and related phenomena

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Today

- Across languages, the scope relations between logical connectives are governed by parameters
- Experiments reveal that children acquiring typologically distant languages begin with the same initial values of these parameters
- Therefore, children's initial scope assignments are not based on input from adults.
- The findings have implications for models of language processing, and for theories of language acquisition

Scope Ambiguities

When sentences contain two logical expressions, they often exhibit scope ambiguities.

Here are some examples…

Scope Ambiguities

All airplanes do not carry pets

There's a perfect tool for every job

A man falls down a flight of stairs every nine minutes

Scope Ambiguities

All airplanes do not carry pets … So don't bother asking.

There's a perfect tool for every job

A man falls down a flight of stairs every nine minutes

Scope Ambiguities

All airplanes do not carry pets … So don't bother asking.

There's a perfect tool for every job … A credit card.

A man falls down a flight of stairs every nine minutes

Scope Ambiguities

All airplanes do not carry pets … So don't bother asking.

There's a perfect tool for every job … A credit card.

A man falls down a flight of stairs every nine minutes … His name is Norbert.

Scope Ambiguities

Some human languages resolve scope ambiguities in one way - strongly favouring one reading …

… whereas other languages resolve them in the opposite way - strongly favouring the other reading.

1) Disjunction in negative sentences
2) Conjunction in negative sentences
3) Modals in negative sentences

Scope of Disjunction

Across languages:

- Disjunction assumes different scope relations when it combines with negation

Disjunction Across Languages

English conforms one of de Morgan's laws of classical logic

NOT(A OR B) ⟶ NOT A & NOT B

*John did**n't** bring beer **or** wine to the party.*

a) John didn't bring beer to the party
AND
b) John didn't bring wine to the party.

Negated disjunctions license a 'conjunctive' entailment

Disjunction across Languages

The **Mandarin** disjunction word is ***huozhe***. Negated disjunctions fail to generate a conjunctive entailment in Mandarin (and Japanese, Turkish, Italian, Russian…).

(*Wo cai*) *Yuehan* ***meiyou*** *dai pijiu* ***huozhe*** *hongjiu*.
(I guess) John not bring beer or wine
'It's either beer or wine that John did not bring.'

Proposal

In **Mandarin,** disjunction is a Positive Polarity Item (PPI).
PPIs take scope over negation at the level of semantic interpretation:

- Surface syntax: NOT … *huozhe*
- Interpretation: *huozhe* > NOT

Positive Polarity Items

In **English**, disjunction is NOT a Positive Polarity Item.

- Surface syntax: NOT … *or*
- Interpretation: NOT > *or*

The Disjunction Parameter

- The value with disjunction taking scope over negation is OR = +PPI
  - Mandarin OR = +PPI
- The value with negation taking scope over disjunction is OR = -PPI
  - English OR = -PPI

The Disjunction Parameter: English

English disjunction is -PPI

English

John did**n't** bring *beer* ***or*** *wine* to the party.

The Disjunction Parameter: Mandarin

Mandarin disjunction is +PPI

Mandarin

pijiu ***huozhe*** *hongjiu* Yuehan **meiyou** dai ~~*pijiu* ***huozhe*** *hongjiu*~~ qu jiuhui.

Disjunction is not Exclusive-OR

Suppose the **Mandarin** disjunction word ***huozhe*** is **exclusive-OR**. If so, adult speakers of Mandarin would **not** interpret negated disjunctions as they do.

Consider the logical formula (A ⊕ B), where '⊕' is exclusive-OR

(A ⊕ B) is **true** if exactly one of {A, B} is true
So ~(A ⊕ B) is **false** if exactly one of {A, B} is true

Adult speakers of Mandarin **accept** negated disjunctions when exactly one of the disjuncts is true. This is the very circumstances in which negated disjunctions would be **false** if ***huozhe*** were ⊕-disjunction.

Exclusive-OR

Exclusive-OR has been documented to be the dominant meaning of disjunction in real life situations:

- Morris (2008) reviewed 240 transcriptions of audiotaped exchanges between 2- to 5-year-old children and their parents - from the CHILDES database
- There were 465 uses of *or* (100,626 conversational turns)
- For children, utterances in which disjunction meant Inclusive-OR accounted for less than 10% of the data
- For adults, uses of *or* with an Inclusive-OR interpretation were produced only slightly more than 10% of the time

Exclusive-OR

An advantage for children:

- Interference with other possible meanings could increase the difficulty of acquiring the term; thus initial meanings are expected to occupy a unique conceptual space.
- Inclusive-OR (A, B, A & B) overlaps with AND (A & B) in that the presence of both options is allowable
- Exclusive-OR (A, B, but not both) has no overlap with AND -- creating less interference during acquisition.

Morris (2008, p. 68, pp. 82-84)

Inclusive-OR versus Exclusive-OR

The claim that exclusive-*or* is the dominant meaning of disjunction in real life is unwarranted:

- Exclusive-OR makes sentences True in a **subset** of the circumstances in which Inclusive-OR is True
- Therefore, **every** utterance by adults or by children that Morris counted as evidence for Exclusive-OR was also evidence confirming Inclusive-OR
- 10% of utterances solely confirmed Inclusive-OR

Inclusive-OR versus Exclusive-OR

The putative advantage of Exclusive-OR is minor:

- Conversations are governed by pragmatic principles
- The **Principle of Cooperation** encourages speakers to make statements that are as 'strong' as possible
- If statements with OR and AND are both True, then speakers use AND, since this makes a **stronger** statement than OR

Inclusive-or versus Exclusive-*or*

Exclusive-*or* has unwanted consequences

- If children initially assigned Exclusive-OR, they will compute non-adult meanings when they attempt complex sentences

E.g, *Mary didn't say that John or Max laughed* … would be **True** if
Mary said that John laughed and
Mary said that Max laughed

The Subset Principle

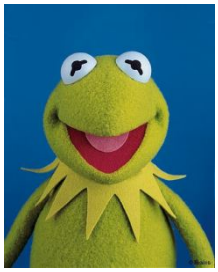
Children initially favor scope interpretations that makes sentences true in the narrowest range of circumstances.

- For disjunction, the subset reading is OR = -PPI, as in English.

Child versus Adult Mandarin

- According to the SSP, **Mandarin-speaking children** are expected to interpret negated disjunctions as in **English**, i.e. with disjunction generating a conjunctive interpretation.
- For Mandarin-speaking **children**, this interpretation is not attested in the input, because **adults** favour the OR = +PPI value

Predictions



The Disjunction Parameter: English

English disjunction is -PPI for both children and adults

Adult English

John did**n't** bring *beer **or** wine* to the party.

Child English

John did**n't** bring *beer **or** wine* to the party.

The Disjunction Parameter: Mandarin

Mandarin disjunction is -PPI for children, and +PPI for adults

Adult Mandarin

*pijiu **huozhe** hongjiu* Yuehan **meiyou** dai *~~pijiu **huozhe** hongjiu~~* qu jiuhui.

Child Mandarin

Yuehan **meiyou** dai *pijiu **huozhe** hongjiu* qu jiuhui.

Truth Value Judgment Task

- Short vignettes were acted out in front of the child and Kermit the Frog. The vignettes were about different animals who were asked, in turn, if they were happy to eat cake, a carrot and a green pepper.
  - If an animal ate both, it received a **gold** medal
  - If it ate only one, it received a **blue** medal
  - If it ate neither one, it received a **black** cross
- With the vegetables removed, Kermit attempted to guess what each animal had eaten, based on the medal it received. On the critical trials, the animal was wearing a **blue** medal (i.e., it had only eaten one vegetable), following the protocols used by Goro and Akiba (2004).

The Set Up

(1) The eating-game: 12 animals are offered 3 kinds of food. Depending on what they eat, they get some kind of reward.

(2) Truth Value Judgment: Kermit the Frog guesses what each animal ate, based on the prize the animal received.

Experimenter: Look! These animals going to play an “eating-game”!!

Experimenter: Here's a piece of cake, a green pepper, and a carrot. All the animals love cake, but they don't like vegetables.
So here's the rule of the game: if an animal eats not only the cake but also the vegetables, he gets a better prize.

Experimenter: For example, if someone eats cake, and the pepper, and also the carrot…then he gets a **gold** medal!

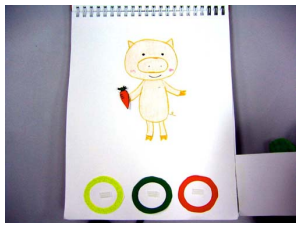
Experimenter: If someone eats cake, and either one of the vegetables, but not both…then he gets a **blue** medal.

Experimenter: If someone eats only cake, but none of the vegetables, then he gets a **black** cross…

Experimenter: Now, here comes a pig. He will play the game.

Experimenter: The pig first picked up the cake. He loves cake and of course he ate it!

Experimenter: Then he picked up the pepper. He doesn't like peppers…but he managed to eat it all up!



Experimenter: Then he picked up the carrot…Oh no, he couldn't eat the carrot!

Experimenter: So, the pig ate the cake, and he ate the pepper, but he didn't eat the carrot. Which prize does he get?

Child: A **blue** medal!

Experimenter: Yes, a **blue** medal!

Experimenter: Now here comes another animal…

- the "eating-game" continues with 12 animals. Every one eats the cake. 4 eat both vegetables, 4 eat only one vegetable, and 4 eat neither

After the eating game, Kermit tries to remember what each character ate:
Kermit: *Ok, now I'm going to tell you how well the animals did.*
*Umm, the pig … I don't remember what he ate…oh, but, he has a **blue** medal!*

Kermit: I know. ***Test sentence is produced***.

Predictions

Child versus Adult Mandarin

Mandarin disjunction is +PPI for adults, but -PPI for children

Adult Mandarin

huluobo ***huozhe*** *qingjiao* Xiaozhu **meiyou** chi *huluobo* ~~***huozhe***~~ *qingjiao*

Child Mandarin

Xiaozhu **meiyou** chi *huluobo* ***huozhe*** *qingjiao*

Test Sentences

Kermit: *Xiaozhu* ***meiyou*** *chi huluobo* ***huozhe*** *qingjiao*
(The pig didn't eat the carrot or the pepper)

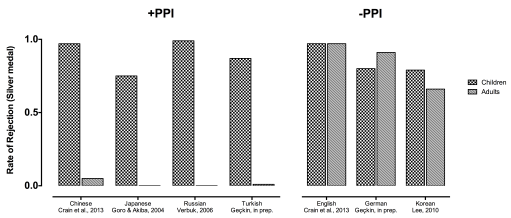
Results

Results

Xiaozhu ***meiyou*** *chi huluobo* ***huozhe*** *qingjiao.*
'The pig did**n't** eat the carrot **or** the pepper'

- Mandarin-speaking **adults** consistently **accepted** the test sentences ('not both' reading = 95%)
- 20 Mandarin-speaking **children** (mean age 4;5) consistently **rejected** them ('neither' reading = 97%)
- To justify their rejections of Kermit's statements, children pointed out that the animals in question had eaten one of the vegetables (hence the **blue** medal).

Child versus Adult Language



Another Scope Ambiguity

Some human languages resolve (potential) scope ambiguities in one way, strongly favouring one reading …

… whereas other languages resolve them in the opposite way, strongly favouring the other reading.

Scope of Conjunction

Across languages:

- Conjunction assumes different scope relations when it combines with negation

Conjunction Across Languages

In classical logic: Not (A & B) ⟶ Not A or Not B
English conforms to classical logic

John didn't bring both beer and wine to the party.

a) John didn't bring beer to the party.
OR
b) John didn't bring wine to the party.

Conjunction Across Languages

In **Mandarin,** the conjunction word is ***he***. Negated conjunctions are interpreted as meaning 'neither' - regardless of word order:

(*Wo cai*) *Yuehan* ***meiyou*** *dai pijiu* ***he*** *hongjiu qu jiuhui.*
(I guess) John not bring beer and wine to party
'As for beer and wine, John didn't bring them to the party.'

Yuehan pijiu ***he*** *hongjiu* ***dou*** ***meiyou*** *dai qu jiuhui.*
John beer and wine both not bring to party
'As for both beer and wine, John did not bring them to the party.'

Positive Polarity Items

In **Mandarin,** conjunction is a Positive Polarity Item (PPI). PPIs take scope over negation at the level of semantic interpretation:

- Surface Syntax: NOT … *he*
  he … NOT
- Interpretation: *he* > NOT

Positive Polarity Items

In **English**, conjunction is not a Positive Polarity Item.

- Surface Syntax: NOT … *and*
- Interpretation: NOT > *and*

The Conjunction Parameter

The value with conjunction taking scope over negation is AND = +PPI
The value with negation taking scope over conjunction is AND = -PPI

- Mandarin AND = +PPI
- English AND = -PPI

Subset Principle

Children initially favor scope interpretations that makes sentences true in the narrowest range of circumstances.

- For conjunction, the subset reading is associated with AND = +PPI, as in Mandarin.

The Conjunction Parameter

- **English-speaking children** are expected to initially favour the AND = +PPI value of the Conjunction Parameter, as in Mandarin.
- For **English-speaking children**, this interpretation is not attested in the input, because adult speakers favour the AND = -PPI value of the parameter.

Test Sentences

Kermit: I know. ***The pig didn't eat both the pepper and the carrot***

Predictions

Child versus Adult English

Adult English

The pig did**n't** eat *both the carrot **and** the pepper*.

Child English

*both the carrot **and** the pepper* the Pig did**n't** eat ~~*both carrot **and** pepper*~~

Results

Results

The pig didn't eat both the carrot and the pepper.

- **Adult speakers of English** consistently **accepted** such sentences (= 'not both' reading)
- But, **English-speaking children** consistently **rejected these sentences,** as did Mandarin-speaking children and adults (= 'both not' reading)

Conclusion: English-speaking children adopted the Mandarin setting of the Conjunction Parameter

Results

- In response to negated conjunctions, 21 **English-speaking children** (mean age 4;9) **rejected** the target 'not…both…and' statements 98% of the time.
- **English-speaking adults accepted** these statements 72% of the time.
- **English-speaking children** justified their rejections of Kermit's statements by pointing out that the animals in question had only eaten one vegetable (hence the **blue** medal).

Summary

- **The Disjunction Parameter:** Mandarin-speaking children initially adopt the English parameter setting
- **The Conjunction Parameter:** English-speaking children initially adopt the Mandarin parameter setting
- Children initially adopt the 'strongest' reading, regardless of the value of the parameter favored by adults. The results are consistent with the **Subset Principle.**

What does it all mean?

The Disjunction Parameter

- OR = –PPI is the subset value
- The interpretation of negated disjunctions by Mandarin-speaking children is the same as in English, but differs from that of Mandarin-speaking adults
- The subset value –PPI comports with classical logic
- On the subset value, surface syntax is isomorphic to Logical Form

The Conjunction Parameter

- AND = +PPI is the subset value
- The interpretation of negated conjunctions by English-speaking children is the same as in Mandarin, but differs from that of English-speaking adults
- The subset value +PPI does not comport with classical logic
- On the subset value, surface syntax is not isomorphic to Logical Form

Interim Conclusions

- Children's default settings do not necessarily conform to classical logic
- Children's default settings sometimes involves raising (or reconstruction), but sometimes not
- If isomorphic representations are computationally easier, then learnability trumps processing complexity

Children's Parameter Values can be Unacceptable for Adults

English
John ~~*can*~~ not *can* come (¬◊)

German
Sie ~~*darf*~~ das land nicht *darf* verlasse (¬◊)
She ~~*can*~~ the country not *can* leave

Italian
Adult: Gianni può non venire (◊¬)
Gianni might not come

Child: Gianni ~~*può*~~ non *può* venire (¬◊)
Gianni ~~*can*~~ not *can* come

The Subset Principle is not Domain General

If there is no parameter (i.e., only one interpretation across languages) then the Subset Principle does not apply:

Some detectives didn't find the clues. ∃ > NOT, *(NOT > ∃)
English ***some*** does not undergo reconstruction
~~some detectives~~ didn't find some detectives the clues

The detective didn't find every clue. NOT > ∀, *(∀ > NOT)
English ***every*** does not raise over negation
every clue the detective didn't find ~~every clue~~

Polarity Sensitivity can be Cancelled

Where negation is not local
You'll ***never*** convince me that Malcolm Turnbull ate ***some*** of the kangaroo.
You'll ***never*** convince me that Malcolm Turnbull brought beer ***and*** wine (¬&)

Where negation is introduced covertly
Only Malcolm Turnbull ate ***some*** of the kangaroo.
Entailment: Nobody else ate ***any*** of the kangaroo (¬∃)
Only Malcolm Turnbull brought beer ***and*** wine
Entailment: Nobody else brought beer ***and*** wine (¬&)

When the logical connective is introduced covertly: VP ellipsis
John brought ***something*** to drink, but Bill didn't (… bring ***anything*** to drink)
John brought beer ***and*** wine, but Bill did***n't*** < ~~bring beer ***and*** wine~~ > (¬&)

Conclusions

- Across languages, children initially favour parameter values that generate scope relations that make sentences true in the narrowest range of circumstances.
- This ensures that children will have access to positive evidence if the local language favours alternative scope possibilities, ones that make sentences true in a broader range of circumstances.
- The pattern of similarities and differences between child language and adult language(s) are difficult to explain on a variety of accounts of children's emerging linguistic competence.