# Logical Sequence Relations in the Framework of Arguments II

by Satoshi Ohashi

## 1. Introduction

The purpose of this essay is to supplement and expand what was attempted in another essay published in the last volume.[1] The terminology here, therefore, is mostly carried over from the previous work and for the notions that were explained there I will not repeat the same explanation.

In the previous essay, a logical sequence represented by p→q was presumed to underlie various types of complex sentence. This implicit premise was crucial for the explanation of the deductive relationship between a subordinate clause and its main clause. In Section 2 below, several reasons for presuming the implicit premise are presented for the purpose of reviewing and supplementing the previous paper. In Section 3, some types of clause relation are compared with respect to the denial of the main clause. This makes clear the logical characteristics of each type, and at the same time implies the necessity to expand the scope of our analysis. It is expanded in Section 4 by incorporating the presumed knowledge of the context in which the premise p→q is established. The relationship between such knowledge and p→q is explained as the latter being inferred from the former either deductively or inductively. In Section 5, a sentence expressing the reason for the logical contradiction of the CONCESSION-CONTRAEXPECTATION relation is regarded as denying the presumed knowledge on which the premise p→q is based. Similarly related to the presumed knowledge is the information expressed in *unless*-clauses, which is regarded as its explicit realisation. In Section 6, the whole process discussed in this essay is diagrmatically described.

## 2. Review

In the previous essay, I attempted to see four types of Logical Sequence

Relation: CONDITION-CONSEQUENCE, CAUSE-EFFECT, MEANS-PURPOSE and CONCESSION-CONTRAEXPECTATION, in the framework of hypothetical syllogisms: Modus Ponen and Modus Tollen. This view will be maintained and is briefly explained here. For instance, a CAUSE-EFFECT relation represented by such a sentence as:

(CAUSE) (EFFECT)
(1) Because Tom made an effort, he passed the exam

is explained to be produced in a process which is diagrammatically described in the form of Modus Ponen as follows:

Diagram 1

p q (Grammatical concord
one make an effort → one pass an exam is intentionally
p breached here)
Because Tom made an effort
(CAUSE)

---

q
he passed the exam
(EFFECT)

Sentence (1) has the underlying logical sequence p → q which functions as the first premise of the Modus Ponen and, together with the second premise functioning as the CAUSE member, brings out the conclusion which functions as the EFFECT member. The logical sequence is presumed to be a time sequence between two general concepts with no particular tense or modality, which explains the intentional breach of the grammatical concord in the diagram above. As the diagram shows, the general concepts themselves are not assingned any particular membership such as CAUSE and EFFECT, which are attached to the elements p and q at later stages in the development of the argument. It might be possible, however, to translate the logical sequence in a linguistic form as a conditional sentence such as

(2) If one makes an effort, one passes an exam.

The reason for presuming the presence of this unstated premise p → q is to explain the deductive relation between the two clauses of Sentence (1). Instead of regarding the EFFECT member as deduced from one premise represented as the CAUSE member, we regard it as the conclusion of the whole argument: p → q, p ⊢ q. It is impossible to deduce anything from just one premise p, but the presence of another premise p → q makes it possible to deduce q from p as the inevitable conclusion.

By assuming the presence of the premise p → q, we can also explain the relationship between other types of Logical Sequence Relation such as follows:

(CONDITION)　　(CONSEQUENCE)
(3) If Tom makes an effort, he may pass the exam.
(MEANS)　　(PURPOSE)
(4) Tom should make an effort in order that he should pass the exam.
(CONCESSION)　　(CONTRAEXPECTATION)
(5) Although Tom made an effort, he did not pass the exam.

Sentences (3)-(5) are considered to share the same premise p → q as Sentence (1). As to Sentences (3) and (4), their production is also described by Diagram 1 with the proper changes of membership attached to p and q. As to Sentence(5), the same p → q is linguistically realised as *although p, not q*. The diagram for Sentence (5) is as follows:

Diagram 2

p　　q
one make an effort　→　one pass an exam
p
Although Tom made an effort
(CONCESSION)

(q)(he passed the exam)
* ¬q he did not pass the exam
(CONTRAEXPECTATION)

This diagram is meant to show the denial of the expected conclusion (q) by the CONTRAEXPECTATION member $\neg q$. Only by assuming the premise $p \rightarrow p$ can we explain the logical contradiction intrinsic to the CONCESSION-CONTRAEXPECTATION relation.

On the other hand, if we did not presume the premise $p \rightarrow q$, Sentence (5) would not be regarded as related to Sentences (1), (3) and (4). Instead, such a sentence as

(6) Althought Tom made an effort, he passed the exam

might be regarded as related to them. In this case, however, the similarity between each sentence is simply that the same pair of propositions are connected by different subordinators and such comparison does not reveal at all the logical property unique to each type of Logical Sequence Relation. In the approach pursued here, Sentence (6) is not logically related to the other sentences because its underlying premise is linguistically represented as

(7) If one makes an effort, one does not pass an exam

and is very different from Sentence (2).[2]

Furthermore, by assuming the premise $p \rightarrow q$ we can explain the relationship between the group of sentences discussed above and the following group of sentences produced by the other type of argument Modus Tollen ($p \rightarrow q,\ \neg q \vdash \neg p$):

(8) Because Tom did not want to pass the exam, he did not make an effort.
(9) If Tom does not want to pass the exam, he may not make an effort.
(10) Although Tom did not pass the exam, he had made an effort.

In these sentences, the element q is negated as $\neg q$ and is now expressed as a CAUSE in (8), a CONDITION in (9), and a CONCESSION in (10). Sentences (8)(9)(10) respectively correspond to Sentences (1)(3)(5) in that they are the

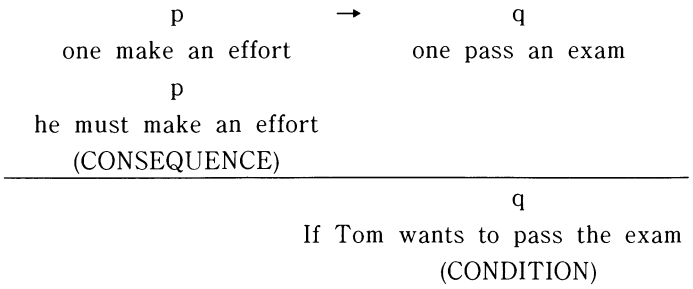
sentences of the same type of Logical Sequence relation. As to Sentence (4), however, it seems to be impossible to express ¬q as a MEANS member and ¬p as a PURPOSE member; the Clause Relational signal of the relation *in order that* is always attached to q or ¬q. This might be a logical property characteristic to the MEANS-PURPOSE relation.

Besides, by assuming the premise p → q, whose elements p and q are assigned their Clause Relational membership at other stages of the argument, such a sentence as (11) below might also be explained as related to the same premise p → q.

(11) If Tom wants to pass the exam, he must make an effort.

In Sentence (11) the element q is expressed as a CONDITION member and the element p as its CONSEQUENCE member. If we mechanically translate the linguistic form *if x, then y* always as x → y, we have to presume another logical sequence q → p for Sentence (11). Sentence (11), however, seems to imply the p → q expressed as Sentence (2) as Sentence (3) does. In addition, semantically, it looks like the MEANS-PURPOSE relation expressed as Sentence (4), and it is not feasible to consider them to derive from different logical sequences. In the approach pursued here, however, it is possible to explain Sentence (11) as sharing the same p → q by assuming that the elements p and q are endowed with their Clause Relational membership at other levels of the argument as shown in the diagram below:

Diagram 3



This diagram is meant to show that in the process of linguistic realisation the CONSEQUENCE membership is attached to p and the CONDITION membership to q, which results in the switch of membership between Sentences (3) and (11). Sentence (11) might be defined as a case where the Clause Relational order — CONDITION first and then CONSEQUENCE — is in conflict with the logical order of p and q — p first and then q — in the development of the argument.

A similar phenomenon can be observed when such a sentence as (12) below is considered in terms of Modus Tollen.

(12) If Tom does not make an effort, he may not pass the exam.

In Sentence (12) $\neg p$ is expressed as a CONDITION member and $\neg q$ as its CONSEQUENCE member. It might be possible, therefore, to assume an underlying premise $\neg p \rightarrow \neg q$ for the sentence.On the other hand, it is also possible to consider this sentence to derive from the same $p \rightarrow q$ which is expressed as Sentence (2). In this interpretation Sentence (12) is logically related to the other sentences explained so far. The close relationship between them is implied by the fact that Sentence (12) is a result of so called *invited inference* from Sentence (3).[3] Invited inference is a logically incorrect type of inference in which *if* $\neg p$, *then* $\neg q$ or *if q, then p* is incorrectly inferred from *if p, then q*. Although it is regarded as logically incorrect, Sentence (12), which has the logical form *if* $\neg p$, *then* $\neg q$, is inclined to be inferred from Sentence (3), which has the logical form *if p, then q*. This phenomenon might be explained in the approach pursued here as the case where the proper logical order of the elements in the development of Modus Tollen — $\neg q$ first and then $\neg p$ — is in conflict with the Clause Relational order — CONDITION first and then CONSEQUENCE. As a result, $\neg p$ is realised as the CONDITION member and $\neg q$ as the CONSEQUENCE member. The whole process might be described by the following diagram.

Diagram 4

p → q

one make an effort — one pass an exam

¬q

he may not pass the exam

(CONSEQUENCE)

---

¬p

If Tom does not make an effort

(CONDITION)

Thus, there seems to be a lot of explanatory advantages in assuming the presence of the unstated premise p → q.

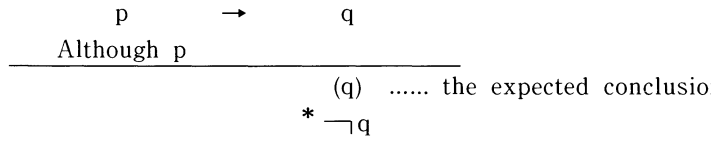
## 3. The denial of the expected conclusion

In this section three types of Logical Sequence Relation are compared with respect to the denial of the logically expected conclusion. The difference between them reveals the characteristic feature of each type of relation. Through this comparison, it becomes clear that the scope of analysis has to be expanded so that it includes the encoder's knowledge supporting p → q. The Logical Sequence Relations to be compared are the CONDITION-CONSEQUENCE, CAUSE-EFFECT and CONCESSION-CONTRAEXPECTATION relations. The sentences used for the comparison are shown below:

(13) If Tom makes an effort, he may pass the exam.
(14) Because Tom makes an effort, he may pass the exam.
(15) Although Tom makes an effort, he may not pass the exam.

The CONCESSION-CONTRAEXPECTATION relation represented by (15) is explained as a relation in which an expected conclusion is denied, which causes some logical frustration. The resultant frustration is shown by the asterisk beside ¬q in the diagram of the relation below.

Diagram 5




The denial of the expected conclusion is, thus, intrinsic to the CONCESSION-CONTRAEXPECTATION relation. On the other hand, the denial of the conclusion with respect to the CONDITION-CONSEQUENCE relation is achieved by supplying another sentence which denies the CONSEQUENCE member as follows:

(16) If Tom makes an effort, he may pass the exam.
But actually he won't pass the exam.

As to the denial of the EFFECT member of the CAUSE-EFFECT relation, we have to modify the sentence as follows:

(17) Because Tom makes an effort, he is expected to pass the exam.
But actually he won't pass the exam.

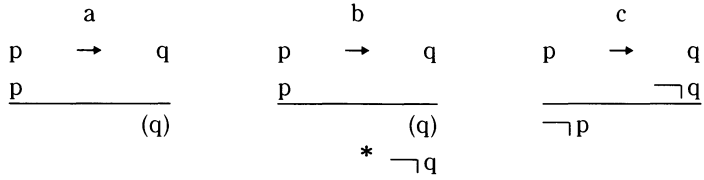
We now have the denial of the expected conclusion with respect to all the three types of relation. The difference between them, however, becomes obvious when we consider the way the logical frustration caused by the denial is resolved in each type of relation.

In order to release the logical frustration in (16), we can add another sentence represented by ¬p as follows:

(18) a If Tom makes an effort, he may pass the exam.
b But actually he won't pass the exam.
c He makes no effort.

This means that the last sentence of (18) supplies the reason for the denial

and the whole sequence attains the logical consistency. The consistency is attained by switching the development of argument from Modus Ponen to Modus Tollen. This process might be described diagrammatically as follows:
Diagram 6




In (a) the conclusion of Modus Ponen is expected to be realised and this expectation is counterd in (b). In (c) ¬p is supplied to attain the consistency of the argument as Modus Tollen. The contradictory ¬q in (b) is reinterpreted as the second premise of Modus Tollen in (c). In this process, the validity of the logical sequence $p \rightarrow q$ is preserved.

On the other hand, the logical frustration caused in (15) and (17) are not released in the same way; the sentence represented by ¬p cannot follow them as shown by (19) and (20):

(19) Although Tom makes an effort, he may not pass the exam.
* He makes no effort.

(20) Because Tom makes an effort, he is expected to pass the exam. But actually he won't pass the exam.
* He makes no effort.

This implies that whereas the information expressed as CONDITION member is deniable, the information expressed as the CONCESSION member or the CAUSE member is not.

In order to resolve the logical frustration caused in (15) and (17), it is required to supply a reason as follows:

(21) a Although Tom makes an effort he may not pass the exam.

b He is using very old textbooks.

(22) a Because Tom makes an effort, he is expected to pass the exam. But actually he won't pass the exam.
b He is using very old textbooks.

It is possible to consider that Sentence b in (21) and (22) invalidates the logical sequence p → q by presenting the new information which totally changes the presumed knowledge supporting the premise p → q. At the time of encoding (a), the premise p → q is actually supported by a lot of unstated background information taken for granted in the context, such as: *Tom must be mentally competent; The exam is not too difficult; The textbooks he is using are proper ones.* Only in the state of the world where such information is true is the premise p → q also believed to be true. It is this state of the world which Sentence b changes and thereby invalidates the premise. The premise p → q is encoded in the state of the world where the textbooks Tom is using are suitable ones. If they are found very old, it is quite another story and the premise p → q is no longer true. Thus, the release of logical frustration in (21) and (22) is achieved not by establishing logical consistency as in the case of (18) but by nullifying the initially attempted argument.

## 4. Deductive and inductive inferences for the logical sequence

The discussion in the previous section has brought to our attention the necessity to consider the encoder's knowledge of the state of the world in which the logical sequence p → q is true. In this section I attempt to describe the process in which sentences of Logical Sequence Relation are produced in an accordingly expanded framework which incorporates such knowledge. Special attention will be paid to two possible processes in which the premise p → q is established: deductive inference and inductive inference. For the sake of convenience, the example sentence used here is the traditional one about Socrates' mortality:

(23) If Socrates is a man, he is mortal.

This sentence is considered to derive from an underlying logical sequence p → q which can also produce other types of Logical Sequence Relation. The premise p → q might be expressed as follows:

(24)　　p　　　　q
　　X is a man　→　X is mortal
　　or
　　All men are mortal (This is a direct linguistic translation of the premise)

This premise, as we have seen in the previous section, is dependent on the encoder's knowledge of the state of the world in which the premise is established. It might include information, such as: *No medicine for eternal life has been discovered; All men have natural organs which are not replaceable like parts of machine; No men are known to have lived more than 150 years; All men are alive; Everything alive dies.* This type of knowledge comprises the context where the logical sequence p → q is established.

One of the processes in which p → q is established is a deductive process in which syllogism is in operation: p → r, r → q ⊢ p → q. For instance, if the encoder mentalises the element *X is a man* in the context mentioned above, it automatically establishes a logical sequence relation with the element *X is alive* because of the contextual knowledge such as *all men are alive,* which may be expressed as *X is a man → X is alive.* The element *X is alive* in turn establishes a logical sequence relation with the element *X is mortal* because of the contextual knowledge such as *everything alive dies,* which might be expressed as *X is alive → X is mortal.* As a conclusion the logical sequence p → q, that is, *all men are mortal* is deduced. This is an example of a deductive inference in which the logical sequence p → q is established. The intermediary element r may vary according to which contextual information is used for the deduction.

The other process in which the logical sequence p → q is established is explained as inductive inference.[4] In inductive inference the encoder identifies two common features between what is compared in the context.

They function respectively as p and q between which the logical sequence is established. For example, in the state of the world where the encoder knows that her grandmother died, that her teacher died, and that her friends died and so on, she can identifies two common features between these events: the fact that her grandmother, her teacher and her friends are all human and the fact that all of them died. Between these features the encoder establishes the logical sequence $p \rightarrow q$, that is, *all men are mortal.*

Thus, in both patterns of its establishment the logical sequence $p \rightarrow q$ is actually supported by a lot of contextual information. Such information is taken for granted and usually is not explicitly shown, although there are some cases in which it is explicitly expressed. Some of these cases are discussed in the next section.

## 5. The explicit signal for the presumed context

The logical sequence $p \rightarrow q$ is supported by a lot of contextual information but it is not stated explicitly. As we saw in Section 3, however, the sentence expressing the reason after the CONCESSION-CONTRAEXPECTATION relation is regarded as evidence for such information. This type of sentence is considered to nullify the logical sequence by changing the context in which it was initially established. If we represent the sentence by r, $\neg r$ was presumed to be true in the initial context. The sentence represented by r denies the presumed knowledge $\neg r$ and thereby invalidates the initial deduction. This phenomenon might be observed in the following pair of sentences about Socrates' mortality:

(25) a Although Socrates is a man, he is not mortal.
b He has invented a medicine for eternal life.

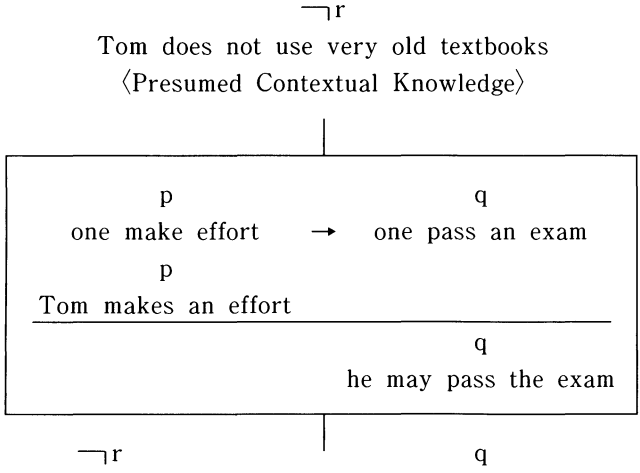
(25) b denies the presumed knowledge that no such medicine has been invented and thereby nullifies the logical sequence established on the basis of this information.

In addition to these sentences which invalidate the original context, there is another explicit signal for the presumed knowledge: *unless*-clauses.

They are considered to be a type of signal for the CONDITION-CONSEQUENCE relation, but their logical function is different from that of *if not p, q,* although they are often treated as sharing roughly the same function. The following sentences might show how the signalling function of *unless*-clauses is performed:

(26) Unless Tom uses very old textbooks, he may pass the exam.
(27) Unless a medicine for eternal life is invented, Socrates is mortal.

The *unless*-clauses in these sentences exclude beforehand the possible context in which the logical sequence is invalidated. The element p of the logical sequence $p \rightarrow q$ is not linguistically realised and instead the exceptional condition $\neg r$ is expressed in the *unless*-clause which is connected with the conclusion q. The process in which (26) is produced might be diagrammatically shown as follows:
Diagram 7.




Unless Tom uses very old textbooks, he may pass the exam.

This diagram is meant to show that $\neg r$ restricts the context in which the deduction takes place. The rectangle is supposed to represent the world

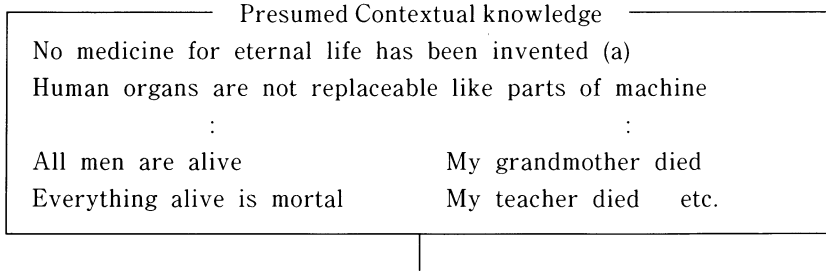
where the possibility of the textbooks being very old is excluded from consideration. In the resultant sentence ¬r is expressed in the *unless*-clause connected with the conclusion q, whereas the element p is not realised.

The function of *unless*-clauses thus understood gives us a clue to the difference between this type of clause and another type of clause, *if not p* which is often treated similarly. While the former is used to restrict the context in which the conclusion is deduced, the latter might be regarded as part of a linguistic representation of the logical sequence ¬p → q. The function of *if not p* is related to the world within the rectangle of Diagram 7, that is, the process of deduction itself, whereas *unless*-clauses are related to the rectangle, that is, restriction of the context.

## 6. Diagram for the whole process

In this section, a diagrammatic description of the whole process discussed in this essay is attempted with the sentence about Socrates' mortality used as an example.

Diagram 8



**Establishment of p → q**

| | |
|---|---|
| p　　r<br>X is a man → X is alive<br>r　　q<br>X is alive → X is mortal | My grandmother and my teacher affirmatively compare with respect to the features of manhood and mortality |
| p　　q<br>X is a man → X is mortal | All men are mortal |
| All men are mortal | |
| 〈Deductive Inference〉 | 〈Inductive Inference〉 |

**Membership assignment**

| | |
|---|---|
| p　　q<br>X is a man　X is mortal | p　　q<br>X is a man　X is mortal |
| p | ¬q |
| Socrates is a man | Socrates is not mortal |
| (CONDITION) | (CONDITION) |
| q | ¬p |
| he is mortal | he is not a man |
| (CONSEQUENCE) | (CONSEQUENCE) |
| 〈Modus Ponen〉 | 〈Modus Tollen〉 |

**Sentence production**

a. If Socrates is a man, he is mortal.

b. If Socrates in not mortal, he is not a man.

〈Logical order is in accordance with Clause Relational order in these sentences〉

c. If Socrates is mortal, he must be a man.

d. If Socrates is not a man, he is not mortal.

〈Logical order is in conflict with Clause Relational order in these sentences

e. Unless a medicine for eternal life has been invented, Socrates is mortal.

〈The state of world ¬a is excluded from consideration〉

This diagram is for the production of sentences of CONDITION-CONSEQUENCE relation. Therefore, the assignment of membership is exemplified by the labels CONDITION and CONSEQUENCE, but other types of membership might also be assigned to the elements p and q, resulting in sentences of different types of Logical Sequence Relation.

The stage of membership assignment, for lack of space, only shows the process relevant to Sentences a and b in which logical order and Clause Relational order are in agreement. As we saw in Section 2, however, it is possible to assume another process of membership assignment which produces sentences such as c and d.

Another point to be noted is also about the stage of membership assignment. So far, in all the diagrams the subordinator *if* was always expressed as part of the element p or q. In the diagram above, however, it is omitted, since membership is not necessarily in one-to-one relationship with its linguistic signals and the selection of a particular subordinator seems to be better treated in the last stage of sentence production. This modification does not change the main points discussed so far.

The stage of sentence production is concerned with assigning the particular tense and modality such as the one expressed by *must* in c in order to realise the sentence in accordance with the pattern of membership determined in the previous stage.

## 7. Conclusion

My tentative view on the production of Logical Sequence Relation has been summed up in Diagram 8 which describes the process as four successive stages. These stages have been postulated as a result of expanding what was discussed in my previous essay, which was mainly concerned with membership assignment, namely, the third stage of Diagram 8. In the previous essay, by presuming the presence of the logical sequence $p \rightarrow q$, various types of Logical Sequence Relation were explained as realising in their characteristic ways the argument of hypothetical syllogism ($p \rightarrow q$, $p \vdash q$) or ($p \rightarrow q$, $\neg q \vdash \neg p$).

In this essay, the perspective has been expanded by incorporating the

stage of presumed contextual knowledge. The contextual knowledge is used to establish the logical sequence p → q and only in the world where such knowledge is true, the logical sequence attains its validity. The process in which the logical sequence is established is explained in two types of inference: deductive inference and inductive inference. The process is described as the second stage in the diagram.

One of the important things to be mentioned here is that logical property of each Logical Sequence Relation must be understood in relation to other sentences with which it comprises a larger context. For instance, only when the CONCESSION-CONTRAEXPECTATION was considered in relation to the succeeding sentence did the notion of presumed contextual knowledge come into our sight. Assuming the presence of such knowledge led to the definition of the function of *unless*-clauses which have different function from that of *if-not* clauses. Similarly, the difference between the CAUSE-EFFECT relation and the CONDITION-CONSEQUENCE relation became clear when they were compared with respect to their deniability. All these facts imply that the logical feature of each relation cannot be correctly grasped if we confine ourselves to the observation within a sentence.

It must be admitted that further elaboration of Diagram 8 is necessary to give more satisfactory explanation of Logical Sequence Relation. For instance, it does not explain why some particular membership is selected. The assignment of membership is assumed to include comparison between the logical conclusion and reality. When CONSESSION-CONTRAEXPECTATION relation is realised, for example, the logical conclusion is against reality. Neither does it explain the encoder's selection between the CAUSE-EFFECT relation and the CONDITION-CONSEQUENCE relation. The selection of the former seems to be related to the encoders's deeper commitment to the validity of the information. These factors must be somehow incorporated into the diagram. However, they seem to be closely related to the problem of modality which belongs to the stage of sentence production, on which I need further research to make any comment.

## NOTES

1. S. Ohashi, (1993) Logical Sequence Relations in the Framework of Arguments. *Research Bulletin of Kagoshima Women's College,* vol. 14, no. 1. There, I briefly discussed some notions presented by Eugine Winter in his theory of clause relational approach towards discourse. They include notions such as Clause Relation, Logical Sequence Relation, Matching Relation, Logical Sequence, Member, Comparative Affirmation, Comparative Denial. For detail information see Winter (1977) & (1982).
2. V.H. Dudman (1991) maintains that English *if*-sentences are generated by four different encoding programmes and accordingly divided into four grammatical *categories.* The first category is called *compound* and an *if*-sentence falls into this category when *if* is selected from the alternatives below:

   Because/as/since/due to the fact that/provided that/
   whether or not/unless/while/despite the fact that/
   (al) though the door was locked, Grannie leapt in through the window.

   Here, the same pair of propositions are connected by various subordinators. The similarity between the sentences produced after the selection of each alternative, however, seems to be only superficial one, since the underlying logical sequence of the sentence connected by *although,* for example, is very different from that of the sentence connected by *if.* It is unlikely in natural sentence production that one has to select between *if* and *although* from the above alternatives. Dudman's approach seems to be based on his viewpoint stated in the same paper: Grammar is a necessary preliminary to semantics.
3. For detail information on invited inference, see Geis & Zwicky (1971).
4. For further discussion on inductive inference, see Section 9 & 10 of my previous essay mentioned in NOTE 1 above. There, a special type of Comparative Affirmation is considered to play an important role for the establishment of logical sequence p → q. It is expressed in a formula: X *and* Y *affirmatively compare with each other with respect to* P *feature and with*

*respect to Q feature.* It is between P and Q that logical sequence is established.

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