Upward Entailment vs Downward Entailment

Just as intuitive judgments about sentence grammaticality have become a cornerstone in syntactic theory, intuitions about entailments between sentences are central for natural language semantics. The intuitions concerning semantic relations can be seen as based on intuitions about truth.

1. Entailment (衍推)

In formal semantics, the notion of truth underlies several important properties of statements, entailment, contradiction, tautology, analytic and synthetic statements.

Entailment

A statement S entails S' if whenever S is true, S' must also be true: in other words, S' is an entailment of S.

S entail S' if whenever S is true, S' is true too.

some examples of entailment shown in (1) and (2).

(1). a. Tina is tall and thin ==> Tina is thin

b. Tina is thin =/=> Tina is tall and thin

(2). a. The door is open ==> the door is not closed.

b. Leo is shorter than Dan ==> Dan is taller than Leo.

c. The solution is odorless ==> the solution does not smell of cloves.

Contradiction

A statement S is a contradiction of S' if S and S' cannot both be true in any circumstances. Contradiction is illustrated in (3):

(3). 'Jones is at home' contradicts 'Jones is not at home', and vice versa.

Tautology

A tautology is a statement which is always true and cannot be false. as in (4):

(4). The universe is either expanding or not expanding.

Analytic statement

An analytic statement is said to be true depending simply on the sense of the words in which it is expressed, and not on particular facts about how things are. For example, you can judge (5) to be true without knowing which particular animal is referred to, because the word *tigress* already contains the information that its denotation is female.

(5). That tigress is a female.

Synthetic statement

A synthetic statement is any statement which has its truth value determined by the way things are and not just by the senses of the words in it. The synthetic statements in (6), in contrast to the statements in (5), cannot be judged true or false without knowing the facts about the particular tigress referred to:

(6). That tigress is pregnant.

Of these properties, entailment is the most important and most often encountered in semantic analysis.(Kearns, 2011)

2. Negative Polarity Items and Quantifiers

Negative Polarity Items (NPIs) are phrases which occur in limited contexts, most famously in contexts of negation. The commonest NPIs are *any* (*anyone*, *anything*) and *ever*, they are licensed by *not*.

(7). a. Sue won't ever go there again.

b. #Sue will ever go there again.

(8). a. The office hasn't notified anyone.

b. #The office has notified anyone.

A structural condition on the licensing:

(9). a. nobody has ever invited Bill to a party.

b. #Bill has ever invited nobody to a party.

(10). a. Nothing was ever done about the vote.

b. Mary ever did nothing about the vote.

Despite their name, NPIs occur in a variety of contexts, they are not actually confined to negative contexts, and occur with some quantifier determiners, in addition

to *no*.

(11). No/less than 10 students has/have ever been to the cinema.

Below examples in (12) to (16) with NPI *ever* show that the NPI may appear in N' or in VP or in both. (Kearns, 2011)

(12).Every

a. [Everyone who has ever been to Belltree Island] will want to go back.

b. #[Everyone who has been to Belltree Island] will ever want to go back.

(13).No

a. [No one who has ever been to Belltree Island] will want to go back.

b. [No one who has been to Belltree Island] will ever want to go back.

(14).Few (weak few)

a. [Few people who have ever been to Belltree Island] will want to go back.

b. [Few people who have been to Belltree Island] will ever want to go back.

(15).Some

a. #[Someone who has ever been to Belltree Island] will want to go back.

b. #[Someone who has been to Belltree Island] will ever want to go back.

(16).Four

a. #[Four people who have ever been to Belltree Island] will want to go back.

b. #[Four people who have been to Belltree Island] will ever want to go back.

It can be generalized that *ever* can be licensed in *every*, *no* and *few*.

Ladusaw (1979) suggested that the contexts which license negative polarity items as downward entailing environments.

3. Upward entailing (向上衍推) vs Downward Entailing (向下衍推)

Below examples (17) - (20) could help us to understand upward entailment and downward entailment. In a structure "DET CNP VP", the left position is the CNP, and the right position is the VP.

(17). $\| play\ volleyball \| \sqsubseteq \| play\ sports \|$

a. Every student plays volleyball. ==> Every student plays sports.

b. Every student plays sports. =/=> Every student plays volleyball.

$\| female\ students \|\sqsubseteq\| students \|$

c. Every student plays sports. ==> Every female student plays sports.

d, Every female student plays sports. =/=> Every student plays sports.

In (17), *every* is left downward entailing (sometimes called left monotone decreasing or monotone↓), right upward entailing (sometimes called right monotone increasing or monotone↑).

(18). $\| play\ volleyball \|\sqsubseteq\| play\ sports \|$

a. No student plays volleyball. =/=> no student plays sports.

b. No student plays sports. ==> no student plays volleyball.

$\| Chinese\ students \|\sqsubseteq\| students \|$

c. No student plays volleyball. ==> No Chinese student play volleyball.

d. No Chinese student play volleyball. =/=> No student plays volleyball.

In (18), *no* is left downward entailing, right downward entailing (sometimes called right monotone decreasing or monotone↓).

(19). $\| know\ English\ and\ Chinese \|\sqsubseteq\| know\ Chinese \|$

a. Some students know English and Chinese. ==> Some students know Chinese.

b. Some students know Chinese. =/=> Some students know English and

Chinese.

$\| English\ students \| \sqsubseteq \| students \|$

c. Some students know Chinese. =/=> Some English students know Chinese.

d. Some English students know Chinese. ==> Some students know Chinese.

In (19), *some* is left upward entailing (sometimes called left monotone increasing or monotone↑), right upward entailing.

(20).$\| wrote\ a\ term\ paper\ and\ made\ a\ class\ presentation \| \sqsubseteq \|$
$wrote\ a\ term\ paper \|$

a. Three students wrote a term paper and made a class presentation. ==> Three students wrote a term paper.

b. Three students wrote a term paper. =/=> Three students wrote a term paper and made a class presentation.

$\| college\ students \| \sqsubseteq students \|$

c. Three college students wrote a term paper. ==> Three students wrote a term paper.

d. Three students wrote a term paper. =/=> Three college students wrote a term paper.

In (20), *three* is left upward entailing, right upward entailing.

According to this form of entailment test, we can know about the upward entailing and downward entailing of other quantifiers. As the following table shows.

	Some	Three	More than two	Most	All	Exactly three	At most one	No	Few
Left upward entailing	yes	yes	yes	no	no	no	no	no	no
Left downward entailing	no	no	no	no	yes	no	yes	yes	yes
Right upward entailing	yes	yes	yes	yes	yes	no	No	no	No
Right downward entailing	no	no	no	no	no	no	yes	yes	yes

In summary, the definitions of upward entailing and downward entailing are given below:

a. A determiner D is right upward entailing iff whenever $B \sqsubseteq C$, D(A)(B) entails D(A)(C).

b. A determiner D is right downward entailing iff whenever $B \sqsubseteq C$, D(A)(C) entails D(A)(B).

c. A determiner D is left upward entailing iff whenever $A \sqsubseteq C$, D(A)(B) entails D(C)(B).

d. A determiner D is left downward entailing iff whenever $A \sqsubseteq C$, D(C)(B) entails D(A)(B).

References

Kearns, K. (2011). *Semantics(Second Edition)*. Palgrave Macmillan.

Ladusaw, W. (1979). Polarity Sensitivity as Inherent Scope Relation. Ph.D. diss., University of Texas, Austin; distributed by IULC.