Meaning and logic

4

The logical approach to meaning is a first step into the investigation of meaning relations. Taking up the notions of truth and reference from Chapter 2, we will consider sentences from the perspective of their truth conditions. The logical view allows the introduction of basic concepts such as logical consequence (or entailment), logical equivalence and incompatibility. In the second part of the chapter these notions are applied to words.

4.1 Logical basics

4.1.1 Donald Duck and Aristotle

Let us start with the provocative (and highly important) question: 'Is Donald Duck a duck?' Suppose you are one of those who answer spontaneously: 'Why, of course!' In that case you would subscribe to the truth of (1):

(1) *Donald Duck is a duck.*

Well, ducks are birds, and birds are animals. Would you also say that (2) is true?

(2) *Donald Duck is a bird.*

And how about (3)?

(3) *Donald Duck is an animal.*

It would not be surprising if you were less sure about the truth of (2) and would not subscribe to the truth of (3). But, if (1) is true, (2) is true; if (2) is true, so is (3). Hence, if (3) is false, there must be something wrong: (2) must be false as well and, consequently, (1) cannot be true either. That is logic: if Donald is a duck, then he is a bird. If he is not a bird, he cannot be a duck.

Well, then, let us take a second look at the original question. Why is it that we are inclined to say that Donald is a duck? Well, it is the fact that his name is Donald 'Duck' and that Donald *looks* like a duck, at least roughly, i.e. if we ignore his having arms with hands instead of a duck's wings. But names are just names, and beyond his looking like a duck there is little to be said in defence of Donald's duckness. Does he quack rather than talk? Does he swim or fly like a duck? Would we expect him to dive for food as ducks do? No. As far as we know, Donald Duck behaves, feels, and thinks in every respect like a human being. So, let us try this:

(4) *Donald Duck is a human being.*

Have you ever seen a human being with a duck's body, with feathers, a beak and duck feet? Is he not much too short for an adult man? Could he run around without his pants all the time if he were not a duck? If we are serious about the initial question, we have to admit that (4) is not true either:

(5) *Donald Duck is neither a duck nor a human being.*

But if we decide to take this stand, we are throwing out the baby with the bath water. According to (5), Donald could be anything *except* a duck or a human. This is certainly not what we want to say. If anything, Donald is a duck or a human. Somehow, he's both at the same time:

(6) *Donald Duck is both a duck and a human being.*

He is a duck that behaves like a human, and he is a human being in a duck's guise. If we take (5) and (6) together, we get (7) and (8):

(7) *Donald Duck is a duck and he isn't.*
(8) *Donald Duck is a human being and he isn't.*

What does logic say about this? That is very clear: (6) contradicts (5), and (7) and (8), as they stand, are each self-contradictory. This cannot be: (6), (7) and (8) cannot be true. Therefore, something like Donald Duck cannot exist. The consequence is acceptable, in a sense. In a world where ducks are ducks and cannot be human, and vice versa (e.g. in what we consider the real world), we would not accept that something or someone like Donald really exists. We would not accept that (6), (7) and (8) are true of anything that really exists.

The underlying principle goes back as far as Aristotle. In his work *Metaphysics*, he formulated the following fundamental law of logic, and not only of logic, but of truth in general (Aristotle, *Metaphysics*, 1005b, p. 262):

> **Law of Contradiction**
> The same attribute cannot at the same time both belong and not belong to the same subject in the same respect.

What the principle says is simply this: a sentence, in a certain reading, cannot be true and false at the same time. (Aristotle assumes that, basically, every sentence says that some attribute (the predicate of the sentence) belongs to some subject.) Our reasoning about Donald Duck with the outcome of (5), (6), (7) and (8) violates this law. If (5) is true, (6) must be false, and vice versa. So, if (5) and (6) are both true, they must also be both false. (7) says that (1) is both true and false, and so does (8) for (4).

But, seriously, is not there something to be said in favour of the truth of (5), (6), (7) and (8)? Yes, there is. And if we take a closer look at Aristotle's law, we realize how our findings about Donald Duck can be reconciled with logic: we have to relate the categorization of poor Donald to different 'respects'. The apparent contradictions can be resolved if we replace (5), (6), (7) and (8) by the following:

(5') *Donald Duck is neither a duck nor a human being in all respects.*
(6') *Donald Duck is a duck in certain respects and a human being in others.*
(7') *Donald Duck is a duck in certain respects, but he isn't in others.*
(8') *Donald Duck is a human being in certain respects, but he isn't in others.*

Or more explicitly:

(5") *Donald Duck doesn't behave like a duck and doesn't look like a human being.*
(6") *Donald Duck looks like a duck but behaves like a human being.*
(7") *Donald Duck looks like a duck but doesn't behave like one.*
(8") *Donald Duck behaves like a human being but doesn't look like one.*

These sentences are no longer contradictory. They are, however, still not compatible with our experience of the real world. Hence, if we accept the truth of these sentences, we have to assume a different world for Donald Duck to exist in – and that, of course, is what we do.

As you might have noted, interpreting the original sentences (5) to (8) in the more explicit way of (5') to (8') or (5") to (8") is an instance of what we introduced in the last chapter as 'differentiation'. The expressions *be a duck* and *be a human being* are interpreted in a more specific reading than what they literally mean. The process is triggered by the need to make things fit into their context, i.e. by applying the Principle of Consistent Interpretation.

4.1.2 The Principle of Polarity

The basic notion of all logical considerations is **truth**. As was stated in 1.1.2 above, truth is not a property of sentences as such, although we mostly talk that way.[1] The question of the truth or falsity of a sentence arises only if the sentence is related to a certain CoU. Since the CoU may vary, sentences are true in some CoUs and false in others. Truth and falsity underlie the following fundamental principle:

> **Principle of Polarity**
> In a given CoU, with a given reading, a declarative sentence is either true or false.

This principle too goes back to Aristotle. It entails (for the notion of logical entailment see the next subsection) the Law of Contradiction since the formulation 'either true or false' is taken in the exclusive meaning of *either – or*: ›either true or false, but not both‹. The ›but not both‹ part is the Law of Contradiction. The Principle of Polarity adds to the Law of Contradiction the condition known as the **Law of the Excluded Middle** (Latin *Tertium non datur*, which means ›there is no third [possibility]‹): there are only these two possibilities, truth or falsity, and no others, i.e. no in-between, no both-true-and-false, no neither-true-nor-false. Later in 9.5 we will see how this principle is reflected in the structure and use of natural language.

In order to have a convenient neutral term for being true or false, one speaks of the **truth value** of a sentence. A sentence has the truth value TRUE if it is true, it has the truth value FALSE if it is false. In general, the truth value of a sentence depends on certain conditions: is the situation expressed by the sentence in accordance with the facts in the given CoU or is it not? These conditions were introduced in 2.2.2 as the **truth conditions** of the sentence. The sentences in examples (9) and (10) have different truth conditions:

(9) *The cat is in the garden.*
(10) *There's milk on the floor.*

(9) is true if the cat is in the garden, and (10) is true if there's milk on the floor. In a given CoU, referring to a certain cat, a certain garden and a certain floor (i.e. the floor of a certain room), they may both be true, or both be false, or one may be true, and the other one false. Their truth conditions are, in principle, independent of each other.

4.1.3 Negation

Due to the Principle of Polarity, any declarative sentence, for example (11), is either true or false:

(11) *John knows the solution.*

If I say *John knows the solution*, I make clear that I have made my choice between two possibilities: either John knows the solution or John does not know the solution. By asserting (11), I not only express that I think that John knows the solution, but also that I do not think that John does *not* know the solution. The utterance of any declarative sentence is understood as tacitly denying that its contrary is true. Thus, any statement that one can express in a language is in this sense polarized: it is the result of a decision between two, just two, opposite possibilities, yes or no, true or false. *Polarization*, as it were, pervades language totally.[2]

It is no surprise then that all languages have systematic means of expressing the polar contrary of a sentence. This is done by what is called **negation**. Negation reverses the truth value of a sentence; it makes a true sentence false and a false sentence true. In English, negation is usually formed by negating the finite verb of the sentence, using the auxiliary *do* if the verb is not an auxiliary itself.

(12) a.	*John knows the solution.*	negation: *John doesn't know the solution.*
b.	*John will die.*	negation: *John will not die.*
c.	*John is clever.*	negation: *John isn't clever.*

In other cases, negation is formed by negating other parts of the sentence, for example so-called quantifiers such as *all, every, some, always* and the like, or by replacing them with appropriate negative expressions:

(13) a.	*Mary is already here.*	negation: *Mary is not here yet.*
b.	*Everybody knows that.*	negation: *Not everybody knows that.*
c.	*She's always late.*	negation: *She's not always late.*
d.	*She sometimes apologizes.*	negation: *She never apologizes.*
e.	*Only John knows the reason.*	negation: *Not only John knows the reason.*

For the present purposes, we need not be concerned with the exact rules and subtleties of negation in English. Let us simply define the **negation of a sentence** as follows

DEFINITION
If A is a sentence that is not negated itself, then its **negation**
(i) is true whenever A is false and false whenever A is true and
(ii) is formed out of A by a standard grammatical procedure such as

- adding the auxiliary *do* to the verb phrase and *not* to the auxiliary (e.g. *did not know*);
- adding *not* to an auxiliary verb (e.g. *was not*);
- adding *not* to a quantifier expression (e.g. *not every*);
- substituting a positive expression by its negative counterpart (e.g. *some* by *no*).

There is only a handful of expressions that require negation by substitution: quantifier expressions containing *some* (*some – no, somewhere – nowhere*, etc.) and a couple of particles such as *already* and *still* (negation: *not yet* and *no more*). Negation by substitution is only relevant if regular syntactic negation with *not* is impossible. Usually, a (positive) sentence has exactly one negation, and this is what will be assumed throughout this chapter. For the sake of convenience **not-A** is used as an abbreviation of the negation of A.

4.2 Logical properties of sentences

Given the notion of truth conditions, a couple of basic logical properties of sentences can be defined. A 'normal' sentence will be true in some CoUs and false in others. This property is called **contingency**: a sentence (in a given reading) is **contingent** if it is neither necessarily true nor necessarily false. Thus, there are two kinds of sentences which are not contingent. The first kind is called logically true: a sentence (in a given reading) is **logically true** if it is true in all possible CoUs. Correspondingly, a sentence that is false in all possible CoUs is called **logically false**.[3] As is common practice in logics, '1' is used for TRUE and '0' for FALSE:

A contingent

A	
1	possible
0	possible

A logically true

A	
1	
0	impossible

A logically false

A	
1	impossible
0	

The sentences in (14) are logically true:

(14) a. *Either Donald Duck is a duck or he is not a duck.*
b. *Every duck is a duck.*
c. *Ducks are birds.*
d. *Two times seven equals fourteen.*

(14a) is true in every CoU due to the Principle of Polarity. We might replace *Donald Duck* by any other subject and *is a duck* by any other predicate. It is the sentence pattern 'either x is p or x is not p' which makes the sentence

true, independent of any contextual conditions. Likewise, (14b) is invariably true due to the structure of the sentence, and (14c) is true because the words *duck* and *bird* mean what they mean, i.e. due to the semantic facts of English. (14d) is a mathematical truth. *Two, seven* and *fourteen* when used as NPs like here always refer to the same abstract objects, the numbers 2, 7 and 14; their referents cannot vary with the choice of a CoU, nor can the outcome of multiplying 2 with 7. In philosophical terminology, sentences such as (14c) and (14d) are called *analytically true*, while the notion of logical truth (and falsity) is reserved for cases such as (14a) and (14b) which owe their truth (or falsity) to specific rules of logic. From a linguistic point of view, there is no essential difference between the type of truth represented by the four sentences: all four of them are true due to their structure and the meanings of the words they contain.

The following sentences are logically false:

(15) a. *Donald Duck is a duck and Donald Duck is not a duck.*
b. *Donald Duck is neither a duck nor is he not a duck.*
c. *Ducks are plants.*
d. *Two times seven is twenty-seven.*

(15a) violates the Law of Contradiction; (15b) the Law of the Excluded Middle; (15c) violates the semantic rules of English and (15d) the rules of mathematics.[4]

The examples show that even logical truth and falsity rest on some basic assumptions:

- the Principle of Polarity;
- the semantics of the language.

These assumptions are absolutely indispensable. The Principle of Polarity is at the very heart of the notions of truth and falsity. The semantic rules of the language are necessary for being able to deal with questions of truth at all. If the sentences and the words they consist of did not have their proper meanings, there would be no point in asking any logical, or semantic, questions.

The logical properties of a sentence are connected to the information it may convey. Contingent sentences may be true or false. Thus, when they are actually used for assertions, they convey information about the situation referred to: it must be such that the situation expressed does in fact pertain. If John tells Mary *there is beer in the fridge*, she learns something about the situation referred to (provided John does not lie and Mary believes him). If John uttered a logically true sentence like *Ducks are birds*, Mary would not learn anything about the given situation. She would, at best, learn something about English. Similarly, she would ask herself what John wants to tell her by saying *Either Donald Duck is a duck or he is not a* *duck*. Taken as a *message*, as information about the world, it would be uninformative. Only contingent sentences can convey information about the world.

4.3 Logical relations between sentences

The truth conditions of two sentences may be related to each other in various ways. The most important relation is logical entailment.[5]

4.3.1 Logical entailment

Recall our discussion above: necessarily, B in (16) is true, if A is true. This is an instance of entailment:

(16) A. *Donald Duck is a duck.*
B. *Donald Duck is a bird.*

The relation of logical entailment is defined by one crucial condition: it is impossible that B is false if A is true. (This is the case with A and B in (16): it is impossible that Donald is a duck (A true) and not a bird (B false). Hence, if he is a duck, he necessarily is a bird.

DEFINITION	A	B	
A logically entails B/B logically follows from A	1	1	
A ⇒ B	**1**	**0**	**impossible**
if and only if[6]:	0	1	
necessarily, if A is true, B is true.	0	0	

Two arbitrary sentences A and B may be independently true or false. This yields four possible combinations of truth values. Logical entailment rules out one of these four combinations, A-true-B-false. If A entails B, the truth values of A and B depend on each other in a particular way: B cannot be false if A is true, and A cannot be true if B is false. Thus, logical entailment results in a certain link between the truth conditions of the two sentences.

The definition of entailment does not tell us anything about the remaining three combinations of truth values. When we say that in (16) a entails b, we say so because of the general condition that ducks are birds. Remember that we found it difficult to decide whether Donald Duck is a duck or not. For the question whether A entails B this does not matter because logical entailment means that *if* A is true, *then* B must be true. If Donald is a duck, he *must* be a bird. But if he is not a duck, he still may be a bird or not. Donald might be a raven; then a is false and b is true. This is

B entails A

A	B	
1	1	
1	0	
0	**1**	**impossible**
0	0	

Table 4.1

A unilaterally entails B

A	B	
1	1	
1	**0**	**impossible**
0	**1**	**possible**
0	0	

Table 4.2

admissible. He might be a cow; then both a and b are false. This too is admissible. What is not admissible is his being a duck but not a bird. Let me give you three more examples of entailments.

(17) A *It's raining heavily.* ⇒ B *It's raining.*
(18) A *Ann is a sister of my mother.* ⇒ B *Ann is an aunt of mine.*
(19) A *Today is Monday.* ⇒ B *Today isn't Wednesday.*

If it is raining, but not heavily so, one can say (17B), but not (17A). Likewise, (18B) can be true without (18A) being true: Ann could as well be a sister of my father or the wife of an uncle of mine. That (19B) may be true and (19A) at the same time false, is immediately clear. In principle, the relation of entailment is asymmetric: A may entail B without B entailing A. (In general, a relation is symmetric if and only if *x is in the relation to y* entails *y is in the relation to x*, it is asymmetric if this does not hold.) Applying the definition of entailment to the case of B entailing A yields the picture in Table 4.1 (it rules out the combination B-true-A-false). Accordingly, B does *not* entail A iff B-true-A-false is possible.[6] If we add this condition to the condition for A entailing B, we obtain a table for A *unilaterally* entailing B (Table 4.2).

There is one way of reversing an entailment: if A entails B, then A is necessarily *false*, if B is *false*. Table 4.3 shows how the truth values of not-A and not-B co-vary with those of A and B. Ruling out the combination A-true-B-false is obviously the same as ruling out (not-B)-true-(not-A)-false.

A entails B = not-B entails not-A

A	B		not-B	not-A
1	1		0	0
1	0		1	0
0	**1**	**impossible**	**0**	**1**
0	0		1	1

Table 4.3

Hence, if Donald Duck is not a bird, he cannot be a duck; if it is not raining, it cannot be raining heavily, and so on. A ⇒ B is equivalent to not-B ⇒ not-A. For example, (16) yields:

(20) **not-B** *Donald Duck is not a bird.* ⇒ **not-A** *Donald Duck is not a duck.*

Let us now take a look at a few examples which are *not* cases of logical entailment, although in each case sentence B would under normal circumstances be inferred from A. What matters, however, is whether the consequence is really necessary or whether it is based on some additional assumptions.

(21) A *Mary is John's mother.* ⇏ B *Mary is the wife of John's father.*
(22) A *John said he is tired.* ⇏ B *John is tired.*
(23) A *The beer is in the fridge.* ⇏ B *The beer is cool.*

There are no *logical* reasons for drawing these conclusions. It is logically possible that parents are not married, that John was lying, or that the fridge does not work or the beer has not been in it long enough. In most cases we draw our conclusions on the basis of our world knowledge, i.e. of what we consider normal, plausible or probable. The notion of logical entailment does not capture all these regularities and connections. It just captures the really 'hard' cases of an *if-then* relation, those based on the Principle of Polarity and the semantic facts alone.

What does logical entailment mean for the meanings of A and B? If A and B are contingent and A unilaterally entails B, both sentences contain information about the same issue, but the information given by A is more specific than the information given by B. The (truth) conditions that B imposes on the situation are such that they are always fulfilled if A is true. Therefore, the truth conditions of B must be part of the truth conditions of A. In general, if no further logical relation holds between A and B, A will impose additional conditions on the situation referred to. In this sense, A contains more information, i.e. is more informative and more specific, than B. The situation expressed by A is a *special case* of the situation expressed by B. As we shall see in 4.3.5, this does not hold if A and/or B are not contingent.

One further property should be noted here: logical entailment is what is called a transitive relation. The general property of transitivity[7] is defined as follows: a relation R is transitive if and only if 'x is in relation R to y' and 'y is in relation R to z' entails 'x is in relation R to z'. Applied to entailment, this means that if A entails B and B entails C then A entails C. For example, *Donald is a duck* ⇒ *Donald is a bird*; *Donald is a bird* ⇒ *Donald is an animal*; hence *Donald is a duck* ⇒ *Donald is an animal*. The property of transitivity immediately follows from the way entailment is defined. Suppose A ⇒ B and B ⇒ C; then if A is true, necessarily B is true; if B is true, necessarily C is true, hence: if A is true, necessarily C is true, i.e. A ⇒ C.

4.3.2 Logical equivalence

The next relation to be introduced is immediately related to entailment:

DEFINITION

A and B are logically equivalent,
A ⇔ B
if and only if:
necessarily, A and B have equal truth values.

A	B	
1	1	
1	**0**	**impossible**
0	**1**	**impossible**
0	0	

Equivalence means having identical truth conditions. Like entailment, equivalence is a transitive relation, but unlike entailment it is a symmetric relation. Since the combinations A-true-B-false and A-false-B-true are both ruled out, the table combines the conditions for A ⇒ B and B ⇒ A: equivalence is **mutual entailment**. Thus, if A and B are contingent, A must contain all the information B contains and B must contain all the information A contains. In other words, the sentences must contain the *same* information. Let us consider a few examples:

(24) A *He is the father of my mother.* ⇔ B *He is my maternal grandfather.*
(25) A *Today is Monday.* ⇔ B *Yesterday was Sunday.*
(26) A *The bottle is half empty.* ⇔ B *The bottle is half full.*
(27) A *Everyone will lose.* ⇔ B *No-one will win.*

For (25), we have to assume that every Monday is necessarily preceded by a Sunday, an assumption that may be taken for granted for the point to be made here. The equivalence in (27) holds if we assume a reading of *lose* and *win* in which *lose* means ›not win‹. Given these assumptions, all four cases rest merely on the semantic facts of English. The equivalence in (24) is due to the synonymy of *maternal grandfather* and *father of the mother*.

4.3.3 Logical contrariety

The logical relations of contrariety and contradiction focus on falsity.

DEFINITION

A is logically contrary to B /
A logically excludes B / B is incompatible with A
if and only if:
necessarily, if A is true, B is false.

A	B	
1	**1**	**impossible**
1	0	
0	1	
0	0	

What follows from the defining condition is that the combination A-true-B-true is ruled out. It also follows that if B is true, A must be false. In other words: the relation is symmetric. We can thus talk of A and B being contraries, and could replace the defining condition by 'A and B cannot both be true'. Other common terms for contrariety are *logical exclusion* and *incompatibility*. Examples of incompatibility would be:

(28) A *It's cold.* B *It's hot.*
(29) A *Today is Monday.* B *Tomorrow is Wednesday.*
(30) A *Ann is younger than Mary.* B *Ann is older than Mary.*

Usually, two contrary sentences cannot both be true but they may both be false. It may be neither hot nor cold, it may be neither Monday nor the day before Wednesday, Ann may be of the same age as Mary. In other words, the *negations* of contraries are normally compatible, they may both be true.

There is a close connection between contrariety and entailment: A and B are logical contraries iff A entails not-B. Note that if A entails not-B, B also entails not-A: both relations rule out A-true-B-true. Applying this, for example, to the sentences in (28) we obtain that, equivalently to the incompatibility stated, we can state that *It's cold* entails *It's not hot*.

4.3.4 Logical contradiction

DEFINITION

A and B are logical contradictories if and only if:
necessarily, A and B have opposite truth values.

A	B	
1	1	impossible
1	0	
0	1	
0	0	impossible

Contradictories are necessarily contraries (but not vice versa). The definition of contradiction adds to the definition of contrariety the condition that A and B cannot both be false. If A and B are contradictories, in every CoU either A is true and B is false or B is true and A is false. Together, A and B represent a strict *either-or* alternative. The classical case of logical contradiction is formed by a sentence and its negation (31); (32) and (33) show, however, that there are other cases as well:

(31) A *It's late.* B *It's not late.*
(32) A *Today is Saturday or Sunday.* B *Today is Monday, Tuesday, Wednesday, Thursday or Friday.*
(33) A *Everyone will win.* B *Someone will lose.*

Although the B sentences in (32) and (33) are not negations (in the grammatical sense) of the A sentences, they are nevertheless logically equivalent to the respective negations, *today is neither Saturday nor Sunday* and *not everyone will win*. A sentence and its negation are per definition always logically contradictory.

Logical contradiction too is linked to the other relations. A and B are logical contradictories iff A is logically equivalent to not-B. In terms of

A	B	A ⇒ B	A ⇔ B	contraries	contradict
1	1			impossible	impossible
1	0	impossible	impossible		
0	1		impossible		
0	0				impossible

Table 4.4 Logical relations

entailment, contradiction can therefore be captured as follows: A and B are contradictories iff A entails not-B (ruling out A-true-B-true) and not-A entails B (ruling out A-false-B-false).

Table 4.4 displays the crucial conditions that define the four logical relations we introduced. Each 'impossible' entry corresponds to an entailment relation. Therefore all other relations can be defined in terms of entailment and negation:

(34) A and B are equivalent *iff* A entails B *and* B entails A
A and B are contraries *iff* A entails not-B
A and B are contradictories *iff* A entails not-B *and* not-A entails B

4.3.5 Logical relations involving logically true or false sentences

Assume we have two sentences A and B, and A is logically false. If we set up a table for the possible truth value combinations on the basis of this information alone, we receive entries 'impossible' in the first two rows, because A cannot be true, regardless of B (Table 4.5). Thus the table fulfils the crucial condition for A entailing B ('impossible' in row 2) and for A and B being contraries ('impossible' in row 1). Note that the choice of B does not play any role in this. Therefore, if A is logically false, it entails anything. This is harmless: the entailment will never become effective because A is never true. Another consequence of A being logically false is that A can never be

A logically false

A	B	
1	1	impossible
1	0	impossible
0	1	
0	0	

Table 4.5

B logically true

A	B	
1	1	
1	0	impossible
0	1	
0	0	impossible

Table 4.6

true together with any sentence B. Hence, logically false sentences are contrary to all other sentences. A similar picture arises if B is logically true (cf. Table 4.6). In this case too the entailment A ⇒ B holds, regardless of A. Since B cannot be false, A-true-B-false is impossible. Applied to natural language sentences, we obtain, for example, the following entailments. In (35a), A is logically false, in (35b) B is logically true. *Mary is tired* is contingent. Putting (35a) and (35b) together, we obtain (35c) (because entailment is transitive):

(35) a. A *Ducks are dogs.* ⇒ B *Mary is tired.*
b. A *Mary is tired.* ⇒ B *Ducks are birds.*
c. A *Ducks are dogs.* ⇒ B *Ducks are birds.*

You will probably find these results confusing and counterintuitive. The cases of entailment considered so far will have made you think that there must be some *reason* for A entailing B. There should be some *meaning connection* between the sentences. But what has Mary's being tired to do with ducks being birds or dogs or whatever? The answer is: nothing. Nonetheless, these are logical entailments. In the definitions of the logical relations it was never said that there must be a meaning connection between A and B. The crucial conditions are given in terms of impossible truth value combinations for A and B. If A-true-B-false is impossible for whatever reason, then A and B fulfil the conditions of entailment. And is not (35c) downright contradictory? Yes, A and B logically contradict each other, but the constellation nevertheless fulfils the condition that A-true-B-false is impossible. This illustrates a very important point, which we will say more about below: the logical relations are *not* meaning relations. They are relations between sentences in terms of their truth conditions but not in terms of their meanings. As the two examples show, logical relations may hold between sentences whose meanings bear no relationship whatsoever. Or (in the case of (35c)) they may hold *despite* the meaning relations between the two parts. As we will see, this does not mean that our intuitions about a connection between logical relations and meaning have to be thrown overboard altogether. If we exclude logically true or false sentences, a connection does exist. But for the moment, it is important to realize that logical relations do not warrant a meaning relation, let alone particular meaning relations. Table 4.7 shows the pictures resulting from A or B or both being non-contingent. Note that, in the particular cases assumed, all empty cells can be filled with 'possible' entries.

Table 4.7 contains results already mentioned: two logically true, or false, sentences are equivalent ('impossible' in rows 2 and 3 of cells 4 and 5); if one sentence is logically true and the other logically false, then they are contradictories ('impossible' in rows 1 and 4 of cells 3 and 6). But some results are counterintuitive in the way of the cases in (35). For example, due to 'impossible' in row 2 of these cases, we obtain entailments like the following:

1
A contingent
B logically true

A	B	
1	1	possible
1	0	impossible
0	1	possible
0	0	impossible

2
A logically false
B contingent

A	B	
1	1	impossible
1	0	impossible
0	1	possible
0	0	possible

3
A logically false
B logically true

A	B	
1	1	impossible
1	0	impossible
0	1	possible
0	0	impossible

4
A logically true
B logically true

A	B	
1	1	possible
1	0	impossible
0	1	impossible
0	0	impossible

5
A logically false
B logically false

A	B	
1	1	impossible
1	0	impossible
0	1	impossible
0	0	possible

6
A logically true
B logically false

A	B	
1	1	impossible
1	0	possible
0	1	impossible
0	0	impossible

Table 4.7 Logical relations resulting from logical truth or falsity

(36) case 3 A *2 plus 2 equals 3.* ⇒ B *Ducks are birds.*
(37) case 4 A *2 plus 2 equals 4.* ⇒ B *Ducks are birds.*
(38) case 5 A *2 plus 2 equals 3.* ⇒ B *Ducks are dogs.*

Even more disturbing than these counterintuitive entailments are those cases where logical relations co-occur that one would normally consider incompatible: the cases 2, 3 and 5 all have 'impossible' entries in rows 1 *and* 2, which means that A entails B, but at the same time A and B are contraries.

All this, however, is perfectly in order. It does not mean that the logical relations are ill-defined. As we will see immediately, they do accord to our intuitions when they are applied to contingent sentences. What the 'pathological' cases (to use a term from mathematical jargon) show is that the concepts of entailment, equivalence, contrariety and contradiction lose their significance under special conditions.

4.3.6 Logical relations under the assumption of contingency

Let us now assume that A and B are both contingent. This has far-reaching consequences for the significance of the logical relations. First of all, we may insert the entry 'possible' into many cells of the defining tables. For example, the definition of entailment rules out A-true-B-false. If we also excluded A-true-B-true, the truth of A would be ruled out altogether and A would be logically false. Hence, the assumption that A is contingent allows us to fill

A	B	$A \Rightarrow B$	$A \Leftrightarrow B$	contraries	contradict
1	1	possible	possible	impossible	impossible
1	0	impossible	impossible	possible	possible
0	1		impossible	possible	possible
0	0	possible	possible		impossible

Table 4.8 Logical relations between contingent sentences

in 'possible' in row 1. Likewise, we can make the same entry in row 4: A-false-B-false must be possible because otherwise B would be logically false. Table 4.8 displays the resulting picture for the four relations. (You can easily figure out the other entries yourself.)

The restriction on contingent sentences renders the five relations much more specific. Compared to the original definitions in Table 4.4, the relations here all carry two 'possible' entries in addition to the defining 'impossible' entries, while the general definition of equivalence leaves open whether the cases A-true-B-true and A-false-B-false are possible or not. Fixing these issues makes equivalence between contingent sentences a more specific relation than equivalence in general. As a consequence, the more specific relations in Table 4.8 cannot co-occur freely. (Note that 'possible' and 'impossible' entries in the same row are incompatible, while 'impossible' and 'no entry' are compatible.) Entailment and equivalence cannot co-occur with contrariety and contradiction: for the former two relations, A and B can both be true, but not so for the latter two. Still, some cells remain open. But this is as it ought to be. If these cells too were filled with 'possible', all relations would be mutually exclusive. It would then no longer make sense to say, e.g. that if A and B are equivalent, then A entails B and B entails A.

Within the domain of contingent sentences a further logical relation can be introduced, the relation of non-relatedness, as it were. It is called **logical independence** and holds between two sentences if and only if all four truth value combinations are possible. This amounts to A entailing neither B nor not-B and B entailing neither A nor not-A.

When one tries to find examples for pairs of contingent sentences that are related by one of the logical relations (except independence), one will realize that, now indeed, this is only possible if the sentences bear some meaning connection. For non-contingent sentences to carry such a relation there must be some reason. For example, if two sentences have the same truth conditions and are hence logically equivalent, then they must have similar meanings, because it is the meanings that determine the truth conditions. It cannot be formally proved that a logical relation between contingent sentences is always due to some meaning connection. But the assumption is one of the most important working hypotheses for semantics. It can be formulated as follows:

Working hypothesis
If two contingent sentences exhibit the relation of entailment, equivalence, contrariety or contradiction, this is due to a particular way in which their meanings are related.

The restriction on contingent sentences does not impose any serious limitation on the field of semantic research. Therefore, logical relationships are very valuable instruments for the investigation of meaning relations not only of sentences but also of words (to which we will turn in 4.5). However, as we have seen in connection with non-contingent sentences, logical relations do not in themselves constitute meaning relations – a point we will return to in 4.6.

4.4 Sentential logic

Sentential logic[8] (SL, for short) is a simple formal system with rules for combining sentences, usually simply represented by variables, by means of certain basic connectives and interpreting the results in terms of truth and falsity. Needless to say, the Principle of Polarity is assumed to hold: every simple or complex SL sentence is either true or false. The only connectives to be considered are those whose meaning can be exhaustively described in terms of the truth values of the sentences they are applied to. (This rules out connectives such as *because*, *before*, *but*, *nevertheless*, etc.) We will only introduce two such connectives: $\neg$ for negation and $\wedge$ for ›and‹. Usually, more connectives are introduced but we will not need more than these two.

DEFINITION
Negation in SL
If A is an SL sentence, then $\neg A$ is also one.
$\neg A$ is true iff A is false.
Conjunction in SL
If A and B are SL sentences, then $(A \wedge B)$ is also one.
$(A \wedge B)$ is true iff A and B are both true.

The negation of A, $\neg A$, is read 'not A' (or, using the Latin word for *not*, 'non A') and the conjunction of A and B, $(A \wedge B)$, is read 'A and B'. With these two rules, we can form complex expressions such as:

(39) a. $\neg\neg A$
b. $(A \wedge B)$
c. $(A \wedge \neg A)$
d. $\neg(A \wedge \neg B)$, etc.

It follows directly from the definitions above that certain complex sentences are logically false or logically true *due to their form*. For example, all sentences of the form $(A \wedge \neg A)$ are logically false: according to the definition of negation, A and $\neg A$ necessarily have different truth values; therefore they can never be both true, and so $(A \wedge \neg A)$ is necessarily false. Among the logically false sentences in (15), (15a) has this form. The other three cases call for different explanations.

4.5 Logical relations between words

The logical relations between sentences can easily be exploited to establish corresponding relations between lexemes and other expressions below sentence level. To be precise, this is possible for all predicate expressions (see Chapter 6); these include all nouns, verbs and adjectives, i.e. the major classes of content words. For establishing logical relations between two expressions, we insert them into an appropriate test sentence and check the resulting logical relations. Such test sentences are illustrated in Table 4.9. Since the words to be checked can apply to quite different sorts of things, it is convenient to use variables in the test sentences.[9]

	Test word	Test sentence
count noun	*car*	*x is a car*
mass noun	*mud*	*x is mud*
adjective	*dirty*	*x is dirty*
intransitive verb	*smell*	*x smells*
transitive verb	*sell*	*x sells y*

Table 4.9 Test sentences

Logical equivalence

Let us first consider the case of equivalence. Examples are hard to find, but here are two:

(40) A *x is a female adult* ⇔ B *x is a woman*
(41) A *x costs a lot* ⇔ B *x is expensive*

What follows from these equivalences for the meanings of the expressions? (40) means that whatever can be called a woman can be called a female adult and vice versa. More technically: the potential referents of *woman* and *female adult* are the same, i.e. the expressions have the same denotation.

Similarly, due to (41) *costs a lot* and *is expensive* are true of the subject referents under the same conditions. Rather than introducing a new term, we will extend the notion of logical equivalence to words and complex expressions such as *female adult* and *cost a lot*.[10] Two such expressions are logically equivalent iff they have the same denotation.

Logical subordination

Suppose the test sentences for two expressions result in entailment:

(42) a. A *x is a duck* ⇒ B *x is a bird*
b. A *x enlarges y* ⇒ B *x changes y*

According to (42a), whatever can be called a duck can be called a bird. Put more technically, the denotation of *duck*, the more specific term, is included in the denotation of the more general term *bird*. Due to the second entailment, the denotation of *bend* is part of the denotation of *change*. Every act of bending something is an act of changing it.

The resulting relation between a general term and a specific term will be called **logical subordination** (*subordination* for short): an expression A is a subordinate of an expression B, iff the denotation of A is included in the denotation of B (Figure 4.1). If A is a subordinate of B, B is called a *superordinate* of A. In set-theoretical terms, A is a subordinate of B if and only if the denotation of A is a *subset* of the denotation of B. In the cognitive terms to be introduced in Chapter 9, the denotation of a subordinate term is a *subcategory* of the denotation of its superordinate terms.

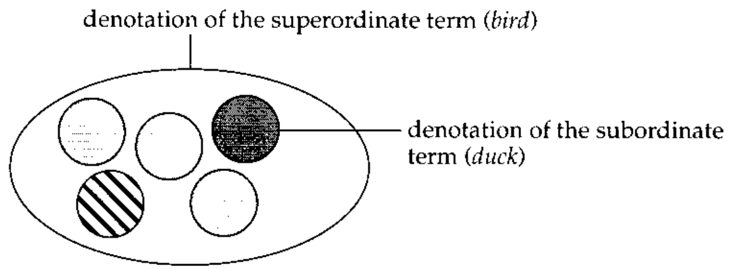

Figure 4.1 Denotations of *duck and bird*

Logical incompatibility

Usually, a superordinate expression does not have just one subordinate, but a set of co-subordinates. For example, all the other terms for types of birds, such as *owl, pigeon, penguin, sparrow, swan* are co-subordinates of *duck*. In addition, they are mutually exclusive: *x is a swan* logically excludes *x is an owl*, and so on for all other pairs. Two terms A and B will be called **logically incompatible** iff their denotations have no elements in common. The

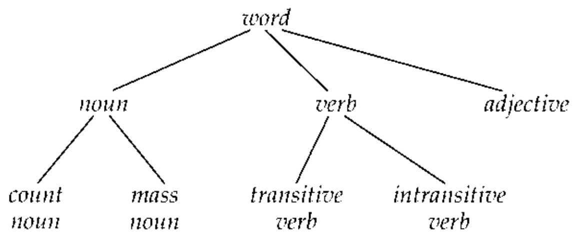

Figure 4.2 Hierarchy of word class terms

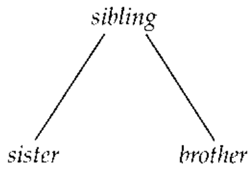

Figure 4.3 Hierarchy of sibling terms

denotation of *swan* could be represented by the hatched circle in Figure 4.1: an area included within the area for the denotation of *bird* and not overlapping with the area symbolizing the denotations of co-subordinates.

The representation of lexemes in hierarchy trees such as in Figures 4.2 and 4.3, a hierarchy for linguistic terms, is based on the two relations of subordination and incompatibility. Since trees are used for representing different relations and structures (e.g. syntactic trees for the syntactic structure), it is important to realize what the arrangement in a given kind of tree signifies. In trees that depict lexical hierarchies, the vertical lines express logical subordination. Co-subordinates are arranged at the same level and understood to be mutually incompatible.

The tree in Figure 4.2 is incomplete in several respects. Further subordinates of *word* could be added, e.g. *article* or *preposition*. We could also expand the tree by adding subordinates of *adjective*. Further subdivisions would be possible below the lowest level, distinguishing sorts of count nouns, intransitive verbs, etc. By contrast, the small tree in Figure 4.3 is, in a sense, complete. In English, there are only two specific terms for siblings: no further co-subordinates can be added to *sister* and *brother*. Also there are no English words for subordinates of *brother* and *sister*. (Other languages, e.g. Hungarian and Japanese, have different terms for elder and younger sisters and brothers.)

Logical complementarity

The subordinates in Figure 4.3 are not only incompatible but form an exhaustive alternative, a strict *either-or* constellation. The corresponding test sentences *x is a sister* and *x is a brother* are logical contradictories – provided we presuppose that x is a sibling. This logical relation is called

Corresponding sentence relation	Word relation	Example
equivalence	**equivalence**	*woman – female adult*
entailment	**subordination**	*bird – duck*
contrariety	**incompatibility**	*duck – swan*
contradiction	**complementarity**	*member – non-member*

Table 4.10 Logical relations between words

logical complementarity: two terms A and B are logically **complementary** iff their denotations have no elements in common and together exhaust the set of possible cases. The notion of complementarity is always relative to a given domain of relevant cases. Absolute complementarity does not occur in natural languages. Take any ordinary noun, for example, *banana;* try to imagine an absolute complementary, say, *non-banana*. The denotation of *non-banana* would have to exclude bananas, but include everything else that could be denoted by any noun whatsoever plus all those things for which we do not have any expressions at all. A word with such a meaning is hard to imagine. Good examples for complementarity are *member–non-member* (domain: persons), *girl–boy* (domain: children), *child–adult* (domain: persons), *indoors–outdoors* (domain: locations). A survey of the logical relations at word and sentence level is given in Table 4.10.

4.6 Logic and meaning

It will now be shown why logical relations are not to be confused with meaning relations such as synonymy and hyponymy (a term to be explained below).

4.6.1 The semantic status of logical equivalence

It is tempting to assume that logical equivalence means identity of meaning, and in fact this is often done in the literature.[11] On a closer look, however, this turns out to be wrong. All logical notions are based on truth conditions and denotations. The first point to be stated is that logical notions only concern descriptive meaning. Second, truth conditions and denotations do not even exhaust this part of the meaning.

Truth conditions and non-descriptive meaning

As to the first point, recall the criteria for correct use with respect to descriptive, social and expressive meaning that were stated in Table 2.5. If, for example, one describes the truth conditions of *this is a barbecue*, one thereby gives a description of the denotation of the word *barbecue*. This, in turn, says something about its descriptive meaning, which determines the denotation. In this sense, truth conditions bear on descriptive meaning. But they have nothing to do with social meaning and expressive meaning. For example, the German sentence and the English sentence in (43) differ in the meanings of the pronouns *Sie* and *you* (cf. 2.3.1; we take the rest of the sentences to be equivalent, in particular the verbs *verhaften* and *arrest*).

(43) a. *Ich werde Sie verhaften.*
b. *I will arrest you.*

The German pronoun of address *Sie* has the same descriptive meaning as *you*, but in addition a social meaning indicating a formal relationship between speaker and addressee(s). The difference, however, does not bear on the truth conditions. If the speaker of the German sentence used the informal pronoun of address instead, the resulting sentence would have exactly the same truth conditions, although it might be socially inappropriate. Similarly, expressions with the same descriptive but different expressive meanings do not differ in truth conditions. Opting, for example, for (44b) rather than (44a) is not a matter of the objectively given facts but of subjective preference.

(44) a. *John didn't take his car away.*
b. *John didn't take his fucking car away.*

Consequently, words and sentences may be logically equivalent, but differ in non-descriptive meaning. We will now see, that logical equivalence does not even mean equal descriptive meaning.

Logical equivalence and descriptive meaning

As we saw in 4.2, all logically true sentences have identical truth conditions. Hence they are all logically equivalent. Clearly, logically true sentences may differ in descriptive meaning (cf. the examples in (14)). The same, of course, holds for logically false sentences (see (15)). Thus non-contingent sentences provide a particularly drastic class of examples of logically equivalent sentences with different meanings. But even for contingent sentences, equivalence does not mean that they have the same descriptive meaning. To see the point, consider once more sentences (25)–(27), here repeated for convenience:

(25) A *Today is Monday.* ⇔ B *Yesterday was Sunday.*
(26) A *The bottle is half empty.* ⇔ B *The bottle is half full.*
(27) A *Everyone will lose.* ⇔ B *No-one will win.*

Intuitively, in the three cases A and B do not have the same meaning, but somehow they amount to the same. They express the same condition in different ways. It is part of the meaning of (25A) that the sentence refers to the day that includes the moment of utterance, and part of the meaning of (25B) that it refers to the immediately preceding day. (26B) highlights what is in the bottle, and (26A) what is not. (27A) is about losing, (27B) about winning. What determines the situation expressed by a sentence, i.e. its proposition, are the elements of the situation and how they are interlinked. The situation expressed by (25A) contains the day of the utterance as an element and specifies it as a Monday. The situation expressed by (25B) is parallel, but different. More than simply defining truth conditions, a natural language sentence represents a certain way of describing a situation which then results in certain truth conditions. Whenever we speak, we make a choice among different ways of expressing ourselves, of putting things; we are not just encoding the facts we want to communicate. There is usually more than one way to depict certain facts.

Although less obvious, the analogue holds for lexemes. For example, in German the big toe is called either *großer Zeh* (›big toe‹) or *dicker Zeh* (›thick toe‹) or, by some people, *großer Onkel* (›big uncle‹). In Serbo-Croat the big toe is called *nožni prst*, ›foot thumb‹. These would all be terms with different descriptive meanings because they describe what they denote in different ways. More examples of logically equivalent expressions with different descriptive meanings can be easily found if one compares terms from different languages which have the same denotation. English has the peculiar term *fountain pen* for what in German is called *Füllfederhalter* (›fill feather holder‹, i.e. a ›feather holder‹ that can be filled) or just *Füller* (›filler‹, in the meaning of ›something one fills‹); in Japanese, the same item is called *mannenhitsu*, literally ›ten-thousand-years brush‹. For a bra, German has the term *Büstenhalter*, ›bust holder‹; the French equivalent *soutien-gorge* literally means ›throat(!) support‹, while Spanish women wear a ›subjugator‹ (*sujetador*) or ›support‹ (*sostén*) and speakers of the New Guinea creole language Tok Pisin put on a ›prison of the breasts‹ (*kalabus bilong susu*). Different languages may adopt different naming strategies for the same categories of things. An interesting field is terms for technical items. The English term *power button* (e.g. of an amplifier) rests on the concept ›button‹, which is borrowed from the domain of clothing, and connects it in an unspecific way with the concept ›power‹, again a metaphor. The equivalent French term is *interrupteur d'alimentation*, literally ›interrupter of supply‹; the object is primarily named after its function of interrupting the current – a somewhat arbitrary choice, since the power button can also be used for switching the device on; the second part *d'alimentation* specifies what is interrupted, namely the ›alimentation‹, a metaphorical term for power supply, originally meaning ›feeding‹, ›nourishing‹. German has yet a different solution for naming that part: *Netzschalter*, ›net switcher‹, where ›Netz‹ is the mains.

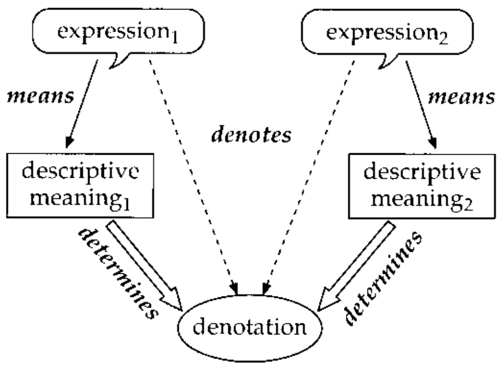

Figure 4.4 Logically equivalent expressions with different descriptive meanings

Thus, let us fix the following important point:

> Logical equivalence is not a sufficient criterion for having the same meaning.

In other words: logically equivalent expressions are not necessarily synonymous (3.3). Equivalence is not even sufficient for descriptive synonymy. The converse is, of course, true: since the descriptive meaning determines truth conditions and denotations, two expressions with the same descriptive meaning necessarily are logically equivalent. Employing the semiotic triangle in a somewhat distorted form, Figure 4.4 displays a configuration of two equivalent expressions with different descriptive meanings.

4.6.2 The semantic status of logical entailment

The fact that the denotation of a logical subordinate is a subset of the denotation of the superordinate may be due to a reverse relation between the descriptive *meanings* of the two terms. Let us roughly consider the descriptive meaning as a set of conditions that a potential referent must fulfil. Then a 'duck' must fulfil all conditions a 'bird' must fulfil plus those particular conditions that distinguish ducks from other sorts of birds. The descriptive meaning of *duck* in this sense contains [all the conditions which make up] the descriptive meaning of the superordinate term *bird*. This is what we intuitively mean when we say that the term *duck* is 'more specific' than the term *bird*. Generally, A ⇒ B may be due to the fact that the meaning of A fully contains the meaning of B. This is the case, for example, for the sentences in (45): A has the same meaning as B except for the addition that the beer is cool.

(45) A *There's cool beer in the fridge.*
B *There's beer in the fridge.*

However, since entailment is only a matter of truth conditions, there need not be such a close connection between sentences or other expressions related by entailment. (46) is a simple example of two sentences A and B where A entails B, but the meaning of B is not contained in the meaning of A:

(46) A *Today is Sunday.*
B *Tomorrow is not Friday.*

The analogue holds for logical subordination between words. Consider, for example, the expressions *son of x's mother-in-law* and *x's husband*. One's husband is necessarily a son of one's mother-in-law. Hence, *x's husband* is a subordinate of *son of x's mother-in-law*. But while the meaning of *x's husband*, i.e. the definition of the potential referent, is something like ›man x is married to‹, the meaning of *son of x's mother-in-law* is ›male child of the mother of the person x is married to‹. The latter contains the mother-in-law as an element of the definition, but this element is not part of the definition of *husband*. Therefore, the meaning of the superordinate is not part of the meaning of the subordinate.

Some authors use the term *hyponymy* for logical subordination.[12] In this volume, *hyponymy* will be reserved for the meaning relation that holds between A and B if the meaning of A is fully contained in the meaning of B. The notion will be formally introduced in the next chapter. The point to be stated here, in analogy to the relationship between logical equivalence and identity of meaning, is thus:

> Logical entailment and subordination do not necessarily mean that the meaning of one expression is included in the meaning of the other.

Analogues hold for the other relations, logical incompatibility and complementarity. For example, as we could see in connection with (32) and (33), A and B can be logical contradictories without one being the negation of the other (cf. the definition of negation on pp. 61–2).

4.6.3 Logic and semantics

The discussion has shown that logical properties and relations do not directly concern meaning. Rather, they concern denotations and truth conditions, an aspect of linguistic expressions which is *determined* by meaning, more precisely by descriptive meaning. A logical approach to meaning is therefore limited as follows:

- It does not capture those parts of meaning that do not contribute to the determination of truth and reference. Expressions with the same descriptive meaning but different social or expressive meanings cannot be distinguished by logical methods.
- It does not capture descriptive meaning itself, but only some effects of it.
- It does not capture differences between the descriptive meanings of expressions with identical truth conditions or denotations. In particular, it fails to yield any insights into the meanings of non-contingent sentences.

If the limitations of the logical approach, and the nature of the results it is able to produce, are carefully kept in mind, it is, however, a powerful instrument for the semanticist. Due to the fact that truth conditions and reference are determined by descriptive meaning, the logical approach can produce the following kinds of results:

- If two expressions are not logically equivalent, their meanings are different.
- If an expression A does not entail an expression B, the meaning of B is not part of the meaning of A.
- If one of the logical relations holds between two expressions, their descriptive meanings must be closely related.

The logical approach therefore provides us with simple instruments to test expressions for their meaning relations with others. This makes logical relations very important data for semantic analysis. If two expressions are equivalent, or if one entails, or excludes, the other, this is a fact which semantic analysis has to account for.

Checklist

Law of Contradiction	logical entailment
Law of the Excluded Middle	logical equivalence
Principle of Polarity	logical contradictories
truth	logical contraries
truth conditions	logical independence
truth value	logical equivalence
negation	subordinate
contingent	superordinate
logically true	complementarity
logically false	logical incompatibility

Exercises

1 For the following sentences, which one is the proper negation, A or B? Check the truth conditions of A and B: which one is necessarily true if the positive sentence is false?

(a) *It's always raining here.* A *It's never raining here.* B *It's not always raining here.*
(b) *All the kids are sick.* A *All the kids are not sick.* B *Not all the kids are sick.*
(c) *Somebody helped me.* A *Nobody helped me.* B *Somebody did not help me.*
(d) *She's still here.* A *She's not yet here.* B *She isn't here anymore.*

2 Which of the following statements are true, which ones are false?
(a) If A is logically true, then not-A is logically false.
(b) If A is contingent, then not-A is either logically true or logically false.
(c) A and not-A are always logically contrary.
(d) If A entails not-B, then B entails not-A.
(e) It is logically impossible that A entails not-A.

3 Define logical equivalence, logical contrariety and logical contradiction in terms of logical entailment.

4 Check the following pairs of sentences A and B: which truth-value combinations are possible? Do they represent cases of logical entailment, equivalence, contrariety, contradiction or none of these relations?
(a) A *John sold the book to Mary.* B *Mary bought the book.*
(b) A *I turned the light off.* B *It's dark now.*
(c) A *Many liked the show.* B *Nobody liked the show.*
(d) A *Some of the kids are sick.* B *Some of the kids are not sick.*
(e) A *Only 50 per cent of the people here have a job.* B *Fifty per cent of the people here don't have a job.*

5 Which logical relation applies to the following pairs of words?
(a) *vehicle, bus* (b) *bus, train*
(c) *married, unmarried* (d) *pleasant, unpleasant*
(e) *buy, sell* (f) *above, below*

6 Which possible parts of meaning are not captured by the logical method and why are they not?

7 Discuss the limits of the logical method for the investigation of descriptive meaning.

8 Discuss the ways in which the logical method is useful for the investigation of word meaning.

Further reading

Cruse (1986, Chapter 4) for logical relations between words. Partee et al. (1993, Chapter 6) for definitions of the logical properties and relations with respect to logic.

Notes

[1] When we talk of sentences in this chapter, it is tacitly understood that we talk of *declarative* sentences. The question of truth or falsity does not immediately apply to interrogative sentences (questions), imperative sentences (commands) or other non-declarative sentence types.

[2] This trait of human language will play an important part in the discussion of prototype theory in 9.5.

[3] In other terminologies, logically true sentences are called *tautologies* (*tautological*) or *analytical* and logically false sentences *contradictions* (*contradictory*). Informally logically false sentences were referred to as 'self-contradictory' above.

[4] As we have seen in 4.1.1, sentences such as (15a) and (15b) are readily reinterpreted as to make *some* sense. But this does not keep such sentences from being logically false in their literal reading.

[5] An alternative term is *logical consequence*.

[6] *If and only if*, sometimes abbreviated *iff*, connects two conditions that are equivalent. *If and only if* constructions are the proper form of precise definitions.

[7] There is no connection between the notion of a 'transitive relation' and the syntactic notion of a 'transitive verb'.

[8] Sentential logic is also called *propositional logic* and *statement logic*. We prefer the term *sentential logic*, because the units of the system are sentences, rather than statements or propositions. It is sentences which are connected by connectives, and it is sentences for which the logical notions are defined.

[9] In English, count nouns and mass nouns differ as follows: count nouns usually allow both singular and plural forms, they require an article when they are in the singular; mass nouns allow only for the singular (when a mass noun is used in the plural, its meaning is shifted as to yield a count noun reading), they can be used as 'bare mass nouns' without an article.

[10] Some authors consider logical equivalence a variant of synonymy, for example Cruse (1986, p. 88), who uses the term *cognitive synonymy* for the same relation. Synonymy and equivalence must, however, be distinguished, a point we will come back to in 4.6.1.

[11] For example in Lyons (1995, p. 63).

[12] For example, Lyons (1977), Cruse (1986).