier or certain non-monotone operators in a sentence, the conjunctive and universal meanings might not entail the excludable alternatives to the sentence.

no entailment of excludable alternatives:

$$\begin{aligned} \diamond(\text{sally eats ice cream}) \wedge \diamond(\text{sally eats cake}) &\not\Rightarrow \\ &\diamond(\text{sally eats ice cream} \wedge \text{sally eats cake}) \end{aligned}$$

$$\begin{aligned} (\text{sally eats ic} \rightarrow \text{sally is happy}) \wedge (\text{sally eats c} \rightarrow \text{sally is happy}) &\not\Rightarrow \\ (\text{sally eats ic} \wedge \text{sally eats c} \rightarrow \text{sally is happy}) & \end{aligned}$$

hence, conjunctive and universal strengthening are available.

satisfying the condition, standard route 1

appropriate structural properties of sentences

for example, if disjunction or an indefinite are unembedded in a sentence, or are embedded merely under a universal quantifier, the conjunctive and universal meaning entail an excludable alternative to that sentence.

sally ate ice cream or cake

sally must eat ice cream or cake

entailment of an excludable alternative:

$$\begin{aligned} \Box(\text{sally eats ice cream}) \wedge \Box(\text{sally eats cake}) \Rightarrow \\ \Box(\text{sally eats ice cream} \wedge \text{sally eats cake}) \end{aligned}$$

hence, conjunctive and universal strengthening are unavailable.

satisfying the condition, standard route 2

missing lexical alternatives

if disjunction or an indefinite lack a conjunctive or a universal quantifier alternative, it might be that no alternatives to sentences containing them are excludable. the non-entailment condition is trivially satisfied in such cases.

child speech: sally ate ice cream or* cake. (singh et al 2016,
⇒ sally ate ic \wedge sally ate c tieu et al 2016, etc)

warlpiri: water falls or* wind blows (bowler 2014)
⇒ rain is falling \wedge wind is blowing

hebrew: a* boy arrived (bar-lev & margulis 2014)
⇒ every boy arrived

(see bar-lev 2018, staniszewski 2021, jeretič 2022, among others, for examples of analogously-derived universal inferences of weaker expressions in other domains)

the thesis

disjunctive and indefinite sentences generating conjunctive and universal inferences due to missing alternatives is more common than either the above selection of examples or the standard claims may lead one to conclude.

specifically, disjunction and indefinites across perhaps all languages can generate conjunctive and universal inferences even if they do not occur under existential quantifiers or other appropriate operators (standard route 1), and even if they do have conjunctive and universal lexical alternatives (standard route 2).

two assumptions

assumption 1: alternatives and grammar

missing alternatives and grammar

a sentence only has the alternatives that grammar can generate.

failure of the generation of alternatives

- grammar may fail to generate conjunctive or universal alternatives to disjunctive or indefinite sentences due to missing lexical alternatives to disjunction and indefinites (this was the standard route 2 above).
- grammar may fail to generate conjunctive or universal alternatives to disjunctive or indefinite sentences due to an application of grammatical operations in those sentences that are restricted to disjunction and indefinites (a route to conjunctive and universal meanings that we will study today).

assumption 1: alternatives and grammar

indefinites and disjunction on islands

if a relative of mine wins the lottery, i will become a millionaire.

possible: $\exists x$: relative $x \wedge (x \text{ wins} \rightarrow \text{i am a millionaire})$

if sally or molly wins the lottery, i will become a millionaire.

possible: $(s \text{ wins} \rightarrow \text{i am a millionaire}) \vee (m \text{ wins} \rightarrow \text{i am a millionaire})$

if every relative of mine wins the lottery, i will become a millionaire.

impossible: $\forall x$: relative $x \rightarrow (x \text{ wins} \rightarrow \text{i am a millionaire})$

if sally and molly wins the lottery, i will become a millionaire.

impossible: $(s \text{ wins} \rightarrow \text{i am a millionaire}) \wedge (m \text{ wins} \rightarrow \text{i am a millionaire})$

grammar can generate structures in which disjunction/indefinites take exceptional scope; but not structures in which conjunction/universal quantifiers do so.

assumption 1: alternatives and grammar

indefinites and disjunction and other scope constraints

fewer than 5 students read a book.

possible: $\exists x$: book $x \wedge$ fewer than 5 students read x

fewer than 5 students read emma or persuasion.

possible: fewer than 5 students read $e \vee$ fewer than 5 students read p

fewer than 5 students read every book.

impossible: $\forall x$: book $x \rightarrow$ fewer than 5 students read x

fewer than 5 students read emma and persuasion.

impossible: fewer than 5 students read $e \wedge$ fewer than 5 students read p

(e.g., fleisher 2015, pace takahashi; cf. mayr & spector 2012)

grammar allows disjunction/indefinites to shift scope with certain downward-monotone operators, but does not allow this for conjunction/universal quantifiers.

assumption 2: substitution and contextual alternatives

alternatives to structures derived by movement

sentences containing disjunction or an indefinite that have undergone scope shift have as alternatives sentences in which this disjunction or indefinite have not undergone the respective scope shift (as well as all their alternatives), at least to the extent these are generated by grammar.

(cf. katzir 2007 and trinh 2024 on binding theory)

in particular,

[_S ... indefinite/disjunction ...],

[_S ... universal/conjunction ...]

∈ ALT([indefinite/disjunction_x [_S ... × ...]])

a warm-up exercise,
no new consequences

implicatures of exceptional scope disjunction and indefinites

if sally or molly wins the lottery, i will become a millionaire.

observed implicature

$$(s \text{ wins} \rightarrow i \text{ am a millionaire}) \vee (m \text{ wins} \rightarrow i \text{ am a millionaire}) \wedge \\ \neg((s \text{ wins} \rightarrow i \text{ am a millionaire}) \wedge (m \text{ wins} \rightarrow i \text{ am a millionaire}))$$

(charlow 2019)

computation of implicatures

structure and basic meaning

[sally or molly]_x [if x wins the lottery, i will become a millionaire]

$(s \text{ wins} \rightarrow i \text{ am a millionaire}) \vee (m \text{ wins} \rightarrow i \text{ am a millionaire})$

alternatives

{ $(s \text{ wins} \rightarrow i \text{ am a millionaire}) \vee (m \text{ wins} \rightarrow i \text{ am a millionaire})$,
 ~~$(s \text{ wins} \rightarrow i \text{ am a millionaire}) \wedge (s \text{ wins} \rightarrow i \text{ am a millionaire})$,~~
 $(s \text{ wins} \rightarrow i \text{ am a millionaire})$, $(m \text{ wins} \rightarrow i \text{ am a millionaire})$,
 $(s \text{ wins} \vee m \text{ wins} \rightarrow i \text{ am a millionaire})$,
 $(s \text{ wins} \wedge m \text{ wins} \rightarrow i \text{ am a millionaire})$ }

excludable alternatives

$(s \text{ wins} \vee m \text{ wins} \rightarrow i \text{ am a millionaire})$,

$(s \text{ wins} \wedge m \text{ wins} \rightarrow i \text{ am a millionaire})$

computation of implicatures

entailment of an excludable alternative:

$$(s \text{ wins} \rightarrow i \text{ am a millionaire}) \wedge (s \text{ wins} \rightarrow i \text{ am a millionaire}) \Rightarrow \\ (s \text{ wins} \vee m \text{ wins} \rightarrow i \text{ am a millionaire})$$

hence, conjunctive strengthening is unavailable. what we get instead:

$$(s \text{ wins} \rightarrow i \text{ am a millionaire}) \vee (s \text{ wins} \rightarrow i \text{ am a millionaire}) \\ \neg(s \text{ wins} \vee m \text{ wins} \rightarrow i \text{ am a millionaire}) \wedge \\ \neg(s \text{ wins} \wedge m \text{ wins} \rightarrow i \text{ am a millionaire})^* \\ \Rightarrow (s \text{ wins} \rightarrow i \text{ am a millionaire}) \vee (m \text{ wins} \rightarrow i \text{ am a millionaire}) \wedge \\ \neg((s \text{ wins} \rightarrow i \text{ am a millionaire}) \wedge (m \text{ wins} \rightarrow i \text{ am a millionaire}))$$

three representative predictions

santorio's puzzle

the lottery has 100 tickets (1-100). sally bought tickets 31-70 (= 40 tickets):

if the winning ticket is between 1-70 or between 31-100, (santorio 2018)
sally probably won.

if the winning ticket is from either of the two groups,
sally probably won.

a simple disjunctive interpretation is false:

$\#$ (if the winning ticket is between 1-100, sally probably won)

a wide conjunctive interpretation is correct:

(if the winning ticket is between 1-70, sally probably won) \wedge
(if the winning ticket is between 31-100, sally probably won)

santorio's puzzle

the lottery has 100 tickets (1-100). sally bought tickets 1-40 (= 40 tickets):

*#if the winning ticket is between 1-70 or between 31-100,
sally probably won.*

a wide disjunctive interpretation is too weak:

(if the winning ticket is between 1-70, sally probably won) \vee
(if the winning ticket is between 31-100, sally probably won)

santorio's puzzle - derived

structure and basic meaning

[between 1-70 or between 31-100]_P

[if the winning ticket is P sally probably won]

(if w in 1-70, probably s won) \vee (if w in 31-100, probably s won)

alternatives

{ (if w in 1-70, probably s won) \vee (if w in 31-100, probably s won),
~~(if w in 1-70, probably s won) \wedge (if w in 31-100, probably s won),~~
(if w in 1-70, probably s won), (if w in 31-100, probably s won),
(if w in 1-100, probably s won), (if w in 31-70, probably s won) }

excludable alternatives

(if w is between 1-100, sally probably won),

(if w is between 31-70, sally probably won)

santorio's puzzle - derived

no entailment of excludable alternatives:

(if w is between 1-70, sally probably won) \wedge
(if w is between 31-100, sally probably won) \nRightarrow
(if w is between 1-100, sally probably won),
(if w is between 31-70, sally probably won)

hence, conjunctive strengthening is available.

(conjunctive strengthening follows from recursive exhaustification, with a pruning of the conjunctive alternative at the first layer, ie, no alternatives are includable)

bar-lev & fox's puzzle

there are two teams, team a and team b, each with 5 kids as members, and with 3 kids on both teams (thus, 4/7 kids are on a single team):

most kids who are on team a or team b are on both teams

(bar-lev & fox 2020)

most kids who are on either team are on both teams

a simple disjunctive interpretation is false:

$\#(\text{most of the 7 kids are on both teams})$

a wide conjunctive interpretation is correct:

$(\text{most kids on team a are on both teams}) \wedge$

$(\text{most kids on team b are on both teams})$

bar-lev & fox's puzzle - derived

structure and basic meaning

[team a or team b]_x [most kids who are on x are on both teams]

(most kids on team a are on both teams) \vee

(most kids on team b are on both teams)

alternatives

{ (most kids on a are on a+b) \vee (most kids on b are on a+b),

~~(most kids on a are on a+b) \wedge (most kids on b are on a+b),~~

(most kids on a are on a+b), (most kids on b are on a+b)

(most of the 7 kids are on a+b), (most kids on a+b are on a+b) }

excludable alternative

(most of the 7 kids are on a+b)

bar-lev & fox's puzzle - derived

no entailment of excludable alternatives:

$$\begin{aligned} &(\text{most kids on } a \text{ are on } a+b) \wedge \\ &(\text{most kids on } b \text{ are on } a+b) \not\Rightarrow \\ &(\text{most of the seven kids are on } a+b) \end{aligned}$$

hence, conjunctive strengthening is available.

downward-monotonicity puzzle

jointly, more than 1000 students get into oxbridge each year, though oxford and cambridge each accepts fewer than 1000 students (let's say):

fewer than 1000 students got into cambridge or oxford

fewer than 1000 students got into either of those schools

s simple disjunctive interpretation is false:

$\#(\text{fewer than 1000 students got into oxbridge})$

a wide conjunctive interpretation is correct:

$(\text{fewer than 1000 students got into cambridge}) \wedge$
 $(\text{fewer than 1000 students got into oxford})$

downward-monotonicity puzzle - derived

structure and basic meaning

[cambridge or oxford]_x [fewer than 1000 students got into x]

(fewer than 1000 stds got into c) \vee (fewer than 1000 stds got into o)

alternatives

{ (fewer than 1000 stds got into c \vee fewer than 1000 stds got into o),
~~(fewer than 1000 stds got into c \wedge fewer than 1000 stds got into o),~~
(fewer than 1000 stds got into c), (fewer than 1000 stds got into c),
(fewer than 1000 stds got into oxbr), (fewer than 1000 stds got into o+c) }

excludable alternative

(fewer than 1000 stds got into oxbr)

downward-monotonicity puzzle - derived

no entailment of excludable alternatives:

$$\begin{aligned} &(\text{fewer than 1000 students got into cambridge}) \wedge \\ &\quad (\text{fewer than 1000 students got into oxford}) \not\Rightarrow \\ &\quad (\text{fewer than 1000 students got into oxbridge}) \end{aligned}$$

hence, conjunctive strengthening is available.

wrap-up

the logic

in some cases, disjunctive and indefinite sentences lack parallel conjunctive and universal alternatives because the grammar can generate the former but not the latter. this may affect what scalar implicatures the sentences give rise to.

the predictions

we identified three classes of configurations where this can be observed. dauntingly much remains to be explored (other configurations, other constraints on grammatical operations, scalar implicatures besides free choice, etc).

one highlight

we showed that even np-i indefinites participate in exceptional scope, that is, they can take even the widest scope in sentences - if they can be universally strengthened. (our examples were with *either*, which behaves like an existential fci, but all our observations extend *mutatis mutandis* to *any* as well.)