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Effect of Clearly Marked Given-new Information on Transitive Inference

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The purpose of the present study was to examine the effect of the pseudo-cleft sentence as the second premise for transitive inference. When the pseudo-cleft sentence as the second premise involved the given term, which was also involved in the first premise, in its presuppositional part, inference was facilitated. Otherwise, the pseudo-cleft sentence was highly confusing for the subjects. These facilitation and hindrance effects held both when the inference concerned *stronger-weaker* relation among the terms (Experiment 1) and when it concerned *rule-be ruled by* relation (Experiment 2). Results were discussed from the viewpoint of integration of given and new information in the premises.

Key words : transitive inference, given-new information, pseudo-cleft sentence

One of the major findings of recent research in human information processing of text is that we can and do integrate individual sentences with each other, and/or with our existing knowledge. What makes a text potentially integratable should be some consistency within the text. The successful integration may depend upon the extent of our effort to discover the consistency, by using the existing knowledge about the aspects of the world relevant to the topic, the writer's communicative intention, and so on.

All above mentioned seem to be true for the transitive inference, known as the "three-term series problem." This type of problem is presented to the subjects, usually as three written sentences, like this : *Tom is better than Sam ; Tom is worse than John ; Then, who is the best ?* In the following, "first premise," "second premise," and "question" are used to denote the three serial sentences composing the problem, respectively. Both premises can be regarded as written under the unifying theme of the relative *goodness* among the men. Also, the two premises share a co-referant, or repeated concept, *Tom*. A unifying theme and a repeated concept are both potential souces of intra-text consistency. Therefore, although the basic process of solving a three-term series problem might be one of using the purely logical property of a relation (transitivity), there seems to be some interesting text-processing aspects to be approached from the viewpoint of information integration.

Let us begin by reviewing Huttenlocher's (1968) argument that her subjects constructed a single linear array of three ordered terms in their imagery spaces, before answering the question. As to the notion of the spatial representation of the ordered terms, Desoto, London & Handel (1965) proposed the similar kind of hypothesis. One of their predictions, known as "principle of end-anchoring," states that it is easy to establish the spatial representation when the premise, whether it might be the first or second, proceed from the end term to the middle one (suppose the relation of $A>B>C$; the "end" means A or C, and the "middle" means B). Huttenlocher restricted this end-anchoring effects just to the second premise. Note that as in the exemplifying problem above, the second premise involves one given term, which is also involved in the first premise, that is the repeated concept, as well as the third, new term, which is never involved in the first premise. According to her prediction, it would be easy to

attach the third term to already fixed two-term array in one's imagery space when the second premise involves the third thrm as its grammatical subject in a relational sentence, or as its logical subject (in other word, the agent of the action) in an active and passive verb sentences. In an active sentence, the logical subject is identical to the grammatical subject, whereas in a passive sentence, it is identical to the gramatical object, or more precisely, the nominal immediately following the preposition *by*.

Potts and Scholz (1975) agreed on Huttenlocher's characterization of the subject's internal representation, based on the results of their own experiments, in which they measured the reading time for premises independently of the question-answering time. But they also casted doubt on the effects of the grammatical status of the third term involved in the second premise. They indicated, for example, the mean reading time for the premise pair : $B>C$; $A>B$ (11.68 s) was not shorter than one for the pair : $A>B$; $B>C$ (11.44 s). They concluded that this results was not congruent with Huttenlocher's prediction. For our starting position, let us accept both Huttenlocher's and Potts & Scholz's arguments as suggesting that, in the process of solving a three-term series problem, the integration of two premises is the major process, and that it would occur as the process of attaching of new information conveyed by the second premise to the tentatively fixed representation of what the first premise has stated.

Huttenlocher (1968; Huttenlocher & Strauss, 1968) explained the integration process in reference to the subject's spatial strategy. This strategy, however, seems to be rather specific to mental ordering of objects. Integrating the premises written in a natural language might involve a more general process which is common to comprehending the begining part of a well-organized text. In such the text, usually, a topic sentence comes first, and is followed by a connected sentence. In this situation, the first sentence inevitablly will be filled with somewhat new elements to the reader. On the other hand, the second, connected sentence will consist of the now given, recoverable elements and some newly added elements. Therefore, the cues for integration of these sentences will be likely more in the second sentence than in the first one. One of such the cues is a repeated concept found in the second sentence, which must have its antecedent in the first one. Another cue may be the surface structure of the sentence. The surface structure has been regarded as telling the reader what part of the sentence the writer stressed (Halliday, 1985; Bever & Langendoen, 1971).

Both the repeated concept and the surface structure concern the given-new strategy in sentence comprehension proposed by Clark & Haviland (1974). According to this strategy, the reader-listener will (1) identify the given and new information respectively, (2) search for the memory representation that matches the given information to, and then (3) revise the memory representation by attaching the new information to it. For the present purpose, let us call these sub-processes "identifying," "matching," and "attaching" process, respectively. Concerning the role of repeated concept, Haviland and Clark (1974) proved that a sentence was understood faster when it involved the word which had a direct antecedent in the proceeding context, than when the antecedent in the context was an indirect one. These results are congruent with their prediction deriven from the theory of given-new strategy. If this factor, directness of antecedent, is kept equal, we can expect the effects of different surface structure will be clearly observed.

Based on the given-new strategy theory, it would be predicted that the more clearly the surface structure of the second sentence marks which part is given and which part is new, the

more helpful it is for the reader to understand the sentence. Therefore, we could also expect such the surface structure will be helpful for the subjects to solve three-term series problems, if it is appropriately adjusted to the second premse. Because in the three-term series problem setting, the repeated concept (*B* in the relations of *A*>*B*; *B*>*C*) is always named by same word in the two premises, we can measure the effects of the surface structure, keeping the effect of directness of the antecedent equally most available.

Let us examine the given-new information structures in Sentences 0−s and 0−p below:

0−s. *Andy is stronger than Bill.*
0−p. *One who is stronger than Bill is Andy.*

The sentence 0−p is obtained by rewriting 0−s as a subject-selective pseudo-cleft sentence, without any change in the basic meaning. The sentences 0−s and 0−p share the same logical meaning, or state the same relation (*Andy*>*Bill*).

It would be soon noticed that 0−p implies that the writer of the sentence presupposes that the reader already knows that someone is stronger than Bill (given information). Also, it would be noticed that the writer of 0−p intended to tell who was so, as a new information. Under this presupposition about the reader's knowledge, 0−p would be pragmatically correct. Therefore, we can regard the 0−p as clealy and correctly marking the given-new information if the presupposition is really justified. Like any other pseudo-cleft sentence, the second premise of 0−p can be parsed into two major parts, that is, the presuppositonal (Ps) and focal (Fc) parts: (Ps) *One who is stronger than Bill*; (Fc) [*The one*] *is Andy*. The pseudo-cleft construction is an example of grammatical presupposition, which means that the grammatical structure may, in itself, tell us what part the writer presupposed the reader already knew (Ps), and what part the writer intended to add as a new information (Fc).

Let Sentences 0−s and 0−p be the second premises for the three-term series problems respectively, below:

x−s. *Charlie is weaker than Bill.*
Andy is stronger than Bill.
Who is the strongest ?
x−p. *Charlie is weaker than Bill.*
One who is stronger than Bill is Andy.
Who is the strongest ?

As to x−p, after the solver has represented the relation given by the first premise, he or she will possibly presuppose that there is another man, who may be stronger than *Bill*, or may be weaker than *Charlie*. Then, the pseudo-cleft second premise is pragmatically correct, because the presupposition is real for the solver. In this case, the solver will solve x−p more easily than x−s, becase x−p marks given-new information more clearly, and this will expectedly facilitate the integration of the second premise to the first one.

For the purpose of comparison, let us predict the relative difficulties between the two problems below:

y−s. *Calvin is weaker than Ben.*
Ben is weaker than Abe.
Who is the strongest ?
y−p. *Calvin is weaker than Ben.*

One who is weaker than Abe is Ben.
Who is the strongest ?

The second premise of y−p is pragmatically incorrect: it has the third term *Abe* in its presuppositional part, where, according to the linguistic convention, a given element should be positioned. Therefore, we can predict that the second premise in y−p will counteract the subject's effort to identify the given and new informations involved in the second premise. And this will result in a poorer performance for y−p than for y−s, where the second pemise is a standard comparative sentence.

In the present study, these predicted facilitation and interference effects of pseudo-cleft sentence as the second premise on the solution of three-term series problems were examied through the two following experiments. In Experiment 1, the predictions given above were tested using the premises that expressed the relations as adjectives (comparative sentences). Experiment 2 concerned the case in which the relations are expressed by using transitive verbs (verb senteces). In both experiments, Japanese-speaking undergraduates were presented the problems written in Japanese. For the Japanese-speaking people, using the pseudo-cleft construction is a conventional way to lay stress.

Experiment 1

Method

Subjects. Fourty-eight undergraduates of Kumamoto University, Japan, voluntarily served as subjects in response to the author's asking. Half of them (control group) were presented a set of 16 standard three-term series problem. The others (experimental group) were presented a corresponding set of another 16 problems, in which the second premises were turned into the pseudo-cleft sentences.

Materials. All materials were written in Japanese. The problems presented to the subjects concerned the linear order among three fictional men along the *stronger-weaker* dimension. There are eight possible ways to make a pair of ordered premises about a relation such as $A>B>C$. (See Table 1.) Becouse each of these eight types of pair were accompanied by each of the questions, that is, *Who is the strongest?* and *Who is the weakest?*, there were 16 different problems in a set. Two corresponding sets of problems were prepared, one for the control group, and another for the experimental group. The standard set, for the control group, consisted of the 16 problems, each with both premises being standard comparative sentences. Sixteen different triplets made out of 48 men's name were respectively assigned to the 16 problems so that no term appeared in more than one problem in the same set. The pseudo-cleft set, for the experimental group, consisted of 16 problems, too. But each problem in this set had the second premise written in pseudo-cleft construction. There was a one-to-one correspondence between the two sets. For example, Type 1−s problem with the weakest-question in the standard set had its only counterpart in the pseudo-cleft set, 1−p, as follows:

1−s. *Masaru is stronger than Hideo. And,*
Tadashi is weaker than Hideo. Then,
who is the weakest?

(In Japanese: *Masaru wa Hideo yori tsuyoi. Soshite, Tadashi wa Hideo yori yowai. Dewa,*

mottomo yowai no wa dare ka?)

1−p. *Masaru is stronger than Hideo. And,*
one who is weaker than Hideo is Tadashi.
Then, who is the weakest?

(in Japanese: *Masaru wa Hideo yori tsuyoi. Soshite, Hideo yori yowai no wa Tadashi da. Dewa, mottomo yowai no wa dare ka?*)

As illustrated by this example, the two corresponding problems shared the same three terms to be ordered, the same first premise, and the same relational term in the second premise. The two problems were different only in the surface structure of the second premise, one being in standard comparative construction, and the other in pseudo-cleft comparative construction. Each problem was typed so that the two premises were in the first line, and the question was in the second line, and then was made into a slide.

Procedure. The subjects were individually instructed, pretrained on two extra problems, and tested on the sixteen problems. They were instructed to read problems in a natural way, i.e., from top to bottom lines as well as from left to right edges of the lines. They were required to orally answer as quickly as possible, but never to do so by random guessing. The presentation of problems and the measurement of solution times were automatically executed by a Toyo Physical Electronic Tachistscope. The problems were displayed on a screen for 20 seconds at a rate of 1 every 24 seconds. A quartz stop clock was started simultaneously with the presentation of a problem, and was stopped by a voice key as soon as the subject begun to say the answer. The experimenter recorded the answer and the solution time in hundredths of a second. No subject complained about the difficulty in reading the problems.

Results

No subject made four or more errors. The sulution time was converted into logarithm whenever an analysis of variance or a t-test was applied to them. All mean values of solution time refered in the following are geometrical ones, which were calculated excluding the errors.

The mean solution time and the percentages of errors are shown in Table 1, organized by pairing each standard problem (upper) with its psedo-cleft counterpart (lower). Concerning Types 1 to 4, whose second premises had the given and new terms disposed like in the exemplifying problems x−s and x−p, the solution time was shorter for the pseudo-cleft than standard material. The one-tailed t-tests were carried out individually on the differences between the paired mean solution time for each Type 1 to 4 in Table 1. The significant differences were observed for Type 1 with both the *strongest* question, $t(45)=2.21$, $p<.01$) and the *weakest* question, $t(45)=2.44$, $p<.01$. On the contrary, concerning Types 5 to 8, whose second premises were like the ones in the problems y−s and y−p, solution time was longer for the pseudo-cleft than the standard materials. The t-tests revealed that the differences were significant for Type 5 with the *weakest* question $t(41)=2.05$, $p<.05$, for Type 7 with *strongest*, $t(42)=2.53$, $p<.01$, and with *weakest*, $t(42)=2.46$, $p<.01$. It should be noted that these significant differences above are the ones between the two corresponding problems in which only the surface structure of the second premise was different.

To estimate the differential effects of the pseudo-cleft second premises between Types 1 to 4 and Types 5 to 8 throughout the whole data, a 2 × 2 analysis of variance was carried out, with the between-subject factor being materials (standard vs. pseudo-cleft), and the

within-subject factor being the grammatical position of given term (GPGT: Type 1 to 4, i.e., as object or presupposition; vs. Type 5 to 8, i.e., as subject or focus). The varience between eight problems within each GPGT condition (four types × two questions) were treated as the residual effects and pooled into the divider when culiculating the F-ratio for the within-subject factor. The main effect of GPGT, $F(1, 666)=59.38$, $MSe=.017$, and the interaction effect of GPGT × materials, $F(1, 666)=39.52$, $MSe=.017$, were significant at level $P<.001$. However, the main effect of material was just trivial, $F(1, 46)<1$. Figure 1 shows the interaction.

The simple main effect of the material were significant for both GPGT conditions: for

Table 1. Geometric mean solution time in seconds with error rate (%) in Experiment 1.

Types of problem	Formatives of the second premise	Questions: *Strongest ?*	Questions: *Weakest ?*
Given term as grammatical object or as presupposition			
1: $A>B, C<B$	s. *C is weaker than B*	8.77 (4)	9.81 (4)
	p. [*weaker than B*] = *C*	7.31 (0)	7.75 (4)
2: $B<A, C<B$	s. *C is weaker than B*	9.14 (4)	8.03 (0)
	p. [*weaker than B*] = *C*	8.42 (4)	7.63 (0)
3: $B>C, A>B$	s. *A is stronger than B*	7.53 (4)	8.54 (4)
	p. [*stronger than B*] = *A*	6.81 (0)	7.24 (0)
4: $C<B, A>B$	s. *A is stronger than B*	8.38 (0)	9.82 (4)
	p. [*stronger than B*] = *A*	8.27 (0)	8.72 (0)
Given term as gramatical subject or focus			
5: $A>B, B>C$	*s. B is stronger than C*	10.36 (0)	8.58 (0)
	p. [*stronger than C*] = *B*	10.51 (0)	10.48 (21)
6: $B<A, B>C$	*s. B is stronger than C*	10.16 (8)	8.62 (8)
	p. [*stronger than C*] = *B*	10.96 (29)	10.48 (17)
7: $B>C, B<A$	*s. B is weaker than A*	7.09 (4)	9.56 (4)
	p. [*weaker than A*] = *B*	8.98 (13)	12.29 (13)
8: $C<B, B<A$	*s. B is weaker than A*	8.70 (8)	9.87 (13)
	p. [*weaker than A*] = *B*	10.06 (25)	11.35 (21)

notes : Letters s and p denotes the standard and psedo-cleft materials, respectively.
[*weaker than B*] = *C* means *One who is weaker than B is C* ; the parenthisized part is the presuppositional part.

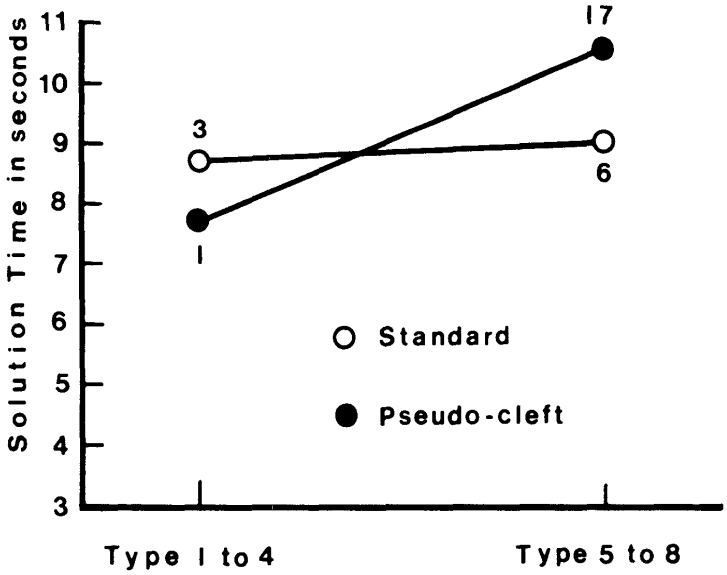

Figure 1. Geometric mean solution time in Experiment 1 as a function of the grammatical position of the given term in the second premise. The numbers adjacent to each point are the mean error rates (%).

Type 1 to 4, $F(1, 712)=10.93$, $MSe=.024$, $P<.01$, and for Type 5 to 8, $F(1, 712)=16.86$, $MSe=.024$, $P<.001$. The simple main effect of GPGT was significant only for the pseudo-cleft material, $F(1, 666)=97.5$, $MSe=.017$, $P<.001$, but not for the standard material, $F(1, 666)=1.37$, $MSe=.017$, $P>.05$. Table 1 and Figure 1 also show that the distribution of errors was roughly like the differences in solution time. More errors occured to Types 5 to 8, especially to the pseudo-cleft material, although no stochastic analysis was applied to the error rates.

Discussion

As summarized in Figure 1, results clearly supported the previously stated predictions. The pseudo-cleft sentence as the second premise really facilitated and interfered the solution of three-term series problem, according to the grammatical position of the given repeated term in the second premise. Every difference between the corresponding two problems should be attributable just to their different surface structure in second premise, in reference to the experimental design adopted here. In spite of their rather complicated surface structure, a pseudo-cleft sentence as the second premise, was not generally confusing for the subjects in itself. Far from that, it was even helpful for them when it organized the given term in its presuppositional part. The results also revealed that the same construction was entirely confusing for the solvers when it organized the given term in the focal part. These results are interpretable from the given-new strategy (Clark & Haviland, 1974) as will be mentioned later in the general discussion.

Even within the standard materials as the control, the grammatical position of the given term (GPGT) contributed to the differential performance between Type 1 to 4 problems and Type 5 to 8 problems, although not significantly: Type 1 to 4, where the second premise involved the given term as its grammatical object, was easier to solve than Type 5 to 8, where

the given term was the grammatical subject of the second premise. The direction of this difference between the types within the standard materials are congruent with Huttenlocher's prediction. For the sake of description, these phenomena could be called "end-anchoring effect". In the second premise of each Type 1 to 4 problem, the given term is the grammatical object, or more precisely, the object of the particle *yori* (*more than*). The Japanese particle *yori* marks the word immediately preceeding it as indicating the starting position of action, or the base for judgement or inference the sentence represents. The organization of the standard Japanese comparative with a given term (word) placed immediately before the particle *yori* (like the second premise in Type 1 to 4) seems to be rational and helpful from the viewpoint of the given-new strategy, because such the sentence presents the substantial given term, to the reader, as the criterion for the comparative judgement. The seemingly superior performance for Type 1 to 4 could be explained in relation to this *yori*-given term accompaniment. This grammatical function of *yori* holds after a standard comparative sentence is rewritten into the correspondent psedo-cleft sentences, where *yori* is necessarily included in the presuppotional part. And the most superior performance for Type 1 to 4 in pseudo-cleft materials could be regarded as the accumulated result of the effect of the *yori*-given term accompaniment and the effect of the correctly organized pseudo-cleft construction. Both effects are congruent with the theory of given-new strategy, as will be discussed later.

These results can be specific to the comparative relation which we must express by using the particle *yori* (*more than*, in English). There are many relations appropriate for the three-term series problem situation, and many way to express the relations. Out of such relations, Experiment 2 will focus on the relation expressed in an active and a passive verb sentence.

Experiment 2

In Experiment 1, where materials concerned the *stronger-weaker* relation, the predicted effects of the pseudo-cleft second premises were observed. The purpose of Experiment 2 is to test whether the results of Experiment 1 can be replicated, even if the transitive relations between three terms are described in active and passive verb sentences. Not only the standard verb sentences, but also the correspondent subject-selection pseudo-cleft sentences were used as the materials. For example, the pseudo-cleft sentence which is corresponding to the standard active verb sentence 0'−s is like 0'−p:

0'−s. *Andy rules Bill.*
(In Japanese: *Andy wa Bill o shihai-suru.)*
0'−p. *One who rules Bill is Andy.*
(Bill o Shihai-suru no wa Andy da.)

A standard active verb sentence, according to Halliday (1983), usually has its new elements at the end. Therefore, Sentence 0'−s is usually regarded as having a given-new information structure like this:

Given: *Andy rules someone.*
New: *The someone is Bill.*

On the other hand, the pseudo-cleft sentence, 0'−p clearly marks, as analysed previously, the given-new structure just reversed to 0'−s, like this:

Given: *Some one rules Bill.*
New: *The someone is Andy.*

Now, let us embed Sentences 0'−s and 0'−p in the three−term series problems x'−s and x'−p respectively.

x'−s. *Charlie is ruled by Bill. And,*
Andy rules Bill. Then,
Who is in the most ruling position?
x'−p. *Charlie is ruled by Bill. And,*
one who rules Bill is Andy. Then,
Who is in the most ruling posisiton?

The second premise in x'−p marks the given-new information more clearly in its special construction than the one in x'−s, and it does so by disposing the given term *Bill* in the preppositional part. Now, we could predict that, like as in Experiment 1, x'−p will be easier for the subjects to solve than x'−s.

For the sake of comparison, let us take another example:

y'−s. *Calvin is ruled by Ben. And,*
Ben is ruled by Abe. Then,
Who is in the most ruling position.?
y'−p. *Calvin is ruled by Ben. And,*
one who is ruled by Abe is Ben. Then,
Who is in the most ruling position.

In y'−p, the second premise involved the third, new term *Abe* in its presuppositional part. This will be bewildering to the subject, and it will take more time to solve y'−p than y'−s. There predictions were tested in Experiment 2, using the materials written in Japanese.

Method

The method was same as in Experiment 1, except that the subjects were another 48 undergraduates of Kumamoto University, Japan, and that the materials concerned *rule-be ruled by* relations. (See Table 2). The problems used in Experiment 2 were obtained from those in Experiment 1, simply by substituting the relational terms *stronger-weaker* by *rule-be ruled by*, respectively, as well as by acommpanying the new questions *Who is in the most ruling position* and *Who is in the least ruling position.* No subjects casted doubt to the validity of transitivity in these problems. Processing and analysing data was same as in the previous experiment.

Results

No subject made three or more errors. The mean solution time and the error rates are shown in Table 2. The same trends were observed between the two corespondent materials as in the previous experiment. For 9 out of 16 compared problems, the differences in solution time were significant: Type 2 problem with *most ruling* question, $t(45)=2.08$, $P<.05$; Type 3 with *most ruling*, $t(46)=2.45$, $P<.01$; Type 4 both with *most ruling*, $t(44)=1.83$, $P<.05$, and

Table 2. Geometric mean solution time in seconds with error rate (%) in Experiment 2.

Types of problem	Formatives of the second premise	Questions	
		Most ruling ?	*Least ruling ?*
	Given term as grammatical object or as presupposition		
1: $A>B, C<B$	s. *C is ruled by B*	8.59 (4)	8.83 (4)
	p. [*ruled by B*] = *C*	8.19 (0)	7.67 (0)
2: $B<A, C<B$	s. *C is ruled by B*	8.96 (4)	8.56 (11)
	p. [*ruled by B*] = *C*	7.60 (0)	8.54 (0)
3: $B>C, A>B$	s. *A rules B*	7.16 (0)	8.12 (4)
	p. [*rules B*] = *A*	5.91 (0)	7.10 (0)
4: $C<B, A>B$	s. *A rules B*	7.59 (8)	9.83 (4)
	p. [*rules B*] = *A*	6.56 (0)	7.47 (0)
	Given term as gramatical subject or focus		
5: $A>B, B>C$	*s. B rules C*	7.60 (4)	7.12 (0)
	p. [*rules C*] = *B*	8.01 (4)	8.95 (29)
6: $B<A, B>C$	*s. B rules C*	7.97 (0)	7.58 (12)
	p. [*rules C*] = *B*	9.57 (12)	9.84 (42)
7: $B>C, B<A$	*s. B is ruled by A*	6.33 (0)	7.49 (0)
	p. [*ruled by A*] = *B*	7.49 (4)	8.30 (4)
8: $C<B, B<A$	*s. B is ruled by A*	6.95 (8)	8.82 (0)
	p. [*ruled by A*] = *B*	8.91 (16)	9.30 (16)

notes : Letters s and p denotes the standard and psedo-cleft materials, respectively.
[*ruled by B*] = *C* means *One who is ruled by B is C* ; the parenthised part is the presuppositional part.

with *least ruling*, $t(45)=3.72$, $P<.01$; Type 5 with *least ruling*, $t(39)=2.32$, $P<.05$; Type 6 both with *most ruling*, $t(45)=2.09$, $P<.05$, and with *least ruling*, $t(33)=2.25$, $P<.05$; Type 7 with *most ruling*, $t(45)=2.29$, $P<.05$, and Type 8 with *least ruling*, $t(40)=2.62$, $P<.01$.

The overall analysis of variance about the solution time revealed that both main effects of materials, $F(1, 46)<1$, and GPGT (grammatical position of the given term in the second premise), $F(1, 673)=1.06$, $MSe=.014$, were not significant, but that the interaction effect of these two factors was highly significant, $F(1, 673)=50.42$, $MSe=.014$, $P<.001$. Figure 2 shows the interaction. The simple main effects of material were significant at both GPGT conditions: For Type 1 to 4, $F(1, 719)=17.87$, $MSe=.017$, $P<.001$, and for Type 5 to 8, $F(1,$

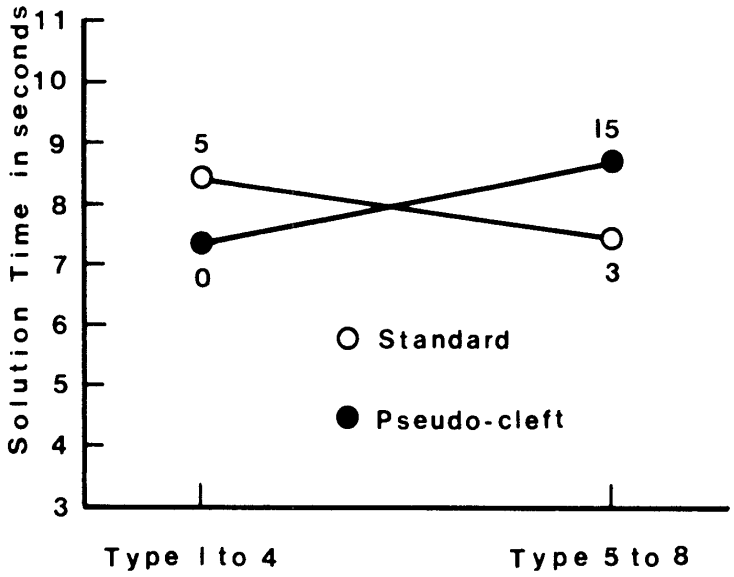

Figure 2. Geometric mean solution time in Experiment 2 as a function of the grammatical position of the given term in the second premise. The numbers adjacent to each point are the mean error rates (%).

719)=33.61, MSe=.017, P<.001. Also, the simple main effects of GPGT were significant at both the standard materials, F(1, 673)=19.73, MSe=.014, P<.001, and the pseudo-cleft materials, F(1, 673)=23.12, MSe=.014, P<.001.

Discussion

All differences between the coupled standard and pseudo-cleft problems in Table 2 were in the predicted direction. The pseudo-cleft construction in the second premise were helpful and confusing for the subject to solve the problems, depending on the grammatical position of the given term. When the second premise was a pseudo-cleft sentence that involved the given term in its presuppositional part, it facilitated the solution. In this point, the result of Experiment 1 was replicated in Experiment 2. Therefore, the effects of the pseudo-cleft second premises in the two experiment will be discussed later without any special discrimination between them, in spite of the structual difference between comparative (Experiment 1) and verb (Experiment 2) sentences.

Within the standard materials, the solution time varied according to the grammatical position of the given term in the second premise, but in a different direction from those in Experiment 1. When the second premise involved the given term as its grammatical subject, whether or not active or passive, the solution time was shortened. This result is just reverse to the one in Experiment 1, which concerned the comparative sentences. So-called end-anchoring effect is not the case as to the verb-sentence, at least as to the positive sentence. This means the present results is not congruent with Huttenlocher's (1968) prediction that when the second premise is an active verb-sentence, the end-anchoring effect will be observed just like as when the second premise is a relational sentence. Huttenlocher's theory could predict precisely only about the case in which the second premise was a passive sentence. Another model seems to be required to adequately explain even only the results of

the control group in Experiment 2, much more to explain the whole results of the experiment.

If we accept Halliday's (1985) analysis of sentence and apply it to the standard active and passive sentences, the given-new contract theory (Clark and Haviland, 1974) would explain well the results: According to Halliday, as mentioned previously, a reader-listener will regard the elements placed in the ending part of the sentence as the new ones, if there is not any special marking, for example, some other part being boldly typed, or loudly spoken. This means that the begining part of the sentence will usually be regarded as the given elements. The second premises in Type 5 to 8 problems are the case, and they were easier to solve. Fully against Huttenlocher's prediction, the results of standard materials in Experiment 2 should be summerized, like this: when the given term is the grammatical subject of the second premise, regardless of the voice, the problem is easy to solve. This is just contrastive to the result concerning the comparative sentences. There seem to be different given-new information structures between comparative sentence and verb sentence.

Genaral Discussion

The most remarkable finding from the present experiments is that the grammatical marking of presupposition-focus information in the second premise significantly affects the solution of three-term series problems. When the second premise was a pseudo-cleft sentence, involving the given term in its presuppositional part, and involving the new term in its focal part (Type 1 to 4 problems), the solution was facilitated. On the contrary, when the given and new terms were conversely disposed in the pseudo-cleft second premise, (Type 5 to 8 problems), the solution was hindered. These effects held when the relational terms were *stronger-weaker* (Experiment 1) and also when they were *rule-be ruled by* (Experiment 2).

In view of the experimental design adopted in the present study, the shortened correct solution time to the Type 1 to 4 problems in pseudo-cleft materials in both experiments should be attributed to some aspect of their second premise. However, the formative of the second premise in these materials was more complicated than in standard comperatives and standard verb sentences. Generally, we could expect that the more complicated the formative of the sentence is, the longer it takes us to process the sentence. But the present results show this is not the case. Not any evidence has been obtained indicating that the problems in the pseudo-cleft materials were generally harder for the subjects to solve than the standard problems. In order to explain these facilitation effects, some additional factors should be taken in consideration. Let us take the subject's knowledge about the general structures of the problem as such a factor. In the experimental situation like the present one, the subject will know, most probably through the instruction and the pretraining trial in advance, that three terms should be given, and that two neighboring terms should be related in a premise. After the first premise is comprehended, the subject will expect, in reference to this knowledge, that one more term should be given in the second premise, and that the third, new term should be related to one of the given terms also involved in the first premise. These expectations will direct the subject's attention to what the third term is, and to which given term in memory the third is related. Under these expectations and directed attention, the subject will read and try to comprehend the second premise. Therefore, the effects of particular aspects of the second premise, if any, might be well discussed together with the factor of subject's expectation.

With taking these factors in consideration, and based on Clark & Haviland's (1974) model, let us propose a model of how the pseudo-cleft second premises are processed. In the model below, "Ps" and "Fc" indicate the terms at the presuppositional part and the focal part, respectively:

(1) read the second premise.
(2) pick up the term at the presuppositional part of the second premise.
(3) Compare the just picked-up term to the terms given in the first premise. If the terms match, identify it as the given term, and go to (4). If not, go to (3').
(3') Pick up another term (Fc) in the second premise, and go to (3) again.
(4) Pick up the term at the focal part of the second premise.
(5) Is the just picked-up term the one already identified as the given term? If not, identify it as the third, new term; go to (6). If so, go to (5').
(5') Pick up another term (Ps) in the second premise, and go to (5) again.
(6) Attach the term identified as the third one to the already established representation of the first premise, keeping its stated relation to the given term.

For the present purpose, this simple model is consistent with the data. Steps 2 and 4 reflect the way in which the particular formative of pseudo-cleft sentence directs the subject in identifying the given and new terms, respectively. Step 3 represents the matching process argued in Clark and Haviland (1974). Step 5 reflects the subject's expectation that in the second premise, one of the two terms is the given term and another is the third term. And step 6 reflects the status of the given term as the criterion in the relational judgement. The problem in which the second premise involves the given term in the presuppositional part (see Type 1 to 4 problem in Table 1, and those in Table 2) will be processed through Steps 1−2−3−4−5−6 to exit. On the other hand, the problem whose second premise involves the given term in its focal part (Type 5 to 8 problems) must go through Steps 1−2−3−3'−3−4−5−5'−5−6 to exit. Therefore, on this model, Type 1 to 4 pseudo-cleft problems take the subject less time to process than Type 5 to 8 problems.

The situation for the standard comparative sentences, on this model, is almost similar to the above, because they are marking the presupposition-focus structure, too, as previously discussed. However, they do it rather moderately by depending on the particle *yori* (*more than*). In this case, it may take more time to proceed through Step 2. Also Step 3' may be not so hard to pass through, even if the subjects could not find the given term in the presuppositional part, that is the position immediately preceding *yori*. After all, the problems whose standard second premises involves the given term as their grammatical objects (Type 1 to 4) will take the subject more time with added time at step 2 than the corresponding pseudo-cleft problems. The standard problems whose second premise involves the given term as their grammatical subjects will not take the subject so much time, with reduced time at step 3', as the corresponding pseudo-cleft problem. The results summarised in Figure 1 could be explained like the above.

Also, granted that the grammatical subject of a verb sentence can be considerd as the given element of the sentence, as Halliday (1972) argued, the present model would fit the results concerning the standard materials in Experiment 2. According to the model, Type 1 to 4 problems in standard verb sentences would require the solver to drop in the optional Steps 3' and 5', and this would delay the solution. The left-up inclining graph of the standard materials in Figure 2 indicates that the model is valid for this part of the results in Experiment 2. The standard verb sentences seem to have a different given-new structure from

the standard comparative sentences, in which the particle *yori* (*more than*) marks which element is given one.

In these discussion, we have been avoiding the controversy of whether or not the mental imagery is involved in solving three-term series problems. Rather, the stress has been placed on how far the results can be attributed to the factors common in the general process of reading text, mostly based on the theory of given-new strategy (Clark & Haviland, 1974). From this point of view, the findings from the present experiments might be summarized as follows:

First, the formative distinction of presupposition and focus in the pseudo-cleft construction has its psychological reality. The formatives might make it easier or harder for the subject to identify the given and new terms in the second premise, and therefore, make it easier or harder to match the given term in the second premise with its antecedent in memory. The facilitation effect of the pseudo-cleft second premise obtained from these experiments suports Bever & Langendoen's (1971) argument insisting that some surface structures of sentence are less complex psychologically in spite of their grammatical complexity. Also, the fact of hindrance effect of the pseudo-cleft second premise suggests that such the inverse relation between grammatical and psychological complexity, if any, is not general but depends upon the proceeding context of the sentence. Together with the result of Hornby's experiment (1974), where subject's attention in picture-sentence matching was really affected by the grammatical marking of given-new information, the present findings clarified the important role of the surface, not the deep, structure of the sentence in comprehending sentence or text. Along this line, we explained the differential performances within the standard materials in the present materials, with the assumption that even the standard comparative and verb sentences have their own respective ways to mark the presupposition and focus. In previous studies which assumed some linguistic processes in solution of three-term series problems (for example, Clark 1969; Sternberg 1980), the stress has never been placed on the role of the surface structure of the premises, but only on their deep structure, or the basic propositions involved in them. However, in reference to the results of the present experiments, the suface structure, especially of the second premise, seems to play an important role in solving the three-term series problem.

Second, the matching process in the given-new strategy theory really intervened in the solution. The different solution time for many problems between and within the two materials seems to be consistent with the proposed model, which are involving the matching process, and the identifying process as its prerequisite (see Step 3 and 5 in the model). Besides this, one episode may be helpful to understand the argument: Some subjects, in the experimental groups both of experiment 1 and 2, who were received the pseudo-cleft materials, confessed after their test session, that they felt sometimes as if four term were involved in a problem. All the problems these subjects identified as having made them feel so belong to Type 5 to 8. When the subjects encountered the Type 5 to 8 problems, whose second premise involved the third, new term in its presuppositional part, the situation for these subjects might be as follows: The actual new term, might be picked up as the candidate for the given term in Step 3 on the model, based on its grammatical status in the sentence, and the subject should fail to find its antecedent in his or her memory. Meanwhile, the actual given term, which existed in the focal part, might be not regarded as the given one. Under this supposed situation, it would be natual for the subject to feel as if there were four terms in the three-term se ies problem, for a moment. For these problems, Type 5 to 8, Table 1 and 2 shows long solu..on

time and large error rates. This poor performance arises from the momentary or eventual failure in matching the given term in the second premise with its antecedent in memory.

The discussion above is not neccesarily against the theories of mental imagery. It is true, for the present, that we can not argue against the possibility that the attatching process (step 6) may be an imagery process of constructing a spatial representation. However, it is also true that most of the present results can be explained in terms of the principles based on the given-new strategy (Clark and Haviland 1974), which have been proved to be valid for many other verbal behaviors and linguistic phenomena (Haviland and Clark, 1974; Hornby, 1974; Yekovich, Walker, and Blackman, 1979). And we would point out that the verbal behaviors and the linguistic phenomena do not seem to be always based on our spatial image.

One might argue that the present results are specific to Japanese language. Certainly, it seems to be easier to make the pseudo-cleft version of a sentence in Japanese than in English (compare the exemplifying English sentences 1−s and 1−p in Experiment 1; and sentences 0'−s and 0'−p in Experiment 2, with the corresponding parenthisized Japanese sentences). This means that the native Japanese-user might be familiar to this formative, and sensitive to what the paticular formative implies in itself. An experiment using the material written in English or other languages will be able to clarify the contribution of this seemingly Japanese-specific factor, if any, to the present results.

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