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Covert Downward Entailment in Child English and Japanese*

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English and Japanese differ in the interpretation of disjunction in simple negative sentences. However, the contrast vanishes in a ‘covert’ negative entailment created by the focus operator (*only/dake*). Experiments with English/Japanese children reveal their sensitivity to the interpretive interaction of disjunction with the focus operator, despite their divergent linguistic input. Our results suggest that disjunction is Boolean inclusive-*or* in both languages, because disjunction in both languages licenses conjunctive entailments under ‘covert’ negation. The findings also empirically support a nativist approach to the acquisition of semantics, with the semantics of natural language disjunction innately specified, rather than learned from experience.

1. Disjunction in Simple Positive and Negative Sentences

It is almost a truism that, in ordinary declarative sentences, the use of disjunction (e.g., English *or*) implies a “disjunctive” (‘not both’) interpretation, although this interpretation is not logically entailed. Statements of the form *A or B* are pragmatically odd as descriptions of situations in which both *A* and *B* are true. The implicature of ‘exclusivity’ is the consequence of the availability of another statement, namely *A and B*, which is more informative. A pragmatic principle *Be Cooperative* (cf. Grice 1975) entreats speakers to be as informative as possible. Upon hearing someone use the less informative statement with *or*, listeners infer that the speaker was being cooperative and, hence, was not in a position to use the more informative statement with *and*. So the speaker is taken to imply the negation of the statement with *and*.

Assuming that ordinary declarative sentences make up the vast majority of children’s experience, it would hardly be surprising for children to reach the conclusion that natural language disjunction is exclusive-*or*, and not inclusive-*or*

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(see Crain, Goro and Thornton 2005), unless this conclusion is unworkable for some other reason.

Input favoring the exclusive-*or* interpretation of disjunctive statements is encountered even more often by children learning other languages. Whereas this interpretation of disjunction is more or less the same in English and Japanese in ordinary declarative sentences (cf. (1) and (2)), the parallel seems to end there.

- (1) Mark speaks Icelandic *or* Swahili.
(but I'm not sure which language he can actually speak)
- (2) Maaku-wa aisurandogo *ka* suwahirigo-wo hanasu.
Mark-TOP Icelandic *or* Swahili-ACC speak
(but I'm not sure which language he can actually speak)

In simple negative sentences, the Japanese disjunction operator *ka* and the English operator *or* are assigned different interpretations, such that English abandons the exclusive-*or* reading of disjunction, whereas Japanese retains it. Japanese is surprising in this regard, since negation creates a downward entailing (henceforth, DE) linguistic environment. The defining property of DE environments is that they license inferences from claims about things to claims about subsets of those things, as the following examples from English illustrate.

- (3) John does not speak an Asian language.
- (4) John does not speak Japanese.

In English, any circumstance in which (3) is true is one in which (4) is also true, so negation manifests the defining DE property. Another diagnostic of DE property involves disjunction. In English, when disjunction appears in the scope of negation, it yields an entailment in which the truth conditions of whole sentence can be recast with conjunction presiding over both disjuncts, as in (5).

- (5) John does not speak Japanese *or* Chinese.

→ John does not speak Japanese *and* does not speak Chinese.

The “conjunctive” entailment of disjunction in DE linguistic contexts calls to mind one of the De Morgan’s laws of propositional logic: $\neg(A \vee B) \rightarrow \neg A \wedge \neg B$. The truth tables in (6) illustrate the logical equivalence between disjunction under the scope of negation and the conjunction of the two negated premises.

(6)	A	B	$A \vee B$	$\neg(A \vee B)$	$\neg A$	$\neg B$	$\neg A \wedge \neg B$
	0	0	0	1	1	1	1
	0	1	1	0	1	0	0
	1	0	1	0	0	1	0
	1	1	1	0	0	0	0

The fact that English disjunction *or* under negation conforms to the laws of logic suggests that it has the semantics of the corresponding logical expression, inclusive Boolean disjunction. We assume that in positive contexts (i.e., ones that are non-DE), the Boolean operator continues to supply the basic meaning of *or*, but a derived exclusive-*or* interpretation is added to the basic meaning, due to a conversational implicature (e.g., Grice 1975; also see Goro 2004 for detailed discussion). This implicature is canceled in negative sentences in English, so these sentences are faithful to the laws of logic.

By contrast, negative statements with disjunction appear to be unfaithful to the laws of logic in Japanese. In Japanese, the disjunction operator *ka* fails to license conjunctive entailments in simple negative sentences. Consider the following example, which is the Japanese counterpart to (5).

- (7) Jon-wa nihongo *ka* chuugokugo-wo hanasa-nai.
John-nom Japanese *or* Chinese-acc speak-neg

The sentence in (7) lacks the conjunctive entailment that its English counterpart has; John doesn't speak Japanese *or* he doesn't speak Chinese, but the speaker is unsure which language he does not speak. Hungarian disjunction *vagy* also generates this kind of "disjunctive" interpretation in simple negative sentences, as Szabolcsi (2002) points out. According to Szabolcsi, the interpretation of disjunction in simple negative sentences is a locus of cross-linguistic variation: the disjunction operators in Hungarian, Russian, Japanese, Dutch, etc. do not yield conjunctive entailments in simple negative sentences, whereas conjunctive entailments are generated in English, German, Korean, etc. In the present paper, we restrict our attention to the contrast between English and Japanese.

Following Szabolcsi (2002), Goro (2004) proposes that the Japanese disjunction operator *ka* is a positive polarity item (PPI), which cannot be interpreted within the scope of local overt negation. For example, in (7), the polarity sensitivity of *ka* forces it to be interpreted outside of negation, even though it appears within the potential scope domain of negation (i.e., the direct object position) in surface syntax. The PPI analysis of Japanese disjunction thereby permits us to maintain the view that the semantics of *ka* corresponds to inclusive Boolean disjunction.

An important piece of evidence for this claim comes from the fact that the interpretive contrast between English *or* and Japanese *ka* disappears in certain linguistic environments. We discuss one of these environments in the next section, namely sentences that contain the focus operator *only* (or its Japanese counterpart *dake*). For further details and analysis, see Goro (2004).

2. Focus Operators Create Covert DE environments

The focus operator *only* does not create a typical DE linguistic environment (cf. von Stechow 1999). For example, the sentence in (8) does not entail (9), since *John speaks an Asian language* could be true in a situation in which *John speaks Japanese* is false; for instance, John could speak Chinese, not Japanese.

- (8) Only John speaks an Asian language.

(9) Only John speaks Japanese.

Horn (1969) proposed that the meaning of sentences containing *only* consists of two conjoined propositions: one proposition is about the focused element (i.e., John in current case), and the other proposition is about the background individuals. Example (10) represents the fully decomposed meaning of the sentence in (8) under Horn's analysis.

- (10) a. John speaks an Asian language, and
b. Everyone other than John does not speak an Asian language.

Adopting Horn's terminology, we will refer to the proposition about the focused individual, i.e., (10a), as the "presupposition", and refer to the proposition about the contrast set of individuals, which is (10b), as the "assertion". We intend no theoretical commitments by adopting this terminology.

The presupposition (10a) is the 'overt' meaning component of (8). This component does not involve any DE operator. This explains why the standard DE tests fail for sentences with *only*; for example *John speaks an Asian language* (i.e., the presupposition of (8)) does not entail *John speaks Japanese* (the presupposition of (9)). By contrast, the assertion (10b) is the 'covert' meaning component of (8). This meaning component does create a DE environment. To see this, observe that the first sentence in (11) entails the second sentence:

- (11) Only John speaks an Asian language
→ Everyone other than John doesn't speak Japanese

Based on this observation, we conclude that sentences containing *only* introduce a covert DE operator in the assertion. The DE operator is negation, or the semantically equivalent of negation. It is expected, on this analysis, that when English disjunction appears in the scope of the covert DE operator, it licenses conjunctive entailments. So, for example, when *or* appears within the scope of focus operator *only*, it is expected to yield conjunctive entailments in the 'covert' meaning component, the assertion. Example (12) illustrates.

- (12) Only John speaks Japanese or Chinese
→ Everyone other than John doesn't speak Japanese and everyone other than John doesn't speak Chinese

By contrast, we saw earlier that *or* yields a "disjunctive" interpretation in the presupposition of sentences with the focus operator *only*, as illustrated in (13).

- (13) Only John speaks Japanese or Chinese
→ John speaks Japanese or he speaks Chinese

Summarizing, the meaning of sentences containing *only* consists of two conjoined propositions. While the covert meaning component of sentences containing *only* (i.e., the assertion) generates a covert DE operator, the overt component does not. Consequently, the disjunction operator *or* licenses conjunctive entailments in sentences containing *only*, but such entailments are licensed only in the covert meaning component, the assertion.

In the previous section, we remarked that Japanese disjunction operator *ka* fails to sanction conjunctive entailments in simple negative sentences (cf. (7)). This is due to the polarity sensitivity of the Japanese disjunction operator *ka* in the presence of overt negation. However, the contrast between Japanese *ka* and English *or* vanishes within the covert DE meaning component associated with sentences containing the focus operator *dake* (“only”). For example, (14) is the Japanese counterpart to the English example in (12) and, here, *ka* creates the conjunctive entailment.

- (14) Jon-*dake-ga* nihongo *ka* chuugokugo-wo hanasu.
John-*only-NOM* Japanese *or* Chinese-ACC speak
“Only John speaks Japanese or Chinese.”

→ Everyone other than John doesn’t speak Japanese *and* doesn’t speak Chinese

As (14) reveals, the positive polarity effect for *ka* is inhibited in the covert meaning component of sentences with the focus operator (see Goro (2004) for detailed discussion). The PPI status of disjunction *ka* is rendered inert when it appears in the scope of the covert DE operator, negation or the semantic equivalent of negation. The fact that *ka* yields conjunctive entailments underscores our claim that natural language disjunction is inclusive Boolean disjunction. According to the present analysis, then, English *or* and Japanese *ka* have identical semantics, whereas they differ in polarity sensitivity (Japanese *ka* is a PPI, English *or* is not).

So far we have observed that the disjunction operators of English and Japanese yield contrasting interpretations in simple negative sentences. This contrast disappears when the disjunction operator, in either language, is interpreted in the scope of a covert DE operator generated in sentences containing *only/dake*. The next section examines issues in the acquisition of the meaning of disjunction in English and Japanese. Specifically, our concern is whether or not differences in adult input in simple negative sentences with disjunction has any effect on the acquisition of the semantics of disjunction in these languages.

3. The Acquisition of *ka/or*

We have established that both English disjunction *or* and Japanese disjunction *ka* correspond to inclusive Boolean disjunction. The crucial evidence for this conclusion is the fact that they both license conjunctive entailments when they are interpreted under the scope of negation, as in De Morgan’s laws (or, more generally, when they appear in the scope of any DE operator). For example, in

the covert DE context associated with sentences containing *only/dake*, *ka* and *or* both create identical conjunctive entailments. However, due to the polarity sensitivity of *ka*, its “logical” interpretation only emerges in certain environments. In simple negative sentences, *ka* always takes scope over local overt negation, and therefore fails to yield conjunctive entailments. This property of *ka* has an effect of obscuring its semantics, especially its Boolean (inclusive-*or*) character. In simple negative sentences, the meaning of *ka* is compatible with a non-Boolean analysis of the lexical item.

If children acquire the semantics of the disjunction operator from experience using general-purpose learning algorithms, as some models of language development would suppose, the facts that *ka* receives a “disjunctive” interpretation in both positive and simple negative sentences would be expected to affect the acquisition process. Specifically, it is possible that the behavior of *ka* in both positive sentences and in simple negative sentences could mislead Japanese children at certain stages of acquisition, prompting them to conclude that *ka* is a “non-logical” connective, i.e., non-Boolean element that does not semantically interact with negation according to De Morgan’s laws. In that case, such children should continue to assign the “disjunctive” interpretation to *ka* in other linguistic environments, including the covert DE component associated with sentences with *dake* “only”. For those children, then, the sentence in (14) means that everyone other than John doesn’t speak Japanese OR doesn’t speak Japanese. On this scenario, *ka* would continue to yield the disjunctive interpretation in this context, just as in simple negative sentences. In other words, under experience-based learning approach, it is anticipated that Japanese children may get confused about the semantics of *ka*, and could end up with non-adult interpretation of the disjunction operator in certain contexts.

However, recent studies on the acquisition of semantics of disjunction have raised an alternative to such experience-based learning models. An alternative model, based on Universal Grammar, makes different predictions about Japanese children’s initial interpretation of *ka*. The UG-based model anticipates that children learning any language interpret disjunction as Boolean inclusive-*or*, regardless of the input they encounter. Evidence supporting this model has been reported in experimental studies with English-speaking children, who were found to compute adult-like interpretations of disjunction *or* in various linguistic contexts (Chierchia et al. 2001; Gualmini and Crain 2002; Crain et al. 2002; Gualmini and Crain 2004, among others). Chierchia et al. (2001), for example, showed that English-speaking children age from 3 to 6 interpreted *or* differently in the first and the second argument of the universal quantifier *every*. Crain et al. (2002) and Gualmini and Crain (2004) further showed that children were sensitive to abstract structural notion (c-command) when interpreting sentences containing *not* and *or*. In short, there are strong empirical grounds to support the conclusion that children, at least by about around age 4, have adult-like knowledge about the semantics of *or*. These findings suggest that the semantics of natural language disjunction is innately specified in UG (cf. Crain, Goro and Thornton 2005). Under this UG-based account, it is predicted that the acquisition of disjunction will not be seriously impeded by the properties of input: children in any linguistic community assign the Boolean interpretation to disjunction operator in their language, however misleading the input is. In the remainder of the paper, we pursue the following

prediction of the UG-based model: that English and Japanese speaking children both assign the (adult-like) conjunctive interpretation to disjunction within the covert DE component of sentences containing *only/dake*¹.

Let us summarize the issues surrounding the acquisition of disjunction. The main question is whether or not differences in input affect the process of the acquisition of disjunction. Due to the polarity sensitivity of Japanese *ka*, input data to Japanese children is systematically different from input data to English children. Specifically, *ka* in simple negative sentences fails to exhibit its Boolean character, hence depriving Japanese children of a major source for correcting a possible non-Boolean analysis of the disjunction operator. Thus, if experience plays a crucial role in the acquisition of disjunction, at least a certain proportion of Japanese children would show difficulty in licensing the “logical” conjunctive entailments for sentences with *ka*, in contrast with English children. The covert DE context that is created by the focus operator *only/dake* provides an excellent testing ground for investigating children's semantics of disjunction, since, in that linguistic environment, the effect of positive polarity disappears and the identical “logical” interpretation of *or/ka* emerges for adult speakers. If Japanese and English children show contrasting behavior in interpreting disjunction in the context, we would conclude that input matters for the acquisition of disjunction; however, if Japanese and English children assign the identical “logical” interpretation to disjunction, the inference would be that the properties of input do not mislead children and, therefore, the finding would add support for the UG-based approach to the acquisition of disjunction.

With these goals in mind, we conducted experiments with the identical design with English-speaking children and with Japanese-speaking children. The research strategy was to investigate their interpretations of disjunction in the covert DE component of sentences with *only/dake*. The following section reports the design and the results of the experiments.

4. Experiments

The central objective of the experiments was to investigate English/Japanese children's interpretation of disjunction within the covert DE component associated with sentences containing a focus operator. The test sentences thus contained disjunction *or/ka* and a focus operator *only/dake*, as shown for both English and Japanese in (15).

- (15) a. Only Bunny Rabbit will eat a carrot or a green pepper.
b. Usagichan-dake-ga ninjin ka piiman-wo taberu-yo.
rabbit-*only*-NOM carrot *or* green pepper-ACC eat-dec

¹ In fact, experimental studies on Japanese children's interpretation of *ka* in simple negative sentences revealed that vast majority of Japanese children around age 5 assign English-type conjunctive interpretation to *ka* in this context, in apparent disregard for the input. See Goro and Akiba (2004) and Goro (2004).

Under the present analysis, the meaning of the sentences (15) is decomposed into the following two components.

- (16) a. Bunny Rabbit will eat a carrot *or/ka* a green pepper.
 b. Everyone else will not eat a carrot *or/ka* a green pepper.

What is crucial here is children’s interpretation of the assertion meaning component, which contains a covert DE operator (represented as negation in (16b)). If children assign the Boolean semantics to *or/ka*, the disjunction will be interpreted under the scope of the covert DE operator and will, therefore, yield a conjunctive entailment. In that case, the interpretation of the assertion can be paraphrased as: *everyone else will not eat a carrot AND will not eat a green pepper*. Under this interpretation, the test sentence is true in the situation illustrated in Table 1, but is false in the situation illustrated in Table 2 below:

Table 1: Condition I (True)

	carrot	green pepper
Winnie the Pooh	*	*
Bunny Rabbit	√	*
Cookie Monster	*	*

Table 2: Condition II (False)

	carrot	green pepper
Winnie the Pooh	*	*
Bunny Rabbit	√	*
Cookie Monster	*	√

However, if children assign non-Boolean semantics to the disjunction operator in their language, then it does not semantically interact with the covert DE operator; it would yield the “disjunctive” interpretation. The “disjunctive” interpretation of the assertion can be paraphrased as: *everyone else will not eat a carrot OR will not eat a green pepper*. On this interpretation, the sentence is true in Condition II.

Summarizing, if English/Japanese children assign the Boolean interpretation to *or/ka*, then they should accept the test sentence in (15) in Condition I, but they should reject it in Condition II. By contrast, if children assign non-Boolean semantics of *or/ka*, then they should also accept the test sentence in Condition II. We conducted experiments with English-speaking and Japanese-speaking children, to compare their linguistic behavior.

The experiments, each of which was performed in English and Japanese respectively, were identical in design, with only minimal changes in some of the toy props. The experimental design employed the Truth Value Judgment task, in the Prediction Mode (cf. Crain and Thornton 1998). There were two experimenters. One of them acted out the stories using the toy props, and the other manipulated the puppet, Kermit the Frog. While the story was

being acted out, the puppet watched it along with the subject. In each trial, the story was interrupted - after the introduction of the characters and a description of the situation - so that the puppet could make a prediction about what he thought would happen. Then, the story was resumed, and its final outcome provided the experimental context against which the subject evaluated the target sentence, which had been presented as the puppet's prediction. The puppet repeated his prediction at the end of each story, and then the subject was asked whether the puppet's prediction had been right or wrong.

One experimental session contained eight trials. Four of them were target sentences, and the other four were fillers. The trials were presented pseudo-randomly, to balance the truth values of the expected responses for each trial. In this way, the subject could not be biased by the responses he/she had previously made. Sample trials in English for Conditions I and II are illustrated in (17) and (18), respectively.

(17) A Sample Trial for Condition I (True)

Experimenter 1 (storyteller): "This is a story about Pooh, Bunny Rabbit and Cookie Monster. They came to a vegetable garden, which has some carrots and green peppers. Those vegetables look fresh and tasty. I wonder what they will do next. What do you think, Kermit?"

Experimenter 2 (puppeteer): "Hmm, let's see. I know that Pooh loves honey, but I don't know if he likes vegetables. I know that Bunny Rabbit loves vegetables, so she will go for them. I know that Cookie Monster loves cookies, but I'm not sure if he likes vegetables.² So here's what I think will happen next. I think **only Bunny Rabbit will eat a carrot or a green pepper.**"

Experimenter 1: "Now, let's see what will happen!" (Acting out each of the three characters: Pooh decides not to eat anything, because what he wanted to eat was honey. Bunny Rabbit, on the other hand, happily eats a carrot. Cookie Monster does not eat anything, because he wanted cookies rather than vegetables.) "OK, this is what actually happened. Now, Kermit, what was your prediction?"

Experimenter 2: "I said only Bunny Rabbit would eat a carrot or a green pepper."

(18) A Sample Trial for Condition II (False)

Experimenter 1 (storyteller): "This is a story about Pooh, Tigger, and Donald Duck. They found a strange tree which has some apples and bananas. They may want to get the fruits, but the tree is tall. I wonder what will happen next. What do you think, Kermit?"

² The puppet described his predictions about what each of the characters would do before presenting the target sentence. This is to make the contrastive set salient so that the child could easily associate *only* to the subject noun rather than to the object noun (cf. Paterson et al. 2003).

Experimenter 2 (puppeteer): “Hmm, let’s see. Pooh does not look like a good jumper. But I know that Tigger is a good jumper. And I don’t think that Donald Duck can jump high. So here’s what I think will happen next. I think **only Tigger will get an apple or a banana.**”

Experimenter 1: “Now, let’s see what will happen!” (Acting out each of the three characters: Pooh cannot jump high and he tries to climb the tree, but he fails because the surface of the tree is so slippery. Tigger, in contrast, easily jumps high enough to get an apple. Donald Duck cannot jump high, but he tries to fly and succeeds to get a banana from the lower branches.) “OK, this is what actually happened. Now, Kermit, what was your prediction?”

Experimenter 2: “I said only Tigger would get an apple or a banana.”

The Japanese version of the experiment used exactly the same protocols. Some of the characters in the stories were replaced by other characters to ensure that the Japanese children were familiar with the characters.

Twenty-one English-speaking children, recruited at the Center for Young Children at University of Maryland Collage Park, participated in the English-version of the experiment. They ranged in age from 3;6 to 5;8, with a mean age of 5;0. For the Japanese version of the experiment, twenty Japanese-speaking children were recruited from Totsuka Sumire Yoochien in Yokohama, Japan. They ranged in age from 4;2 to 7;4, with a mean age of 5;4. Each subject was tested individually. The results were summarized in Tables 3.

Table 3: Results

	% correct responses English ³	% correct responses Japanese
Condition I (True)	93% (39/42)	98% (39/40)
Condition II (False)	93% (39/42)	98% (39/40)
Overall accuracy	93% (78/84)	98% (78/80)

It is clear from Table 3 that both English-speaking children and Japanese-speaking children correctly accepted the test sentences in Condition I, and correctly rejected the test sentences in Condition II. The two groups of children showed no significantly different behavior in interpreting disjunction within sentences containing a focus operator. Most crucially for our purpose, the high rejection rate in Condition II shows that children assigned the conjunctive truth condition to disjunction in the assertion component of the test sentences. This, in turn, suggests that they assigned the Boolean semantics to the disjunction operator in their language, despite the differences in input.

³ A control group of 31 adult English speakers (undergraduate students of University of Maryland at College Park) participated in the same experiment. They consistently accepted the target sentences in Condition 1, and constantly rejected them in Condition II.

5. Conclusion

In our experiments, there was no evidence of a significant effect of input on the acquisition of disjunction. Both English-speaking children and Japanese-speaking children were able to compute the derived logical truth conditions of Boolean disjunction, despite the fact that the Boolean character of Japanese *ka* is highly obscured in the input to children, due to its polarity sensitivity. Our experimental findings add further empirical support for the UG-based approach to the acquisition of disjunction. According to this model, the Boolean semantics for natural language disjunction is innately specified in UG and, therefore, the specific input they encounter is unlikely to seriously mislead children. Any experience-driven leaning accounts (e.g., Tomasello 2000, 2003 among others) would appear to be hard-pressed to explain the findings of the present studies. We leave it as a challenge to such models to account for the absence of any impact of input characteristics on the outcome of acquisition.

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