Only the Dark Knight is free to choose

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ARC CENTRE OF EXCELLENCE IN COGNITION AND ITS DISORDERS

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Goals and a caveat

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This project is designed to distinguish inferences from entailments.

The project has no ties to industry, and no social benefit.

(please feel free to leave at any time)

Entailments vs Inferences

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When disjunction is in the scope of a downward entailing operator, ∇, statements of the form $\nabla[A \vee B]$ **entail** $[\nabla A \& \nabla B]$

- Children compute Conjunctive Entailments

When disjunction is in the scope of a modal operator, $\Diamond$, statements of the form $\Diamond[A \vee B]$ license the **inference** **[**$\Diamond A \& \Diamond B]$

- Children compute Free Choice Inferences

Entailments vs Inferences

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FCIs are not typically computed when the modal verb is in the scope of negation (Chierchia, 2013).

Batman is not allowed to eat pasta or chicken.

√ Conjunctive Entailment: $\sim \Diamond(p \vee q) = \sim \Diamond p \wedge \sim \Diamond q$

Negated Free Choice Inference: $\rightsquigarrow \sim (\Diamond p \wedge \Diamond q)$

There is more to the story about what Alfred allows Batman to eat, and what he does not allow Batman to eat. In this talk…

Mandarin Chinese

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Experiment 1: Negative sentences with disjunction, no modal

(1) Bianfuxia mei chi yidalimian huozhe jirou.
Batman NEG eat pasta or chicken
'Batman did not eat pasta or chicken'

Experiment 2: Add a modal verb

(2) Bianfuxia mei beiyunxu chi yidalimian huozhe jirou.
Batman NEG PM-modal eat pasta or chicken
'Batman was not allowed to eat pasta or chicken'

These experiments reveal how (adult) Mandarin differs from English

Mandarin Chinese

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Experiment 3: Replace disjunction *huozhe* by *renhe* ‘any,’ no modal

(3) Bianfuxia mei chi lanzi li de renhe yi-zhong shuiguo.
Batman NEG eat basket inside DE any one-CL fruit
‘Batman didn’t eat any kind of fruit in the basket’

Experiment 4: Add the deontic modal verb *keyi* ‘is allowed to’

(4) Bianfuxia bu keyi chi lanzi li de renhe yi-zhong shuiguo.
Batman NEG may eat basket inside DE any one-CL fruit
‘Batman wasn’t allowed to eat any kind of fruit in the basket’

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Experiment 5: Insert the focus adverb *zhiyou* 'only' in pre-topic position

(5) Zhiyou Bianfuxia chi-le yidalimian huozhe jirou.
only Batman eat-ASP pasta or chicken
'Only Batman ate pasta or chicken'

Experiment 6: Add the deontic modal verb *keyi* 'is allowed to'

(6) Zhiyou Bianfuxia keyi chi yidalimian huozhe jirou.
only Batman may eat pasta or chicken
'Only Batman was allowed to eat pasta or chicken'

Mandarin Chinese

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7th Experiment: VP ellipsis in Mandarin Chinese (later talk)

Batman was allowed to eat pasta or chicken, …

Lexical VP:

… *but The Joker wasn't allowed to eat pasta or chicken*

Ellided VP:

… *but The Joker wasn't* < ~~allowed to eat pasta or chicken~~ >

Disjunction in English

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English conforms to one of de Morgan's laws:

NOT (A OR B) $\longrightarrow$ NOT A & NOT B

Bruce Wayne didn't bring beer or wine to the party.

a) Bruce Wayne didn't bring beer to the party

AND

b) Bruce Wayne didn't bring wine to the party.

Negated disjunctions license a 'conjunctive' interpretation

Disjunction in Mandarin

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In Mandarin, negative sentences with the disjunction word *huozhe* do not generate a conjunctive interpretation.

Bruce Wayne meiyou dai pijiu huozhe hongjiu qu jiuhui.

'It's either beer or wine that Bruce Wayne did not bring.'

The Disjunction Parameter

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Mandarin disjunction is a Positive Polarity Item (PPI). By definition, PPIs take scope over negation at LF:

Surface syntax: NOT > *huozhe*

Logical Form: *huozhe* > NOT

English disjunction is NOT a Positive Polarity Item:

Surface syntax: NOT > *or*

Logical Form: NOT > *or*

The Disjunction Parameter: Mandarin

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

Adults

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

Children

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

The Disjunction Parameter: English

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English disjunction is [-PPI] for both children and adults

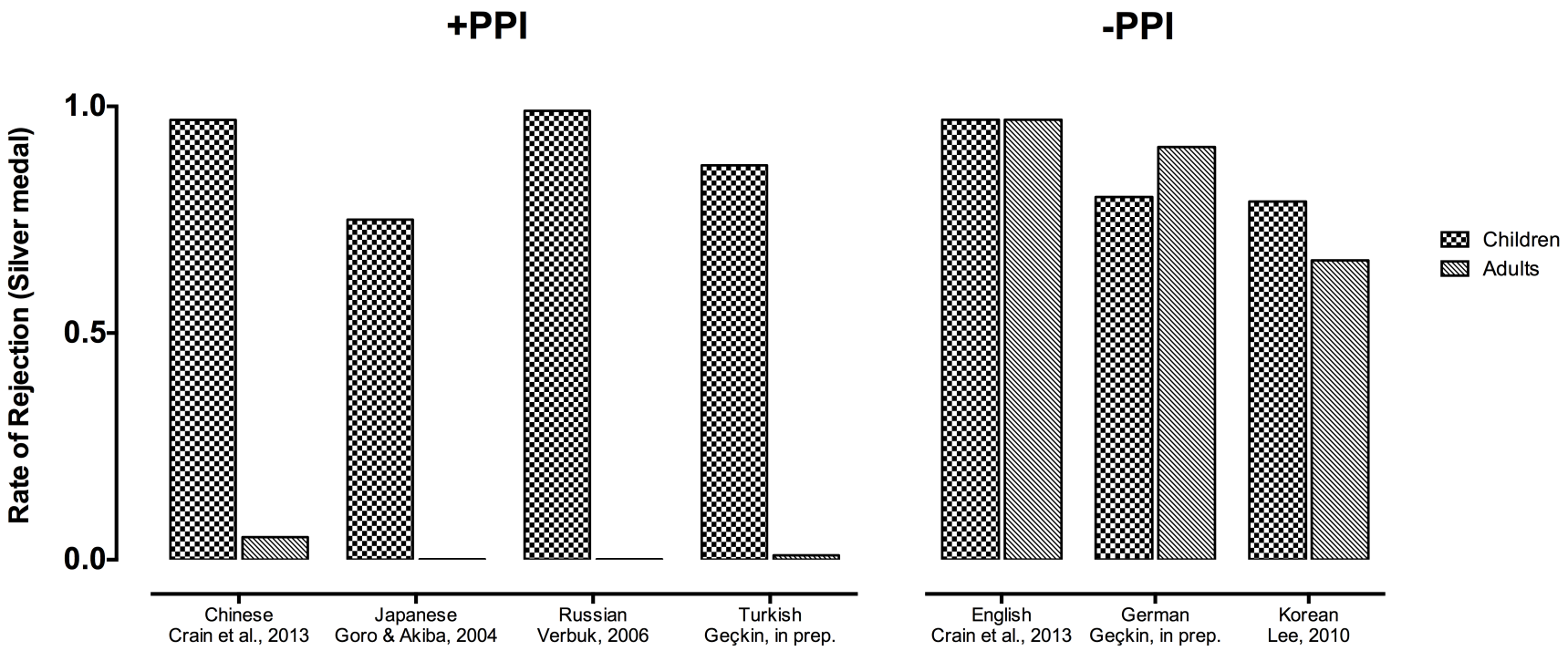
Adults

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

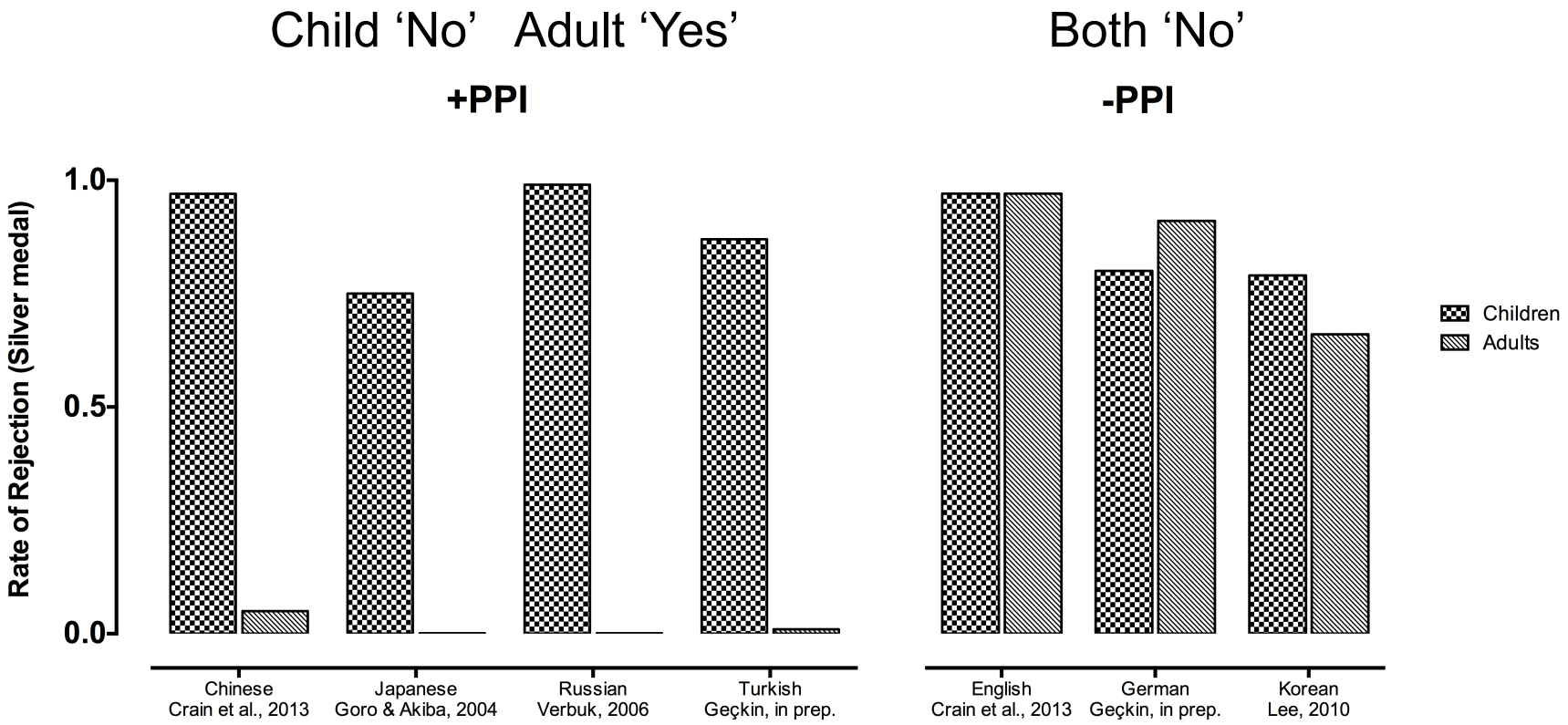
Children

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

Child versus Adult Language



Child versus Adult Language



Experiment 1: Crain, Goro, Notley & Zhou (2011)

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Experiment 1: negative sentences with disjunction, without a modal

(1) Bianfuxia mei chi yidalimian huozhe jirou.
Batman NEG eat pasta or chicken
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ARC CENTRE OF EXCELLENCE IN COGNITION AND ITS DISORDERS

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(1) Bianfuxia mei chi yidalimian huozhe jirou.
Batman NEG eat pasta or chicken
'Batman did not eat pasta or chicken'

Child: n= 20, mean age = 4;6: 97% No, when Batman ate just pasta

'Batman didn't eat pasta or chicken.' (NEG > OR) = $\sim p \wedge \sim c$

Experiment 1: Crain, Goro, Notley & Zhou (2011)

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(1) Bianfuxia mei chi yidalimian huozhe jirou.
Batman NEG eat pasta or chicken
'Batman did not eat pasta or chicken'

Child: n= 20, mean age = 4;6: 97% **No**, when Batman ate just pasta

'Batman didn't eat pasta or chicken.' (NEG > OR) = $\sim p \wedge \sim c$

Adult: n = 20 undergrads: 95% **Yes**

'It is pasta or chicken that Batman didn't eat.' (OR > NEG) = $\sim p \vee \sim c$

Experiment 2

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Participants:
22 Mandarin-speaking children 4;9 to 5;8 (mean 5;4)
20 Mandarin-speaking adults (undergrads)

Procedure: *Truth Value Judgment Task*
A puppet and the child watch stories acted out by experimenter.
The puppet describes the events that took place in the story
The child task is to judge the truth or falsity of the puppet's statement

Materials:
Four trials with a test sentence and a filler sentence

Experiment 2

The experimenter asks the puppet, Kermit the Frog, what Batman was allowed to eat, and what he wasn't allowed to eat. First, Kermit produced a filler sentence:

Wo zhidao yijian shiqing: Bianfuxia beiyunxu chi shousi.
I know one-CL thing: Batman PM allow eat sushi
'I know one thing, Batman was allowed to eat sushi.'

Then, Kermit asked himself "Now, what wasn't Batman allowed to eat? Hmmm, I know…" Then, he produced a test sentence:

Bianfuxia mei beiyunxu chi yidalimian huozhe jirou.
Batman NEG PM allow eat pasta or chicken
'Batman was not allowed to eat pasta or chicken.'

Experiment 2

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Add the modal

(2) Bianfuxia mei beiyunxu chi yidalimian huozhe jirou.
Batman NEG PM-modal eat pasta or chicken
'Batman was not allowed to eat pasta or chicken'

Experiment 2

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(same as Experiment 1, but with the modal)

(2) Bianfuxia mei beiyunxu chi yidalimian huozhe jirou.
Batman NEG PM-modal eat pasta or chicken
'Batman was not allowed to eat pasta or chicken'

Children: 70% No, when Batman was allowed to eat just pasta
Negated Conjunctive Entailment: $\sim \Diamond(p \vee c) = \sim \Diamond p \wedge \sim \Diamond c$

Experiment 2

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(2) Bianfuxia mei beiyunxu chi yidalimian huozhe jirou.
Batman NEG PM-modal eat pasta or chicken
'Batman was not allowed to eat pasta or chicken'

Children: 70% **No**, when Batman was allowed to eat just pasta
Negated Conjunctive Entailment: $\sim \Diamond(p \vee c) = \sim \Diamond p \wedge \sim \Diamond c$

Adults: 70% **Yes** in this context
Negated Free Choice Inference: $\sim \Diamond(p \vee c) \rightsquigarrow \sim \Diamond p \vee \sim \Diamond c$

Comparison with English PPI *Some*

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Negative sentences with existential indefinite *some* + 'is allowed to'

Batman was not allowed to eat some of the chicken

some is +PPI for adults (∃ > NEG)

Adult: Neg Free Choice Inference: $\exists x\ \text{Chicken}(x) \wedge \sim \Diamond\ \text{Eat}(b, x)$

There was some chicken that Batman was not allowed to eat.

Comparison with English PPI *Some*

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Negative sentences with existential indefinite *some* + 'is allowed to'

Batman was not allowed to eat some of the chicken

some is -PPI for children (NEG > ∃)

Child: Neg Conjunctive Entailment: $\sim \exists x$ Chicken(x) $\wedge \Diamond$ Eat (b, x)
Batman was not allowed to eat any of the chicken.

NB: This experiment has not be conducted!

Experiment 3: Huang & Crain (2014)

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Experiment 3: Replaced disjunction *huozhe* ‘or’ by *renhe* ‘any,’ no modal

(3) Bianfuxia mei chi lanzi li de renhe yi-zhong shuiguo
Batman NEG eat basket inside DE any one-CL fruit
‘Batman didn’t eat any kind of fruit in the basket’

Experiment 3: Huang & Crain (2014)

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Experiment 3: Replaced disjunction *huozhe* ‘or’ by *renhe* ‘any,’ no modal

(3) Bianfuxia mei chi lanzi li de renhe yi-zhong shuiguo.
Batman NEG eat basket inside DE any one-CL fruit
‘Batman didn’t eat any kind of fruit in the basket’

Control sentences without *renhe* ‘any’ (to ensure that children know *renhe*)

Bianfuxia mei chi lanzi li de yi-zhong shuiguo.
Batman NEG eat basket inside DE one-CL fruit
‘Batman didn’t eat one kind of fruit in the basket’

Experiment 3: Huang & Crain (2014)

ARC CENTRE OF EXCELLENCE IN COGNITION AND ITS DISORDERS

Experiment 3: Replaced disjunction *huozhe* 'or' by *renhe* 'any,' no modal

(3) Bianfuxia mei chi lanzi li de renhe yi-zhong shuiguo.
Batman NEG eat basket inside DE any one-CL fruit
'Batman didn't eat any kind of fruit in the basket'

Control sentences without *renhe* 'any' (to ensure that children know *renhe*)

Bianfuxia mei chi lanzi li de yi-zhong shuiguo.
Batman NEG eat basket inside DE one-CL fruit
'Batman didn't eat one kind of fruit in the basket'

Children (n = 21, mean age 5;1, 90% No)

Adults (n = 20, 94% No)

$$\sim (a \vee b \vee c \ldots) = \sim a \wedge \sim b \wedge \sim c \ldots$$

Experiment 4: Huang, Zhou & Crain (ms)

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Experiment 4: negation = bu ‘not’ + *renhe* ‘any’ + deontic modal = *keyi* ‘may’

(4) Bianfuxia bu keyi chi lanzi li de renhe yi-zhong shuiguo.
Batman NEG may eat basket inside DE any one-CL fruit
‘Batman wasn’t allowed to eat any kind of fruit in the basket’

Experiment 4: Huang, Zhou & Crain (ms)

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Experiment 4: negation = bu ‘not’ + *renhe* ‘any’ + deontic modal = *keyi* ‘may’

(4) Bianfuxia bu keyi chi lanzi li de renhe yi-zhong shuiguo.
Batman NEG may eat basket inside DE any one-CL fruit
‘Batman wasn’t allowed to eat any kind of fruit in the basket’

Children (n = 22, mean age = 5;1 93% No)

Adults (n = 20, 100% No)

√ Neg Conjunctive Interpretation: $\sim \Diamond (a \vee b \vee c) = \sim \Diamond a \wedge \sim \Diamond b \wedge \sim \Diamond c \ldots$

* Neg Free Choice Inference: $\sim \Diamond (a \vee b \vee c) \rightsquigarrow \sim (\Diamond a \wedge \Diamond b \wedge \Diamond c \ldots)$

Disjunction is [-PPI] for children, so the FCI is cancelled (NEG > OR)
Disjunction is [+PPI] for adults, yielding a ‘not both’ interpretation (OR > NEG)

The focus adverb *zhiyou* ‘only’

Experiment 5: Insert the focus adverb *zhiyou* ‘only’ in pre-topic position

(5) Zhiyou Bianfuxia chi-le yidalimian huozhe jirou.
only Batman eat-ASP pasta or chicken
‘Only Batman ate pasta or chicken’

Experiment 6: Add the modal verb *keyi* ‘is allowed to’

(6) Zhiyou Bianfuxia keyi chi yidalimian huozhe jirou.
only Batman may eat pasta or chicken
‘Only Batman was allowed to eat pasta or chicken’

Experiment 5: *zhiyou* + *houzhe*

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Experiment 5 introduced the focus adverb *zhiyou* 'only'

(5) Zhiyou Bianfuxia chi-le yidalimian huozhe jirou.
only Batman eat-ASP pasta or chicken
'Only Batman ate pasta or chicken'

Presupposition: As for Batman, $(p \vee c)$
Assertion: As for everyone else, $\sim (p \vee c) = \sim p \wedge \sim c$

Children (n= 26, mean age 4;7): 86% rejections, when someone in the contrast set ate either just pasta

Adults (n = 20) 88% rejections

Experiment 6: *zhiyou* + *keyi* + *houzhe*

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Experiment 6 added the Mandarin deontic modal verb *keyi* 'is allowed to.'

(6) Zhiyou Bianfuxia keyi chi yidalimian huozhe jirou.
only Batman may eat pasta or chicken
'Only Batman was allowed to eat pasta or chicken'

As for Batman, $\Diamond(p \vee c) \rightsquigarrow \{\Diamond p, \Diamond c\}$

As for everyone else,

√ Negated Free Choice Inference: $\sim(\Diamond p \wedge \Diamond c)$

* Negated Conjunctive Entailment: $\sim \Diamond p \wedge \sim \Diamond c$

Experiment 6: *zhiyou* + *keyi* + *houzhe*

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The presupposition is that Batman is free to choose between the two dishes, so the truth conditions for the presupposition can be represented as an option set, **{**◊p, ◊c**}**. The assertion entails that no one in the contrast set was free to choose between the items in the option set.

(6) Zhiyou Bianfuxia keyi chi yidalimian huozhe jirou.
only Batman may eat pasta or chicken
'Only Batman was allowed to eat pasta or chicken'

Children (n = 22, mean age = 5;4) 92% acceptances
when someone else was allowed to eat just pasta

Adults (n = 20) 78% acceptances

Experiment 6: *zhiyou* + *keyi* + *houzhe*

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Expressing the meaning of the assertion can be achieved using external negation, or by positioning negation inside the determiner phrase.

√ *It is not the case that anyone else was allowed to eat pasta or chicken*.

√ *Nobody else was allowed to eat pasta or chicken*.

$$\sim \exists \{\Diamond p, \Diamond c\} \quad = \quad \sim \exists (\Diamond p \wedge \Diamond c)$$

Expressing the meaning of the assertion can not be achieved by using sentences that combine disjunction with local (predicate) negation.

* *Everyone else was not allowed to eat pasta or chicken*.

$$\forall (\sim \Diamond p \wedge \sim \Diamond c)$$

Proposal

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Although these logical formulas are equivalent, the corresponding sentences in human languages have different truth conditions:

$$\forall \sim \Diamond(p \vee c) \quad = \quad \sim \exists \Diamond(p \vee c)$$

√ *Nobody else was allowed to eat pasta or chicken*.

* *Everyone else was not allowed to eat pasta or chicken*.

Verifying the Proposal using PPI *some*

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The English PPI *some* loses it polarity sensitivity when it is in the predicate phrase of a sentence with the focus adverb *only*.

Only Batman ate some (≈ any) *pasta*.

Negation is also beyond the reach of a PPI when it is outside the clause that contains the PPI, or when it is inside a Determiner Phrase.

It is not the case that any other superhero ate some (≈ any) *pasta.*

No other superhero ate some (≈ any) *pasta.*

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The Dark Knight Thanks You