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Bransford and Franks (1971, 1972) argued that, when presented with a series of semantically-related sentences, subjects will spontaneously integrate and store the semantic information contained in those sentences and subsequently use this information as their basis for recognition. If integration and storage of ideas is a purely semantic process, then the meanings of semantically-related sentences should be integrated despite differences in language of presentation. Three studies were performed to test the applicability of the Bransford-Franks model to bilingual subjects' memory for semantically-related German and English sentences. Other models of bilingual sentence memory are also discussed. Data from the present studies indicate that memory for semantically-related sentences involves integration and storage of wholistic ideas as well as memory for specific items.

ABSTRACTION OF BILINGUALLY-PRESENTED IDEAS

by

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INTRODUCTION

Semantic Integration--The Bransford-Franks Hypothesis and its Implications

The recent literature on human memory has contained several studies concerning the nature of the information which is stored about a series of semantically-related sentences which have been experienced nonconsecutively (Bransford & Franks, 1971; Bransford & Franks, 1972; Franks & Bransford, 1972; Katz, 1973; Katz, Atkeson, & Lee, 1974; Singer & Rosenberg, 1973). Bransford and Franks (1971, 1972) argued that subjects spontaneously integrate the semantic information in related sentences into a complete idea. According to Bransford and Franks, this wholistic semantic idea, rather than the individual acquisition sentences, is stored in memory.

Bransford and Franks' position has been supported in studies of memory for both concrete sentences (e.g., "The old car pulling the trailer climbed the steep hill," Bransford & Franks, 1971) and abstract sentences (e.g., "The unrealistic goals proposed by the leader resulted in frequent disillusionment," Franks & Bransford, 1972).

If integration and storage of ideas is purely a semantic, alinguistic process, as Bransford and Franks (1971, 1972) have stated, then the meanings of semantically-related sentences should be integrated despite differences in syntax and phonology. One may express approximately the same idea in each of two languages. However, the strings produced in each of the two languages to convey this idea will certainly differ

from each other in phonology and probably in syntax as well. Semantic integration should occur for sentences expressing different parts of the same idea, despite the fact that these sentences are presented in different languages. Some support for the view that integration occurs among items which differ in form, but are semantically-related, has been provided by Pratt (1974) using semantically-related pictures and sentences. The present study investigated the process of integration among semantically-related sentences presented in two different languages to bilingual subjects.

The Bransford-Franks Paradigm and Specific Findings

Bransford and Franks (1971, 1972) presented subjects with a set of acquisition sentences, each of which expressed part of the meaning of an arbitrarily-chosen idea. Subsequently, subjects were given a recognition test to determine what information had been stored about the acquisition sentences.

Each acquisition sentence expressed one, two, or three of the four semantic relations contained within an idea. A semantic relation was defined as a portion of an idea which can be expressed as a declarative sentence containing a simple subject and a predicate composed of a verb and either a modifier (e.g., predicate adjective, adverbial phrase, etc.) or an object. Examples of sentences expressing a single semantic relation are "The car was old," "The car was pulling the trailer," "The car climbed the hill," and "The hill was steep" (Bransford & Franks, 1971). The sentence "The old car climbed the hill" expresses two semantic relations. The sentence "The old car pulling the trailer

climbed the steep hill" expresses four semantic relations. That is, the latter sentence expresses a complete four-part idea.

For each sentence on the recognition test, the subject indicated how confident he was of having heard that sentence during the acquisition task. Subjects were most confident that they had heard sentences which completely exhausted the semantic information contained in each of the presented ideas. Since no single acquisition sentence had expressed an idea in its entirety, these confidence ratings could not be attributed to memory for specific sentences. Moreover, the greater the number of semantic relations expressed in a recognition sentence, the more positive was the confidence rating that it received. Subjects' ratings for sentences that they had actually heard during acquisition (OLD sentences) did not differ significantly from their ratings for sentences that they had not heard (NEW sentences), but which were equivalent in semantic complexity (i.e., expressed an equivalent number of semantic relations).

In the Bransford and Franks studies, the recognition list also included sentences which combined semantic relations across rather than within ideas. These sentences (NONCASE sentences) expressed the same number of semantic relations as did those sentences which expressed all four semantic relations within an idea (FOURS). Rather than being consistent with a single idea, the sentences which combined semantic relations across ideas took part of their meaning from one idea and the rest of their meaning from other ideas. Subjects were very confident that they had not heard these (NONCASE) sentences. Thus, recognition ratings were shown to be dependent upon factors other than the number of semantic

relations expressed in a sentence. Instead, all semantic relations expressed in a sentence had to be indigenous to the same idea in order for the sentence to receive a positive confidence rating.

Bransford and Franks concluded that memory for a set of semantically-related sentences did not contain a representation of the specific sentences which had been experienced during acquisition. It was suggested that complete ideas were integrated from the partial information given in those sentences. In addition, it was hypothesized that these processes of integration and storage of ideas occur at some exclusively semantic, alinguistic level (Bransford & Franks, 1971).

Bilingual Memory: Two Possibilities

Studies in the areas of free recall and recognition memory have presented evidence that bilinguals semantically encode and store items from bilingual lists rather than storing their morphemic characteristics (e.g., Nott & Lambert, 1968; Kintsch, 1970; Kintsch & Kintsch, 1969). According to these authors, bilinguals have a single semantic system and do not separately store equivalent items from their two languages.

Tulving and Colotla (1970) have reported data from studies on free recall of bilingual and trilingual lists of unrelated words. These authors, contrary to the conclusions of the Kintsches (Kintsch, 1970; Kintsch & Kintsch, 1969) and Nott and Lambert (1968), have hypothesized that the bilingual's languages represent separate memory stores. According to this theory, list items are tagged at input according to the language in which they are presented.

The Abstraction of Bilingually-Presented Ideas

If a bilingual acquisition list of semantically-related sentences were presented to bilingual subjects, it is conceivable that these sentences would be labeled at input according to their language of presentation. Thus, memory might consist of a list of the sentences presented in one language and a separate list of the sentences presented in some other language. When presented with a recognition sentence, a subject would need to search only the list of sentences corresponding to the language in which the recognition sentence was given. His decision would require a search of half the number of items which would need to be searched if all acquisition sentences were presented in the same language. Therefore, one might expect that presenting the acquisition sentences in different languages would aid subjects in identifying those sentences which had been presented during acquisition.

Alternatively, the position held by Bransford and Franks (1971) implies that the information contained in a set of related sentences is stripped of all syntactic and morphophonemic properties (i.e., all properties which would betray the language in which they were presented). If this is so, then, within the paradigm used by Bransford and Franks (1971), integration of semantic ideas should occur for any set of semantically-related sentences, regardless of their particular surface structure properties. If bilinguals encode equivalent items from their two languages in a single semantic system, semantically-related sentences in two different languages should be encoded similarly. This similarity in encoding should facilitate the integration of related sentence meanings into a complete idea. In the Bransford and Franks paradigm, if

half of the sentences related to an idea are presented in one language and half in another language, bilinguals should integrate the semantic information contained in those sentences into a complete idea. As in the Bransford and Franks studies, the greater the number of semantic relations expressed by a sentence, the more positive should be the confidence rating given by subjects. Sentences which combine semantic relations across ideas (NONCASE sentences) should still receive high negative ratings. Recognition sentences which have been presented during the acquisition phase should not receive higher ratings than those recognition sentences which have not been heard previously.

Bransford and Franks (1971) have predicted that the mean rating for a particular recognition sentence should be lower than the mean rating for any sentence of which it is a subset. This prediction should also obtain for sentences of different languages. For example, the sentences (1) "The rock which rolled down the mountain crushed the tiny hut" and (2) "Der Fels der den Berg hinunter rollte zerschmetterte die Huette" ("The rock which rolled down the mountain crushed the hut") should receive a more positive mean rating than (3) "The rock rolled down the mountain." Confirmation of these intersentential predictions was considered by Bransford and Franks (1971) to be essential to the support of their hypothesis regarding the integration and storage of linguistically-presented ideas.

A third possible model for the storage of semantically-related sentences holds that ideas are integrated intralingually. According to such a model, the information expressed in one language is stored as separate from information expressed in the other language. Integration

of the information expressed by acquisition sentences would occur separately for each language. Within the framework of this two-store model, storage of semantically-equivalent ideas, tagged according to language of presentation, would result.

A finding that would favor adoption of such a two-store model would be one where the intersentential predictions made by the Bransford-Franks model were more likely to be confirmed between sentences of the same language than between sentences of different languages. That is, it would be predicted that recognition confidence ratings for two sentences which are compared to the same stored idea would bear the same relationship to each other that is predicted by the Bransford-Franks model. Such comparisons would occur when both sentences are presented in the same language. If two sentences are compared with different stored ideas, then confidence ratings for these sentences would not necessarily bear the relationship to each other which the Bransford-Franks model predicts. Recognition sentences which are presented in different languages would be compared to different stored ideas and, therefore, the intersentential predictions made by Bransford and Franks (1971, 1972) might not hold.

A crucial test of the validity of a single- vs. a two-store model is beyond the scope of the present investigation. Evidence which would favor a two-store model has been outlined above. However, even if the intersentential predictions made within the structure of the Bransford-Franks model were verified for pairs of sentences of different languages, arguments could still be made in favor of a two-store model of bilingual memory. The present studies seek to test the validity of the constructive,

conceptual model of sentence memory proposed by Bransford and Franks (1971, 1972), when input sentences contain information which would allow subjects to distinguish recognition sentences on the basis of language of presentation.

METHOD

Study I

Subjects. Subjects for the present study were 19 German-English bilinguals who participated voluntarily. They resided in the North Carolina communities of Chapel Hill, Greensboro, and Winston-Salem. Eight subjects were natives of German-speaking countries, and the remainder were natives of the United States. The criterion for bilingualism was that the subject must have lived in an environment where he spoke primarily German for at least one year and must have lived in an environment where he spoke primarily English for at least one year.

Materials. Four ideas, each composed of four semantic relations, were chosen for use in this study. The sentences that represented each of these ideas in its entirety (FOURS) are presented in Table 1. Both the English and the German versions of each idea are given. Ideas B and D were selected from among the ideas used by Bransford and Franks (1971). One modification was made in Idea B, changing the word "jelly" to "jam" to facilitate translation of the sentence into German. Idea A and Idea C were formulated by the author with advice from a native of Germany.

All meaningful sentences expressing one, two, or three of the semantic relations within each idea were derived from each of the sentences which expressed a complete idea (i.e., from the FOURS). For each idea, there were four sentences which expressed one semantic relation each (ONES), four sentences which expressed two semantic relations

TABLE 1

FOURS REPRESENTING THE COMPLETE IDEAS USED

Idea A. The dog, which ran down the street, jumped over the small child, who was playing with marbles.

Der Hund, der die Strasse entlang lief, sprang ueber das kleine Kind, das mit Murmeln spielte.

Idea B. The ants in the kitchen ate the sweet jam, which was on the table.

Die Ameisen in der Kueche assen die suesse Marmelade, die auf dem Tisch war.

Idea C. The man, who stumbled over a rusty rake in the garden, broke his leg.

Der Mann, der ueber einen rostigen Rechen in dem Garten stolperte, brach sich das Bein.

Idea D. The rock, which rolled down the mountain, crushed the tiny hut at the edge of the woods.

Der Fels, der den Berg hinunter rollte, zerschmetterte die winzige Huette am Rande des Waldes.

each (TWOS), and three sentences which expressed three semantic relations each (THREES). These sentences were formulated in English and then translated into German. All of the possible sentences for Idea Set A are given in Table 2.

Translations were made by two German-English bilinguals who worked independently. One translator was a native of Germany; the other, of the United States. Agreement between the translators on the wording of the translations was excellent. The translations made by the two translators differed in only three places. These differences in the vocabulary to be used for the experimental stimuli were easily resolved in meetings between the author and each of the translators. The German stimuli used in the study were acceptable to both translators. In addition, both translators believed the English sentences used as stimuli to be acceptable translations of the German stimuli which were derived from them.

Four sentences which combined semantic relations across rather than within ideas (NONCASE sentences) were also composed by the author. After these sentences were prepared in English, they were translated into German by the translators. These (NONCASE) sentences are presented in Table 3.

An acquisition list of 24 sentences was selected from the above sentences. One sentence containing three semantic relations within a single idea (i.e., one THREE), one sentence containing two semantic relations within a single idea (i.e., one TWO), and one sentence expressing a single semantic relation (i.e., one ONE) were presented from each idea in each language. Thus, on the acquisition list, there were

TABLE 2

SENTENCES CONTAINED IN IDEA SET A

FOUR

The dog, which ran down the street, jumped over the small child, who was playing with marbles.
Der Hund, der die Strasse entlang lief, sprang ueber das kleine Kind, das mit Murmeln spielte.

THREES

The dog jumped over the small child, who was playing with marbles.
Der Hund sprang ueber das kleine Kind, das mit Murmeln spielte.

The dog, which ran down the street, jumped over the small child.
Der Hund, der die Strasse entlang lief, sprang ueber das kleine Kind.

The dog, which ran down the street, jumped over the child who was playing with marbles.
Der Hund, der die Strasse entlang lief, sprang ueber das Kind, das mit Murmeln spielte.

TWOS

The dog, which ran down the street, jumped over the child.
Der Hund, der die Strasse entlang lief, sprang ueber das Kind.

The dog jumped over the small child.
Der Hund sprang ueber das kleine Kind.

The small child was playing with marbles.
Das kleine Kind spielte mit Murmeln.

The dog jumped over the child, who was playing with marbles.
Der Hund sprang ueber das Kind, das mit Murmeln spielte.

ONES

The dog ran down the street.
Der Hund lief die Strasse entlang.

The dog jumped over the child.
Der Hund sprang ueber das Kind.

The child was small.
Das Kind war klein.

The child was playing with marbles.
Das Kind spielte mit Murmeln.

TABLE 3

NONCASE SENTENCES

NONCASE SENTENCE ONE

The child, who stumbled over a rusty rake in the garden, broke his leg.

Das Kind, das ueber einen rostigen Rechen in dem Garten Stolperte, brach sich das Bein.

NONCASE SENTENCE TWO

The child, who ran down the street, jumped over the rock at the edge of the small woods.

Das Kind, das die Strasse entlang lief, sprang ueber der Fels am Rande des kleinen Waldes.

NONCASE SENTENCE THREE

The dog, which ran down the street, broke the small table in the garden.

Der Hund, der die Strasse entlang lief, brach den kleinen Tisch in dem Garten.

NONCASE SENTENCE FOUR

The man in the hut crushed the tiny ants, which were on the table.

Der Mann in die Huette zerschmetterte die winzigen Ameisen, die auf dem Tisch war.

six sentences related to each idea--three in English and three in German. Thus, the acquisition list included the same number of sentences as the acquisition list used by Bransford and Franks (1971, 1972).

Certain restrictions were followed in preparing the acquisition list. Both an English sentence and its German equivalent could not appear on the list. Also, if a particular sentence containing three semantic relations of a single idea were presented, then the list also contained a sentence expressing two semantic relations which included the semantic relation left out by the sentence containing three semantic relations. This sentence containing two semantic relations was given in the same language in which the sentence containing three semantic relations was presented. For example, if the sentence, "The dog, which ran down the street, jumped over the child who was playing with marbles" (three semantic relations), was presented, then a sentence containing two semantic relations, such as "The small child was playing with marbles," was also presented. The latter sentence includes the semantic relation ("The child was small") which the former sentence excluded.

The order of the acquisition sentences on the list was random, with the stipulation that no two sentences from the same idea set were consecutive. In addition, the list was divided into six blocks of four sentences each, with each of the ideas being represented by exactly one sentence in each block. German sentences and English sentences were distributed randomly throughout the list, as were THREES, TWOS, and ONES.

For each sentence in the acquisition list, an elliptical question, which asked for information concerning the semantic content of the sentence, was constructed. These elliptical questions were brief "wh-"

questions. For example, the elliptical question for the sentence, "The dog, which ran down the street, jumped over the small child," could have been "Ran where?" or "Which child?" The elliptical question which was used for a given sentence was always in the same language as that sentence. Each elliptical question sought information about only one of the semantic relations contained in the sentence. Information about each of the semantic relations was sought by at least one, but not more than two, elliptical questions.

A recognition list of 46 sentences was also compiled. Included were the four sentences which expressed the ideas in their entirety (i.e., the four FOURS), two in each language. Four sentences expressing three semantic relations each had not been placed on the acquisition list in either language. These sentences (NEW THREES) were placed on the recognition list, two in each language. In addition, eight sentences expressing two semantic relations each and eight sentences expressing one semantic relation each had not been chosen as acquisition items. These sentences (NEW TWOS and NEW ONES) were also placed on the recognition list, four in each language at each of the two complexity levels. The four NONCASE sentences shown in Figure 3 were included on the recognition list, two in each language. These sentences combined semantic relations across ideas.

Twelve sentences which had been selected for inclusion on the acquisition list were also included on the recognition list. These sentences included one sentence expressing three semantic relations, one sentence expressing two semantic relations, and one sentence expressing a single semantic relation, from each of the four idea sets.

Taken together, there were two sentences which had been previously experienced (OLDS) from each of the three semantic complexity levels in each language.

Three English and three German sentences, one at each complexity level in each language, were selected from the acquisition list and placed on the recognition list in translated form. That is, unlike the previously-presented sentences (OLDS), which were presented in the same language on both the acquisition list and the recognition list, the translated sentences were presented in opposite languages on the acquisition and recognition lists.

Using a Norelco 150 cassette recorder, a tape recording was made of the acquisition list, in the forward direction (beginning with Sentence Number 1 and ending with Sentence 24) and the backward direction (beginning with Sentence 24 and ending with Sentence 1). The recognition list, also, was recorded in both the forward and backward directions. On the tape, each acquisition sentence was followed by its corresponding elliptical question.

Four color charts were used in a color-naming task during the acquisition phase. Each color chart consisted of one 2 3/4" square of each of the following colors: blue, green, red, yellow. These squares were cut from colored construction paper. The four squares on each color chart were stapled side-by-side in a single row on an 8½" by 11" sheet of white mimeograph paper. This row of colored squares was placed in the center of the paper, 2 7/8" from both of the 11" sides.

Procedure. Eight subjects were tested individually. The remainder of the subjects were tested in three groups, each comprised of three or

four subjects. At the beginning of the acquisition phase, the subjects were given a blank sheet of 8½" by 11" white paper and were asked to number it, from 1 to 24, along the left-hand side. The subjects then received the following directions: "This is an experiment on short-term memory. You will be hearing some sentences, one at a time, on this tape recorder. Some of the sentences will be in English and some in German. After each sentence, I will stop the machine and hold up one of these color charts (experimenter held up a chart). When I do, please read off the names of the colors from left to right in the language in which the sentence was presented. Then, I will put down the colors and turn the machine on again. You will then hear a question about the sentence which came just prior to the color-naming. This question will be in the same language as its corresponding sentence. Please write your answer next to the appropriate number on your answer sheet. Your answer should, also, be in the same language as the sentence. Then, I will present the next sentence on the tape and we will repeat the procedure until you have heard all of the sentences."

The experimenter reviewed the procedure and asked the subject(s) whether the instructions were clear. Subjects were not informed of the subsequent recognition task. When the acquisition phase had been completed and the acquisition protocols had been collected, the subjects were given a 5-minute break. Subjects were instructed not to discuss the experiment during the break.

At the beginning of the recognition phase, each subject received a recognition answer sheet, shown in the Appendix. Then, the experimenter read the directions: "During this part of the experiment, you will be

hearing another list of sentences, all of which are related to the ones you heard before. You will hear the sentences one at a time. Again, some of the sentences will be in English and some in German. After you hear each sentence, I would like you to indicate whether or not you think you heard that exact sentence, word for word, presented in the same language during the first part of the experiment. If you think you heard that exact sentence in the same language, you would circle Y. If not, circle N.

"Next to each Y and N, you see the numbers 1 through 5. This is to be used as a scale indicating how much confidence you have in your 'yes' or 'no' answer. If you are very sure of the answer you give, circle '5'. If you are moderately sure, circle '3' or '4'. If you are unsure or have low confidence in your answer, circle '1' or '2'. The higher the number you circle, the more confidence you have in your answer."

The subject(s) were asked whether they had any questions concerning this task. If there were no questions, the recognition phase was begun. After the last test sentence, the purpose of the experiment was explained.

Four subjects were presented with both the acquisition list and the recognition list in the forward direction. Five subjects received the acquisition list in the forward direction and the recognition list in the backward direction. Five received acquisition backward and recognition forward, and five received both lists in the backward direction.

Rationale for Studies II and III

Study II was a replication of Bransford and Franks (1971) using the English language stimuli composed for use in Study I. Study III was a German language replication of Bransford and Franks (1971), also using

stimuli used in Study I. These two studies using monolingual lists were performed in order to provide a baseline against which the results of the bilingual study (i.e., Study I) could be compared.

Study II

Subjects. Subjects were 18 undergraduates enrolled in an introductory psychology course at the University of North Carolina at Greensboro. All subjects participated to fulfill a course requirement.

Materials. The same acquisition and recognition lists used in Study I were modified for use in Study II. The sentences on both lists were presented only in English in this study. Thus, the acquisition and recognition sentences that appeared in German during Study I were now presented in their English translation. Elliptical questions corresponding to those German sentences were also presented in English.

Both the acquisition list and the recognition list were presented using the same order of presentation used in Study I. However, certain deletions were made in the recognition list. As previously mentioned, certain recognition sentences in Study I were translations of sentences which had been presented during acquisition. These recognition sentences were excluded from the recognition list for Study II. Since there were six such translated sentences given on the recognition list for Study I, exclusion of these items reduced the number of recognition sentences to 40 for Study II.

The color charts used in the color-naming task in Study I were again used. Tape recordings were made of the acquisition and recognition lists presented in both directions.

Procedure. The procedure for Study II was identical to that for Study I, with the exception that bilingual lists were not mentioned in the instructions. As in Study I, subjects heard the sentences, named colors, and answered elliptical questions.

During the recognition phase, the subject again was requested to decide whether or not the presented sentences had also been presented during the acquisition phase. As in Study I, subjects were told to indicate the degree to which they were confident of their "yes" or "no" answer. These confidence ratings were again given on a scale of 1 to 5, with "5" indicating very high confidence.

In Study II, the acquisition list as well as the recognition list was presented to three subjects in the forward direction. Five subjects received the acquisition list in the forward direction and the recognition list in the backward direction. For five subjects, the acquisition list was given in the backward direction and the recognition list forward. Three subjects received both lists in the backward direction.

Study III

Subjects. Subjects for Study III were ten German-English bilinguals who participated voluntarily. They resided in the cities of Chapel Hill, Durham, Greensboro, and Winston-Salem, North Carolina. Eight subjects were natives of the United States. One subject was a native of Germany and one was a native of France. The criterion for bilingualism was the same as that used in Study I.

Materials. The acquisition sentences, elliptical questions and recognition sentences used in Study III were the German translations of the sentences and questions used in Study II. Both the acquisition and

recognition list were presented to subjects in the same order in which they had been presented during Study II.

Once again, sentences presented in the Study I recognition list which had been presented in the opposite language on the Study I acquisition list were excluded from the recognition list for Study III. Thus, the recognition list for Study III had 40 items.

The same color charts used in Studies I and II were again employed in Study III. Tape recordings were made of the Study III acquisition and recognition lists presented in both directions.

Procedure. The procedure for Study III was identical to that for Study II.

In Study III, three subjects were presented with both the acquisition list and the recognition list in the forward direction. The acquisition list was presented in the forward direction and the recognition list in the backward direction for two subjects. Presentation of the acquisition list was in the backward direction and presentation of the recognition list in the forward direction for three subjects. Two subjects received both lists in the backward direction.

RESULTS

Study I

Confidence ratings accompanying "yes" answers were converted to pluses and ratings accompanying "no" answers were converted to minuses. A mean recognition rating was obtained across subjects for each sentence in the recognition list.

Ninety out of 111 predictions that a sentence would receive a higher rating than one which was a subset of it were confirmed. A Monte Carlo technique (Bransford & Franks, 1971) showed that this result was significant at the .001 level. Predictions made for Idea Set A are shown in Table 4. The number preceding each sentence indicates its position in the recognition list when that list was presented in the forward direction. Numbers shown in parentheses are mean recognition ratings for the sentences which precede them. Among NEW sentences alone, 34 of 40 such predictions were supported ($p < .001$). Among German sentences, 24 out of 28 predictions were supported ($p < .001$). Twenty-two out of 27 predictions made among English sentences were supported ($p < .001$).

Forty-six out of 55 predictions made between sentences of the same language were confirmed ($p < .001$), while 44 of 56 predictions made between sentences of different languages were supported ($p < .01$).

Mean ratings were calculated for each subject for German FOURS and NONCASE sentences and for English FOURS and NONCASE sentences. In addition, mean ratings were calculated for each subject for OLD, for NEW, and for translated sentences at each complexity level from ONES to

TABLE 4

RECOGNITION SENTENCES AND PREDICTIONS FOR IDEA SET A

FOUR

10. The dog, which ran down the street, jumped over the small child, who was playing with marbles. (-0.16)

THREES

21. The dog, which ran down the street, jumped over the child, who was playing with marbles. (-0.42)

40. (OLD) Der Hund sprang ueber das kleine Kind, das mit Murmeln spielte. (+3.47)

TWOS

5. The dog jumped over the child, who was playing with marbles. (+1.11)

24. Der Hund sprang ueber das kleine Kind. (+0.58)

29. (OLD) Der Hund, der die Strasse entlang lief, sprang ueber das Kind. (+1.32)

ONES

14. (translated) The dog ran down the street. (-3.16)

17. The child was small. (-4.68)

33. (OLD) The child was playing with marbles. (-0.47)

44. Der Hund sprang ueber das Kind. (-1.00)

Predictions: 10 > 21; 10 > 40; 10 > 5; 10 > 24; 10 > 29; 10 > 14; 10 > 17; 10 > 33; 10 > 44; 21 > 5; 21 > 29; 21 > 14; 21 > 33; 21 > 44; 40 > 5; 40 > 24; 40 > 17; 40 > 33; 40 > 44; 5 > 33; 5 > 44; 24 > 17; 24 > 44; 29 > 14; 29 > 44.

THREES in each language. Group means for each sentence type are shown graphically in Figure 1.

A 2 (language of presentation) X 5 (semantic complexity) analysis of variance with repeated measures on both factors (shown in Table 5) was performed on the mean ratings given by subjects for NEW sentences in each language at each level of semantic complexity (i.e., NONCASES, ONES, TWOS, THREES, and FOURS). This analysis showed a significant main effect of semantic complexity, F (4, 72) = 62.36, $p < .001$. German sentences received higher ratings than English sentences, F (1, 18) = 7.52, $p < .025$. The interaction between semantic complexity and language of presentation was also statistically significant, F (4, 72) = 4.06, $p < .01$.

In subsequent post hoc comparisons using the Newman-Keuls procedure (Winer, 1971), mean ratings for FOURS, for NEW THREES, and for NEW TWOS were each shown to be significantly greater than those for NEW ONES ($p < .01$ for all comparisons) and for NONCASE sentences ($p < .01$ for all comparisons). Subjects were more certain of having heard NEW ONES than of having heard NONCASE sentences ($p < .01$). Among English sentences alone and among German sentences alone, exactly the same comparisons yielded significance at the .01 level. Subjects also gave significantly higher confidence ratings to German FOURS than they did to German NEW TWOS ($p < .05$). Ratings for German FOURS were greater than those for English FOURS ($p < .01$). Subjects gave higher ratings to German NEW THREES than to English NEW THREES ($p < .01$) and higher ratings to German NEW TWOS than to English NEW TWOS ($p < .01$).

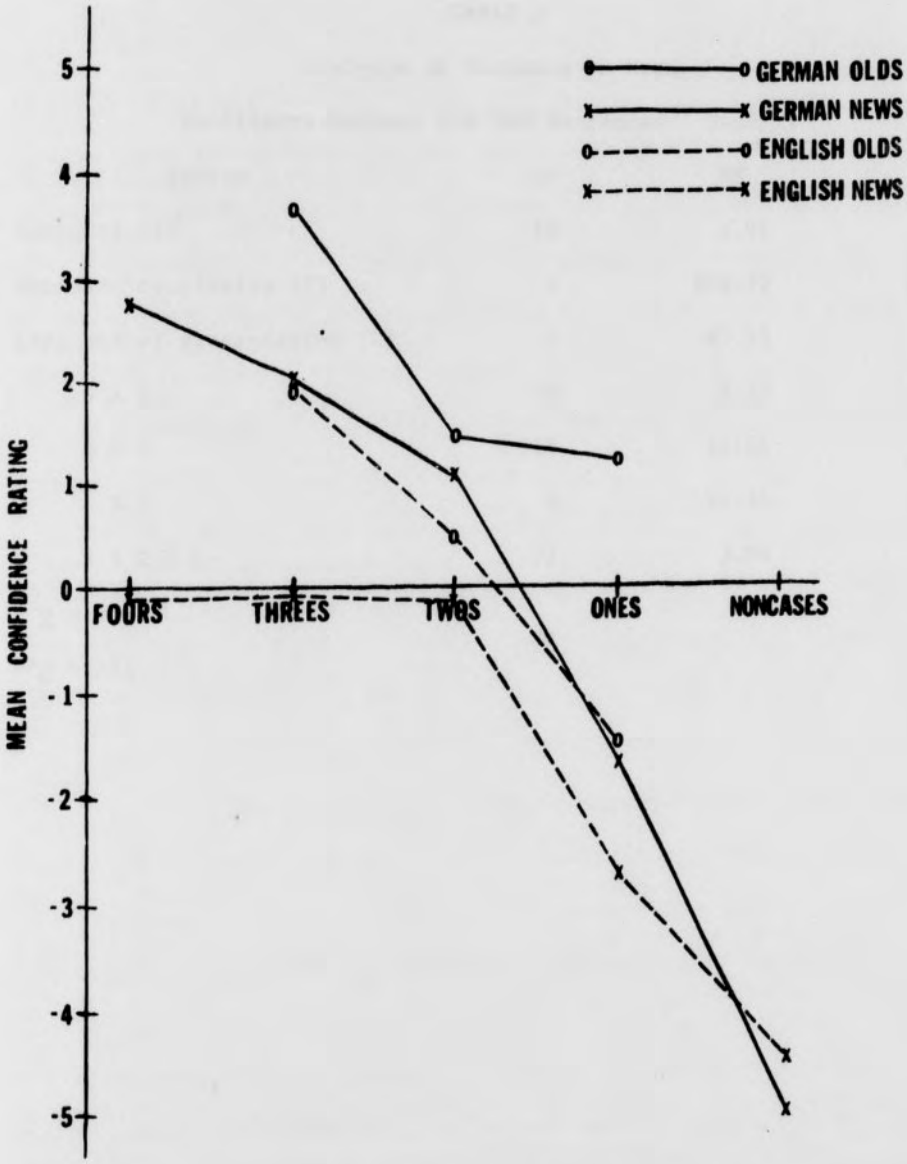

Figure 1. Mean Confidence Ratings by Sentence Complexity for German and English OLDS and NEWS (Study I)

TABLE 5

Analysis of Variance on Mean

Confidence Ratings for NEW Sentences: Study I

Source	df	MS	F
Subjects (S)	18	8.96	
Semantic complexity (C)	4	258.72	62.36**
Language of presentation (L)	1	87.25	7.52*
S X C	72	4.15	
S X L	18	11.61	
C X L	4	14.36	4.06**
S X C X L	72	3.54	

* $p < .025$

** $p < .01$

Variance components for data included in the analysis of variance reported above were computed using the computational formulae for utility indices compiled by Gaebelein and Soderquist (1974). The following factors and interactions each accounted for at least 10% of the variance: semantic complexity, 49.43%; subjects X semantic complexity, 15.31%; subjects X language of presentation, 10.71%; and subjects X semantic complexity X language of presentation, 10.88%.

A 2 (language of presentation) X 3 (NEWS vs. OLDS vs. translated sentences) X 3 (ONES vs. TWOS vs. THREES) analysis of variance with repeated measures on each of the three factors was also performed (Table 6). Significant main effects were found for semantic complexity, F (2, 36) = 39.12, $p < .001$; for the NEWS-OLDS-translated sentences dimension, F (2, 36) = 11.90, $p < .001$; and ratings for German sentences were significantly higher than those for English sentences, F (1, 18) = 8.93, $p < .01$. The interaction of semantic complexity X NEWS-OLDS-translated sentences X language of presentation was also significant, F (4, 72) = 3.61, $p < .01$. However, since this interaction seemed to have little meaning and accounted for less than 2% of the variance, it will not be discussed further.

Newman-Keuls tests showed that THREES were given significantly higher ratings than TWOS ($p < .01$) and ONES ($p < .01$). Subjects gave TWOS higher ratings than ONES ($p < .01$). OLD sentences received more positive confidence ratings than did NEW sentences ($p < .01$) and translated sentences ($p < .01$), but NEW sentences did not differ from translated sentences.

TABLE 6

Analysis of Variance on Mean Confidence Ratings for ONES, TWOS, and THREES: Study I

Source	df	MS	F
Subjects (S)	18	22.11	
Semantic complexity (C)	2	306.99	39.12*
NEWS vs. OLDS vs. translated (N)	2	114.98	11.90*
Language of presentation (L)	1	169.48	8.93*
S X C	36	7.85	
S X N	36	9.66	
C X N	4	9.41	1.82
S X L	18	18.97	
C X L	2	6.97	0.75
N X L	2	5.01	0.65
S X C X N	72	5.16	
S X C X L	36	9.24	
S X N X L	36	7.72	
C X N X L	4	25.02	3.61*
S X C X N X L	72	6.93	

*$p < .01$

The following factors and interactions each accounted for at least 10% of the variance among confidence ratings for sentences included in this analysis: subjects, 11.71%; semantic complexity, 16.67%; subjects X language of presentation, 10.05%; and subjects X semantic complexity X NEWS-OLDS-translated sentences X language of presentation, 11.00%.

Study II

Mean recognition ratings for the Study II stimuli, all of which were presented in English, were again obtained across subjects for each sentence in the recognition list.

Seventy out of 82 predictions that a sentence would receive a higher mean rating than a sentence which was a subset of it were supported ($p < .001$, by Monte Carlo assessment). Among NEW sentences alone, 33 out of 40 such predictions were correct ($p < .001$).

Mean ratings were also calculated for each subject for FOURS and for NONCASE sentences, and for OLD sentences and for NEW sentences at each complexity level from ONES to THREES. Figure 2 is a graph of the group means for each sentence type.

A repeated measures analysis of variance (Table 7) was performed on the mean ratings given by subjects for NEW sentences at each level of semantic complexity. Semantic complexity yielded a significant main effect, F (4, 68) = 59.70, $p < .001$. Subsequent Newman-Keuls tests indicated that FOURS, NEW THREES, and NEW TWOS each received more positive ratings than NEW ONES (all comparisons significant at the .01 level) and NONCASE sentences ($p < .01$ for all comparisons). NEW ONES received significantly higher confidence ratings than NONCASE sentences ($p < .01$).

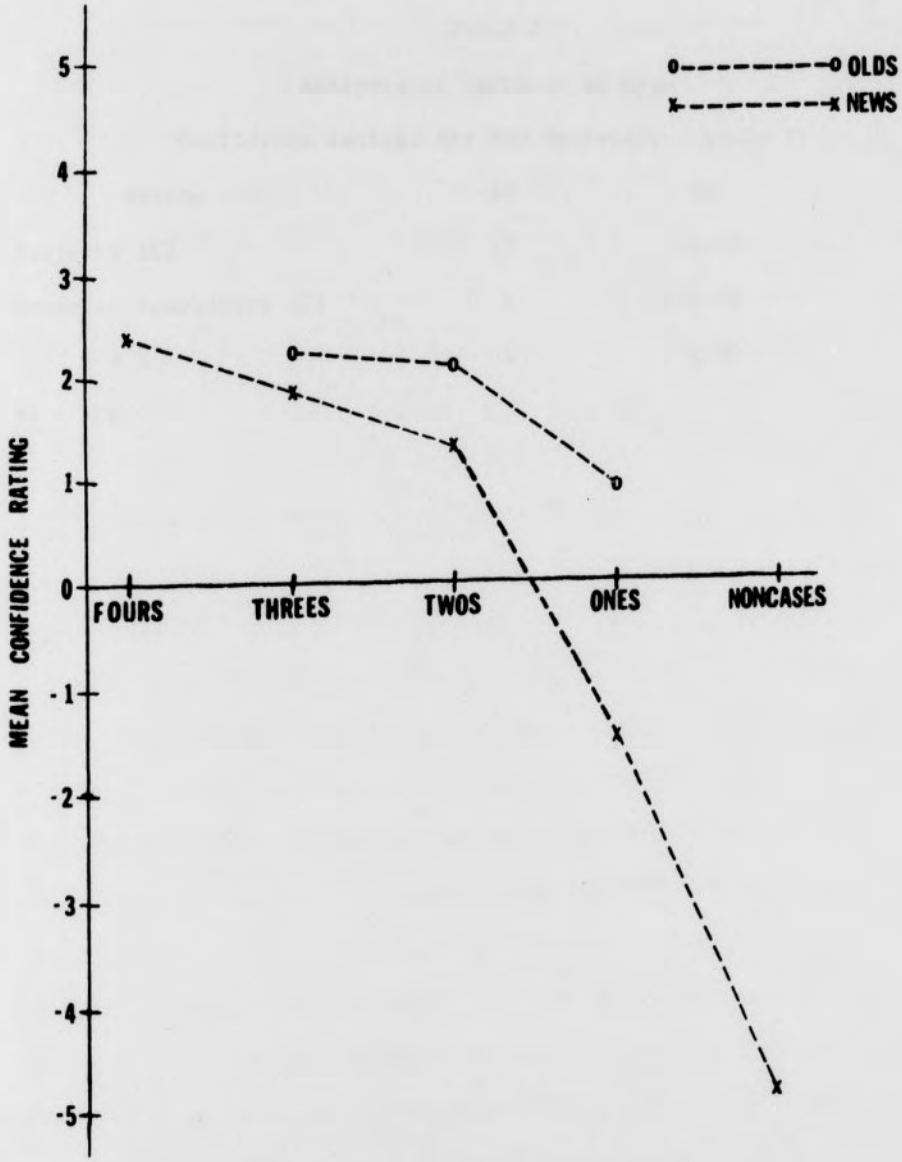

Figure 2. Mean Confidence Ratings by Sentence Complexity for OLDS and NEWS (Study II)

TABLE 7

Analysis of Variance on Mean

Confidence Ratings for NEW Sentences: Study II

Source	df	MS	F
Subjects (S)	17	6.28	
Semantic complexity (C)	4	173.09	59.70*
S X C	68	2.90	

*$p < .01$

Subjects accounted for 11.28% of the variance among ratings for sentences included in the foregoing analysis. Semantic complexity accounted for 67.90% of the variance and the subjects X semantic complexity interaction accounted for 20.82%.

A 2 (NEWS vs. OLDS) X 3 (ONES vs. TWOS vs. THREES) repeated measures ANOVA was also performed on the data for Study II (Table 8). The main effects of both semantic complexity, F (2, 34) = 19.00, $p < .001$, and NEWS-OLDS, F (1, 17) = 13.28, $p < .01$, were significant, with OLD sentences being given higher confidence ratings than NEW sentences. The interaction of semantic complexity by NEWS-OLDS also yielded significance, F (2, 34) = 4.65, $p < .025$. Newman-Keuls post hoc comparisons showed that subjects gave significantly higher ratings for THREES and TWOS than they did for ONES ($p < .01$ for both comparisons). However, ratings for THREES and for TWOS did not differ. OLD ONES received significantly higher ratings than NEW ONES ($p < .01$). However, OLD THREES and NEW THREES did not differ, nor did OLD and NEW TWOS. For OLD sentences alone, only the difference between THREES and ONES was significant ($p < .05$). NEW THREES and NEW TWOS each received more positive confidence ratings than NEW ONES ($p < .01$ for both comparisons).

Factors and interactions accounting for more than 10% of the variance in the analysis described above were: subjects, 36.38%; semantic complexity, 17.05%; subjects X semantic complexity, 17.05%; and subjects X semantic complexity X NEWS-OLDS, 13.29%.

Study III

A mean confidence rating was calculated across subjects for each of the recognition sentences in Study III, all of which were presented in German.

TABLE 8

Analysis of Variance on Mean Confidence

Ratings for ONES, TWOS, and THREES: Study II

Source	df	MS	F
Subjects (S)	17	13.81	
Semantic complexity (C)	2	61.49	19.00**
NEWS vs. OLDS (N)	1	40.52	13.28**
S X C	34	3.24	
S X N	17	3.05	
C X N	2	11.74	4.65*
S X C X N	34	2.52	

* $p < .05$

** $p < .01$

Fifty-six out of 82 predictions that a given recognition sentence would receive a higher mean confidence rating than one which was a subset of it were confirmed ($p < .017$, by Monte Carlo assessment). NEW recognition sentences alone yielded 30 out of 40 correct predictions ($p < .011$).

A mean rating was also obtained for each subject for FOURS and for NONCASE sentences. Mean confidence ratings were compiled for each subject for OLD sentences and for NEW sentences at each complexity level from ONES to THREES. These mean ratings are shown graphically in Figure 3.

A repeated measures analysis of variance (Table 9) was performed (similar to that for Study II) on the mean ratings given by subjects for NEW sentences at each semantic complexity level. A significant effect of semantic complexity was found, F (4, 36) = 31.27, $p < .001$. Newman-Keuls post hoc analyses showed that ratings for FOURS, for NEW THREES, and for NEW TWOS were each significantly greater than those for NEW ONES and for NONCASE sentences ($p < .01$ for all comparisons). NEW THREES received higher ratings than FOURS in Study III, although this result did not attain significance.

Semantic complexity accounted for 71.10% of the variance among ratings for NEW sentences, while the interaction of subjects X semantic complexity accounted for 23.49% of the variance.

A 2 (OLD vs. NEW sentences) X 3 (ONES vs. TWOS vs. THREES) analysis of variance with repeated measures on both factors was performed (Table 10) on the mean confidence ratings given by subjects. A significant main effect of semantic complexity was found, F (2, 18) = 17.15, $p < .001$.

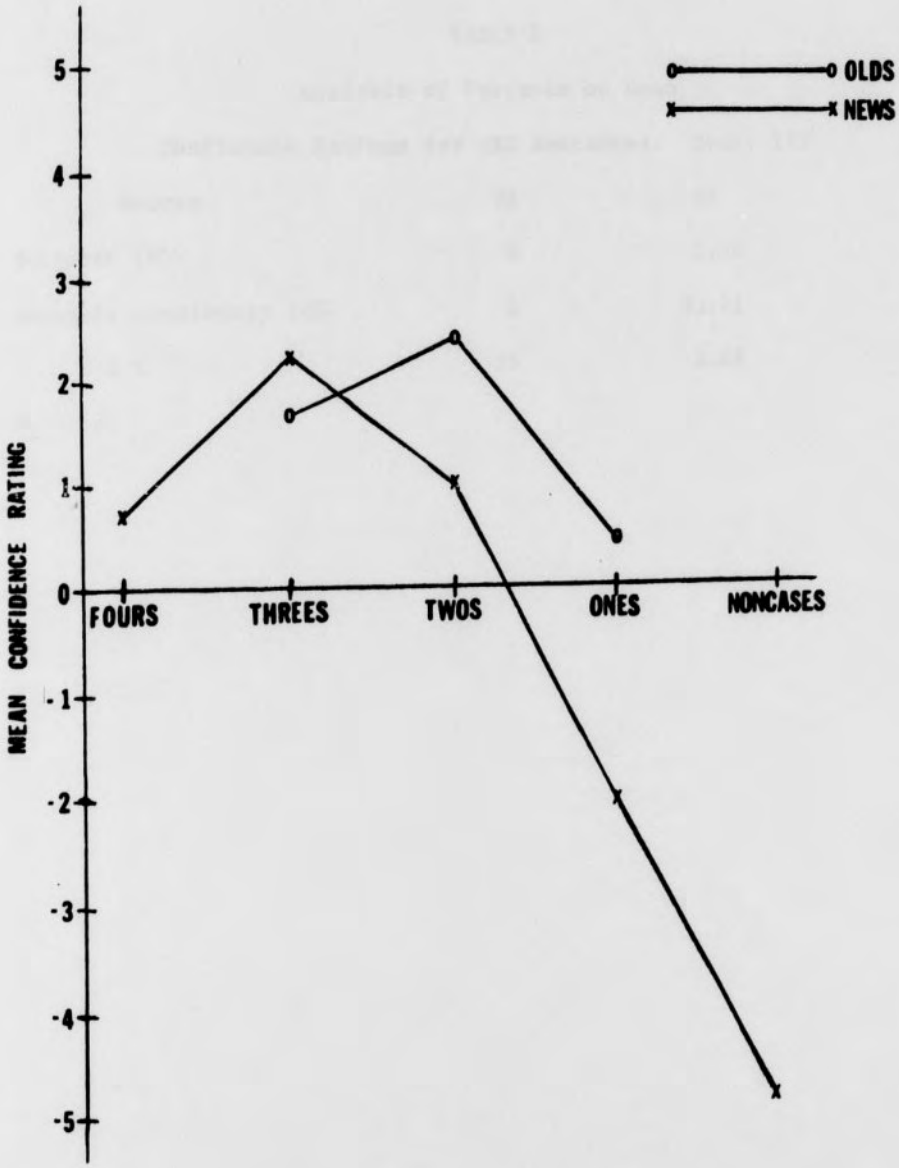

Figure 3. Mean Confidence Ratings by Sentence Complexity for OLDS and NEWS (Study III)

TABLE 9

Analysis of Variance on Mean

Confidence Ratings for NEW Sentences: Study III

Source	df	MS	F
Subjects (S)	9	2.46	
Semantic complexity (C)	4	83.71	31.27*
S X C	36	2.68	

*$p < .01$

TABLE 10

Analysis of Variance on Mean Confidence

Ratings for ONES, TWOS, and THREES: Study III

Source	df	MS	F
Subjects (S)	9	5.57	
Semantic complexity (C)	2	45.70	17.15**
NEWS vs. OLDS (N)	1	19.55	10.10*
S X C	18	2.66	
S X N	9	1.94	
C X N	2	11.68	2.55
S X C X N	18	4.57	

* $p < .05$

** $p < .01$

OLD sentences received significantly higher ratings than NEW sentences, F (1, 9) = 10.10, $p < .025$. The interaction of semantic complexity X NEW-OLD was not significant. Post hoc comparisons done by the Newman-Keuls technique indicated that THREES and TWOS were given more positive ratings than ONES ($p < .01$ for both comparisons).

The following factors and interactions were each found to account for at least 10% of the variance in the data included in the present analysis: subjects, 16.52%; semantic complexity, 25.49%; subjects X semantic complexity, 15.78%; and subjects X semantic complexity X NEW-OLD, 27.08%.

The results of the above analyses for Study III conflicted somewhat with results reported by Bransford and Franks (1971) for similar English sentences. Since the mean confidence ratings for FOURS were somewhat lower than those given for NEW THREES and NEW TWOS, although this difference was not significant, and since ratings for OLD sentences were significantly higher than those for NEW sentences, it was thought that ratings for sentences composed by Bransford and Franks (1971) (i.e., Idea Sets B and D) might differ from those for sentences composed by the present author (i.e., Idea Sets A and C), such that only ratings for Bransford and Franks' sentences followed the pattern of results found by those authors. Two further analyses were performed to test this possibility.

A mean rating was calculated for each subject for FOURS composed by Bransford and Franks and for FOURS composed by the present author. Mean confidence ratings were also compiled for each subject, by author, for OLD sentences and for NEW sentences at each complexity level from ONES to THREES.

A 2 (author) X 4 (semantic complexity, excluding NONCASE sentences) analysis of variance with repeated measures on both factors (Table 11) was performed on the data for NEW sentences. A significant effect of semantic complexity was found, F (3, 27) = 9.41, p < .001. However, there was no significant effect of author, and the semantic complexity X author interaction was not significant.

Post hoc analyses done by the Newman-Keuls test showed that there were no significant differences among ratings for FOURS, for NEW THREES, and for NEW TWOS. However, ratings for each of these levels of complexity were significantly higher than those for NEW ONES (p < .01 for all comparisons).

Factors and interactions which accounted for greater than 10% of the variance were: subjects, 10.21%; semantic complexity, 28.16%; subjects X semantic complexity, 33.48%; and subjects X semantic complexity X author, 22.51%.

A repeated measures ANOVA with two levels of author, two levels of NEWS-OLDS, and three levels of semantic complexity (ONES vs. TWOS vs. THREES) was also performed (Table 12). Significant main effects were found for semantic complexity, F (2, 18) = 17.14, p < .001, and NEWS-OLDS (with OLD sentences receiving higher ratings than NEW sentences), F (1, 9) = 10.10, p < .025. The semantic complexity X NEWS-OLDS X author interaction also yielded significance, F (2, 18) = 5.90, p < .025, but accounted for less than 5% of the variance. No other factors or interactions were significant.

Newman-Keuls post hoc comparisons showed that ratings for THREES and for TWOS were significantly higher than those for ONES (p < .01 for both comparisons). Ratings for THREES did not differ from those for TWOS.

TABLE 11

Analysis of Variance on Mean Confidence

Ratings for NEW Sentences by Author: Study III

Source	df	MS	F
Subjects (S)	9	6.15	
Semantic complexity (C)	3	63.27	9.41*
Author (A)	1	2.28	1.48
S X C	27	6.72	
S X A	9	1.54	
C X A	3	10.72	2.37
S X C X A	27	4.52	

*$p < .01$

TABLE 12

Analysis of Variance on Mean Confidence

Ratings for ONES, TWOS, and THREES by author: Study III

Source	df	MS	F
Subjects (S)	9	11.14	
Semantic complexity (C)	2	91.31	17.14**
NEWS vs. OLDS (N)	1	39.10	10.10*
Author (A)	1	0.41	0.14
S X C	18	5.33	
S X N	9	3.87	
C X N	2	23.33	2.55
S X A	9	2.88	
C X A	2	0.44	0.08
N X A	1	0.30	0.08
S X C X N	18	9.14	
S X C X A	18	5.25	
S X N X A	9	3.59	
C X N X A	2	29.26	5.90*
S X C X N X A	18	4.96	

* $p < .025$

** $p < .01$

At least 10% of the variance was accounted for by each of the following factors and interactions: subjects, 11.23%; semantic complexity, 17.32%; subjects X semantic complexity, 10.73%; subjects X semantic complexity X NEWS-OLDS, 18.41%; subjects X semantic complexity X author, 10.58%; and subjects X semantic complexity X NEWS-OLDS X author, 10.00%.

DISCUSSION

The present studies investigated the applicability of the Bransford-Franks model (Bransford & Franks, 1971, 1972) to memory for a bilingual list of semantically-related sentences. Although the results presented in this paper are supportive of the Bransford-Franks position in several ways, many aspects of the data are inconsistent with such an hypothesis as expressed by Bransford and Franks (1971, 1972). The data from the present studies suggest that the general validity of the Bransford-Franks model should be questioned. The discussion here will, at first, focus upon those aspects of the data which are in agreement with the Bransford-Franks hypothesis. Secondly, those data which are incongruous with the Bransford-Franks model will be presented. Finally, hypotheses which might account for the data presented here will be discussed.

Findings Supporting the Bransford-Franks Model

Bransford and Franks have proposed that, within the paradigm which they used, confidence ratings for recognition sentences should be a monotonically increasing function of the number of semantic relations expressed by a sentence. NONCASE sentences, however, according to Bransford and Franks, should receive very negative ratings, since they express information which is inconsistent with any of the ideas given during acquisition. In addition, these authors state that confidence ratings for sentences actually presented during acquisition should not differ from confidence ratings for similar sentences which were not previously heard by subjects.

Bransford and Franks (1971) felt that the strongest evidence for their position would be given by results showing (1) that the mean confidence rating for a particular recognition sentence was higher than the mean confidence rating for any recognition sentence which it contained as a subset and (2) that subjects' ratings for sentences expressing a single semantic relation (i.e., ONES) were higher than ratings for NONCASE sentences.

Study I was designed to test the Bransford-Franks model by presenting acquisition sentences which were semantically-related, but which were presented to bilinguals in two different languages. Recognition memory for these sentences was tested using a bilingual list of related sentences. Results from Study I indicated that both stipulations made by Bransford and Franks were met at beyond the .01 confidence level for recognition sentences overall, for NEW sentences alone, for German sentences alone, and for English sentences alone.

Studies II and III were undertaken to provide data for monolingual lists with structure and semantic content similar to that of the bilingual lists used in Study I. Data from these studies also confirmed the two postulates made by Bransford and Franks (1971) for strong support of their model of memory.

In all three studies, NONCASE sentences received very high negative ratings. In fact, all subjects gave the highest negative rating possible (i.e., a minus five) for German NONCASE sentences in Study I, and for all NONCASE sentences in Study II and in Study III.

Further support for the Bransford-Franks model is provided, in Study I, by the data for all recognition sentences combined and for

German sentences alone and, in Study II, by data for English sentences. The prediction that recognition ratings would be a monotonically increasing function of the number of semantic relations expressed by a sentence was confirmed in these three instances.

Bransford and Franks (1971) have reported data which show that a significant difference between ratings for OLD sentences and ratings for NEW sentences was obtained only at the semantic complexity level of ONES. This finding was replicated in the data for Study II. Even in instances where OLD sentences received significantly higher ratings than NEW sentences at the level of TWOS and/or THREES, this difference accounted for a very small proportion of the total variance (i.e., less than 5% in all cases) and seems relatively unimportant.

Findings Which Conflict with the Bransford-Franks Model

Much evidence favoring the Bransford-Franks model of memory has been referred to in the previous section. However, data have also been collected in the present studies which seem equivocal, at best, with respect to that model.

For all analyses performed, subjects' mean confidence ratings for FOURS, for THREES, and for TWOS were each significantly different from ratings for ONES and for NONCASE sentences. This is a finding which, taken by itself, is in strong support of the Bransford-Franks position. However, significant differences among these three highest levels of semantic complexity were found in only two instances. Among NEW German sentences in Study I, FOURS were given significantly higher ratings than NEW TWOS. However, ratings for German FOURS did not differ from those for German NEW THREES. Also in Study I, when data for OLD and NEW

sentences were combined, confidence ratings for THREES were significantly above those given for TWOS. In all other instances, tests of differences among FOURS, THREES, and TWOS revealed no statistically significant findings.

In addition to findings of few significant differences among the three highest levels of semantic complexity, it should be noted that, in several cases, even the predicted ordering of means (i.e., FOURS > THREES > TWOS) was not found. Among NEW English sentences in Study I, mean ratings for FOURS, for NEW THREES, and for NEW TWOS had approximately the same numerical value. Among NEW sentences in Study III, the mean for NEW THREES was higher than that for NEW TWOS, which was, in turn, higher than that for FOURS.

When the data for OLD sentences are combined with that for NEW sentences, there were three instances where the predicted ordering of means with respect to semantic complexity was violated. The overall results of Study I show that the mean rating for FOURS, while higher than that for TWOS, is lower than that for THREES. The same ordering of means was found in Study I for English sentences alone. In Study III, the ordering of means (with combined data from OLD sentences and NEW sentences) was THREES > TWOS > FOURS.

As previously reported, in findings for Study III, 56 out of 82 predictions that a sentence would receive a higher mean rating than one which was a subset of it were confirmed. This result, although significant at beyond the .02 level, is less impressive than other results reported here and in other studies (Bransford & Franks, 1971; Bransford & Franks, 1972; Franks & Bransford, 1972) for similar types of data.

Individual Differences in Confidence Ratings

In the present studies, NONCASE sentences exerted powerful control over confidence ratings given to such sentences. As a result, when NONCASE sentences were included in the data analyses for these studies, semantic complexity was found to account for large proportions of the total variance (e.g., from 49.43% in Study I to 71.10% in Study III). Such results are misleading in that they obscure important individual differences in subjects' ratings for sentences at the other levels of semantic complexity.

In analyses where the NONCASE sentences were excluded, semantic complexity accounted for a much smaller percentage of the variance. In fact, individual differences in subjects' responses to the various levels of semantic complexity (i.e., interactions between subjects and semantic complexity, or between subjects, semantic complexity, and other variables) accounted for about twice as much, or more, of the variance as was accounted for by the semantic complexity dimension itself. Thus, although the semantic complexity of a recognition sentence strongly affected the rating given that sentence, subject variables also had a powerful effect upon the ratings for a particular FOUR, THREE, TWO, or ONE.

Within the present studies, group data for the German sentences in Study I and group data for Study II provide the best evidence for the Bransford-Franks model. However, even if one includes, as confirmations of predictions, cases where adjacent levels of semantic complexity received the same mean confidence rating, only 9 of 19 subjects supported the Bransford-Franks model on an individual level among German sentences in Study I. If only cases where the FOURS > THREES > TWOS > ONES > NONCASES

ordering is strictly adhered to, data for only 4 out of 19 subjects support the Bransford-Franks model on an individual level. In Study II, 4 out of 18 subjects confirmed the Bransford-Franks hypothesis on an individual level. Thus, even in those studies where the group data may support the Bransford-Franks model, strong support of the model was not found in the data for individual subjects. Other individual data in the present studies provide even less strong arguments for the applicability of the Bransford-Franks model to individual performance. Comparison of these data with similar data from the studies performed by Bransford and Franks would be helpful as a comparison. However, no such data is publicly available.

Most subjects (15 out of 19 subjects for English sentences in Study I; 17 out of 19 subjects for German sentences in Study I; 18 out of 19 for all sentences in Study I; 18 of 18 subjects in Study II; and 10 of 10 in Study III) gave their most negative ratings to NONCASE sentences. In all studies reported here, ONES were the most likely sentences to receive the second highest negative ratings (12 out of 19 subjects for English sentences in Study I; 13 out of 19 subjects for German sentences in Study I; 14 of 19 for all sentences combined in Study I; 17 out of 18 subjects in Study II; and 8 out of 10 in Study III). Thus, in all three studies, the data for individual subjects at the levels of ONES and NONCASES is consistent with the group data. ONES received lower confidence ratings than sentences at higher levels of semantic complexity, but ONES were given higher ratings than those given to NONCASE sentences.

Predictions that FOURS would receive higher confidence ratings than THREES or TWOS and that THREES would receive higher ratings than TWOS received little support among the data for individual subjects. If we assume that a subject is responding randomly at the level of FOURS, THREES, and TWOS, then for a given subject, FOURS would be equally as likely to receive a lower rating than THREES as to receive a higher rating than THREES. The same probabilities would apply to the other two predictions. Accordingly, using the formula for the binomial distribution, if N equals the total number of subjects in a study, if r equals the numbers of subjects giving data confirming a prediction in that study, and if p and q are each equal to .50, then the formula

$$P_C = 1 - \sum_{0}^{r} \binom{N}{r} p^r q^{N-r}$$

will give the probability, P_C, that r out of N subjects responding randomly will provide data confirming a given prediction.

The data for individual subjects shown that the predictions made were supported at beyond the .05 level in only three instances. In Study I, 14 out of 19 subjects gave higher ratings to German FOURS than to German TWOS (P_C = .0095). Also in Study I, 14 out of 19 subjects gave higher mean rating for all FOURS combined than they did for all TWOS combined (P_C = .0095) and 13 out of 19 subjects gave THREES higher confidence ratings than were given to TWOS (P_C = .0317). The individual subjects data for the prediction that German THREES would receive higher ratings than German TWOS approached significance (P_C = .0835). Thus, in the present studies, in only a few instances, was evidence found that the Bransford-Franks model is valid for individual subjects who are responding to sentences at the level of FOURS, THREES, and TWOS.

Conclusions

The general validity of the Bransford-Franks model for subjects like those who participated in the present studies seems questionable according to most of the analyses presented. The original intent of these studies was to test the applicability of the Bransford-Franks model to memory for bilingual lists of semantically-related sentences. In light of the weak support for that model provided by the data presented here for monolingual lists, it seems inappropriate to discuss the utility of the Bransford-Franks model for describing the performance of bilingual subjects who have been presented with a bilingual list of related sentences.

The present author attempted to ensure that sentences used in the studies reported here were similar to those used by Bransford and Franks (1971). Two of the four idea sets employed were borrowed from among those used in the Bransford and Franks (1971) studies. The procedure for all three of the present studies followed that reported by Bransford and Franks (1971) with only one apparent exception. In the present studies, the recognition list was presented to each subject only one time, whereas Bransford and Franks (1971) presented the entire recognition list twice. Data reported by Bransford and Franks (1971) indicate that the results for the first trial on a list were highly similar to results obtained on the second trial. It seems unlikely that results obtained in the present studies are the artifacts of a basic procedure which differed from that used by Bransford and Franks (1971).

It seems quite predictable, both at an individual and at a group level, that ratings for FOURS, for THREES, and for TWOS will be higher

than those given for ONES and for NONCASES. It also appears that, in general, ratings given for ONES will exceed those given for NONCASE sentences. With the exception of a few instances, however, the data indicate that one cannot predict the relative standing of the ratings which an individual subject will give for FOURS, THREES, and TWOS.

Subjects can recognize sentences which express relationships which they have not previously experienced (i.e., NONCASES). With regard to other levels of semantic complexity, the best prediction which can be made is that short sentences (i.e., ONES) will be given less positive ratings than relatively long sentences (i.e., FOURS, THREES, and TWOS). Such findings lend relatively weak support to the Bransford-Franks assertion that subjects are acquiring ideas and nothing more.

For sentences of the type used in the present studies, Katz, Atkeson, and Lee (1974) hypothesize that subjects' ratings for a given sentence are dependent upon an estimation of the size of the set of sentences which are as complex as the given sentence. According to Katz et al. (1974), subjects' ratings are inversely related to this "set size" (with "set size" being smallest in the case of FOURS and largest in the case of ONES). Data from the present studies, especially the data for individual subjects, conflict with the "set size" hypothesis since it would predict that FOURS should consistently be given higher confidence ratings than THREES and TWOS.

A variation of the "set size" hypothesis may, however, be applicable to the data presented here. One factor which may have influenced subjects' confidence ratings is the way in which the input and recognition lists were perceived. Subjects may have perceived the recognition

list as a set of relatively long sentences interspersed with a set of short sentences. Since most of the acquisition sentences were relatively long (i.e., two-thirds of them were TWOS and THREES), a relatively long recognition sentence had a greater probability of having been heard previously than a short recognition sentence had. Subjects' recognition ratings may have been based upon a decision as to whether a given recognition sentence belonged to the set of relatively long sentences or to the set of short sentences. It is possible that discriminations of sentence length beyond the level of TWOS are infrequently made or that such discriminations are made by very few subjects.

In the Bransford and Franks (1971) studies, absolute differences between the group means for the five levels of complexity parallel those found in the present studies. In both sets of studies, there was a large difference between the means for NONCASE sentences and the mean for ONES. The difference between the mean for ONES and the mean for TWOS was also large in both the Bransford and Franks (1971) studies and in the present studies. It is possible that the data for FOURS, THREES, and TWOS in the Bransford and Franks (1971) studies also show little predictability for the individual subject and no significant differences among the group means for these complexity levels.

In all three of the present studies, OLD sentences were given more positive ratings than NEW sentences. The semantic complexity X NEWS-OLDS interaction was not significant in two of the three studies, and never accounted for more than 3% of the variance. Therefore, it is likely that OLDS were given higher ratings than NEWS at all levels of semantic complexity. However, this difference between ratings for OLD

sentences and ratings for NEW sentences accounts for only a small proportion of the total variance (about 3 to 6%). Thus, the NEWS-OLDS factor was a relatively weak predictor of the confidence ratings received by recognition sentences.

Differences obtained along the NEWS-OLDS dimension may have occurred because subjects occasionally made positive identification of OLD sentences. For example, certain acquisition sentences may have been phrased such that retention of their original form was not difficult. At other times, similarities among the input sentences may have made discrimination of OLD and NEW sentences problematic. Such factors would be likely to cause significant differences in ratings for OLD vs. NEW sentences. However, the strength of such an effect would be low, as in the present studies.

It is unlikely that cues regarding language of presentation aided subjects in identifying OLD sentences since significant differences between OLDS and NEWS were also obtained in the monolingual studies.

If semantic complexity had been a stronger factor in the present experiments, a weak effect of the NEWS-OLDS dimension would have provided little evidence against the Bransford-Franks model. Such results could have led to the conclusion that, although memory for specific idea-related sentences exists, it is relatively weak when compared with memory for the integrated ideas themselves. In light of the present results, subjects may be acquiring ideas but may be unable to distinguish many FOURS, THREES, and TWOS from these stored ideas. However, representations of certain acquisition sentences may also have been stored. Occasional correct recognition of OLD sentences and correct

rejection of NEW sentences may be a function of such factors as similarities or differences in grammatical relations (Singer & Rosenberg, 1973), or recognition (especially in the case of FOURS) that a sentence of a particular length was never heard previously.

Correct rejection of NONCASE sentences indicates that subjects retained information concerning which semantic relations had and had not occurred within the same acquisition sentence. That is, subjects knew which semantic relations were contained within the same idea. However, lack of statistically significant differences among ratings for FOURS, THREES, and TWOS favors an interpretation different from the Bransford-Franks notion that subjects stored only complete ideas abstracted from the partial information given in related acquisition sentences. Subjects may have stored such wholistic ideas, as indicated by the data from NONCASE sentences. In many instances, relatively long acquisition sentences may have been indistinguishable from these stored ideas, while ONES and NONCASES could be easily discriminated from ideas. With sentences at higher levels of complexity, subjects may have been incapable of making the discriminations predicted by Bransford and Franks (1971, 1972). Data on relative confidence ratings for FOURS, THREES, and TWOS in the present studies show little consistency across subjects. Unreported data for these studies also show that subjects are not internally consistent in their ratings for the three highest complexity levels. Subjects may have stored ideas but, in many instances, they may have been incapable of distinguishing FOURS, THREES, and TWOS for these representations. In addition to storing ideas, however, weak differences in ratings for OLD vs. NEW recognition sentences indicate

that subjects were occasionally storing information about specific acquisition sentences which allowed them to correctly recognize some sentences which been presented at input. Evidence that subjects made distinctions between some OLD sentences and NEW sentences is contrary to the model suggested by Bransford and Franks (1971, 1972), but should not be surprising.

The present results were obtained using a comparatively short retention interval. Data presented by Pratt (1974) indicate that results which are more supportive of the Bransford-Franks model may be obtained when a delay of 24 hours occurs between the acquisition and recognition phases. Results which could be interpreted as favorable to the Bransford-Franks model might have been obtained in the present studies if a longer delay had been introduced. Longer delay intervals may allow forgetting of specific input items or more rearrangements and reconstructions of input, thereby attenuating the memory for specific form of input. Accordingly, subjects may come to rely less on specific memory and more on general integrations.

As a closing note, regarding the difference in Study I recognition ratings between German sentences and English sentences at all levels of complexity, it should be noted that most of the subjects in that study spoke English in their daily life. While the effect of language of presentation was not strong, the general trend toward more positive ratings for German sentences may have been the byproduct of an orienting response due to the relative frequency with which they hear German spoken in their current environment.

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APPENDIX

RECOGNITION SCORES

Circle the Y (for Yes) if you think you saw or heard the exact sentence or picture just presented to you, circle the N (for No) if you think you did not see or hear that exact sentence or picture. Then circle one of the numbers from 1 to 5 to indicate how sure you are of your Y or N answer. For example, if you are quite positive that you saw the stimulus, circle Y and 5; if you are moderately sure that you did not see the stimulus, circle N and 3. Do not change your answers after we have gone on to the next stimulus.

1. Y N 1 2 3 4 5
2. Y N 1 2 3 4 5
3. Y N 1 2 3 4 5
4. Y N 1 2 3 4 5
5. Y N 1 2 3 4 5
6. Y N 1 2 3 4 5
7. Y N 1 2 3 4 5
8. Y N 1 2 3 4 5
9. Y N 1 2 3 4 5
10. Y N 1 2 3 4 5
11. Y N 1 2 3 4 5
12, Y N 1 2 3 4 5
13. Y N 1 2 3 4 5
14. Y N 1 2 3 4 5
15. Y N 1 2 3 4 5
16. Y N 1 2 3 4 5
17. Y N 1 2 3 4 5
18. Y N 1 2 3 4 5
19. Y N 1 2 3 4 5
20. Y N 1 2 3 4 5
21. Y N 1 2 3 4 5
22. Y N 1 2 3 4 5
23. Y N 1 2 3 4 5
24. Y N 1 2 3 4 5
25. Y N 1 2 3 4 5
26. Y N 1 2 3 4 5
27. Y N 1 2 3 4 5
28. Y N 1 2 3 4 5
29. Y N 1 2 3 4 5
30. Y N 1 2 3 4 5
31. Y N 1 2 3 4 5
32. Y N 1 2 3 4 5
33. Y N 1 2 3 4 5
34. Y N 1 2 3 4 5
35. Y N 1 2 3 4 5
36. Y N 1 2 3 4 5
37. Y N 1 2 3 4 5
38. Y N 1 2 3 4 5
39. Y N 1 2 3 4 5
40. Y N 1 2 3 4 5
41. Y N 1 2 3 4 5
42. Y N 1 2 3 4 5
43. Y N 1 2 3 4 5
44. Y N 1 2 3 4 5
45. Y N 1 2 3 4 5
46. Y N 1 2 3 4 5
47. Y N 1 2 3 4 5
48. Y N 1 2 3 4 5