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ABSTRACT

As part of a series of studies dealing with varieties of interference in sentence learning as assessed by multiple choice tests, a study was undertaken to explore the effects of pictures on inferentially produced interference in recognition memory for sentence information. The subjects were 104 first grade students and 10[illegible] fourth, fifth, and sixth grade students. The design consisted of two levels each of age (younger or older), strategy (pictures or no pictures), the contextual relationship of distractor and test question (related or unrelated), and item type (explicit or implicit). Students in the experimental group were shown pictures while hearing tape recorded sentences. The pictures displayed all sentence information except that which would later become a multiple choice distractor. Students in the control group heard the sentences but did not see pictures. All subjects were given a multiple choice recognition test concerning the content of the sentences. The results indicated that pictures had a strong, positive effect on learning for both younger and older subjects--even when there was potential interference from related materials. The findings support the notion that pictures enhance the distinctiveness of target information rather than increasing the likelihood of confusing the information with distractors. (Appendixes contain the materials used in the study and tables of raw data.) (FL)

Technical Report No. 573

THE EFFECTS OF PICTORIAL AIDS ON INFERENTIALLY-PRODUCED INTERFERENCE IN YOUNGER AND OLDER CHILDREN'S SENTENCE LEARNING

by

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Report from the Project on
Studies in Language: Reading and Communication

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TABLE OF CONTENTS

LIST OF TABLES

THE EFFECTS OF PICTORIAL AIDS ON
INFERENTIALLY-PRODUCED INTERFERENCE
IN YOUNGER AND OLDER CHILDREN'S
SENTENCE LEARNING

Diane Lytton Truman

Under the supervision of Professor Joel R. Levin

ABSTRACT

This study was a continuation of a series of studies dealing with varieties of interference in sentence learning as assessed by multiple-choice tests. Methodology in these studies involved presenting to children a series of sentences and later testing recognition memory for target information with a multiple-choice test. The test included distractors from sentences variously related to sentences in which target information occurred. The basic finding in these studies was that children made more errors on multiple-choice items whose distractors appeared in sentences on the study list and shared similar contexts with target information, compared with items whose distractors did not appear previously. The amount of interference was moderated by the study strategy used.

The object of the present study was to explore the effects of pictures on inferentially-produced interference in recognition memory for sentence information in two age groups. Younger children had a

mean age of seven years, three months. Older children's mean age was eleven years, two months. There were 104 subjects at each age level.

The design consisted of two levels each of age (younger or older), strategy (no-strategy control or provided pictures), contextual relatedness of distractors and test question (related or unrelated) and item type (explicit or implicit). It was predicted that older children would spontaneously infer and thus would have similar levels of interference from implicit information and explicit information, under a control condition. Younger children were predicted not to infer spontaneously, and therefore their level of interference would be higher on explicit items compare with implicit items.

Pictures displayed all sentence information except what would later become a multiple-choice distractor. The pictures were predicted to aid learning of target information for both younger and older subjects compared to control subjects. It was also predicted that when pictures were provided, there would be no difference in interference levels between explicit and implicit items at either age level.

The major finding was that learning with pictures was significantly better than learning without pictures. The results of comparisons of overall levels of interference indicated no differences due to item type (explicit or implicit) at either age level. There was no primary evidence of interference within each item type. Possible sources producing no contextual interference in the control condition may have involved the use of various covert strategies.

Patterns of conditional old errors (the percentage of old errors among all errors) illustrated that implied information may have been a source of error for younger pictures subjects, and for both older control and pictures subjects.

Approved ____________________________

Professor Joel R. Levin
Major Professor

CHAPTER I

INTRODUCTION

Background

There appears to be an increasing interest among educational researchers in the many facets of understanding verbal materials.[1] Today's professional literature reflects this trend with reports of studies using materials such as stories, paragraphs, and sentences which more closely resemble teaching materials used in schools than do the more traditional nonsense syllables and single words of verbal-learning experiments. The related problem of children failing to learn to read likewise is currently a popular theme of television documentaries and news magazines.

Professional researchers realize that this problem must be approached with proper scientific methods involving carefully controlled experiments with limited numbers of variables. There are many questions about intellectual skills related to reading that must be answered before the problem of "why Jane can't read" can be tackled. To the non-professional, these basic questions may appear trivial; but so must have discoveries of basic relationships in other sciences seemed to the uninformed in those areas. Because educational research is such a new field, there awaits to be uncovered many elemental relationships and

[1] Verbal materials may be defined as written or spoken information of any length (syllables to stories).

patterns of behavior. Each of these "minor" findings is important, however, in building a complete picture of what learning is all about--in this case, learning from verbal materials.

Studies of sentence learning, upon which the present study is based, have examined the effects of study strategies such as repeating or "imaging," and the addition of background contexts on reduction of interference between related sentences. Interference is the partial or total obstruction of memory for one piece of information caused by its similarity (on one or more dimensions) to another piece of information. It is concretely evidenced by level and/or pattern of errors on a memory test. Multiple-choice tests were used in these studies to measure learning.

The multiple-choice test commonly is used in schools to measure academic achievement and is made up of questions or test-item stems, each followed by two or more possible answers. The correct answer is usually one of the choices (or "none of the above" or "all of the above" is a choice) and it is accompanied by one or more distractors. Multiple-choice tests are considered recognition tests since they require primarily recognition of the correct answer and do not require recalling it from memory. Tests like these are similar to typical recognition memory tests used in verbal-learning experiments where a series of words is presented for study and later the learner is asked to select these words from among a group of words that includes distractors. A variation in materials may involve presentation of pictures instead of words.

Frequency Theory Explanation of Multiple-Choice Test Performance

Over the years Underwood and his associates have conducted many verbal-learning experiments to study the effects of numerous variables on recognition memory. These studies led Underwood (1971) to identify frequency as one of several components of recognition memory. Frequency theory states that simple discriminations on a recognition test between old items presented during study and new items not presented during study are made on the basis of a subjective frequency differential. Old items have a situational frequency of 1 while new items have a frequency of 0. Underwood, Patterson, and Freund (1972) suggested that the frequency theory of recognition memory explained performance on multiple-choice tests on which the situational frequency of the alternatives had been manipulated. They found that the larger the frequency differential between correct and incorrect choices, the better the performance. Errors occurred when learners could not discriminate differences in situational frequency between the alternatives.

Levin, Ghatala, Guttmann, Subkoviak, and Bender (1978) extended the Underwood et al. (1972) findings to see if frequency theory was a plausible explanation for performance on multiple-choice tests where the units studied were sentences instead of single words. Children studied sentences such as "In his speech, the spaceman told how he laughed at the movie" and were later asked the multiple-choice question "What did the spaceman laugh at? the movie, the speech, the book." Levin et al. (1978) found that when there was competing situational frequency in a distractor (old-present item, as in the above example) performance was reduced compared with the situation where distractors were both new (old-absent item, i.e., if "the letter" replaced "the speech" in the above example) and thus had a situational frequency of 0.

This was the first experimental test, using sentences, to examine Underwood's (1966) position that:

> The recognition test is a very mercurial one. Most of us have taken multiple-choice tests where the alternative answers were all very similar, and we know how difficult it is to choose the correct alternative in such a case as compared to choosing the correct one where alternatives differ widely. In the same sense, we can manipulate recognition measures a great deal by varying the similarity between the verbal units learned and the added or filler words put in as a part of the recognition test [distractors in the Levin et al., 1978 study]. And, given a constant degree of similarity, the measure should vary as a function of the number of added units, if for no other reason than that guessing probabilities will differ. (page 545)

The above example from the Levin et al. (1978) materials illustrates an old-present item where "the movie" and "the speech" had situational frequencies of 1 since both were presented during study. In an old-absent item both distractors were new and only the correct choice had frequency. Clearly a frequency explanation for the better performance in the old-absent condition was supported. However, a simple frequency explanation proved inadequate to explain why the correct answer was still chosen more often than the old distractor in the old-present condition since both the correct and old, incorrect alternatives had the same apparent frequency of 1. According to a strict frequency interpretation, students should not have been able to discriminate between the two choices. Levin et al. (1978) proposed that the correct answer had acquired "contextual" frequency through its association with the test-item stem.

The notion of contextual frequency is simply that subunits of larger units (e.g., letters are subunits within larger units words) acquire both situational frequency and, by being encoded as part of the larger unit, they have additional contextual frequency. In the example above from the Levin et al. (1978) materials, the correct answer and old, incorrect alternative both had the same "item" frequency of 1 from their exposure during study. However, the correct answer became encoded in the larger idea unit of the sentence giving it the additional frequency upon which learners could base their recognition judgment and make the correct selection.

A purist in theory-building might take exception to the way frequency theory has been portrayed up to this point. The reader should not be left with the untested notion that frequency builds up by layers as might be interpreted from the preceding discussion. This "bottom-up" approach suggests that the correct answer accumulated additional frequency and perhaps became more memorable as it appeared in larger units: as a single word it had an item frequency of 1; in a sentence it had an item frequency of 1 plus additional contextual frequency; and, hypothetically, in a paragraph it would have item frequency, plus contextual frequency from both its parent sentence and paragraph. It may be more likely that, as Levin et al. (1978) proposed, frequency accrued to larger idea units themselves and it is the frequency of the entire idea unit that was used to choose the correct answer. Thus, when a target word appeared within the context of a sentence ("movie" within "...the spaceman told how he laughed at the movie"), the frequency of the whole idea unit--the idea expressed by the test item stem and correct answer--was used to make the correct choice on the test. Whether frequency builds in layers, or whether the frequency of single words gets subsumed in their contingent sentence or paragraphs, or whether the two views are equivalent, is an interesting question but will not be addressed further by this study.

An Alternative Explanation

It should be pointed out that a frequency explanation of multiple-choice test performance is only one possible explanation. As Levin et al. (1978) stated,

> Thus, we do not purport to provide a strong assessment of frequency theory vis-à-vis its competitors [alternative information-processing theories]. Rather, our intent in this initial investigation is to determine whether predictions stemming from the theory (even if not uniquely from it) will be supported in more complex recognition situations. If not, the applicability of frequency theory to these situations would be seriously challenged. (page 41)

Associationist theory (Anderson and Bower, 1973; also see Gagné, 1978) offers an alternative explanation for correct performance on multiple-choice tests where competing frequency is built into a distractor (Levin, Ghatala, and Truman, 1979). It might be that there are more pathways, or connections, established between the correct answer and the test-item stem due to their closer association during study. The associationist approach would predict that the more connections there are between the question and a particular alternative, the more likely it is that the alternative will be chosen over other alternatives.

The mechanisms by which these pathways are established are no doubt complex and are probably more appropriately addressed by linguists. A "surface" and perhaps simplistic analysis of the Levin et al. (1978) results might be that pathways between the question and correct answer were greatest because the correct answer ("the movie") was the direct object of the noun ("the spaceman"). This relationship was probably stronger than the relationship between the noun and its indirect object ("the speech"), which was the old, incorrect distractor, even though "the speech" was closer temporally to "the spaceman."

Information-Processing Strategies

It has also been demonstrated that certain information-processing strategies affect recognition memory for sentence information when distractors with competing frequency are included on multiple-choice items. Levin et al. (1978) asked subjects to either repeat the study sentences or to form mental images of the contents of each, predicting that imagery would enhance subjects' semantic processing (i.e., encloding of the materials at the meaning or comprehension level). Imagery would thus overcome frequency interference from competing distractors by enabling learners to keep each sentence separate in memory. Repeating sentences, a more rote-like strategy, was predicted to distract subjects from processing the "deeper" (Craik and Lockhart, 1972) meaning of each sentence, causing more errors on the test. As Levin et al. (1978) noted, the repetition strategy may demand greater attention to surface features of sentences such as pronounceability of individual words, at the expense of encoding sentence meaning.

The Levin et al. (1978) predictions were upheld by the test results. Imagery subjects made fewer overall multiple-choice errors than did repetition subjects, although both groups of subjects made more errors on old-present items compared with old-absent items.

In a follow-up study, Ghatala, Levin and Truman (1978) found that imagery instructions enhanced recognition memory compared with repetition instructions, on multiple-choice items where old distractors were from two different study sentences that shared the same subject noun as sentences containing target information. For example, a target sentence was "The lady demanded the seat" and its variation sentence was "The lady cashed the check." The multiple-choice item was "What did the lady demand? the seat, the check, the ticket," where "the check" was the old distractor.

Imagery also helped overcome interference on items where old distractors and correct answers occurred in two different study sentences with synonymous subjects (e.g., "the woman" replaced "the lady" in the variation sentence). Repetition instructions, on the other hand, predictably did not reduce interference. The greatest amount occurred when old distractors and correct answers were from two different sentences with shared subjects; the least amount occurred when they were from two unrelated sentences (e.g., "The banker cashed the check" was the unrelated variation of the above target sentence); and an intermediate amount occurred when they were from two different sentences with synonym subjects.

In summary, different information-processing strategies differentially affect the amount and pattern of interference on multiple-choice items where old distractors are related to correct answers via shared contexts. The Ghatala et al. (1978) results simultaneously demonstrated the validity of contextual frequency since the amount of interference on multiple-choice tests produced by old distractors varied, depending upon the relationship between the sentence in which the old distractor occurred and the sentence in which the correct answer occurred. With this brief background, the nature of the present problem can be stated.

Statement of the Problem

Based on the Ghatala et al. (1978) findings, a likely prediction is that interference on multiple-choice items will occur when old distractors are implied in different sentences sharing subjects with target sentences.

The implied information, which would be an old distractor, would not be explicit in the study sentence but would readily be inferrable from its context. To the extent that there are developmental differences in the ability to infer information (see later review of literature), so might there also be differences in the amount of interference produced by implied distractors. Likewise, since different information-processing strategies have been shown to moderate interference, they might also moderate interference in the case where implied old distractors are included as multiple-choice alternatives.

The object of the present study was to explore the effects of an imagery-like strategy on inferentially-produced interference in recognition memory for sentence information in two age groups. A younger age group was selected from first graders; older children were fourth, fifth, and sixth graders. The ages of the older children approximated the ages of subjects used in related sentence studies (Ghatala et al., 1978; Ghatala, Levin, Davis, and Truman, in press; Levin et al., 1979; Levin et al., 1978) whereas younger children were selected to allow a comparison to be made of definite inferencers--older children--with younger children who may not be automatic inferencers. Pictures were chosen as the information-processing strategy to extend the earlier results obtained with imagery (i.e., reduction in interference) to a strategy that has been used successfully in other settings to increase learning (see review by Pressley, 1977).

CHAPTER II

REVIEW OF THE LITERATURE

Related Sentence Studies

This study is a continuation of a series of studies dealing with varieties of interference in sentence learning as assessed by multiple-choice tests (Ghatala et al., 1978; Ghatala et al., in press; Levin et al., 1979; Levin et al., 1978). Methodology in these studies involved presenting to children a series of sentences and later testing memory for sentence information with a multiple-choice test that included distractors from target sentences or from separate sentences variously related to target sentences.

Levin et al. (1978). The object of this study in the series was briefly discussed earlier. Specifically, it was to extend the frequency theory of multiple-choice performance to settings where materials more closely approximated the type used in schools, namely sentences. The guiding prediction was that the particular alternatives included as distractors on a multiple-choice item determined to a large degree the performance on that item.

Pilot testing assured the experimenters that sufficient test errors would occur in order to test the hypotheses--a necessary requirement. Study sentences were unrelated and fairly complex as in, "In his speech the spaceman told how he laughed at the movie." Each sentence contained two plausible answers (verified by pilot tests) to a multiple-choice question. For this sentence the question and one set of alternatives were "What did the spaceman laugh at? the movie, the speech, the book." The correct answer was "the movie," and since this was the old-present item, "the speech" was the old, incorrect alternative with "the book" the new, incorrect alternative. In an old-absent item, the alternatives were "the movie, the letter, the book." Both distractors were new, never having been seen during study.

The experimenters further manipulated their multiple-choice items by varying the form of the correct answer, substituting a synonym variation of the correct answer such as "the film" for "the movie." They predicted that this synonym version of the correct answer, along with inclusion of an old, incorrect alternative, would further increase interference over all other item types. A verbatim answer, on the other hand, with two new distractors (verbatim-old absent) was predicted to result in the fewest errors; an intermediate number of errors was predicted to occur on verbatim-old present items and on synonym-old absent items; and greatest on synonym-old present items. The authors cited evidence from their own research (Ghatala and Levin, 1974; Ghatala, Levin and Wilder, 1975) and Underwood and Zimmerman (1973) as evidence that frequency accrues not only to surface features of words (for example characteristics of letters or orthographic frequency, Underwood's, 1971, terms), but also accrues to the deeper meaning of words (Ghatala, Levin, Bell, Truman, and Lodico, 1978; Levin et al., 1978; Underwood, Kapelak, and Malmi, 1976). This was the basis for inclusion of test items with synonym variations of correct answers, to test whether recognition performance would be reduced by changing perceptual characteristics of the words, even though semantic meaning remains the same, compared to the case where verbatim answers were given.

By instructing subjects to image or repeat study sentences, the authors predicted that they were increasing or decreasing, respectively, the chances that subjects would semantically process sentences, and, therefore, these instructions would enhance or diminish multiple-choice performance (Levin et al., 1978). Imagery subjects were instructed to listen to each sentence and try to form mental images of the action taking place in each. Repetition subjects were asked to repeat each sentence aloud.

Twenty fourth- and twenty fifth-grade children served as subjects and participated in the study individually. Twenty concrete, complex sentences were displayed on note cards to each child as he or she simultaneously listened to each sentence on a tape recorder. A 24-hour delay between the study phase and time of test was used to increase the likelihood of enough recognition errors occurring to test the hypotheses. After 24 hours the experimenter returned to administer the test, which consisted of tape recorded questions and alternatives. The testing was done in an incidental-learning format, with children not being told beforehand that they would be tested on the sentences.

The test results verified the predictions. Subjects did significantly better on verbatim-old absent items than on verbatim-old present items. The mean correct on verbatim-old absent items was 73.5% compared with 63% correct recognitions on verbatim-old present items. The average correct on verbatim-old absent items, 73.5%, was significantly better than the average correct on synonym-old absent items, which was 56.6%, demonstrating that the best recognition judgments were made when both semantic and perceptual features of the correct answer were given on the test (Levin et al., 1978). The average correct on synonym-old present items, 51%, was significantly worse than the averaged correct on verbatim-old present items and synonym-old absent items combined, which was 59.75%. This last comparison showed that both changing the perceptual characteristics of the correct answer and including distractors with competing frequency would result in worse performance compared with performance when only one of these frequency manipulations was done.

Across all conditions imagery subjects averaged 65.75% correct while repetition subjects averaged only 56.25%, a significant difference. Although there was this overall difference between the two orienting instructions, the pattern of errors was similar. When further analyses were done to examine error patterns, it was found that errors on both verbatim-old present items and on synonym-old present items were made because subjects selected mostly old alternatives rather than new alternatives, under both imagery and repetition. This finding further enhanced the authors' conclusion that frequency was operating to induce subjects to select the attractive, old alternative. Two analyses with independent groups of subjects in a nonlearning condition where only the test was administered, confirmed that there were no biases toward selecting either of the two distractors. In other words, the old, incorrect alternatives were not particularly attractive and neither were the new, incorrect alternatives particularly unattractive.

Ghatala et al. (1978). As discussed previously, the Levin et al. (1978) results warranted a followup study to test a "contextual frequency" explanation for why correct answers were chosen more often than old, incorrect alternatives. A simple "item frequency" prediction would be that there should not have been a preference for either alternative. Ghatala et al. (1978) had 42 fourth-grade children listen to 36 sentences one day and take an 18 item multiple-choice test the following day. Sentences and test were tape recorded. To test the contextual frequency notion the relationship was varied between the target sentences containing information later tested for, and variation sentences containing distractors.

To review the methodology, on a related test item students were previously exposed to sentences such as "The lady demanded the seat" and its related variation "The lady cashed the check." Related variation sentences had the same objects or subjects ("contexts") as target sentences. In this example "the lady" was the shared context. The multiple-choice question and alternatives were "What did the lady demand? the seat, the check, the ticket." On unrelated items "The lady demanded the seat" was presented during study, along with an unrelated variation "The banker cashed the check," with the above test question and response options being administered later. A synonym variation study sentence included old distractors for the third item type. For example, on the sentence list "The woman cashed the check" was a synonym variation of the target sentence "The lady demanded the seat."

The prediction following contextual frequency theory was that there would be greater interference on related test items where correct answers had shared the same context during study as the old distractors, compared with unrelated test items where distractors were from unrelated sentences with different contexts than target sentences (Ghatala et al., 1978). Synonym variation items were predicted to produce an intermediate amount of interference, less than related items but greater than unrelated items.

The "context" of the target sentences and their variation sentences that the experimenters manipulated is now described in the authors' words:

> In this experiment we are dealing with "context" as a first-order or <u>within-</u> sentence construct. That is, both "the check" and "the seat" may be said to have first-order contextual frequency because both have co-occurred with "the lady." Context as a second-order or <u>between-</u>sentence construct refers to the situation or larger context that each sentence implies. For example, "The lady demanded the seat" might reasonably be set in a theater, bus, lunch counter, or other situation where being seated is relevant. In contrast, "The lady cashed the check" could

> plausibly occur in a bank or at the grocery store--quite a different situation. In the present experiment, the target sentences and their variations were purposely constructed to have quite distinct second-order contexts (in obvious contrast to the paradigm(s) emanating from Bransford and Frank's, 1971, work). This distinction is important, since in this initial experiment it was desirable to examine first-order or within-sentence context effects unconfounded by second-order or between-sentence context effects. (Ghatala et al., 1978, page 357)

The experimenters also varied study strategy instructions as they had done in their earlier study (Levin et al., 1978). Half the subjects were told to image sentences and the other half were told to repeat each sentence three times aloud. Imagery was assumed to enhance the second-order contexts of the sentences, and, therefore, tests of imagery subjects should have fewer recognition errors than tests of repetition subjects.

The temporal proximity between each target sentence and its variation sentence on the study list was varied, to examine "distance" effects on contextual frequency accrual (Ghatala et al., 1978). Half of the sentence pairs of each type (verbatim, synonym, unrelated) were immediately adjacent to one another on the study list; the other half were separated by an average of 11 intervening sentences. Which sentence came first on the study list, target or variation, was randomly determined. The experimenters pointed out that presenting target and variation sentence close together may: (a) increase the confusability of the sentences or, alternatively, (b) highlight the sentences' distinctive second-order contexts, thereby making them less confusable (Ghatala et al., 1978).

Overall, there were significantly more verbatim and synonym errors than unrelated errors. The average errors were 33.7% on verbatim items, 30.6% on synonym items, and 23.4% on unrelated items. These contextual frequency effects on test scores were present only under repetition and not under imagery. Again, imagery subjects performed significantly better overall than repetition subjects. The source of interference could be directly traced to the old distractors since greater than the expected chance level of 50% of all errors were old rather than new, as was the case with the Levin et al, (1978) results. That is, when subjects made errors on the test, they chose the old, familiar distractors more often than the new distractors.

Concerning distance effects on recognition memory for target information, when target and variation sentences were separated by an average of 11 intervening sentences on the study lists, significantly more errors were made on verbatim items and on synonym items, compared to when target and variation sentences were immediately adjacent to each other. Close proximity of the verbatim and synonym sentences to their target sentence on the study list apparently enhanced distinctiveness of correct answers and old information.

<u>Ghatala et al. (in press)</u>. The results of the Ghatala et al. (1978) study demonstrated the validity of the contextual frequency construct, but raised further questions. One question was whether mere exposure to

unrelated distractors during study was enough to cause interference on the later test (Ghatala et al., 1978). Testing this required the addition of a "new" item type, where some target sentences would be paired with dummy sentences so that both distractors would be new on the test. Ghatala et al. (in press) tested this notion by using dummy variation sentences such as "The knife sliced the cheese." A test for whether simple item frequency associated with unrelated items was enough to produce interference was accomplished by comparing error rates on new items (probing for target information that had been "paired" with dummy sentences) with error rates on unrelated items that contained an old distractor. If new items had significantly fewer errors than unrelated items, the experimenters could conclude that the simple item frequency of unrelated distractors caused interference.

Ghatala et al. (in press) also added an instructional condition under which subjects were not given any strategy instructions but were simply told to try and learn the sentences. This control condition yielded a comparison between interference under it and under a repetition strategy that previously had been shown to elicit the contextual frequency interference effects on learning.

The multiple-choice test had three item types: related, which included a distractor that had previously shared a subject or object with the target sentence containing the correct answer (the subject/object difference had no differential effects on test performance and was done only to make it easier to design materials); unrelated, which included a distractor from an unrelated variation sentence; and new, which had two new distractors. Based on their earlier findings, Ghatala et al. (in press) predicted that repetition subjects' performance should be better on both new items and unrelated items, compared with related items.

On new test items, better recognition of correct answers should occur compared with related items, since only the correct answer has frequency on new items. In associationist terms (Anderson and Bower, 1973), a pathway of association exists only between the correct answer and the test-item stem; the two new distractors never occurred in the context of the question. Error rates on unrelated items also should be less than errors on related items since old, unrelated distractors have only item frequency whereas the correct answers have both item frequency and contextual frequency. Thus, a correct answer should be distinguishable from an old, unrelated distractor. Likewise, the correct answer has a stronger association with the test-item stem than does the old, unrelated distractor. Concerning strategy differences, control subjects' performance (relative to that of repetition subjects) was predicted to be moderated by the particular strategy they might employ covertly during study (Ghatala et al., in press).

Forty-two fourth-grade children served as subjects in the Ghatala et al. (in press) study. The materials were similar to materials used by Ghatala et al. (1978) and consisted of 36 sentences, 18 target sentences paired with six each of the variation types--related, unrelated, and new. Half of each type of variation sentence and their target sentences were separated by one intervening sentence on the study list. The other half were separated by at least ten intervening sentences. These distance effects on learning were either small or unsystematic and were not considered further (Ghatala et al., in press). Subjects again participated individually and the same 24-hour delay between study and test was used.

Repetition subjects' results demonstrated the contextual frequency interference effect, with mean error percentages of 31.8% on related items and only 18.3% on unrelated items. There was no significant difference between errors on unrelated items and on new items (19.3%). Thus, the simple item frequency of unrelated distractors did not deter recognition of target information.

Control subjects experienced item frequency interference. They did not have contextual frequency interference. Their mean error percentages on new items was 23.8% which was significantly lower than the 37.3% errors on unrelated items, illustrating item frequency interference. This 37.3% error rate on unrelated items was comparable to the 31.1% errors on related items. The experimenters suspected that this difference in interference effects on learning between strategy subjects and no-strategy subjects might be due in part to the use of varying strategies by control subjects. Repetition subjects were obviously all using the same strategy since they were required to repeat each sentence aloud, whereas control subjects may have been using a variety of strategies, covertly, producing the unexpected finding of item frequency interference effects without additional contextual frequency interference effects.

To examine if this was a tenable hypothesis for control-versus-repetition differences, in a follow-up experiment a separate group of control subjects was given the same task, and subjects were later interviewed to determine what strategy, if any, they had used during study. It turned out that subjects who reported using a silent repetition strategy had similar error patterns to those in the earlier experiment (Ghatala et al., in press) who had been instructed to repeat. Subjects who reported not using any particular strategy had high, nearly identical error rates on all three item types that characterized "poor learner" performance (Ghatala et al., in press). It was only when error scores of these different covert strategy users were averaged that the previously puzzling item-only frequency interference emerged--i.e., from the combination of contextual frequency interference of covert repeaters with "poor learners'" uniformly poor performance.

In another experiment reported by Ghatala et al. (in press), three groups of high school juniors were used as subjects under imagery, repetition, and control instructions. These older repetition subjects demonstrated the same contextual frequency interference on their tests as younger children, in that they did not experience item frequency interference. Significantly more errors were made on related items than on unrelated items, whereas unrelated item errors did not differ from new item errors. Imagery subjects had no differences in error rates among the three item types and performed uniformly better (15% errors across all item types) than either repetition (29% errors) or control subjects (31% errors). However, control subjects had a uniformly high error rate on all item types. This was in contrast to the item frequency interference experienced by younger control subjects who had significantly more errors on unrelated items than on new items, but no further interference from related items (Ghatala et al., in press).

Once again the experimenters sought the source of the control subjects' error pattern by interviewing each subject. They found that those who had covertly repeated the study sentences had contextual frequency interference, as did subjects instructed by the experimenters to repeat. Errors of these older control subjects who reportedly imaged the study sentences were uniformly low on all item types, as was the case with subjects instructed to image. Subjects who reported using no strategy during study had the same uniformly high error rates on all item types as did younger children in the earlier study (Ghatala et al., in press).

One major conclusion from this last series of experiments was that distractors with competing frequency do not always cause interference (Ghatala et al., in press). The only distractors that elicited test interference were those that shared a context with correct anwers by appearing in related study sentences. Furthermore, certain instructional strategies are capable of eliminating contextual frequency interference caused by old, familiar distractors. As for the educational implications of this research, Ghatala et al. (in press) stated that:

> Even though equipping students with efficient information-processing strategies is probably the best way to help overcome contextual-familiarity interference, it may not always be possible to control students' processing activities. Therefore, exploring ways of constructing learning materials so as to minimize potential interference is also indicated. In light of the present finding that over half of our fourth graders and a quarter of our eleventh graders reported having spontaneously employed a rote repetition strategy, research designed to modify existing interference-producing learning materials takes on added significance." (ms. p. 21)

Although there was a drop in the number of control subjects who reported using an inefficient information-processing strategy (repetition) from half of the younger control subjects to one-quarter of the high school subjects, it nonetheless was surprising to find so many older subjects still using a poor learning strategy.

Levin at al. (1979). These authors conducted another experiment to explore the effects of contextual aids on reduction of interference in cases where it had been shown to occur. They realized that it may not be possible for teachers to train students in "instructional "strategies (such as imagery) that reduce interference, so alternatively, Levin et al. (1979) sought "constructional" methods to serve the same purpose. The constructional manipulation they used was to give target sentences and their variations different second-order contexts by adding different prepositional phrases to each.

For example, two sentence pairs were "At the restaurant, the guest chewed the hot dog" and its variation "In the yard, the guest sniffed the tobacco." The later multiple-choice question was "At the restaurant, what did the guest chew? the hot dog, the tobacco, the cupcake," with "the tobacco" as the old distractor. The experimenters expected that there would be less interference when the different contexts appeared in front of the two related sentences, compared with when the contexts were absent, since different contexts were predicted to help subjects keep the related sentences distinct in memory (Levin et al., 1979). To see whether the addition of contexts per se was enough to reduce interference, <u>similar</u> contexts were added to the sentences for half the subjects.

Forty-two fourth- and fifth-grade children participated in the study, all under a repetition strategy, with 21 serving in the same context condition and 21 in the different context condition. The sentence lists had 36 sentences of the same form used in prior studies: article-subject-verb-article-object. And again, there were 18 target sentences paired with six each of the related, unrelated, and new variation sentences. Contexts appeared with sentences for the context subjects but were not given for no-context subjects. On the context list, a random half of the sentence pairs were chosen to have the same context and the other half of the sentences were given different contexts.

Results in the no-context condition replicated earlier results (Ghatala et al., in press), with contextual frequency occurring. The mean correct on related items was 71.4% which was significantly worse than the 84.1% correct on new items. The 78.6% correct on unrelated items was not significantly different from the 84.1% correct on new items.

Concerning the effects of contextual aids on interference, the main hypothesis of the study was verified. In the different-context condition, contextual interference was eliminated as illustrated by the similar level of interference on related items with 87.3% correct, and on new items with 93.6% correct. By contrast, in the same-context condition there was interference from old related and unrelated distractors with both the 69.8% correct on related items and 77.8% correct on unrelated items found to be significantly worse than the 92.1% correct on new items.

The authors comment on the theoretical aspects of their results:

> From a theoretical standpoint, the results fit an associationist framework (Anderson and Bower, 1973), as well as one that is based on presumed "frequency" processes in recognition memory (Underwood, 1971). In either case, pairing the same stimulus with two different responses would be expected to depress subsequent multiple-choice performance when one of the responses is included as a distractor. This is the outcome that has been observed when old-related items appear in the set of multiple-choice alternatives. When an identical (same) context is added to the to-be-learned sentences, the problem still remains and, in theory, should become even more severe. (Though not tested statistically in the present study, interference arising from old-related items <u>was</u> greater in the

> same-context condition than in the no-context condition). Finally, both theories would predict interference from old-<u>unrelated</u> items to occur in a same-context condition, though not in a no-context (or different-context) condition. This is because information that is unrelated when no context is provided (through separate associations to different subjects or objects) should actually acquire relatedness via the common context imposed upon it. As noted above, this is what the results show. (Levin et al., 1979, pp. 254-255)

They also comment on the educational implications of their research by noting the fact that constructional aspects of materials can be altered, for example, by adding distinctive contexts to potentially mutually interfering material, to reduce the possibility of interference occurring (Levin et al., 1979). This may be a more practical method for classroom teachers to aid learning of similar materials than strategy training.

<u>Conditional Old Errors</u>

Before leaving the topic of sentence studies, a distinction should be made between two measures of interference discussed in these studies. The primary measure of interference involved comparisons of error rates (or the complement, but equivalent, number of correct responses). When interference was detected it occurred as differences in the number of errors or correct responses, between different item types.

Supporting the primary measure of interference was secondary evidence illustrated by conditional old error analyses where the proportion of selection of old distractors out of all errors, old and new, was computed (Ghatala et al., 1978). That is, a subject selecting three old distractors out of three errors received a 100%; if only two out of the three errors were old, the subject's proportion was 66.6%; and one out of three, 33.3%. Conditional old errors were computed for each subject, on each of the item types. The averaged proportion of old errors among all errors on each item type could then be tested for the significance of its departure from the "expected" 50%, assuming one old and one new distractor, by the formula:

$$\underline{t}_{N-1} = \frac{\bar{X} - .50}{S/\sqrt{N}} \quad \text{where}$$

N = number of subjects who made errors on a given item type;

$$S = \sqrt{\sum_{i=1}^{N} (X_i - \bar{X})^2/N-1}$$ = sample standard deviation of distribution of conditional old errors;

$\bar{X}$ = averaged conditional old errors across all subjects making errors.

Recall that .50 is the expected proportion of old errors among all errors since pilot subjects for the sentence studies indicated no preference for any of three distractors in a nonlearning condition where only the test was administered. This means that each of the three alternatives had a 33.3% pre-experiment probability of selection. However, since only two alternatives represented errors, each had an equally likely, 50% pre-experimental probability of selection.

Although interpretation of the t test for significance of conditional old errors is fairly straightforward, a basic problem in using the test was that not all subjects made errors (Ghatala et al., 1978). A subject making no old errors among all errors (which assumes errors were made) had a conditional old error proportion of .00, but subjects who made no errors at all on an item type must be excluded from the analysis because in that case the index is undefined. As a result, it is possible that certain high-scoring students will be excluded from the analysis, resulting in "...complex selection problems inherent in less-than-complete data of this kind" (Ghatala et al., 1978, page 361). However, it was still possible to examine patterns of conditional old errors, in descriptive terms, since these patterns yielded additional information about interference.

For convenience sake, interference evidenced by number of overall errors will be referred to as "primary" and interference evidenced by statistically greater than 50% conditional old errors will be referred to as "secondary," although both are evidence of interference. Results from Ghatala et al. (in press) indicated that when subjects had primary evidence of interference stemming from familiar distractors, they also had secondary evidence. The reverse was not true since there was secondary evidence of interference in cases where there was not primary evidence.

Test scores on unrelated items showed secondary evidence of interference, whereas both secondary and primary evidence was found on related items (Ghatala et al., in press). No evidence of interference was found on new items. Although there was no significant difference between the number of overall errors on unrelated items and on new items, when errors were made, old rather than new distractors were chosen on the average (across all conditions) 73.9% of the time, whereas the selection rate of "dummy old" distractors on new items was 49.3%, almost exactly the percentage expected by chance.

It might seem that interference evidenced only by selection of old rather than new distractors is not important because students' overall error rates are not increased. However, this type of interference nonetheless illustrates that the particular distractors included in sets of multiple-choice alternatives affect performance, even on old, unrelated test items (distractors with item frequency but not contextual frequency). It is also interesting to note that even under imagery instructions there were more old than new distractors selected on unrelated items. Thus, there was evidence of interference even under an efficient strategy that eliminated primary interference.

Inferentially-Produced Interference and Relevant Inference Studies

Consider the sentence "The captain hit the nail" where the implied instrument is a hammer. Suppose students were exposed to this related variation sentence along with a target sentence "The captain traded the bat," and were later asked "What did the captain trade? the bat, the club, the hammer." If students inferred the missing implement in the first sentence, "hammer" might be an attractive answer to the test question. To the extent that there is developmental improvement in production of inferences, one might expect differences between ages in the amount of interference caused by implied distractors.

Relevant inference studies. Conflicting results characterize past experiments seeking developmental trends in inferential ability (cf. Kail, Chi, Ingram, and Danner, 1977; Paris and Lindauer, 1976). There have been methodological problems with some of these studies, perhaps in part accounting for discrepancies in findings.

Some researchers (e.g., Paris and Carter, 1973) used a false recognition paradigm where test sentences required recognition judgments. Test sentences were inferences drawn from combining the ideas of two study sentences. For example, Paris and Carter's (1973) study sentences included "The bird is inside the cage" and "The cage is under the table." A true inference on the test was "The bird is under the table." Seven- and ten-year old children were asked if this last sentence had been on the study list.

The researchers failed to find developmental trends in falsely recognizing inference statements but concluded that this may have been caused by the fact that all errors, including false recognitions, decrease with age. This might cancel out any improvements with age in the ability to make inferences, as would be shown by an increase in false recognitions.

Paris and Lindauer (1976) revised this methodology and using a recall task in two experiments, found that six- to seven-year-olds were less likely to make spontaneous inferences than older children ten to eleven years old. Interestingly, in a third experiment younger children acted out sentences forcing the "use" of the inferred information.

They later recalled statistically the same amount of sentence information when given implied sentence information as retrieval cues as when given explicit sentence information, thus demonstrating that they inferred the information. Overall it appeared that total recall was enhanced in this third experiment compared with the first two experiments; however, an older age group was not included in this last experiment, making it difficult to draw conclusions about how well the strategy worked in this experiment, since a different test was used than in the previous experiments. Older children may do proportionately as well with these materials and the acting out strategy, so there still might be an age-related performance difference. On the other hand, younger children's level of recall may be improved by this strategy up to the older children's level, if older children's already good recall without the strategy was not improved further with it.

Kail et al. (1977) did not find developmental trends in inferential ability. They presented to seven- and twelve-year-olds sentences similar to Paris and Carter's sentences (1973). Instead of a false recognition test, test questions were like "Is the bird under the table?" which did not require a recognition judgment. Younger children were found to be as likely as older children to respond affirmatively to this question, which required making an inference from the two study sentences given above.

It appears that finding developmental trends in making inferences is task specific (Paris, 1975; Paris and Lindauer, 1977). Failure to find age-related improvement may be an artifact of the false recognition paradigm, or of too simple a task to discriminate age differences which may have been the case in the Kail et al. (1977) study. Because of these discrepancies among findings in inference studies, it is best to undertake the problem of developmental trends in inferentially-produced interference in small steps.

CHAPTER III

RATIONALE AND PILOT STUDY

Rationale

The necessary first step in this problem is to define its rationale. Why study the development of inferential ability, particularly using a multiple-choice format?

First, it is theoretically interesting. The ability to draw implied information from explicit information is important to verbal comprehension (Paris and Lindauer, 1977). Verbal comprehension is often measured by multiple-choice tests. Knowing whether implied information is a source of interference on multiple-choice tests, under what conditions, and for which ages would add to our understanding of component abilities of verbal comprehension.

Second, it has practical implications. If we were only interested in using the multiple-choice format to detect inferential ability, it is easy to see how instructional strategies and aids that enhance sentence processing (such as imagery and pictures) might be tested with poor readers or slow learners to determine whether improvements could be made in their inferential ability. There is already evidence suggesting that some strategies might aid non-spontaneous inferencers (Paris and Lindauer, 1977). Further research with the multiple-choice format could be done to establish the relationship between inferential ability and reading ability. Paris and Lindauer (1977) implied that if an adequate methodology could be developed to measure inferential ability, success on such a test might be a useful predictor of reading readiness. This exciting idea obviously needs verification, but it first must be demonstrated that inferential ability can be detected by examining interference on multiple-choice tests.

Multiple-choice tests do not require the same type of recognition judgment as do tests used in the false recognition paradigm since subjects do not answer "yes" or "no" to each question. The analogue to statements requiring recognition judments in the false recognition paradigm would be the multiple-choice distractors. Although one cannot precisely define the differences in cognitive abilities required by each test format, intuitively it would seem that the bias of younger children to respond affirmatively in the false recognition paradigm has been eliminated in the multiple-choice paradigm. The multiple-choice format may be just the task Paris and Lindauer (1976) had in mind when they stated, "Future research on children's inferential processes of memory should investigate developmental changes in comprehension of a range of semantic inferences, the role of metamemorial plans in age by strategy interactions, and 'ecologically valid' tasks which permit ready extrapolation to children's everyday tasks and processing demands." (p. 226)

Pilot Study

A pilot study was conducted to test the assumption that implied information can cause test interference. The second purpose of the pilot study was to test the materials to be used in the main study.

Sentences. Eighty sentences of the general form article-subject-verb-article-object were constructed and reviewed by three judges. Sixteen of the sentences were designated as target sentences, which formed subsequent multiple-choice question stems and answers. Sixteen five-sentence sets each contained a target sentence, two related sentences, and two unrelated sentences. Examples of target and variation sentences, test questions and alternatives are presented in Table 1, page 37. Related sentences had the same subject as target sentences, as in the top example in Table 1. Unrelated sentences had a different subject. The noun object in the target sentence "The captain traded the bat" answered the multiple-choice question "What did the captain trade?" Distractors for each test question had previously occurred during study in phrases at the end of related and unrelated variation sentences.

The addition of one related and one unrelated sentence to each set departed from prior relevant sentence studies. These additional variation sentences were included in the pilot study so that old, incorrect alternatives were new, incorrect alternatives for half the subjects and vice versa for the other related and unrelated sentences in each five-sentence set. By counterbalancing the materials in this way there would be additional verification of contextual interference if subjects had similar patterns of errors on both related items and if there

TABLE 1

Examples of Target and Target Variation Sentences Used in Pilot Study

Target:	The captain traded the bat.	
Target Variations:	Related-1	The captain hit the golfball (with the club).
	Related-2	The captain hit the nail (with the hammer).
	Unrelated-1	The mailman hit the golfball (with the club).
	Unrelated-2	The mailman hit the nail (with the hammer).
Test:	What did the captain trade?	
	the bat	
	the club	
	the hammer	
Target:	The repairman painted the garage.	
Target Variations:	Related-1	The repairman fixed the shower (in the bathroom).
	Related-2	The repairman fixed the dishwasher (in the kitchen).
	Unrelated-1	The father fixed the shower (in the bathroom).
	Unrelated-2	The father fixed the dishwasher (in the kitchen).
Test:	What did the repairman paint?	
	the garage	
	the bathroom	
	the kitchen	

were more errors on both of these items than on both unrelated items. Similarly, one would predict that for the same distractor the percentage of students choosing it would be greater when it was contextually familiar or old, than when it was a new distractor. Both of these notions were later verified by the results.

Information that was either implicit or explicit in each sentence is in parentheses in the examples of Table 1. In pre-pilot studies of the materials with first- and fifth graders, implicit versions of study sentences were read and subjects were asked to supply implied information. For example, subjects were asked if they knew what the captain hit the golfball with. If nearly 100% of the subjects in each grade identified the missing information, the sentence was accepted. Sentences not meeting this criterion were rejected for use on the pilot study. This simple test was done to assure that children knew the implied information.

Four target sentences apiece were randomly assigned to the following four mixed-list conditions: related 1 and 2, where old distractors on multiple-choice items occurred in implicit or explicit related variation sentences during the study phase; and unrelated 1 and 2, where old distractors were in unrelated variation sentences. This old information was contained in a phrase at the end of each variation sentence. Lists were mixed with half explicit and half implicit sentences. These were counterbalanced across subjects.

Four mixed lists were formed by systematically rotating sentence sets through lists. Lists included 32 experimental sentences, 16 target sentences paired with one related or unrelated variation. Placement of target and variation sentences on lists was randomly determined.

Multiple-choice test. The recognition test had 16 questions, each followed by three response options: correct choice; old, incorrect choice; and new, incorrect choice. Without having listened to study sentences, a separate group of first- and fifth graders "took" the test and were asked to choose one alternative for each question. Test questions and sentences were redesigned or discarded if there was a significant bias toward one of the alternatives. This procedure allowed for a later analysis of conditional old errors, based on the tested fact that there were no biases toward any of the response options. Therefore, if it was later demonstrated that more errors were old rather than new, the conclusion that inferentially produced interference was creating these errors would be more strongly supported.

For the final test version, the order of the response questions was randomly determined and all pilot subjects received the same random order.

Procedure. Subjects were chosen from elementary schools located in a metropolitan university community. They participated individually in the pilot study in a quiet room separate from regular classrooms. They were told that the experimenter wanted to find out how well they could learn sentences. They were also told, "You are going to listen to some sentences on the tape recorder, and I want you to pay close attention to them because later on I'm going to ask you questions about the sentences." Students then listened to tape recorded sentences. Five seconds elapsed between sentences.

This pilot study was conducted before the Ghatala et al. (in press) study, which showed the potential problem with interpreting control subjects' test results. However, the results of this pilot study did not seem to indicate that control subjects were using anything other than an inefficient strategy since contextual interference was present.

At approximately the same time 24 hours later, the same experimenter returned to the school and tested students individually in the same room. Following procedures in prior studies, the 24-hour delay was used in order to create enough errors to test the hypothesis that implied information is a source of interference. Children were reminded of the sentences they had heard the day before and then listened to 16 tape recorded questions and response options at their own rate. They were told that they had to choose an answer after each question and to guess if not certain. Answers were recorded on paper out of sight of the children.

Results. Twenty-four fourth and twenty-four fifth grade students (their mean age was 10 years, 7 months) participated in the pilot study. It was predicted that subjects this age would spontaneously infer and, therefore, there would be no differences in error rates on explicit and implicit items.

Results proved this to be the case. The mean percentage of errors on implicit items was 34.4% which was not significantly different from the 39.5% errors on explicit items. It appears that fourth- and fifth graders automatically process implied information that later can cause the same level of interference as does explicit information.

Conditional old errors analyses verified that subjects did infer the desired information. When errors were made on both implicit-related items and on explicit-related items, there was a higher percentage of old distractors chosen than new distractors. On implicit-related items, which included an old familiar but implied distractor, conditional old errors averaged 78.9%, which was significantly higher than the 50% expected by chance, $t(22) = 4.21$, $p < .01$. On explicit-related items, where old, familiar distractors were explicit on study sentences, the conditional old error average was 71.9%, which was also significantly higher than 50% $t(21) = 3.11$, $p < .01$. On both implicit-unrelated items and on explicit-unrelated items, the rate of choosing old distractors was near the chance level of 50% (50.9% and 51.8%, respectively). It should be noted that these analyses were based on incomplete data because some subjects made no errors (one subject under implicit-related; six under implicit-unrelated; two under explicit-related; four under explicit-unrelated).

Concerning contextual frequency effects on inferentially-produced interference, there was a significantly greater number of errors on related items (41.2%) than on unrelated items (32.8%), $t(23) = 1.97$, $p < .05$, one-tailed. This demonstrates that contextual frequency interference exists even when a distractor on a multiple-choice item was only implied in a sentence related to target information.

The results of this pilot study verified that implied information causes interference. An interesting followup question, which the main study examines, is what effects study strategies have on this type of interference. For example, imagery has been shown to enhance learning on recognition tests compared with a repetition strategy, which produced interference. Thus, strategies might also affect interference patterns in the inferentially-produced setting.

But there is another possible outcome of imposing strategies on learning in this situation. An argument could be made that imagery, or an imagery-like strategy, might further increase interference by enhancing the implied information, particularly for younger children who may not infer the information (later a distractor) without the aid of imagery. This was a question tested in the main experiment.

Pictorial Aids

To test the effects on interference of an imagery-like aid, pictures were chosen to be shown with sentences for half the subjects in the main experiment. In a review of picture effects on learning, Pressley (1977) concluded that pictures aided sentence learning of children as young as first graders. First graders in the present experiment who may not spontaneously infer information might do so with pictures as aids.

Paris and Lindauer's (1976) results also may be taken as supportive of this position. When younger children acted out sentences it forced the "use" of implied information. In a similar way, pictures might encourage younger subjects in the present experiment to "see" the missing information (although this information is not displayed in the picture). Thus, pictures might aid learning or, alternatively, increase interference and create more errors.

CHAPTER IV

HYPOTHESES

Before presenting the hypotheses, a brief review of the experimental design as presented in Table 2 might aid the reader. There were two levels each of age (younger or older), strategy (control or pictures), item type (explicit or implicit), and contextual relatedness of distractors and test questions (related or unrelated). Contextual relatedness was the only within-subject variable. For the main experiment it was believed best to keep sentence lists all explicit or all implicit (i.e., a between-subject variable) to eliminate any possibility of effects of mixed lists on error patterns.

TABLE 2

Design of Experiment Measuring Effect of Pictorial Aids on Inferentially-Produced Interference in Sentence Learning at Two Age Levels

	Control				Pictures			
	Implicit		Explicit		Implicit		Explicit	
Age Level	Related	Unrelated	Related	Unrelated	Related	Unrelated	Related	Unrelated
Younger								
Older								

The term "item" generally refers to what each multiple-choice question measures (which varies by experimental condition), as in

"This test item was explicit-related for some subjects and was explicit-unrelated for others." For convenience, when the results of the experiment are discussed according to treatment, both the contextual relatedness variable and item type variable (explicit or implicit) are referred to as "items," as in "The results demonstrated that related items were . . ." or "The results demonstrated that explicit items were . . . ."

Concerning the strategy variable, a no-strategy control condition was included to determine whether the results would replicate the pilot study demonstration of contextual interference under no strategy instructions, in view of the Ghatala et al. (in press) control results, where there was no contextual interference. And, in order to preserve the implicit variable, pictures for all subjects (explicit and implicit) did not display the information to be inferred. Thus, "explicit picture" refers to the sentence being explicit, but the corresponding picture not.

Hypotheses 1 and 2 look at overall performance differences between control and pictures subjects, at each age level. Because of strong evidence (Pressley, 1977) that pictures aid learning, results of the present experiment were predicted to replicate these picture effects. The dependent measure used to test these hypotheses was overall number correct.

> Hypothesis 1: Younger pictures subjects will do significantly better on the test than younger control subjects.

Hypothesis 2: Older pictures subjects will do significantly better on the test than older control subjects.

The rest of the hypotheses examine patterns of interference. Interference level was defined as the number correct on related items minus the number correct on unrelated items.

Hypothesis 3: There will be no significant difference in interference levels between explicit items and implicit items within the older control conditions.

Hypothesis 3 predicts that older children will spontaneously infer and, therefore, implicit information will cause the same level of interference as explicit information. This hypothesis follows from results of the pilot study.

Hypothesis 4: There will be a significant difference in interference levels between explicit items and implicit items within the younger control conditions.

Paris and Lindauer (1977) stated "There is developmental improvement in the production and mediation efficiency of inferential processes on many tasks" (p. 46). If this is true, it follows that first graders may not spontaneously infer implicit information in the present study. They did not do so in many studies cited by Paris and Lindauer. Therefore, they should experience less interference on implicit items than on explicit items.

> Hypothesis 5: There will be no significant difference in interference levels between explicit items and implicit items within the older pictures condition.

This prediction is based on the fact that in most cases, pictures aid learning. In this experiment, pictures <u>may</u> have the opposite effect by highlighting the implicit information, causing <u>more</u> errors. This occurrence is unlikely in view of all the evidence (Pressley, 1977) that pictures aid learning. This prediction also follows from results of experiments where older imagery subjects did not exhibit primary evidence of interference. Likewise, even if they spontaneously infer, they should not have interference on implicit items when pictures are provided.

By providing pictures to younger subjects, their performance is predicted to be more like the performance of older subjects.

> Hypothesis 6: There will be no significant difference in interference levels between explicit items and implicit items within the younger pictures condition.

Hypotheses 7 through 14 lead to tests that examine interference within each of the four conditions at each grade. Predictions are logical extensions from Hypotheses 1 through 6.

Hypotheses 7 through 10: For older subjects, there will be interference within the control condition on explicit items (H_7) and on implicit items (H_8), but no interference within the pictures condition on explicit items (H_9) and on implicit items (H_{10}).

Hypotheses 8 through 14: For younger subjects, there will be interference within control condition on explicit items (H_{11}), but no interference within the control condition on implicit items (H_{12}), within the pictures condition on explicit items (H_{13}), and within the pictures condition on implicit items (H_{14}).

CHAPTER V

METHOD

Subjects

Subjects were from two rural primary schools and one semirural primary school. The time of the study was in the last month of the school year. The younger children were all first graders and had a mean age of seven years, three months. The older children were from fourth, fifth, and sixth grades and had a mean age of eleven years, two months. Older children in the pilot study and in prior sentence studies were all from the fourth through sixth grades. First graders were chosen as the younger age group because previous research indicated that this age group might be affected from viewing pictures during study (Pressley, 1977). It was uncertain whether this "effect" would be one of better performance or of worse performance under the conditions of the present study, since arguments can be made in support of either view.

One hundred and four older and 104 younger children were selected from classrooms after parental permission was obtained and after teachers verified that the children were normal learners. There were 52 control and 52 pictures subjects from each grade, and 26 implicit and 26 explicit subjects within each of these conditions.

Materials

All of the materials used in the experiment are in Appendix 1.

Study lists and tests were the same as those used in the pilot study except that lists were either all implicit or all explicit, and to increase test difficulty, eight filler sentences were added that were unrelated to any of the target or variation sentences. Only one related and one unrelated variation sentence per sentence set was used, since predicted results were obtained on the two related and two unrelated sentences in each sentence set used in the pilot study. The pictures were black and white, professionally drawn on 8½" by 11" white paper, and placed in a ring binder.

Procedure

Subjects were assigned to experimental conditions in order of their appearance at the test room. They participated individually both during the study and test phases, with the same male experimenter both times. A 24-hour delay between study and testing was used. With the exception that pictures subjects were asked to look at pictures while hearing the sentences, the procedures were identical to those in the pilot study.

CHAPTER VI

RESULTS

Overview of Data

Raw data are in Appendix 2. Before presenting the results of each hypothesis test, general observations can be made about the data. Table 3 presents the mean percentage correct by condition at each age level. It appears that the test was sufficiently difficult to yield enough errors to test the hypotheses. Younger subjects averaged only 58.25% correct and older subjects averaged 69.50%. Because the main interests of the experiment were "condition within age" comparisons, there were no direct age comparisons.

TABLE 3

Mean Percentage of Correct, Old Errors, and New Errors, According to Age, Strategy, Item Types, and Contextual Relatedness

Age Level	CONTROL												PICTURES											
	Implicit						Explicit						Implicit						Explicit					
	Related			Unrelated			Related			Unrelated			Related			Unrelated			Related			Unrelated		
	C	O	N	C	O	N	C	O	N	C	O	N	C	O	N	C	O	N	C	O	N	C	O	N
Younger	52	26	21	54	23	22	47	29	24	54	26	20	65	22	13	68	20	13	59	29	12	67	19	14
Older	70	19	11	65	20	15	59	28	12	61	27	12	75	17	8	77	16	6	75	19	6	74	18	8

C = Mean percentage correct
O = Mean percentage old errors
N = Mean percentage new errors
Note: Percentages do not always add to 100% (within each cell at each age level) due to rounding error.

Hypothesis Tests

To test Hypotheses 1 and 2, whether there was a main effect of strategy (control or pictures), separate 2 X 2 ANOVAs were conducted for younger and older subjects, with number correct per condition as the dependent variable, and item type (implicit or explicit) as the second variable. Table 4 presents the ANOVA results. For younger subjects there was a main effect of strategy, $F(1,100) = 15.15$, $p < .001$, but no main effect of item type, $F < 1$, and the interaction also was not significant, $F < 1$. For older subjects there also was a main effect of strategy, $F(1,100) = 13.50$, $p < .001$, but no main effect of item type, $F(1,100) = 2.04$, $p < .20$, and no interaction, $F < 1$.

TABLE 4

Analyses of Variance Summaries at Each Age Level, by Strategy and Item Type

Source	df	Mean Square	F	Probability Less Than
		Younger Subjects		
Strategy	1	83.163	15.153	0.001[1]
Item	1	4.240	.773	.382
Strategy X Item	1	.010	.002	.967
Error	100	5.488		
Total	103	6.177		
		Older Subjects		
Strategy	1	69.471	13.501	0.001[2]
Item	1	10.471	2.035	.157
Strategy X Item	1	3.471	.675	.413
Error	100	5.146		
Total	103	5.806		

[1] $\eta^2(\text{Strategy}) = \frac{SS(\text{Strategy})}{SS(\text{Strategy}) + SS(\text{Error})} = .132$ [2] $\eta^2(\text{Strategy}) = \frac{SS(\text{Strategy})}{SS(\text{Strategy}) + SS(\text{Error})} = .119$

Table 5 presents the mean percentage correct according to age and strategy. Clearly, pictures significantly aided learning at both age levels. These results are in agreement with the majority of studies reviewed by Pressley (1977), which indicate that pictures aid learning of first graders and older children. In the present study, younger pictures subjects did as well as older control subjects (64.75% correct compared with 63.75% correct, respectively).

TABLE 5

Mean Percentage Correct According to Age and Strategy*

	Strategy		Across Strategies
	Control	Pictures	
Younger	51.75	64.75	58.25
Older	63.75	75.25	69.50
Across Age	57.75	70.00	

*Collapsed across item type and contextual relatedness.

Table 6 presents the mean percentage correct according to age and item type. There is little difference between the two item types, at both age levels.

TABLE 6

Mean Percentage Correct According to Age and Item Type*

	Item Type		Across Item Types
	Implicit	Explicit	
Younger	59.75	56.75	58.25
Older	71.75	67.25	69.50
Across Age	65.75	62.00	

*Collapsed across strategy and contextual relatedness.

Before presenting results of tests of Hypotheses 3 through 14, it should be pointed out that no primary interference was produced in any of the condition combinations. (See Summary and Conclusions chapter for possible explanations for nonreplication of pilot results where interference occurred). Table 7 presents the mean percentage correct according to age and contextual relatedness. Overall, there were no apparent effects on learning of the contextual relatedness variable (i.e., little or no interference was produced).

TABLE 7

Mean Percentage Correct According to Age and Contextual Relatedness*

	Contextual Relatedness		Across Contextual Relatedness
	Related	Unrelated	
Younger	55.75	60.75	58.25
Older	69.75	69.25	69.50
Across Age	62.75	65.00	

*Collapsed across item type and strategy.

All of the tests of significance were based on t tests for independent samples and were tested at $\alpha = .025$.

Control conditions. Hypothesis 3 predicted no significant difference in interference levels between explicit items and implicit items within the older control condition. The mean percentage correct difference between related and unrelated implicit items was 5% compared with a difference of -2% on explicit items.[1] The $t(50) = .98$ was not significant.

[1]Referring to Table 3, page 51, subtracting mean percentage correct on unrelated items from mean percentage correct on related items can yield either a positive or a negative result, as illustrated by the 5% (70% minus 65%) on implicit items and -2% (59% minus 61%) on explicit items.

Thus, whether old distractors were implicit or explicit in study sentences did not differentially affect interference level for older control subjects. In fact, there was no interference (primary evidence, that is) under either item type, as demonstrated by the results of tests of Hypotheses 7 and 8.

Hypothesis 7 predicted that for older control subjects there would be a significant difference in number of errors between related and unrelated items on explicit items, and Hypothesis 8 predicted that there would be a significant difference on implicit items as well. Neither hypothesis was supported. On explicit items the mean percentage correct on related items was 59% and on unrelated items it was 61%, a non-significant difference, $\underline{t}(25) = .38$. On implicit items the mean percentage correct on related items was 70% and on unrelated items it was 65%, $\underline{t}(25) = -.94$, which also was not significant. Although these results varied from the pilot study results where interference occurred, they support the Ghatala et al. (in press) findings of no contextual interference under a control condition.

Hypothesis 4 stated that there would be a significant difference in interference levels between explicit items and implicit items within the younger control condition. The results did not support this prediction. The mean percentage correct difference between related and unrelated items on implicit items was -2% compared with a difference of -7% on explicit items, $t(50) = -.50$. These results indicate that item type also does not differentially affect interference level for younger control subjects. And, as was true for older subjects, younger control subjects' interference levels on both item types were not significant as shown by results of tests of Hypotheses 11 and 12.

Hypothesis 11 predicted that for younger control subjects there would be a significant difference in number of errors between related and unrelated items on explicit items. The hypothesis was not supported, with a nonsignificant $t(25) = 1.07$. The mean percentage correct on related items was 47% and on unrelated items it was 54%.

Hypothesis 12 predicted that for younger control subjects there would be no significant difference in number of errors between related and unrelated items on implicit items. The hypothesis was supported, $t(25) = .35$, which was not significant. The mean percentage correct on related items was 52% and on unrelated items it was 54%. Thus overall, younger control subjects did not have contextual interference, which supports the Ghatala et al. (in press) results.

Pictures. Hypothesis 5 predicted no significant difference in interference levels between explicit items and implicit items within the older pictures condition. The mean percentage correct difference between related and unrelated implicit items was -2% compared with 1% on explicit items, which was a nonsignificant difference, $t(50) = .65$. Therefore, item type did not differentially affect interference level for older pictures subjects.

Hypotheses 9 and 10 tested whether there were significant levels of interference within pictures on explicit items and on implicit items. Hypothesis 9 predicted that for older pictures subjects there would be no significant difference in number correct between related and unrelated items on explicit items, and Hypothesis 10 predicted that there would be no significant difference on implicit items. Both hypotheses were supported. On explicit items the mean percentage correct on related items was 75% compared with 74% on unrelated items, a nonsignificant difference, $\underline{t}(25) = -.36$. On implicit items, the mean percentage correct on related items was 75% compared with 77% on unrelated items, which also was a nonsignificant difference, $\underline{t}(25) = .58$.

All of the results of the hypotheses tests obtained for older subjects under pictures were the same for younger subjects. Hypothesis 6 predicted that there would be no significant difference in interference levels between explicit items and implicit items within the younger pictures condition. The hypothesis was supported, $\underline{t}(50) = -.82$, and mean differences correct between related and unrelated items were -3% on implicit items and -8% on explicit items.

Hypotheses 13 and 14 examined whether there was interference on explicit and implicit items under pictures. Hypothesis 13 predicted that for younger pictures subjects there would be no significant difference in number correct between related and unrelated items on explicit items, and Hypothesis 14 predicted no significant difference on implicit items. Both hypotheses were supported. The mean percentage correct on related items was 59% compared with 67% on unrelated items, a nonsignificant difference with $\alpha = .025$, $t(25) = 1.74$, although it is significant at $p < .05$ (one-tailed). On implicit items the mean percentage correct on related items was 65% compared with 68% on unrelated items, also a nonsignificant difference, $t(25) = .67$.

Conditional old errors. The results of the hypothesis tests indicated no primary evidence of interference under any of the experimental conditions. The results under pictures were the same as the imagery findings in Levin et al. (1979) and Ghatala et al. (1978). The control subjects' results, although supportive of the Ghatala et al. (in press) findings, contradict pilot test results with control subjects. Examining patterns of conditional old errors lends a different perspective to interference patterns. Table 8 presents the conditional old error percentages by condition at each of the two age levels.

Although there were adequate errors to test the main hypotheses, unfortunately not all subjects made errors on all question types, which precludes unambiguous interpretation of the results (see page 29).

The main tests of the hypotheses pertaining to results under the control conditions demonstrated no primary evidence of interference. This was also generally the finding when conditional old error patterns were examined. For older subjects there was only a small difference in interference levels between implicit and explicit items. On implicit items

TABLE 8

Conditional Old Error Percentages by Condition
at Two Age Levels

	Item Type				Across Items
	Implicit		Explicit		
	Related	Unrelated	Related	Unrelated	
YOUNGER					
Control	55	47	57	55	53.5
Pictures	63	61	74	58	64.0
Across Instructions	59.0	54.0	65.5	56.5	
OLDER					
Control	61	61	70	74	66.5
Pictures	72	72	72	72	72.0
Across Instructions	66.5	66.5	71.0	73.0	

subjects chose old, unrelated distractors at the same rate as they chose old, related items (61%). And, on explicit items, they chose old, unrelated distractors at nearly the same rate as they chose old, related distractors (74% and 70% respectively). It appears, then, that there was no additional interference from the contextual relatedness variable, evidenced by the finding that errors were not greater on related items. However, the rate of choosing old distractors was significantly higher on explicit items than on implicit items, $t(92) = 1.65$, $p < .05$ (one-tailed), with 10 subjects excluded from the analysis because they made no errors.

The present study did not include a "new" item (as a control test of the contextual relatedness gradient: related, unrelated, new), which would have permitted a clean assessment of whether there was interference due to the item frequency of unrelated items. However, the conditional old error patterns in general support the Ghatala et al. (in press) control results where only item interference operated without additional contextual interference. On both implicit and explicit items, in the present study, the older control subjects' rate of choosing unrelated distractors was significantly greater than the 50% rate expected by chance. On implicit items the rate was 61%, $t(23) = 1.75$, $p < .05$ (one-tailed), with two subjects excluded from the analysis; on explicit items the rate was 74%, $t(25) = 4.14$, $p < .01$. This demonstrated that there was interference from the item frequency of unrelated items. It appears that subjects were processing the implied information and that this information caused subsequent interference on the recognition test, as was demonstrated by conditional old error patterns.

Concerning younger control subjects, overall their conditional old error percentage, 53.5%, was closer to the level expected by chance than the older subjects' 66.5%. On explicit items there was little difference between selection rates of related distractors (57%) and unrelated distractors (55%). On implicit items related distractors were chosen at the rate of 55% compared with the rate of 47% on unrelated distractors. These results demonstrated that under control conditions, related and unrelated implicit and explicit distractors do not cause interference with memory for target information. However, based on the Ghatala et al. (in press) results where it was found that control subjects used a variety of covert strategies, results in the present study may be obscured by combining test results over all subjects. Ghatala et al. (in press) found interference effects only in covert repeaters' tests results. The same may be true in the present study, with both younger and older subjects. If these subjects had been interviewed to determine which covert strategies they used, it may have been found that covert repeaters experienced interference. Subjects using no strategy may have experienced item frequency interference only, as was the case with fourth-and fifth graders in Ghatala et al. (in press), or they may have had a similar, high level of errors on both related and unrelated items, as was the case with high-schoolers in Ghatala et al.

One of the main questions of this study was whether first graders infer information. This remains unanswered because primary evidence of interference, the basis for the test, did not occur. The conditional old error analyses have likewise yielded ambiguous results. On both related and unrelated items, the selection rate of old distractors was too near the chance level to make categorical pronouncements that the younger control subjects inferred the information which formed these old distractors.

The lack of any contextual interference pattern evidenced by conditional old errors for older, pictures subjects supports the main hypothesis tests. Mean conditional old error percentages under pictures were remarkable only in the fact that they were all the same, 72%, which is considerably above the percentage expected by chance, $t(87) = 5.98$, $p < .01$ with 15 subjects excluded from the analysis. This percentage is somewhat higher than the 66.5% obtained in the control condition, which also was significantly higher than 50%, $t(92) = 5.37$, $p < .01$ with 10 subjects excluded from the analysis. Thus, even though pictures aided overall learning (see Table 3), when errors were made, old distractors were picked more often than new distractors in the pictures condition. Whether these distractors were implied or explicit made no difference in their later rate of selection. Pictures appeared to have "highlighted" the implied information, even though the implied information was not depicted in the picture, but was available only through the pictures' contexts. Although the selection rate of old distractors on explicit items was the same 72% in both the control and pictures conditions, on implicit items the rate was somewhat higher in the pictures condition (72%) than in the control condition (61%), though the difference was not significant, $p > .05$.

For younger subjects, the rate of choosing old distractors was also significantly greater than 50% in the pictures condition (64.0%), $t(92) = 3.97$, $p < .05$ with 10 subjects excluded from the analysis, compared with the control condition (53.5%), which was near the chance level. An interesting contextual interference pattern was evident on explicit items, where related distractors were chosen significantly more often than unrelated distractors, at an average rate of 74% compared to 58% on unrelated distractors, $t(21) = 2.02$, $p < .05$ (one tailed), with four subjects excluded from the analysis. This supports the main hypothesis test which indicated a near significant difference between related and unrelated errors, $t(25) = 1.74$, $p < .05$ (one-tailed). This main test was not accepted as primary evidence of interference in this condition because the α level was greater than the level chosen prior to conducting the experiment. But, had this been a directional hypothesis test of main interest to the experiment, clearly it would have been indicative of contextual interference.

The question arises as to why younger pictures subjects appeared to have contextual interference but not item interference, on explicit items, whereas older subjects had item interference only. Specifically, older subjects' conditional old error percentages were 72% on both related and unrelated items, whereas younger subjects' rates were 74% on related items and 58% on unrelated items. This difference may be due to picture processing differences between the age levels, but this is a tentative explanation.

To summarize the conditional old error results, at both age levels there were more old distractors chosen in the pictures condition than in the control condition. There was no evidence of contextual interference except for younger pictures subjects on explicit items. Old subjects under both control and pictures appeared to have item interference only, with no additional contextual interference. This was also the case with younger pictures subjects on implicit items. Younger control subjects did not appear to have item interference or contextual interference.

CHAPTER VII

SUMMARY AND CONCLUSIONS

The results of the experiment indicated that in both control and pictures conditions, contextual interference did not affect overall learning. Only conditional old error patterns demonstrated that old distractors were the source of errors in certain conditions. For younger subjects, the presence of old distractors appeared to be a source of error in the pictures but not in the control condition. For older subjects, old distractors were apparently a source of errors in both control and pictures conditions. However, results obtained under control conditions at both age levels must be viewed as tentative because these results may be the combination of results from different covert strategy users.

The finding of no primary evidence of contextual interference in the control condition is in contrast to the pilot study results where contextual interference occurred. A possible reason for the nonreplication might be differences in backgrounds between pilot subjects and the subjects used in the main experiment. Pilot subjects were from predominantly well-educated families (i.e., their schools were in a university community), compared with subjects in the main experiment who generally were from rural, farm families. Another possible explanation is that lists were mixed (implicit and explicit) for pilot subjects, and homogeneous for subjects in the main experiment. Exactly why these differences may have affected test results is unclear. A third difference between the pilot study and the main experiment was that different experimenters ran the studies.

A one-day delay between study and test may have affected the interference hypothesis (although the same delay was used in the pilot study). The delay may have caused subjects to forget the sentences to the point that old distractors had little impact on learning.

It was difficult to draw conclusions about whether younger subjects inferred information. Conditional old errors seemed to indicate that pictures aided their inferential ability since there were more old errors (inferred information) in the pictures than in the control condition. But because of the possibility of subjects using different covert strategies under a control condition, it is impossible to state categorically that they did not also infer information in the control condition.

Until the discrepancies between the pilot results and the main experiment are resolved, the paradigm used in these studies cannot be labeled "better" than those used in other inference studies. It may be too complex ("noisy") to detect inferential ability by "clean" assessments (i.e., primary tests for interference). Thus, the complexity of the experimental design may be a limitation of the experiment. On the other hand, the complexity of inferentially-produced interference may be a difficult question to analyze.[1]

[1]It should be noted that the present experimental design does not permit an analysis of whether interference occurred during study or at test time. Were that of interest, a design that clearly separates study and test factors would have to be employed.

Whether information in variation sentences (later old distractors) was explicit or implicit did not differentially affect overall learning of target information. But when conditional old error patterns are compared between conditions, different conclusions may be reached. In the control condition for younger subjects, the conditional old error percentages were near the 50% chance level. However, in the pictures condition, on implicit items the selection rate of old distractors was 63% on related items and 61% on unrelated items (although the averaged rate, 62%, was not significantly different from the averaged rate, 51%, in the control condition), and on explicit items the rate was 74% on related items and only 58% on unrelated items (which was the only evidence of contextual interference in the experiment). Pictures appeared to somewhat increase the likelihood of selection of old distractors except for explicit-unrelated items.

For older control subjects, explicit items had an overall conditional old error selection rate of 72% and on implicit items the rate was 61%, indicating that explicit distractors were a greater source of error than implicit distractors. Pictures also appeared to increase the selection of old distractors for older subjects on implicit items, where the rate was 72%, which was higher than the 61% in the control condition. On explicit items, the rate was 72% under control and pictures.

Pictures aided learning for both younger and older subjects. This supports the notion that pictures enhance the distinctiveness of target information, rather than increasing the likelihood of confusing the information with distractors. Pictures were so effective that younger pictures subjects' learning was equal to that of older control subjects.

Educational Implications

The replication of positive picture effects on learning again demonstrates how their addition to verbal materials can increase learning. It was interesting to find that pictures brought younger subjects' learning to the level of older control subjects, especially when the age difference is noted--i.e., children in their first school year compared with children whose average age put them in their final year of elementary school. This lends strong support to the prescription to teachers to include pictures as learning aids, particularly when potentially interfering material is presented along with material to-be-learned.

Pictures also appear to be a good substitute for imagery training, which may not always be practical. Both pictures and imagery have now been demonstrated to reduce interference, compared with interference under no-strategy and repetition strategy conditions.

The above comments can be "turned around" to yield a set of precautions to teachers. First, this experiment demonstrated that a control strategy produced less efficient learning than pictures. Coupled with the Ghatala et al. (in press) control results, teachers should be cautioned to be less casual about their students' covert learning strategies. They should take a more aggressive approach to teaching strategies. Second, teachers should be aware that implied information can be a source of test error (as the conditional old error analyses indicated). They should take steps to reduce the possibility of interference occurring (as was suggested above, namely, by imposing strategies during learning), or else eliminate the use of old distractors on multiple-choice items. More research needs to be done, however, to determine the circumstances under which information causes interference. For example, Levin, Ghatala, and Bender (1978) found that unfamiliar distractors that are plausible, combined with synonym variations of correct answers (i.e., synonym-old absent), differentiated "learners" from "nonlearners" without bias against the nonlearners. However, they found that low achievers were more likely than high achievers to choose old, familiar distractors in situations where these distractors were included on multiple-choice items (synonym-old present). The authors suggested that these old distractors might constitute a persistent source of misinformation for the low achievers.

Suggestions for Future Studies

Because a primary question of interest in this experiment--whether younger children infer--could not adequately be answered in the present study because of the potentially ambiguous control condition results (and possibly, the complex experimental design), a followup study is warranted. This followup study might use a repetition strategy which clearly has been demonstrated to elicit the interference effects that were desired in the present study. A simple study would involve using younger repetition subjects under an implicit item condition. There would be strong evidence that younger children inferred the information if they made significantly more errors on related items than on unrelated items or if conditional old errors on either unrelated items or related items were significantly different from 50%.

It would also be of interest to examine whether inferred information causes item interference or contextual interference or both. This assessment could be made only with the addition of a new test item where both distractors are new. Errors on this item would be compared with errors made on related and unrelated items. Adding the new test item to the experiment suggested above would aid in generalizing the results to school settings. In other words, it would be of interest to know whether teachers should be cautioned against including familiar distractors of any type--inferred or explicit--on multiple-choice tests.[2]

Another followup study could examine the differences in contextual interference found here between younger and older pictures subjects, on explicit items. Younger pictures subjects had contextual interference from related distractors and no apparent item interference from unrelated distractors, which follows the Ghatala et al. (in press) findings with older covert repeaters. However, older pictures

[2]In the present experiment, a post hoc analysis was conducted on interference from only those test items (7 of 14) that involved implied implements, the rationale being that implements likely came to mind more spontaneously than the implied settings or objects of the other items. This, perhaps, would create greater contextual interference. Results of this analysis did not support this notion, however.

subjects in the present study did not have signs of interference, which follows the results obtained with the Ghatala et al. (in press) covert imagery subjects. It would be interesting to compare contextual interference patterns of younger pictures subjects with younger repeaters. The question would be whether younger subjects who have contextual interference under pictures would have more interference under repetition.

Another followup study might compare the effects of pictures on learning, with "partial" pictures (Guttmann, Levin, and Pressley, 1977; Ruch and Levin, 1977). A partial picture would not only require inferring the implied information but would also require getting the correct answer from a picture's context. Neither old distractors nor correct answers would be displayed in partial pictures. In such a case, learning under partial pictures may be less than under the picture condition used in the present experiment.

Conclusions

The overall results of this experiment indicate that pictures have a strong, positive effect on learning--even when there is potential interference from related materials. This is an educationally relevant finding and points to the need for further experimentation with pictures, particularly with young children who perhaps have the greatest capacity to benefit from their use.

Although the present experiment's complex design may have been a limitation, it nonetheless yielded many avenues for exploration: picture effects, young-old inference differences, and contextual interference effects, to name just a few.

APPENDIX I:

MATERIALS

INSTRUCTIONS

Pictures Subjects (Conditions 1, 2, 3, 4)*

I'm trying to find out how well younger and older children learn sentences. You're going to listen to some sentences on the tape recorder. I want you to pay close attention to them because later on I'm going to ask you some questions about them.

While you listen to the sentences, I'm going to show you pictures which will help you remember the sentences. Look at each picture as you hear the sentences.

Okay? Let's start.

No Picture Subjects (Conditions 5, 6, 7, 8)*

I'm trying to find out how well younger and older children learn sentences. You're going to listen to some sentences on the tape recorder. I want you to pay close attention to them because later on I'm going to ask you some questions about them.

Okay? Let's start.

Note: After listening to sentences all subjects were told not to discuss the sentences with other children in their class or in other classes.

*Subjects in conditions 1, 3, 5, and 7 listened to implicit sentences; in conditions 2, 4, 6, and 8 sentences were explicit. Pictures were shown with sentences in conditions 1, 2, 3, and 4. Control subjects served under conditions 5, 6, 7, and 8.

Sentences for Conditions 1, 2, 5, 6

1. The actress photographed the balloon.
2. The minister filled the auto tank (with gas).
3. The dentist opened the soup (with the can opener).
4. The bird caught the worm.
5. The judge looked at the bottle.
6. The ashtray was full.
7. The nurse cleaned the floor (with the mop).
8. The robber broke the zipper.
9. The lampshade was crooked.
10. The actress flew overseas (in the airplane).
11. The grandfather dropped the book.
12. The clerk drew in ink (with the pen).
13. The sheriff wore the hat.
14. The janitor ate the cereal (with the spoon).
15. The waiter poured the milk (into the glass).
16. The clown played in the dirt.
17. The maid rinsed the rag.
18. The bee landed on the flower.
19. The clerk borrowed the pencil.
20. The queen wiped the knife.
21. The artist steered the bus.
22. The soldier put away the stick.

23. The sailor scratched his foot.

24. The girl sold the toaster.

25. The minister sniffed the smoke.

26. The batter missed the ball.

27. The clock chimed at noon.

28. The banker arrived after the surgery (at the hospital).

29. The repairman fixed the dishwasher (in the kitchen).

30. The fish bit the hook.

31. The fireman rode on the handlebars (on the bike).

32. The duck swam in the pond.

33. The repairman painted the garage.

34. The clown shoveled (the sand) on the beach.

35. The girl cooked the egg (in the pan).

36. The train crossed the bridge.

37. The teacher pointed to the blackboard.

38. The wrestler carried the groceries (in the bag).

39. The dog barked at the cat.

40. The fireman sneezed in the cemetery.

41. The car hit the tree.

42. The soldier caught the horse (with the rope).

Sentences for Conditions 3, 4, 7, 8

1. The actress photographed the balloon.
2. The cowboy filled the auto tank (with gas).
3. The robber opened the soup (with the can opener).
4. The bird caught the worm.
5. The judge looked at the bottle.
6. The ashtray was full.
7. The maid cleaned the floor (with the mop).
8. The robber broke the zipper.
9. The lampshade was crooked.
10. The reporter flew overseas (in the airplane).
11. The grandfather dropped the book.
12. The baby drew in ink (with the pen).
13. The sheriff wore the hat.
14. The queen ate the cereal (with the spoon).
15. The judge poured the milk (into the glass).
16. The clown played in the dirt.
17. The maid rinsed the rag.
18. The bee landed on the flower.
19. The clerk borrowed the pencil.
20. The queen wiped the knife.
21. The artist steered the bus.
22. The soldier put away the stick.

23. The sailor scratched his foot.

24. The girl sold the toaster.

25. The minister sniffed the smoke.

26. The batter missed the ball.

27. The clock chimed at noon.

28. The fireman arrived after the surgery (at the hospital).

29. The detective fixed the dishwasher (in the kitchen).

30. The fish bit the hook.

31. The artist rode on the handlebars (on the bike).

32. The duck swam in the pond.

33. The repairman painted the garage.

34. The boy shoveled (the sand) on the beach.

35. The grandmother cooked the egg (in the pan).

36. The train crossed the bridge.

37. The teacher pointed to the blackboard.

38. The grandfather carried the groceries (in the bag).

39. The dog barked at the car.

40. The fireman sneezed in the cemetery.

41. The car hit the tree.

42. The farmer caught the horse (with the rope).

INSTRUCTIONS FOR TEST

Yesterday, we listened to some sentences. Today I'm going to ask you questions about the sentences. You will hear tape recorded questions followed by three possible answers. I want you to choose the right answer. Okay? If you don't know the right answer, just guess. Guessing is okay.

Let's start.

TEST QUESTIONS

1. What did the soldier put away?
   c n o
   the stick, the net, the rope

2. What did the repairman paint?
   o c n
   the kitchen, the garage, the bath

3. What did the minister sniff?
   c n o
   the smoke, the air, the gas

4. What did the clown play in?
   o c n
   the sand, the dirt, the snow

5. What did the queen wipe?
   c o n
   the knife, the spoon, the fork

6. What did the clerk borrow?
   o n c
   the pen, the crayon, the pencil

7. What did the artist steer?
   c o n
   the bus, the bike, the car

8. Where did the fireman sneeze?
   o c n
   the hospital, the cemetery, the church

9. What did the judge look at?
   n o c
   the cup, the glass, the bottle

10. What did the robber break?
    n o c
    the key, the can opener, the zipper

11. What did the maid rinse?
    c o n
    the rag, the mop, the brush

12. What did the grandfather drop?
    n c o
    the wallet, the book, the bag

13. What did the girl sell?
    n o c
    the oven, the pan, the toaster

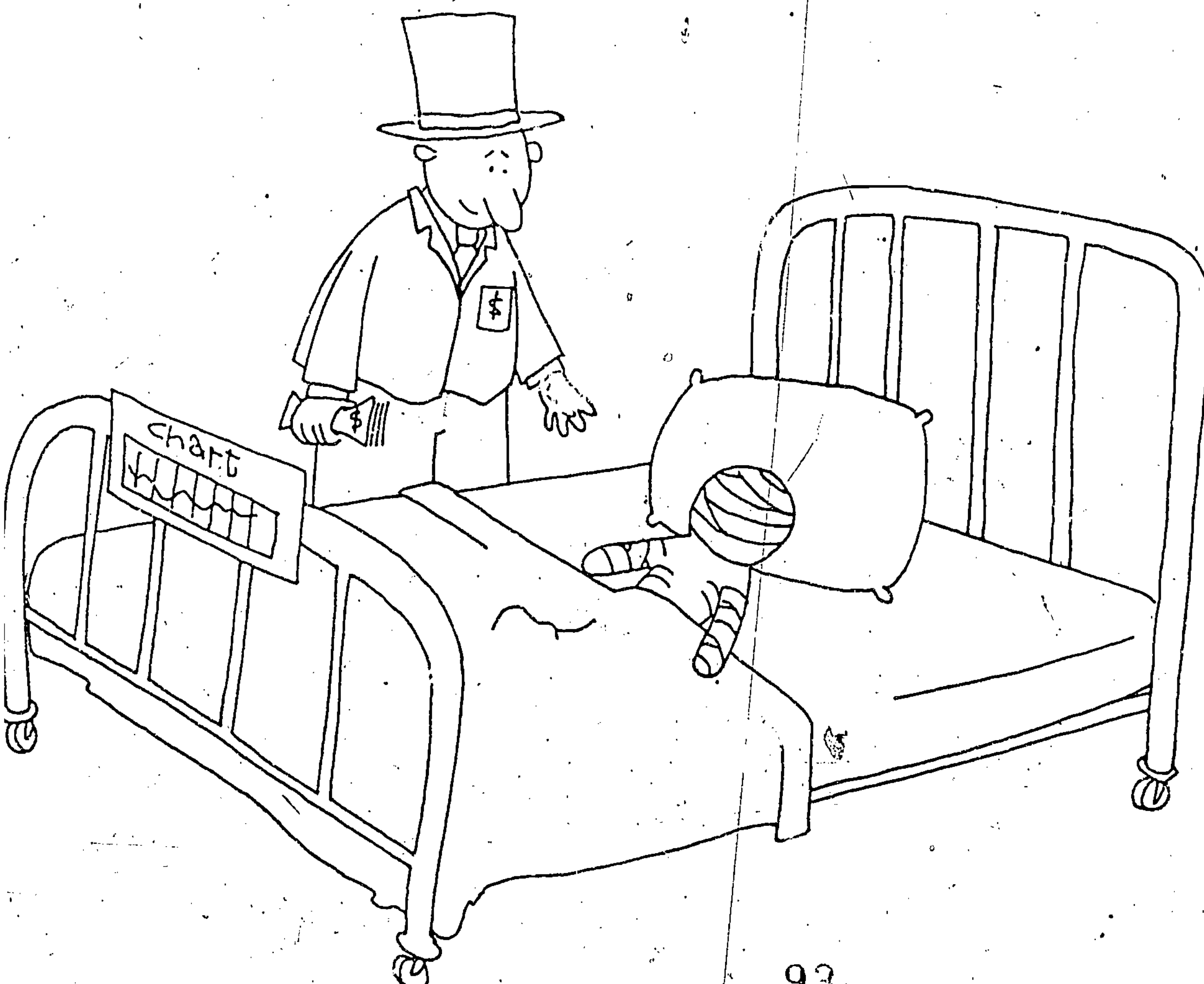
14. What did the acress photograph?
    n c o
    the rocket, the balloon, the airplane

Note: Letters appearing above multiple-choice alternatives represent the following:

- c - correct answer
- o - old, incorrect choice
- n - new, incorrect choice

PICTURE SETS


ACHOO!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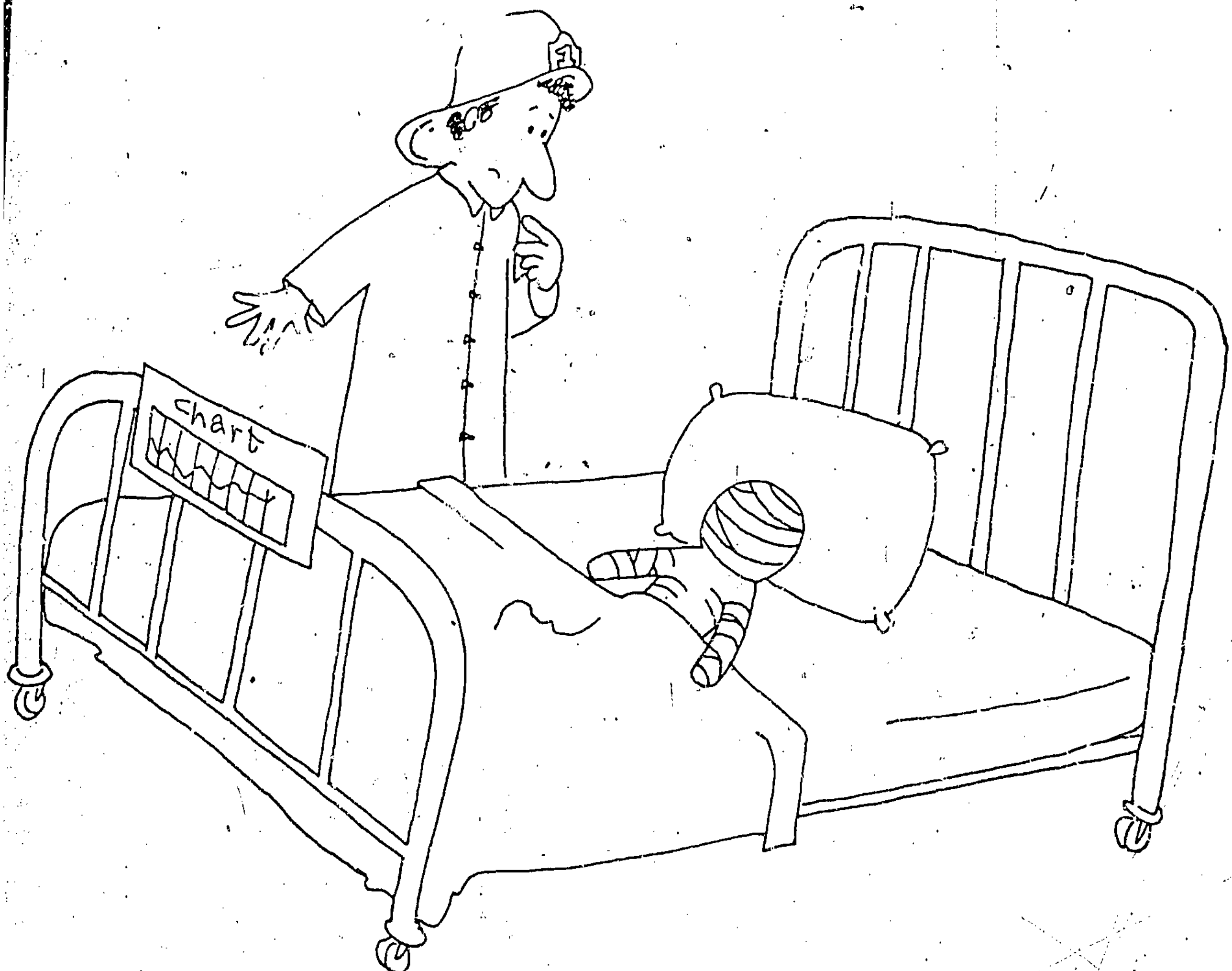
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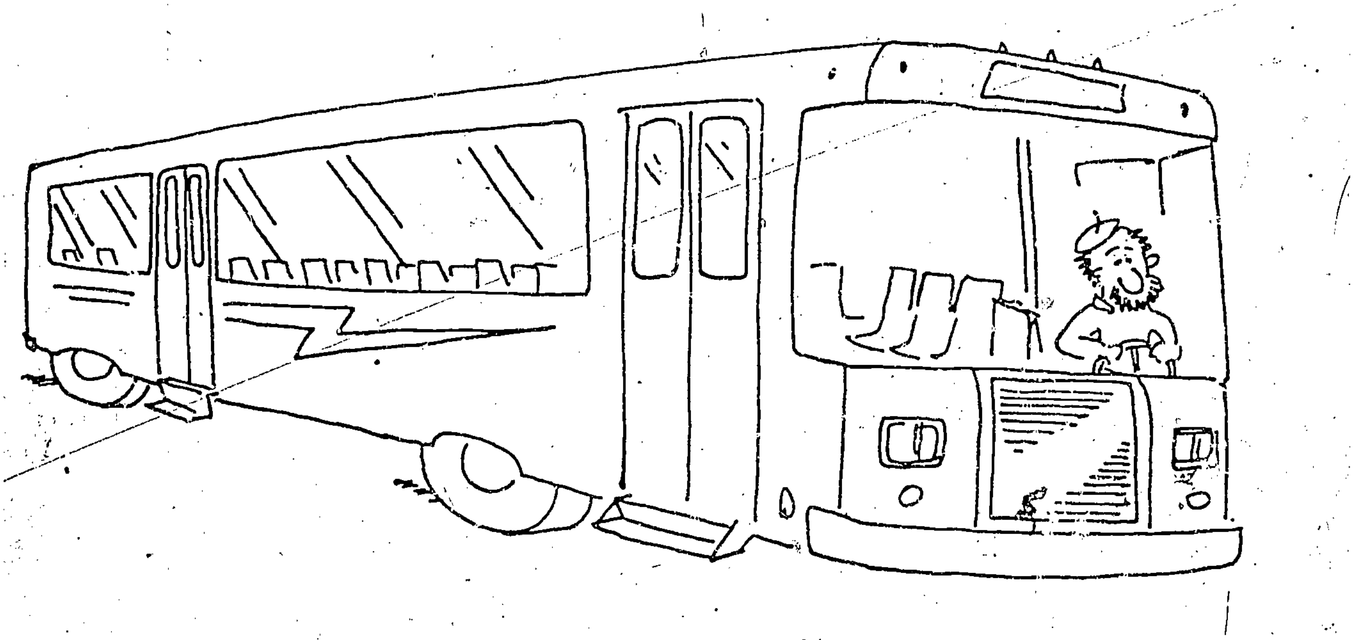

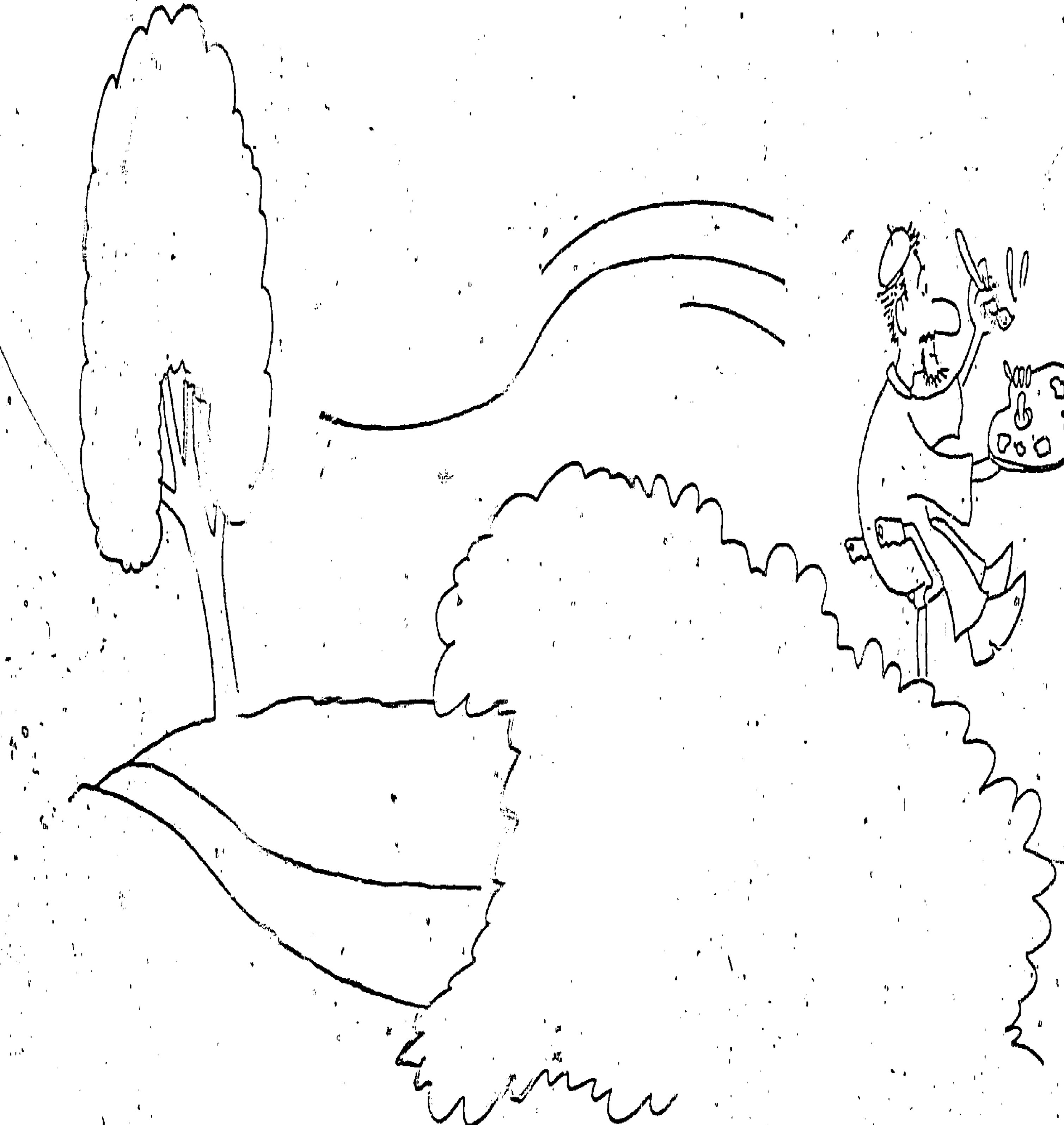

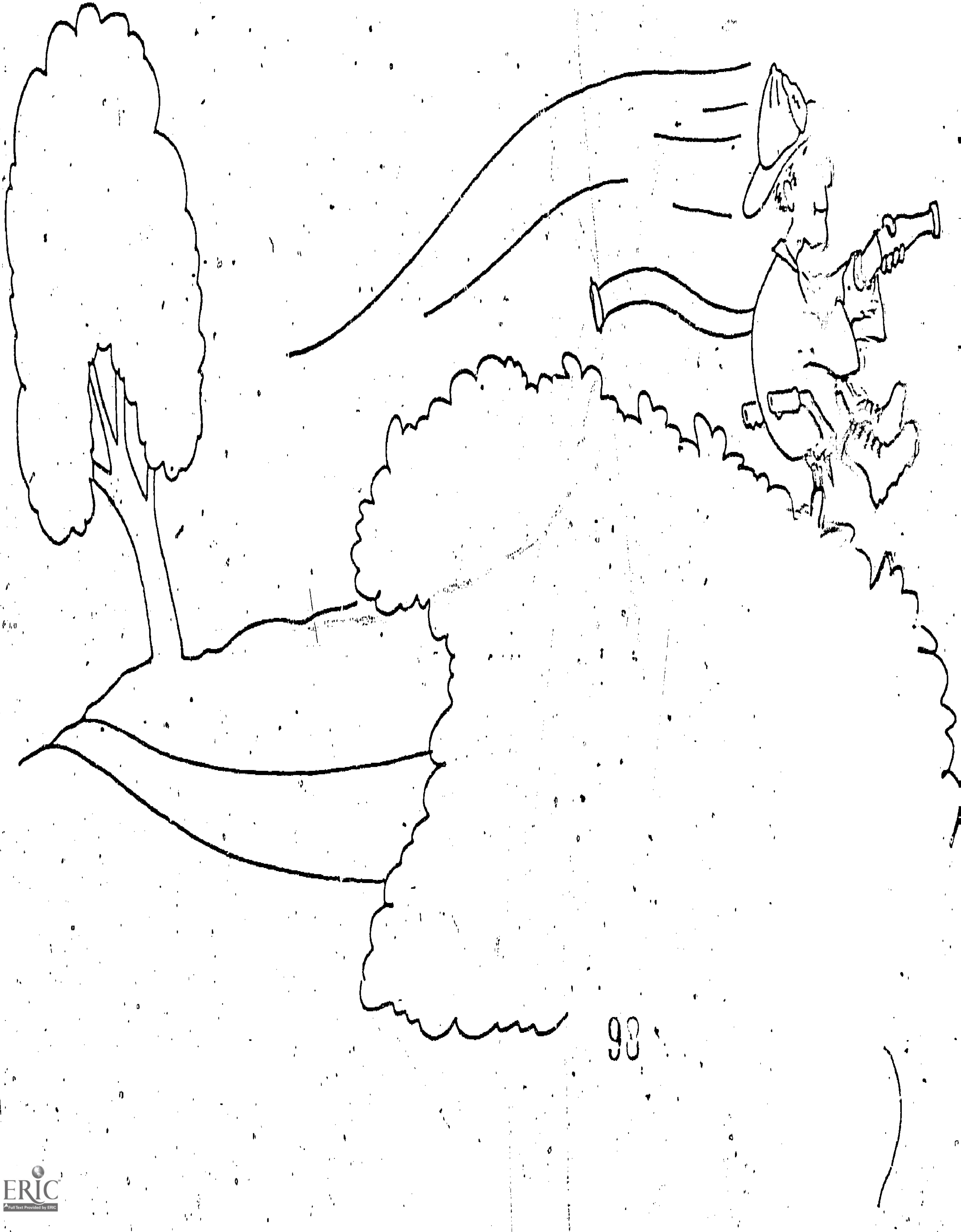

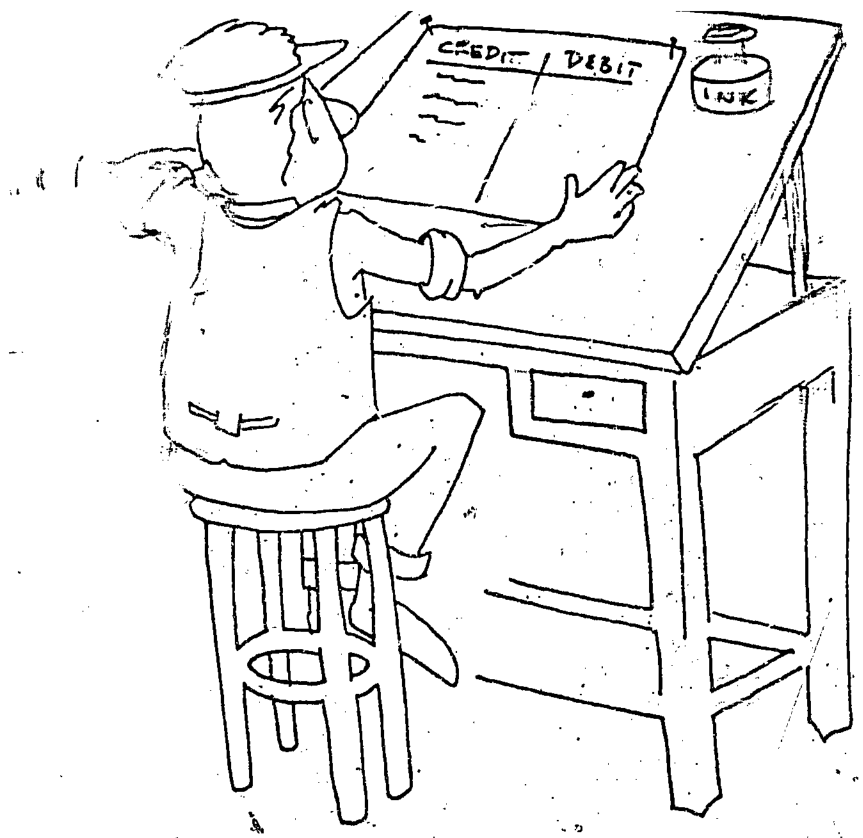
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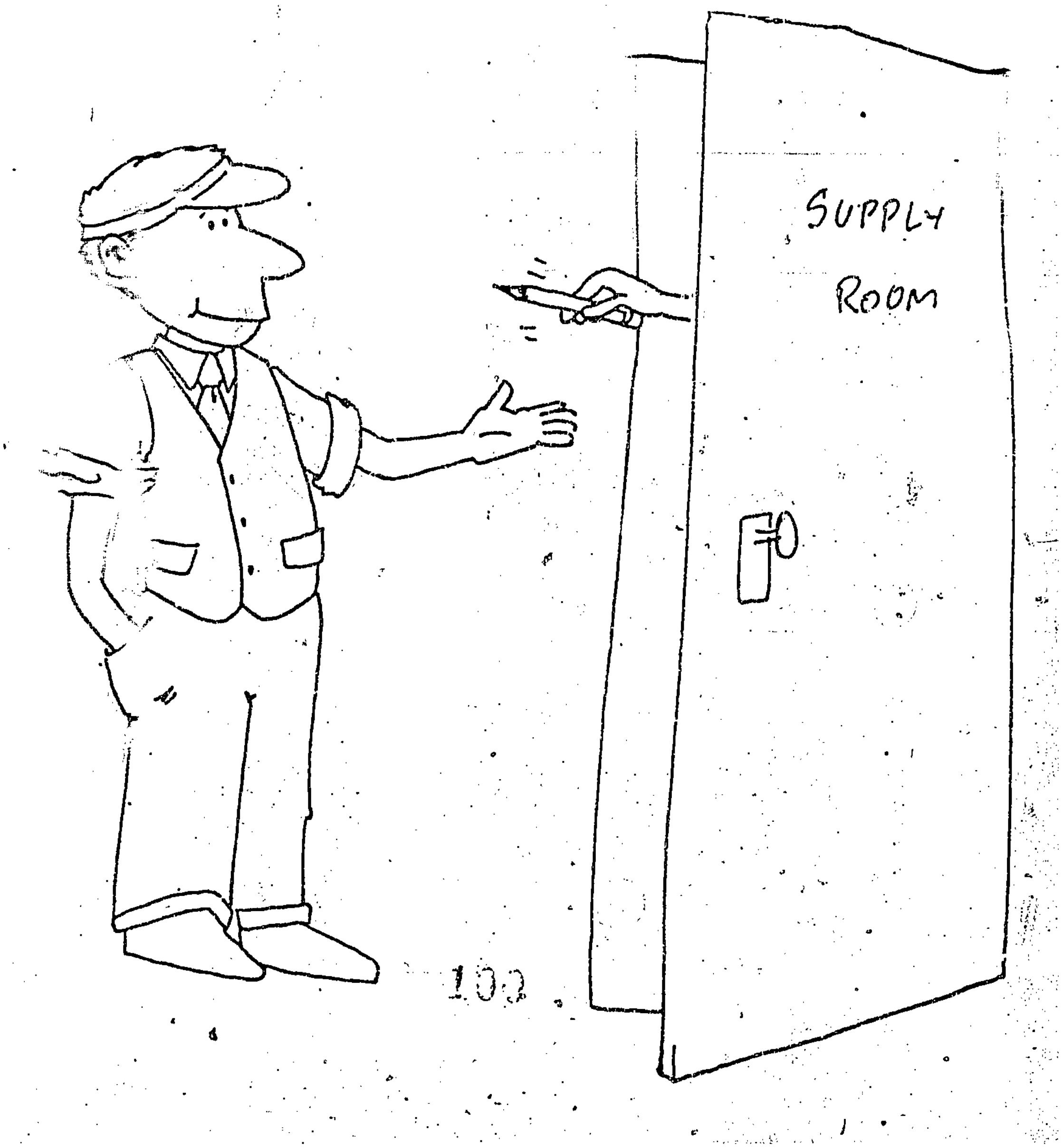
DEBIT
INK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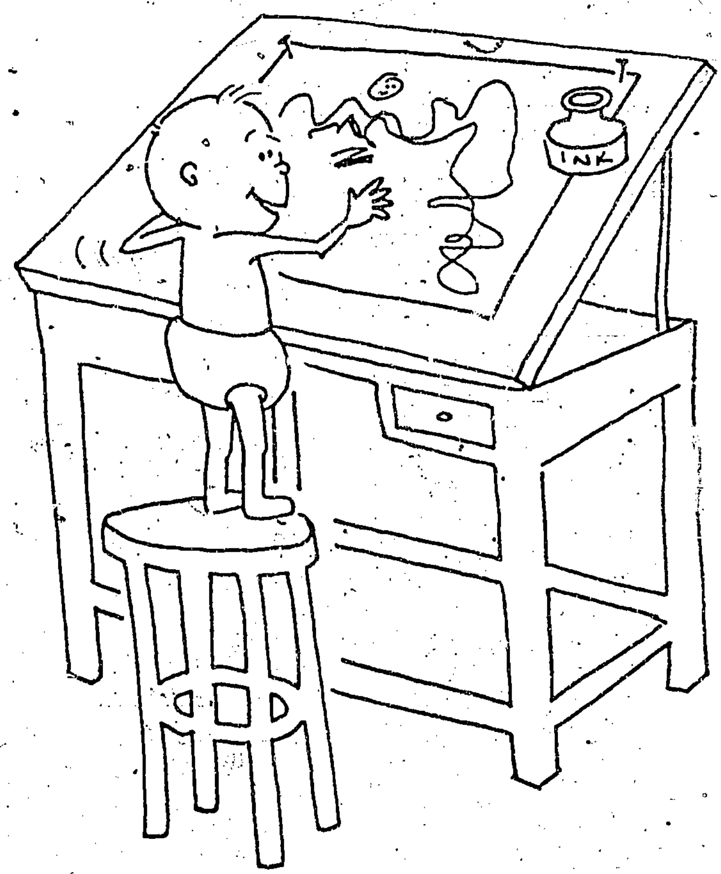
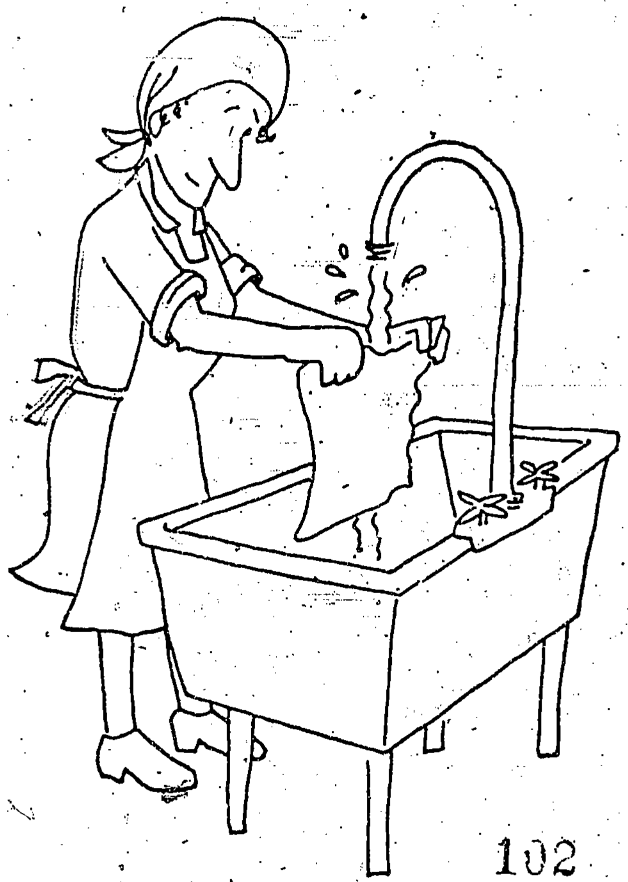
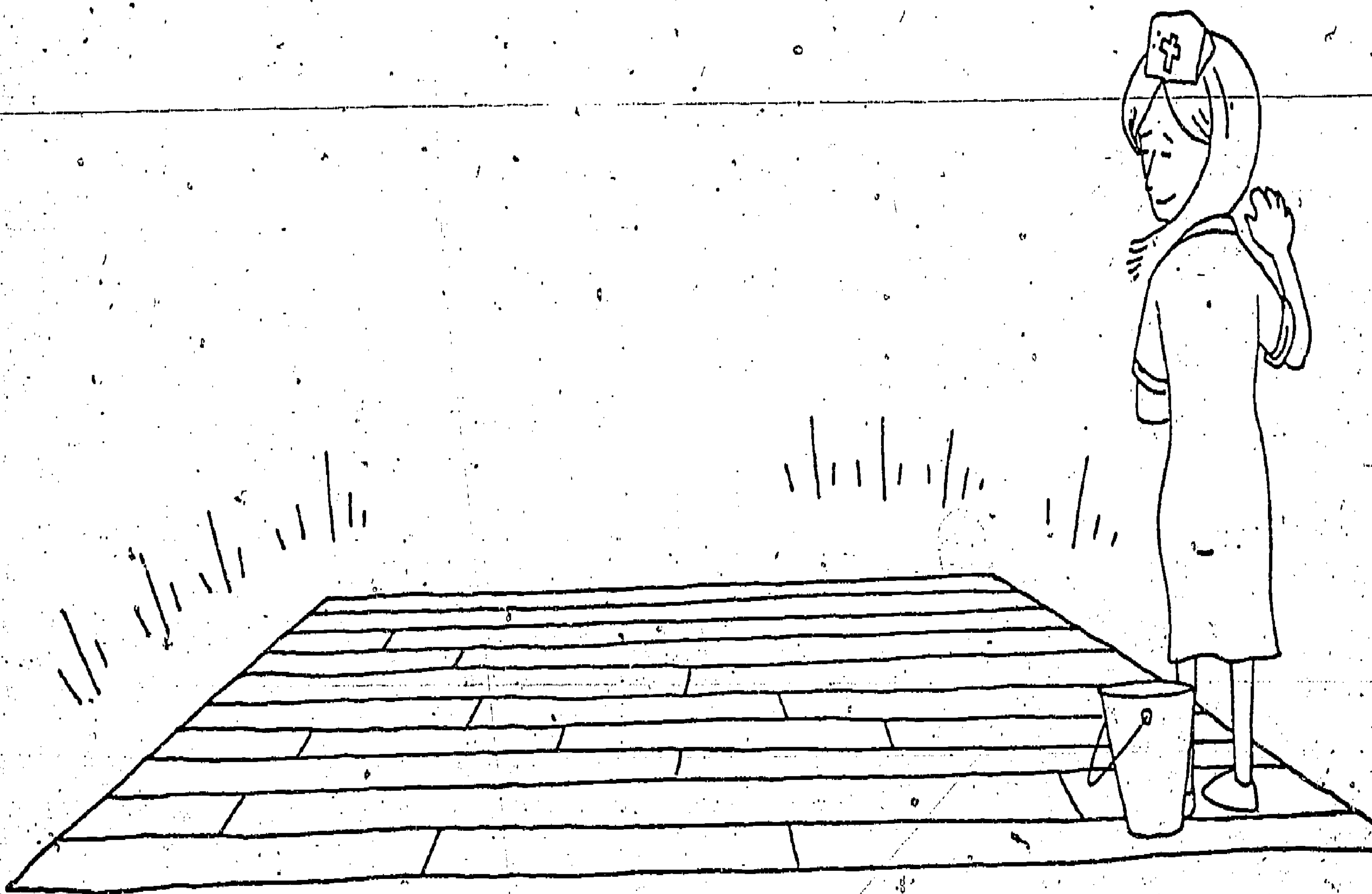
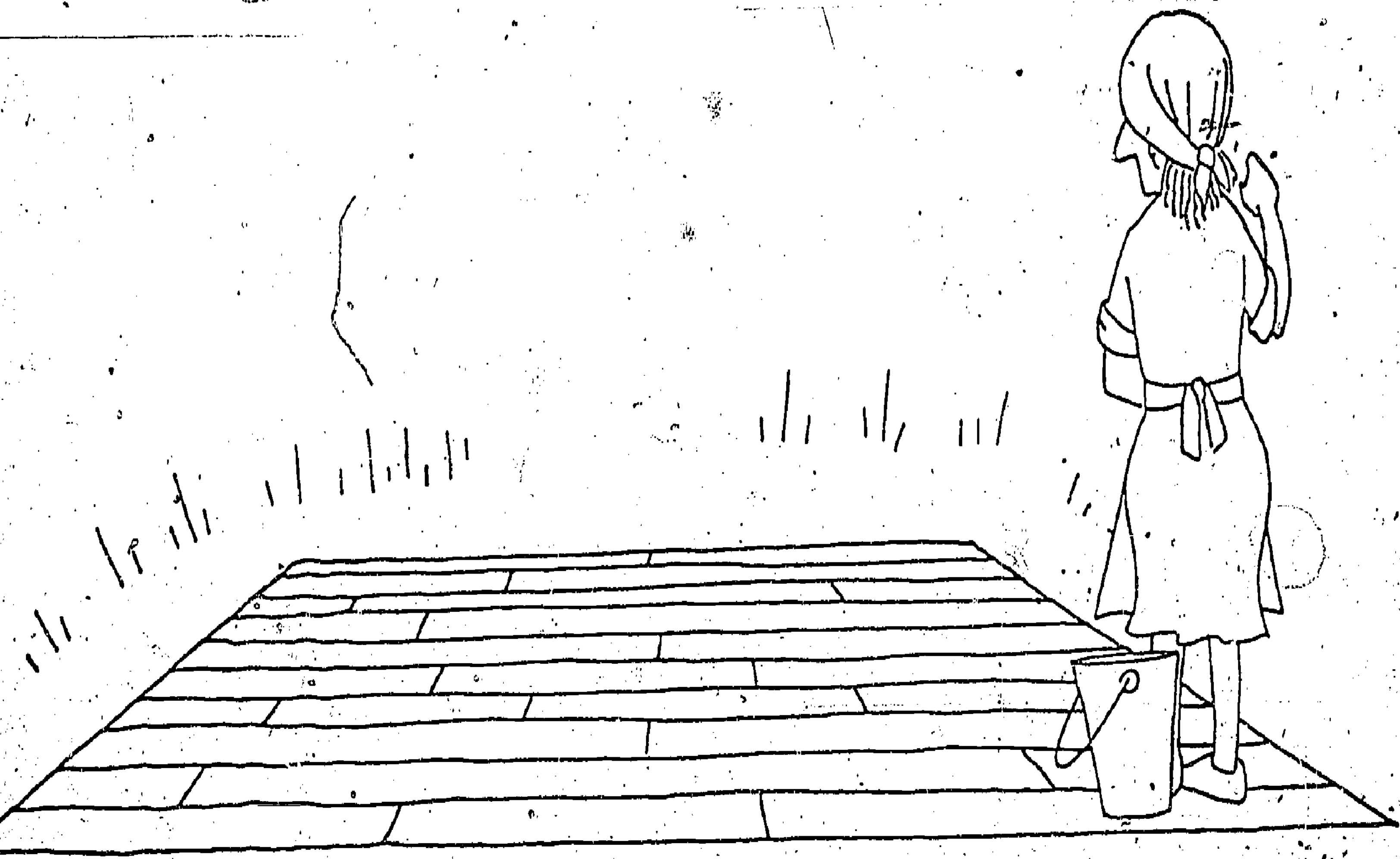
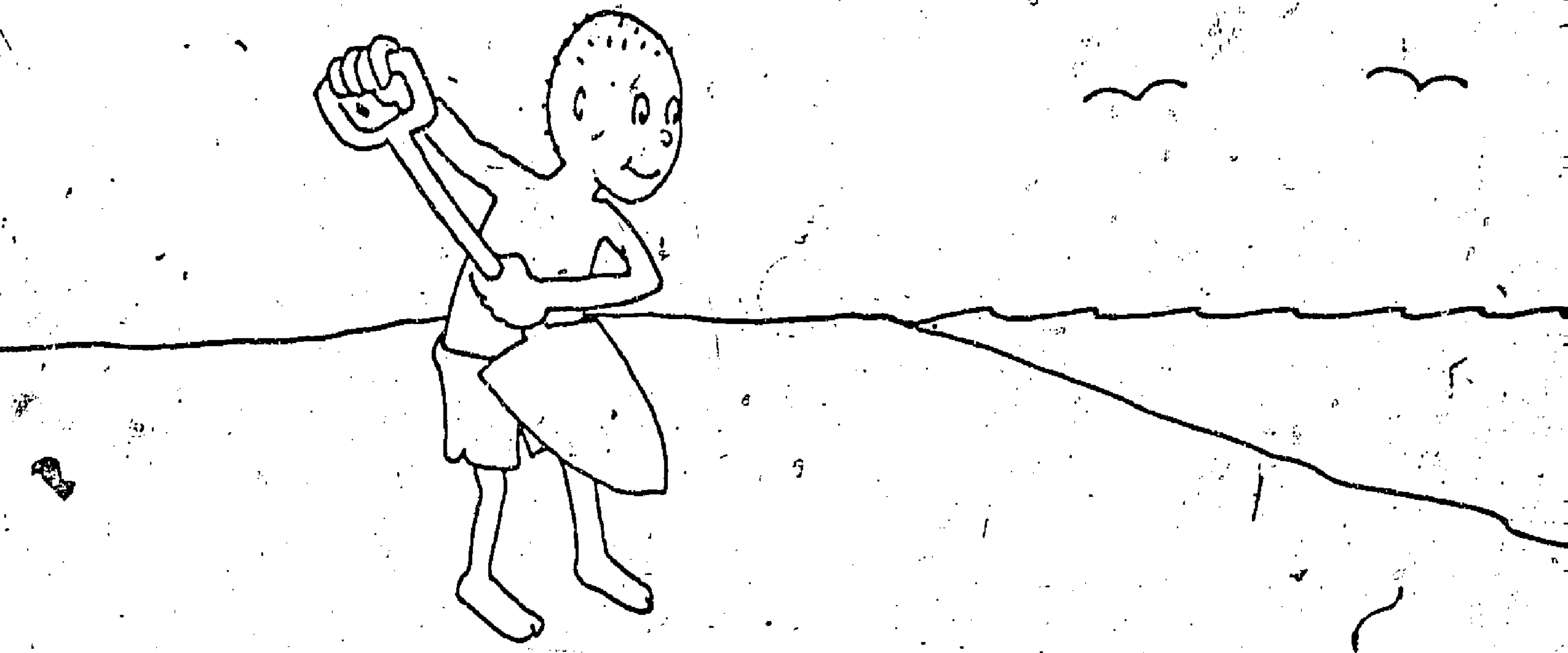
ROOM


INK





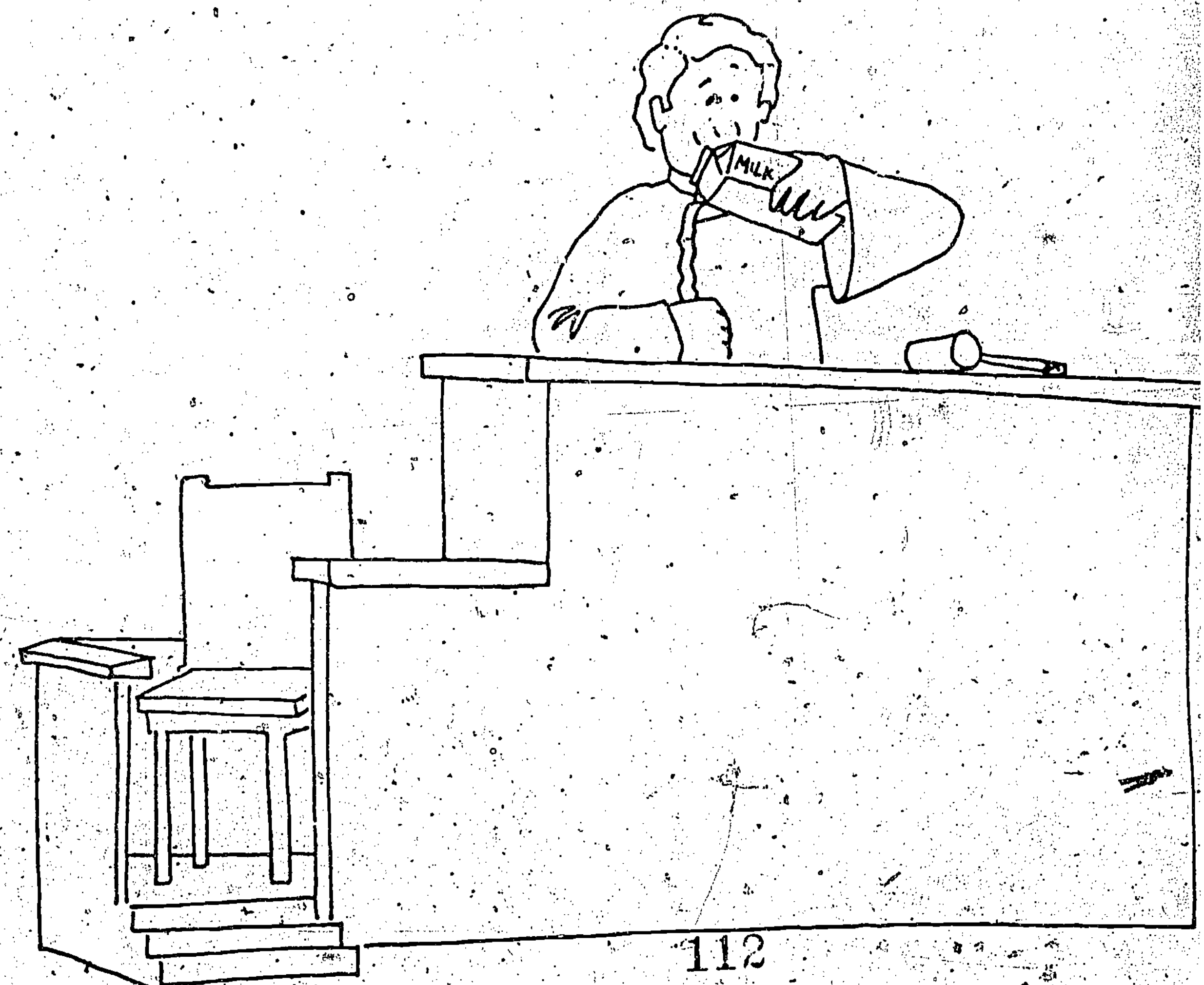





SNAP


SOUP


SOUP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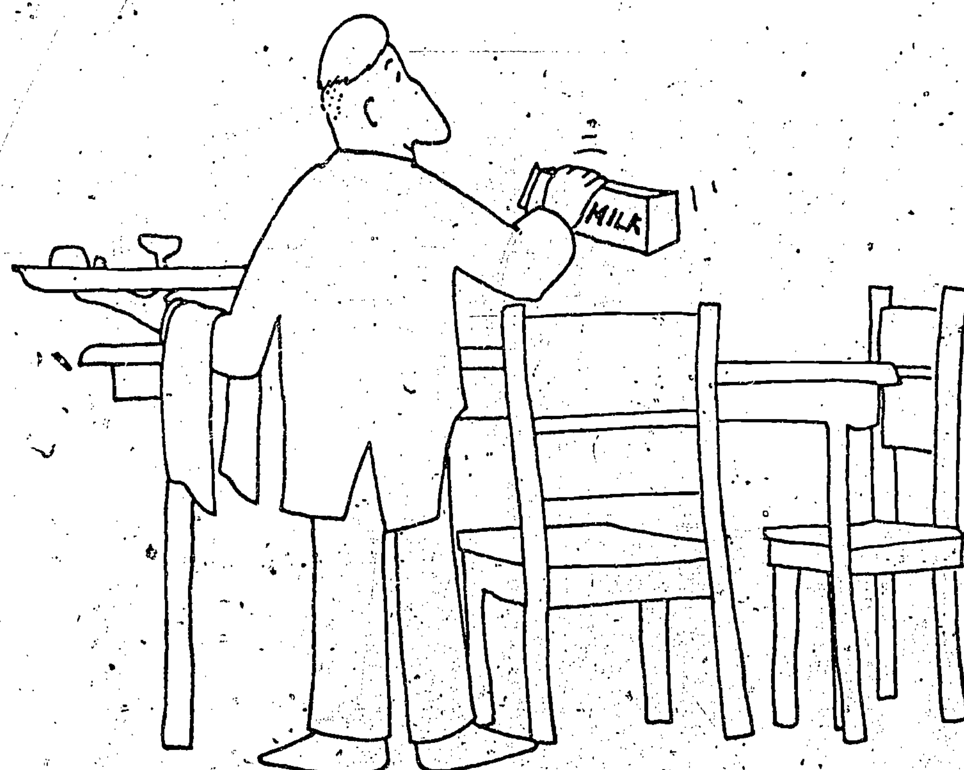
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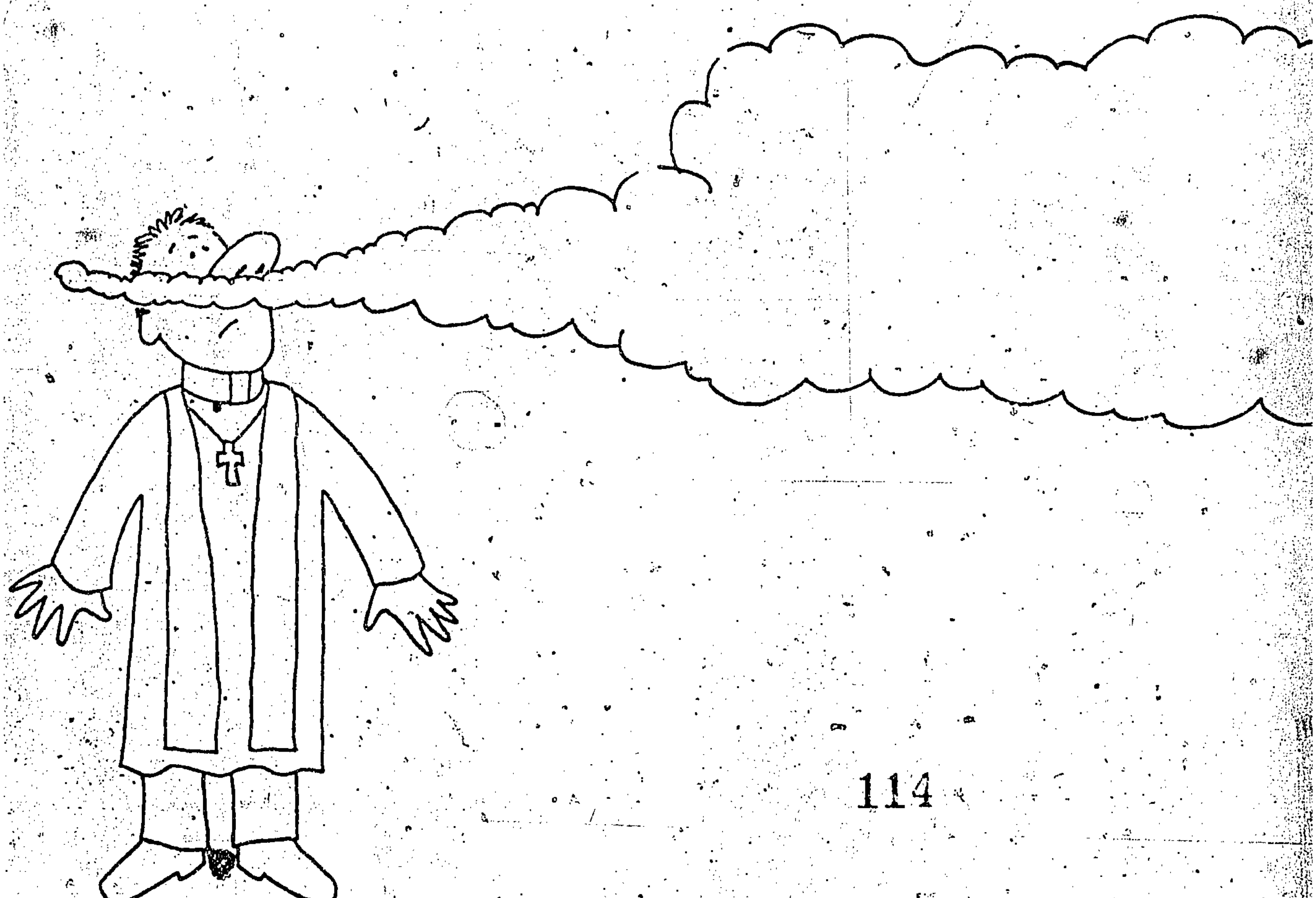
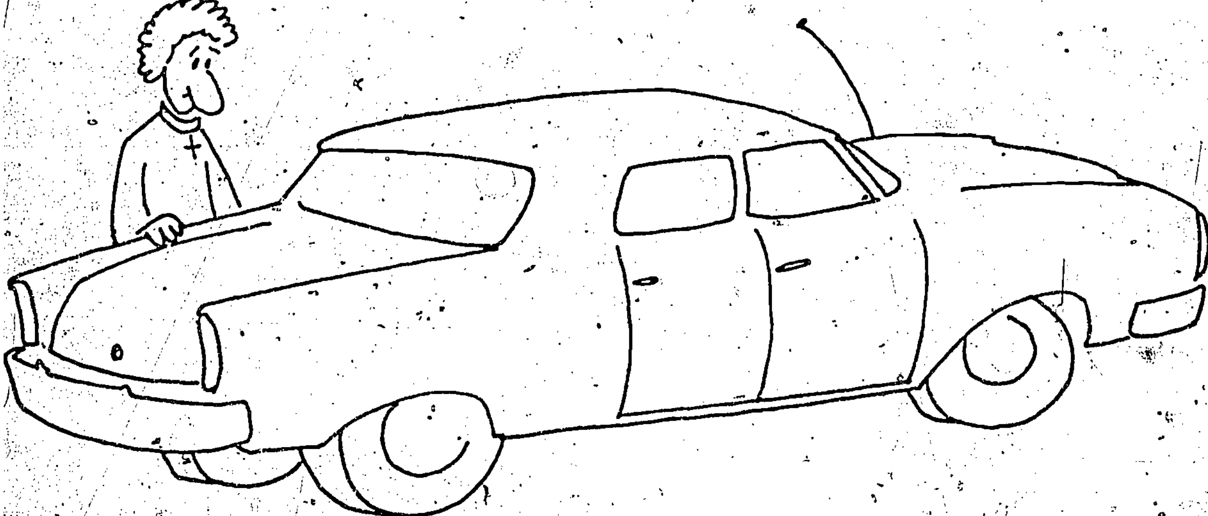
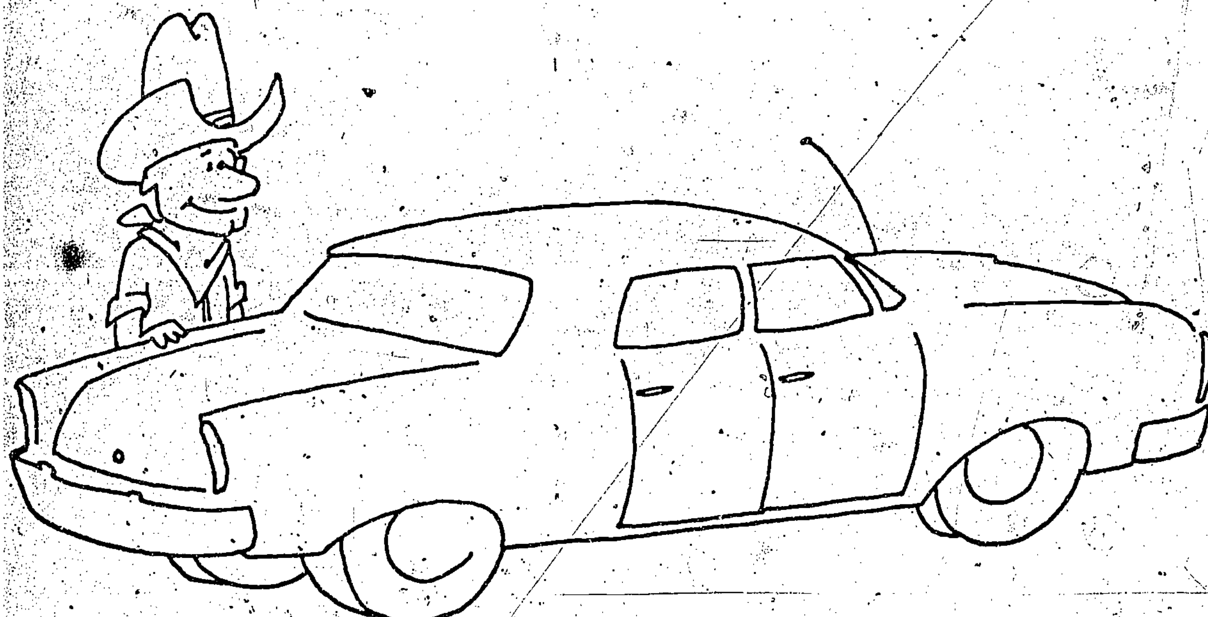
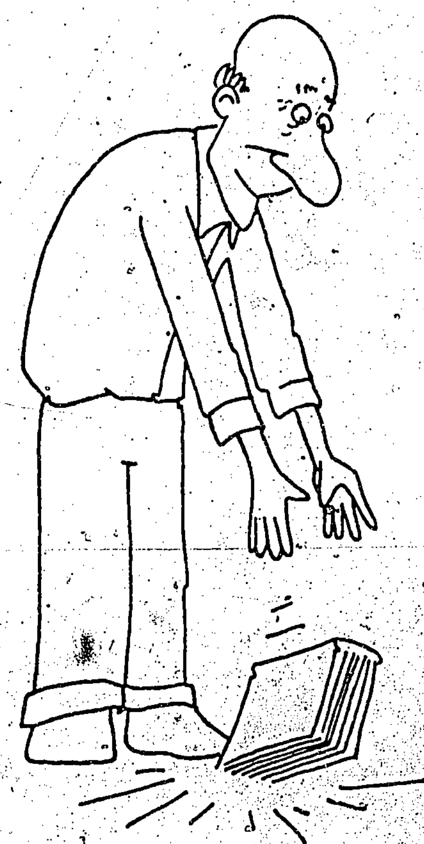
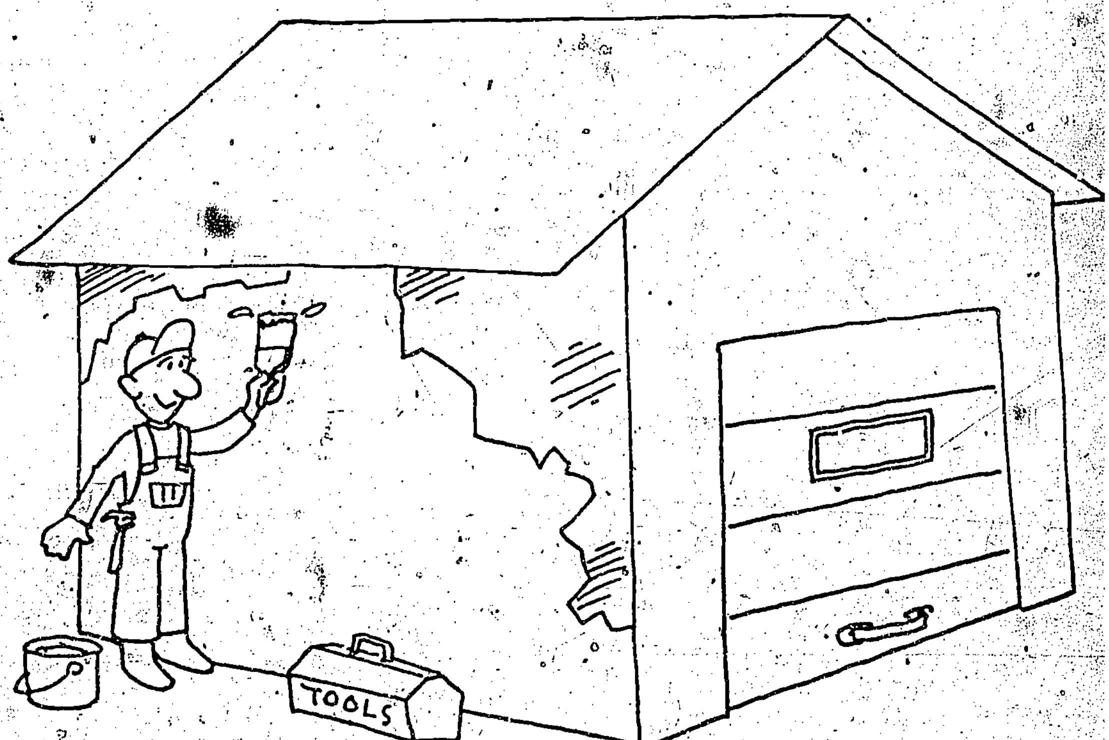


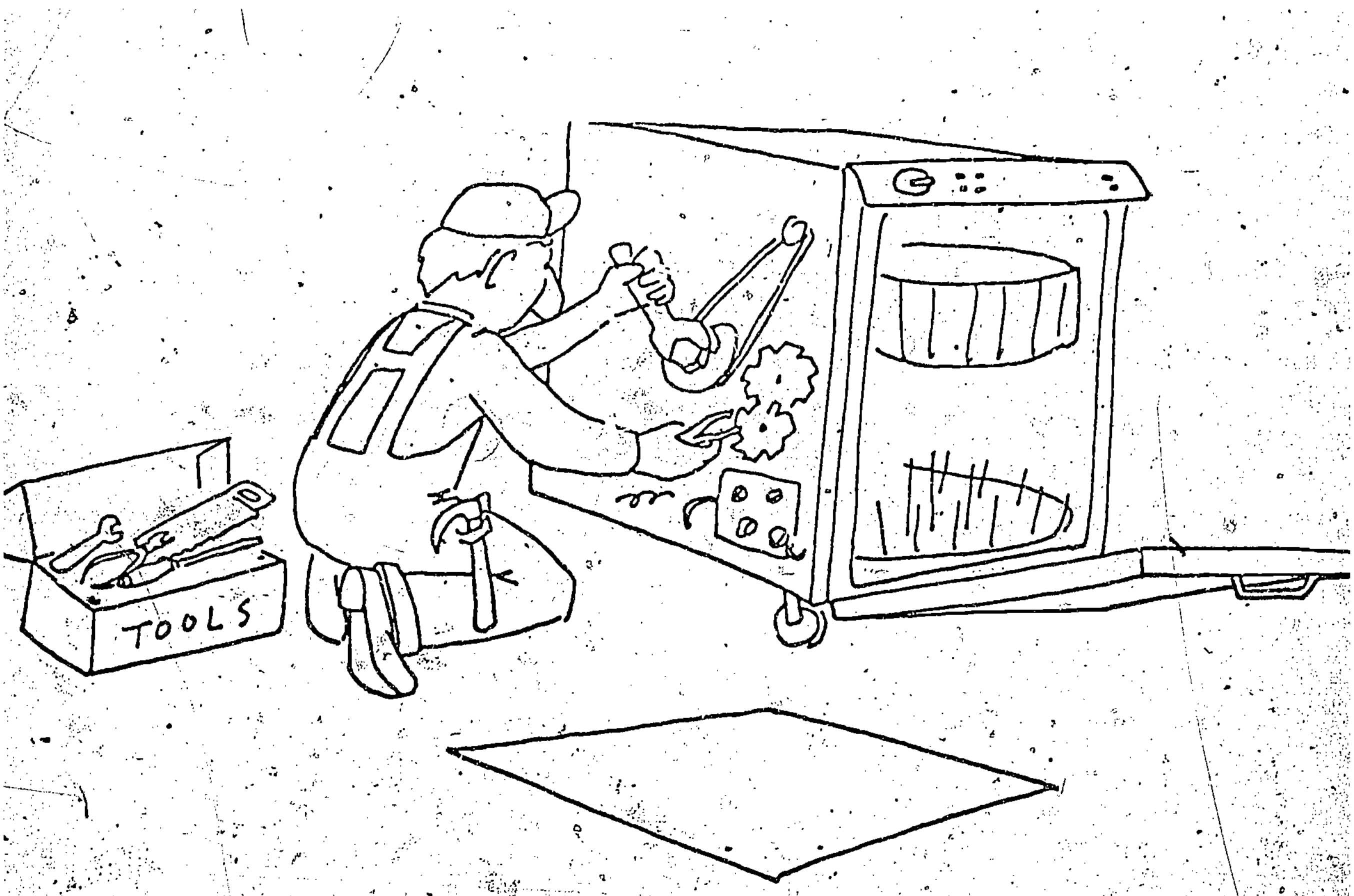


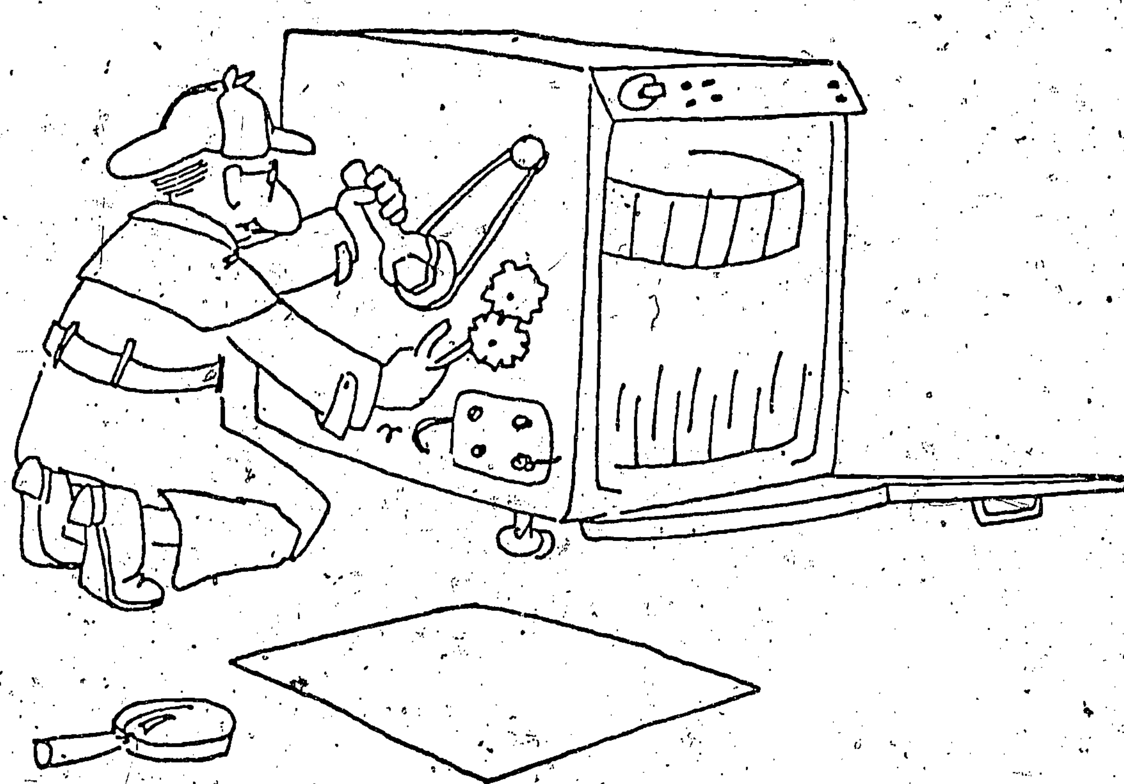




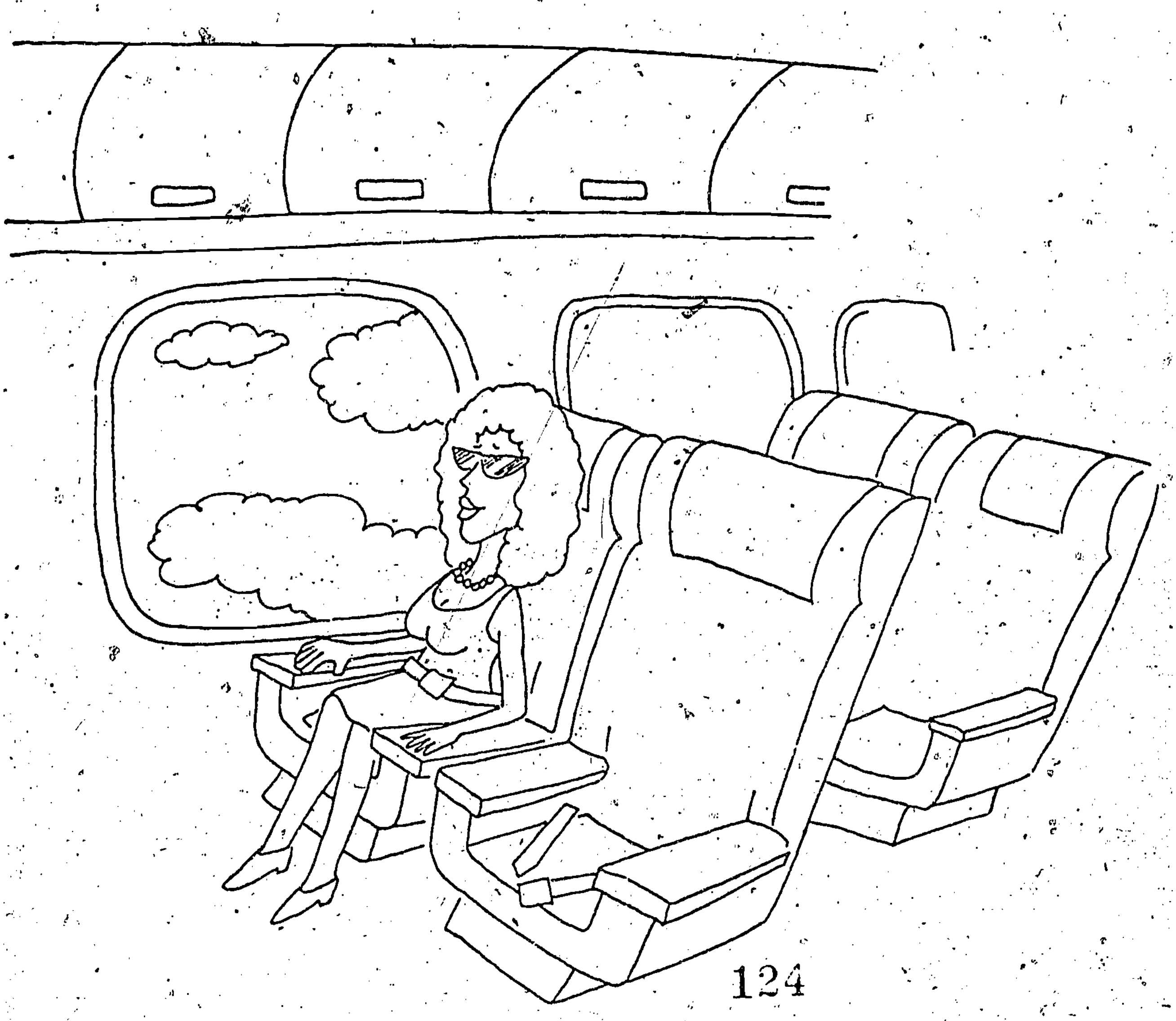

WRESTLING
TEAM

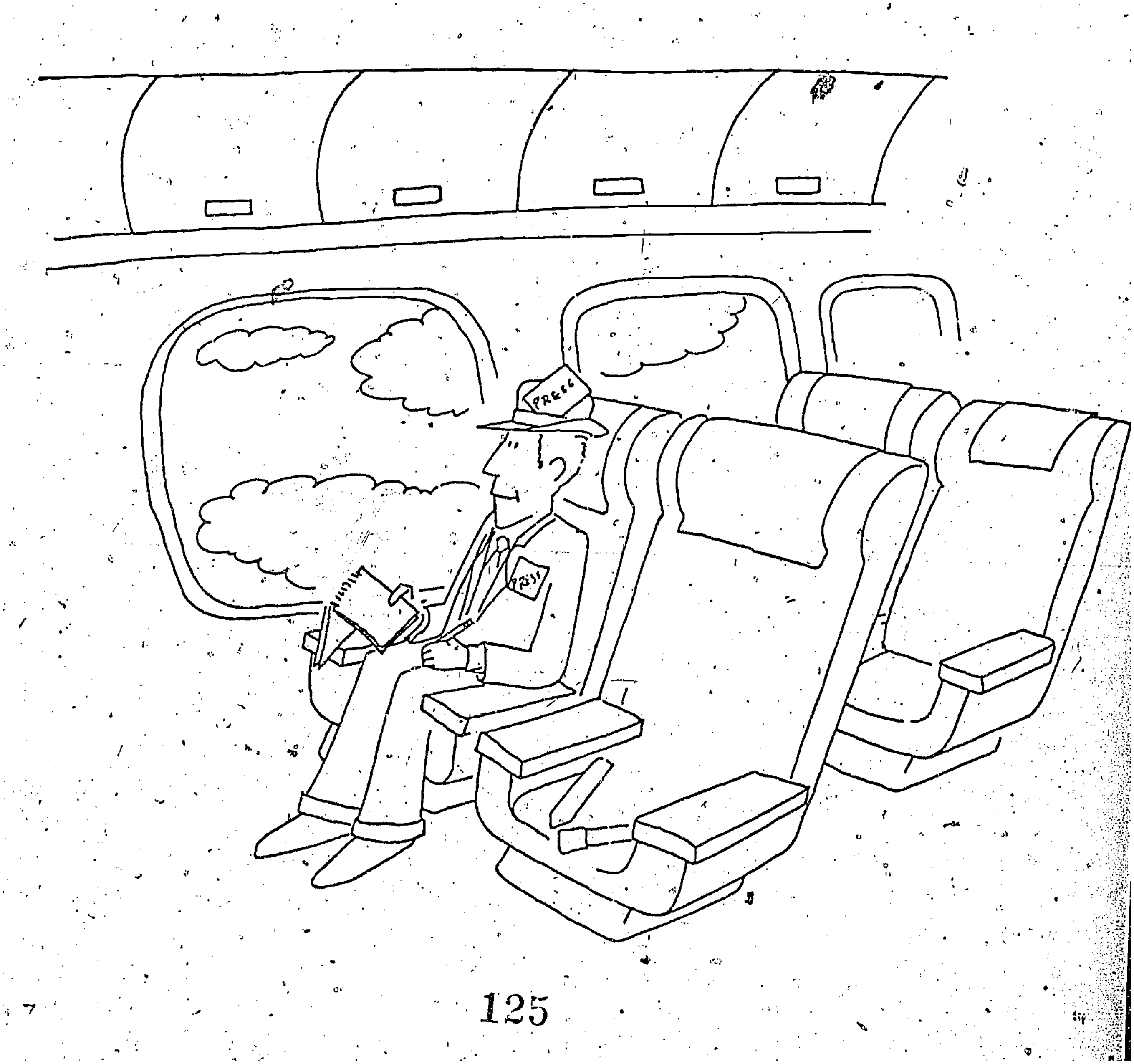

TOOLS

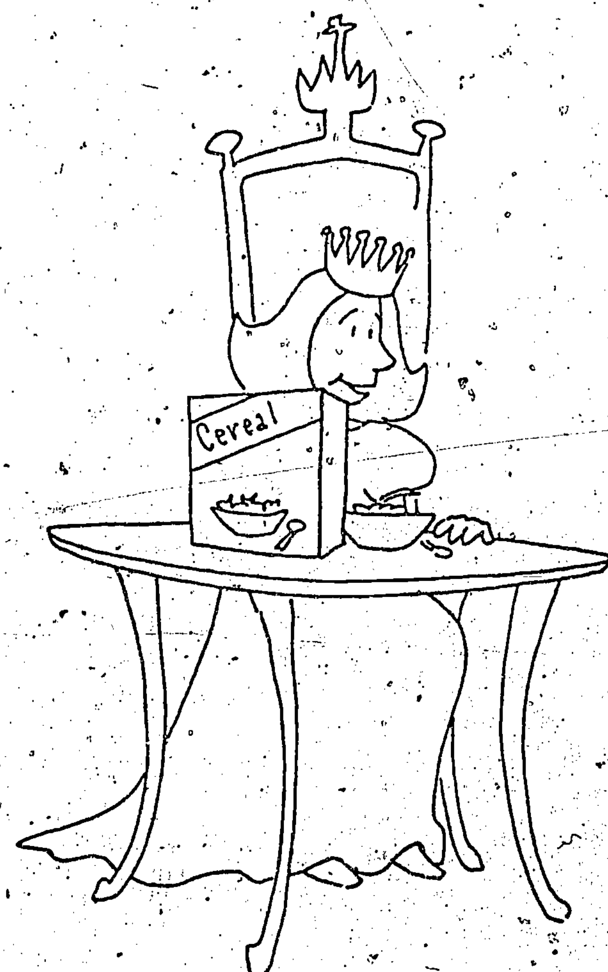

TOOLS

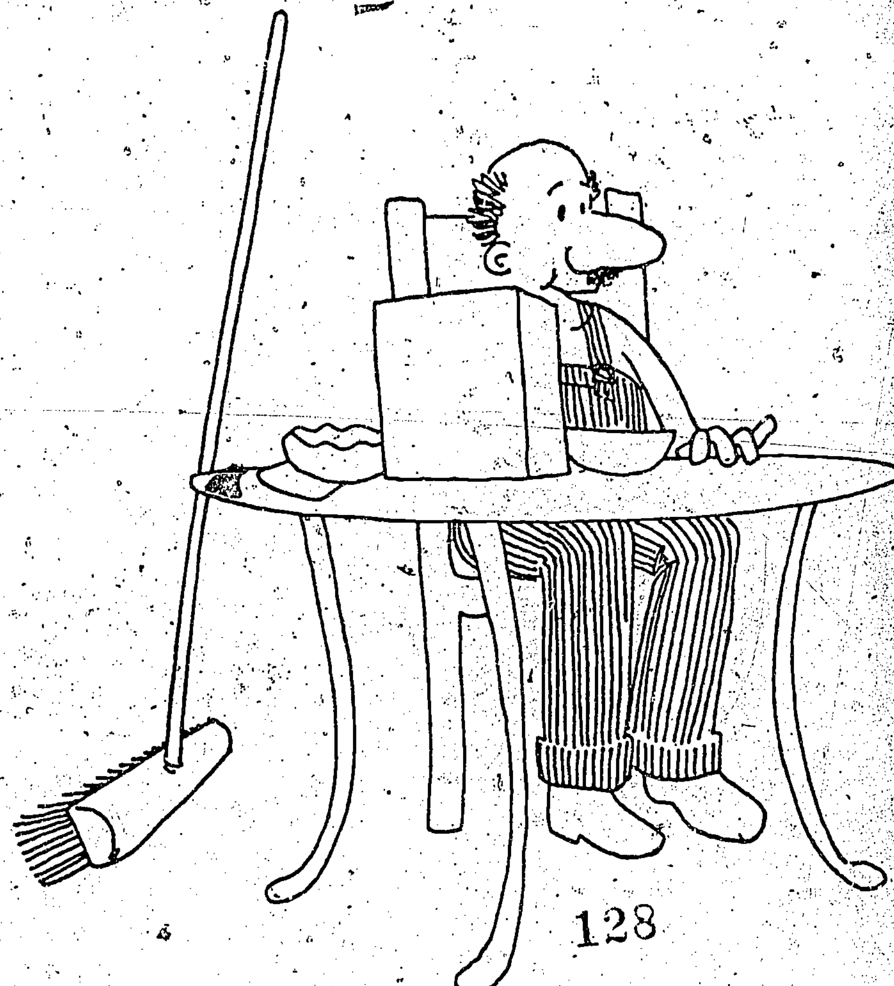


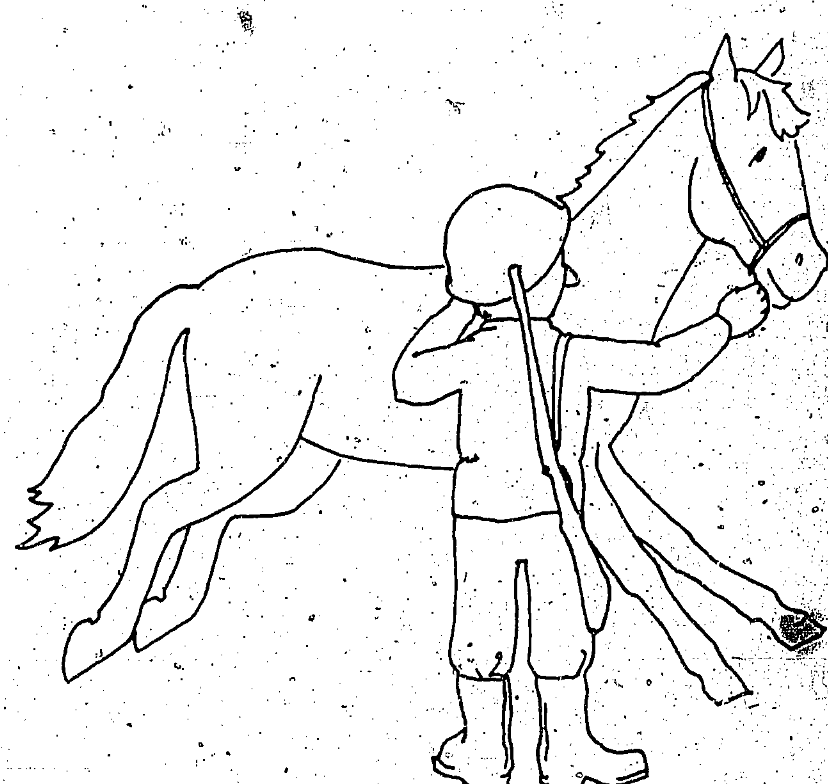

CLICK

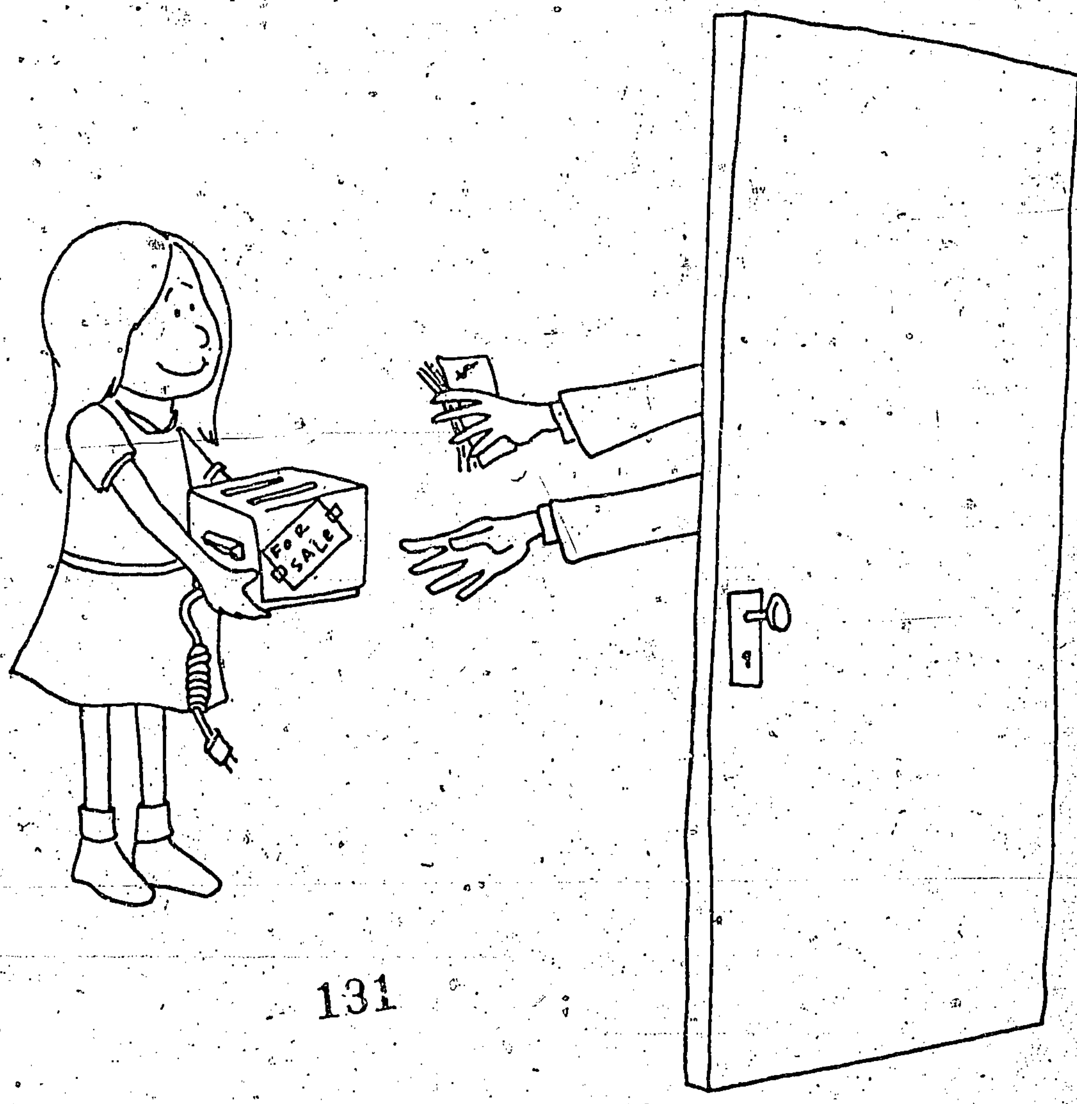



PRESS


Cereal



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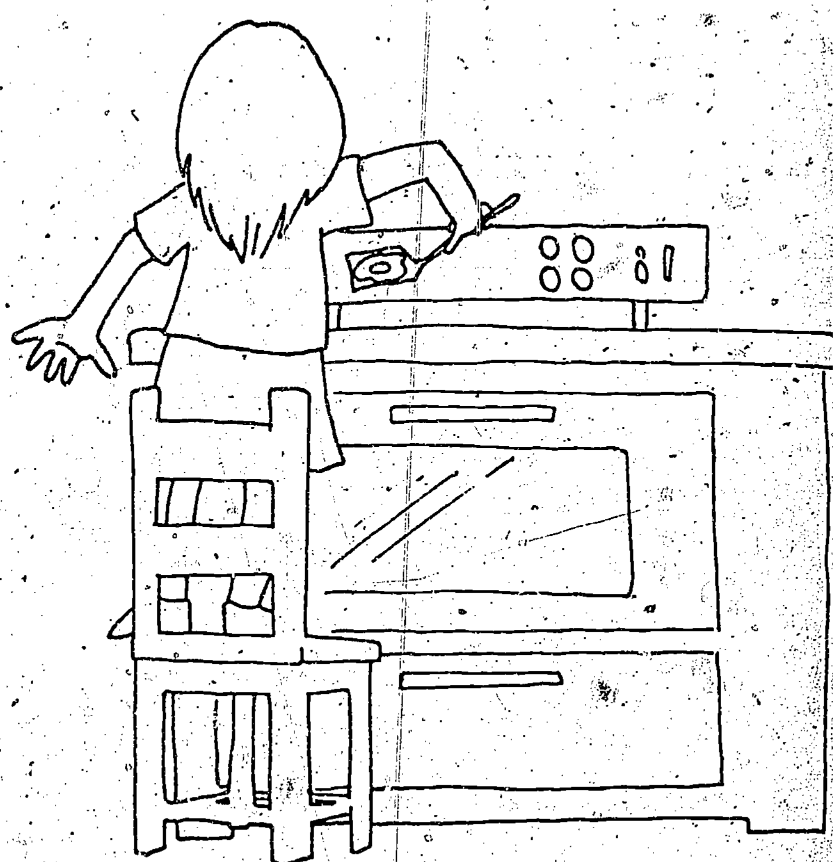
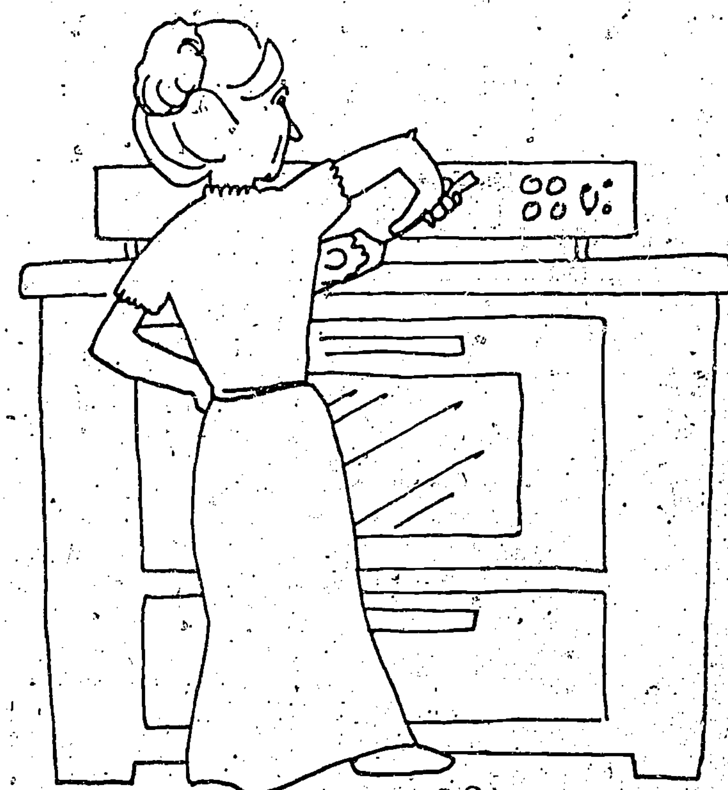
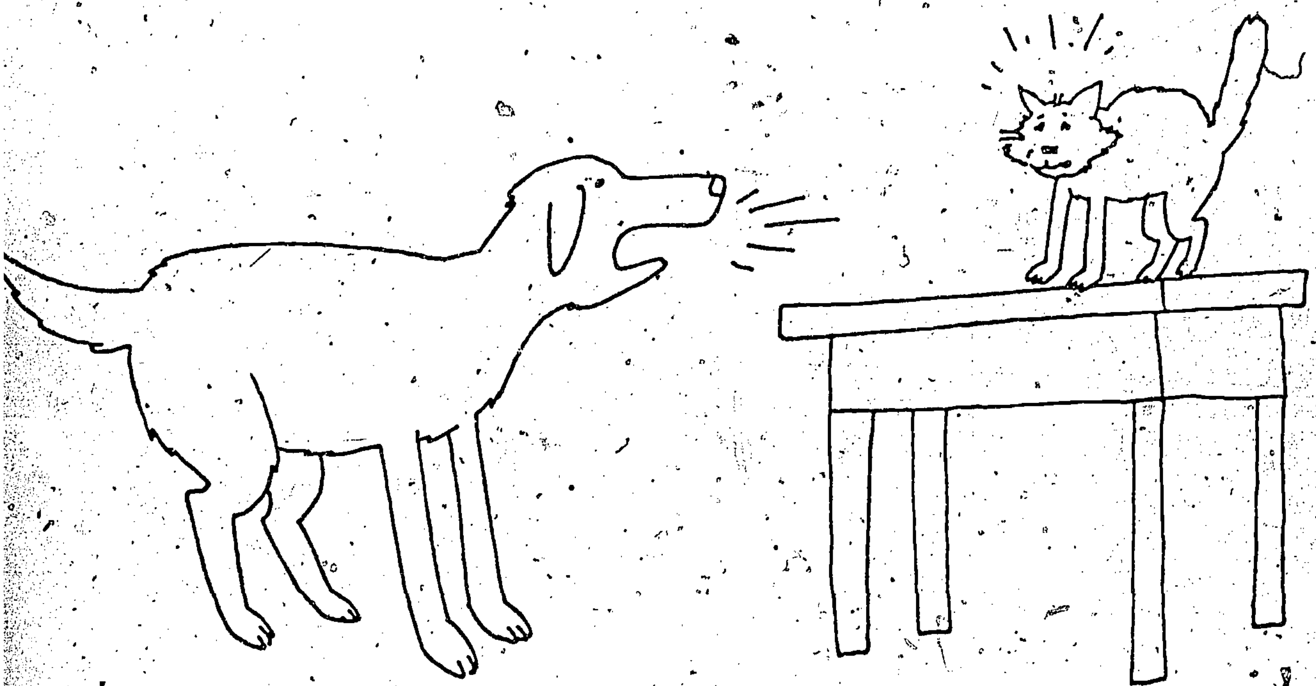
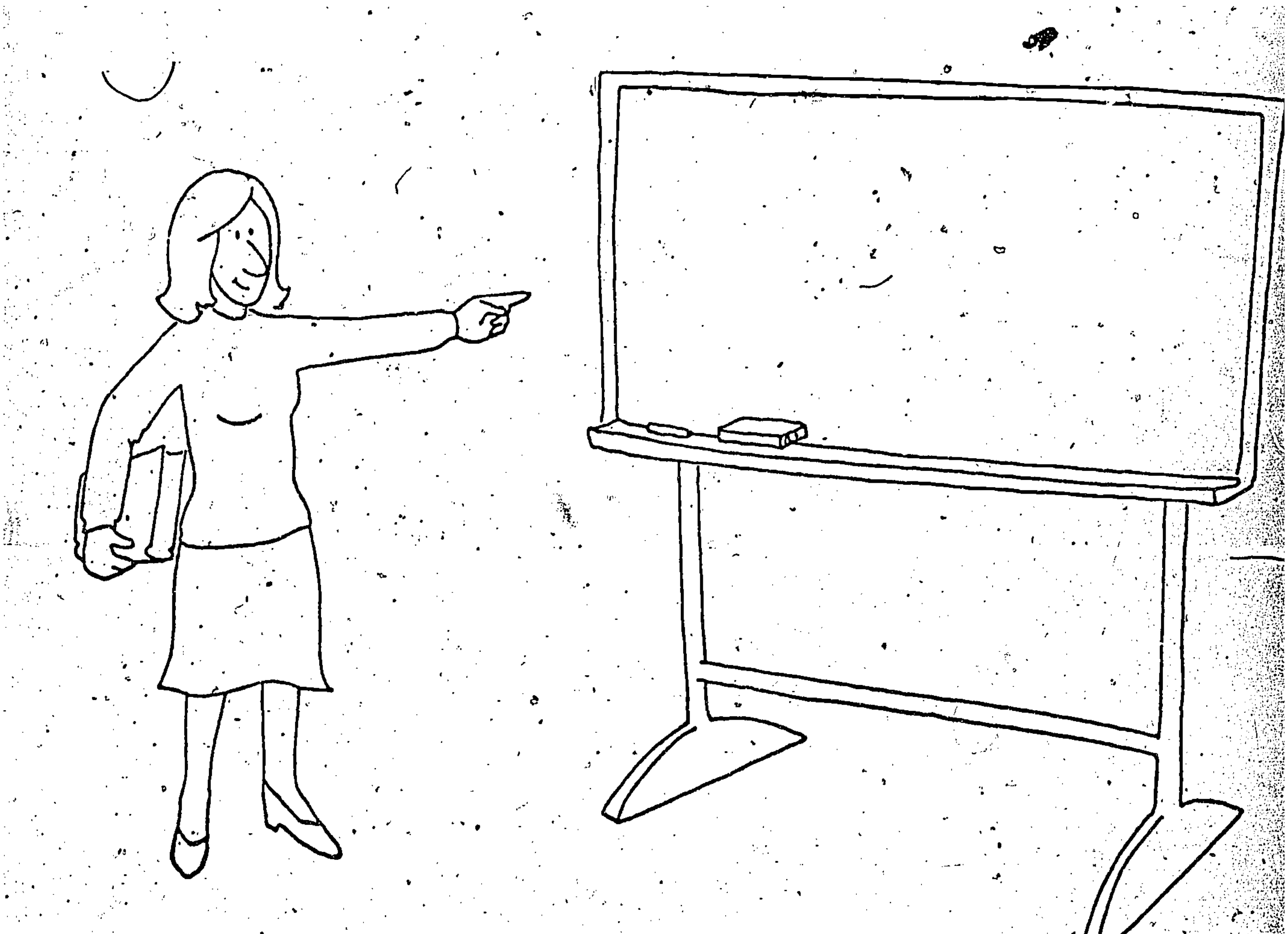


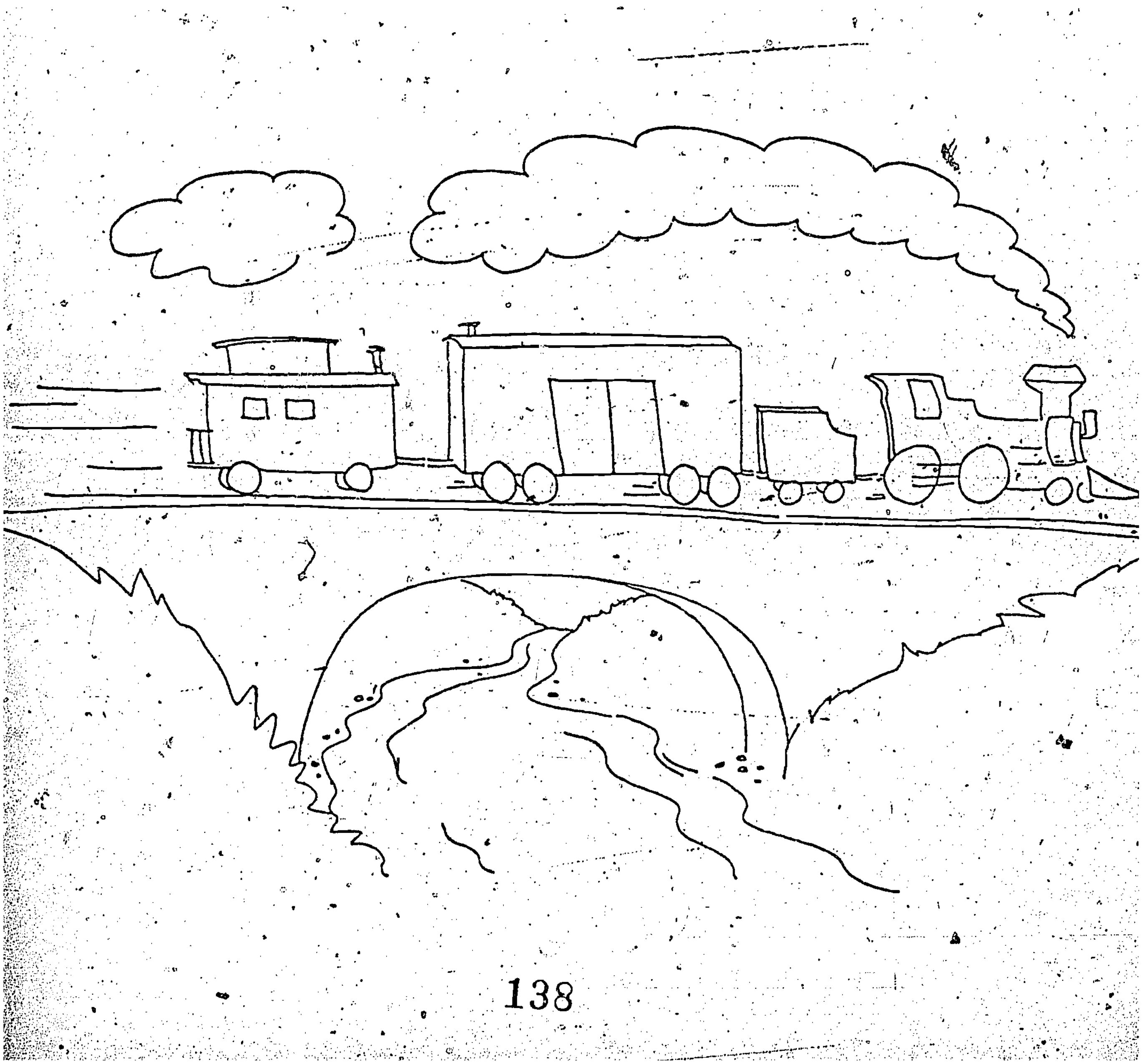


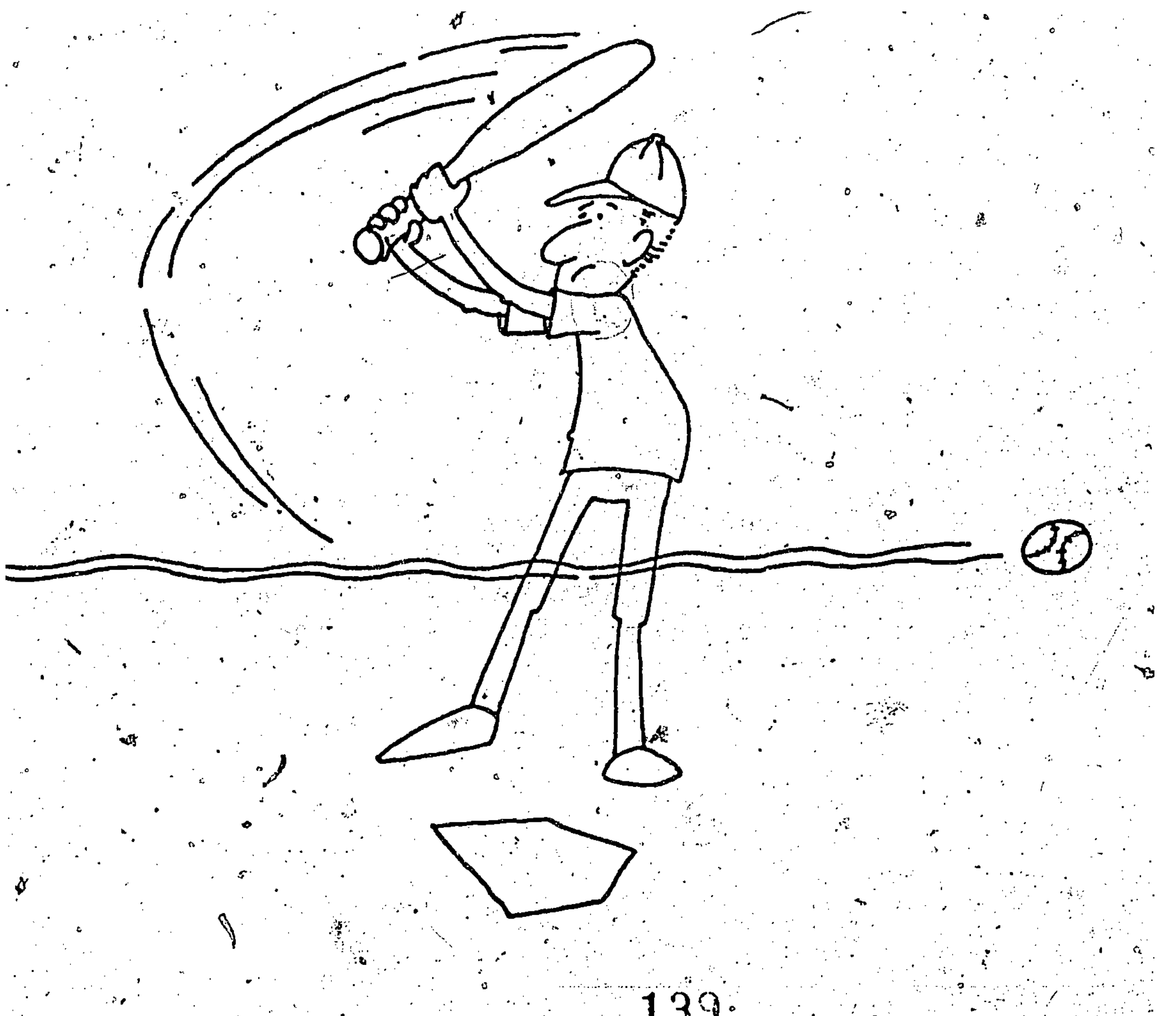
"DUMMY" PICTURES

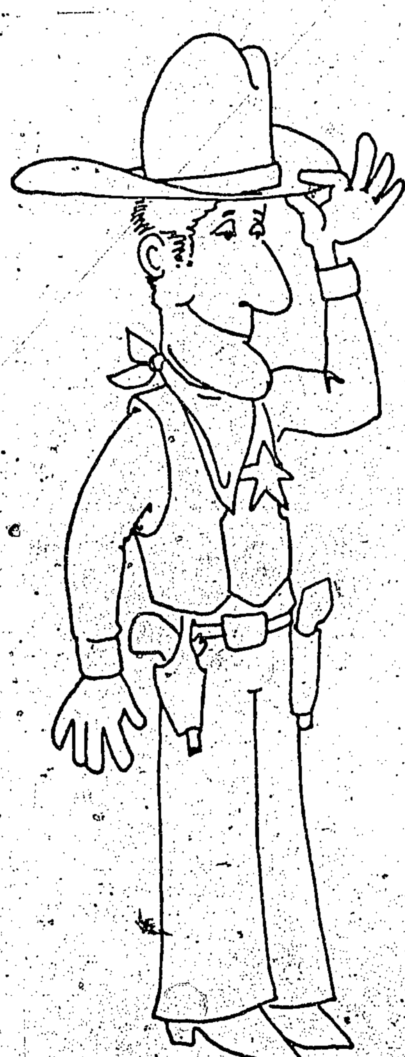

WHAM

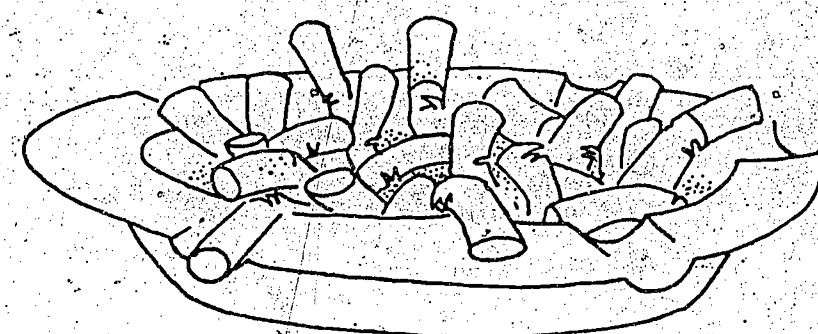


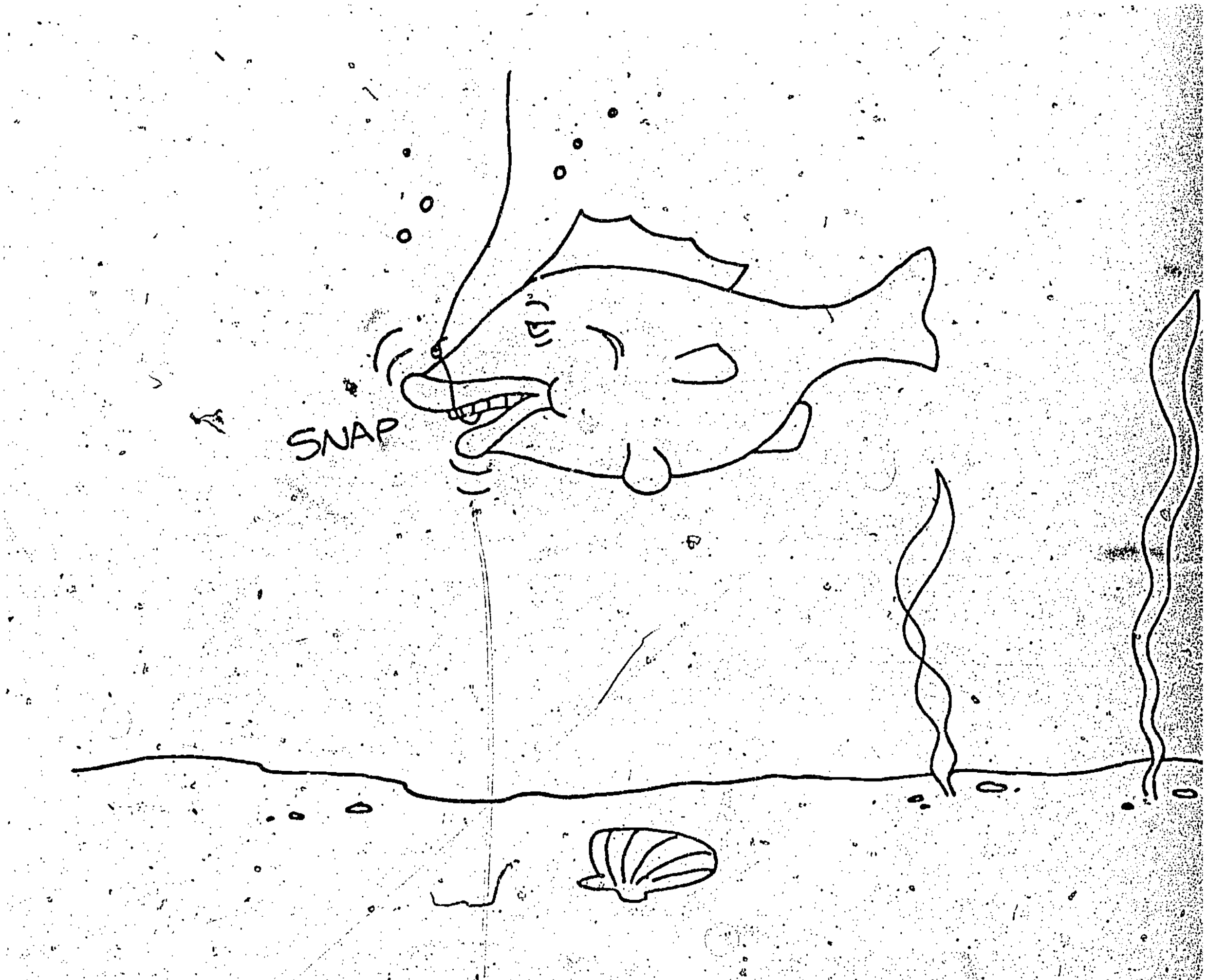


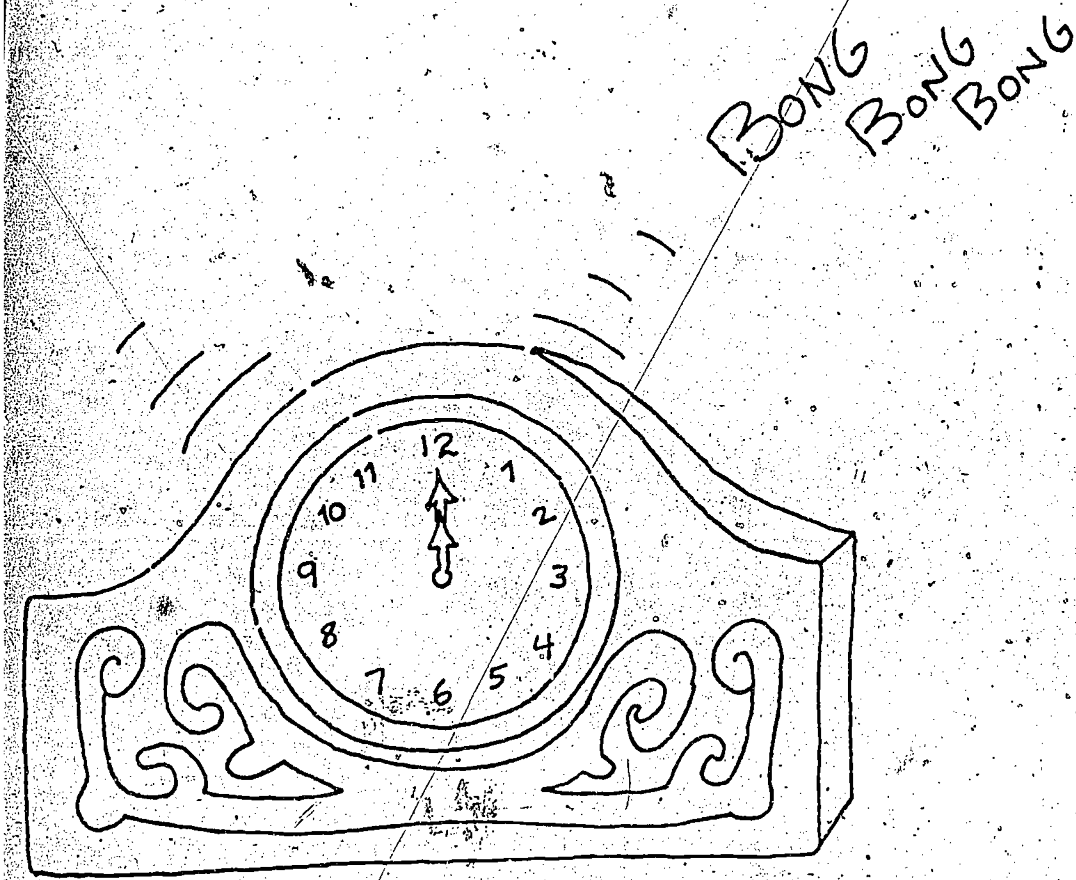


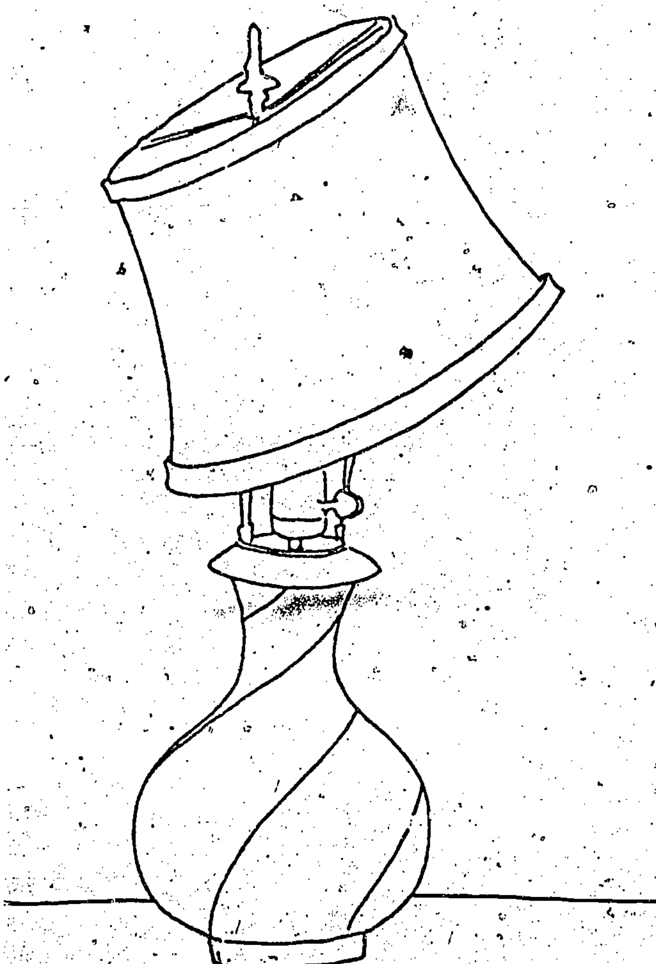


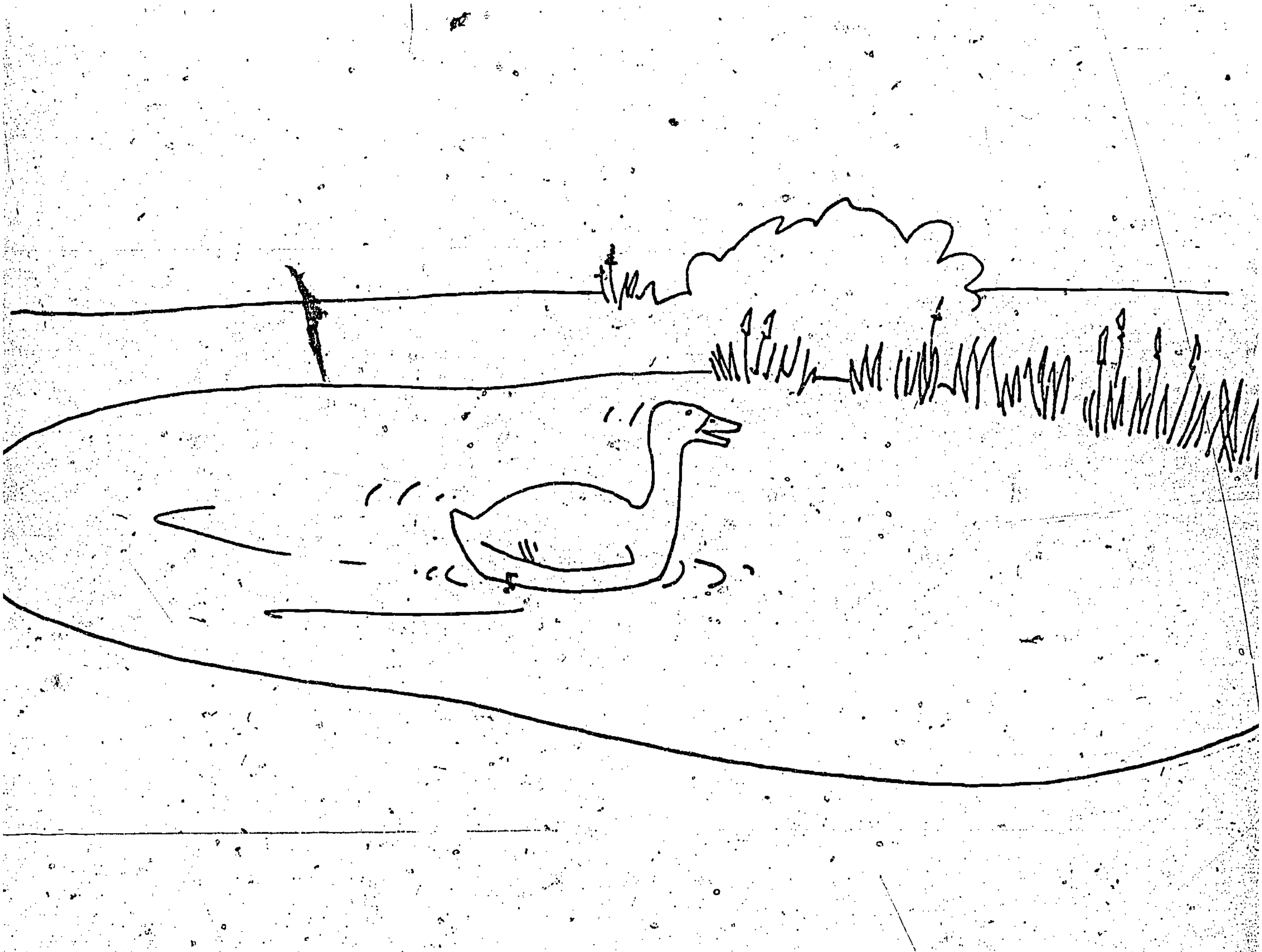


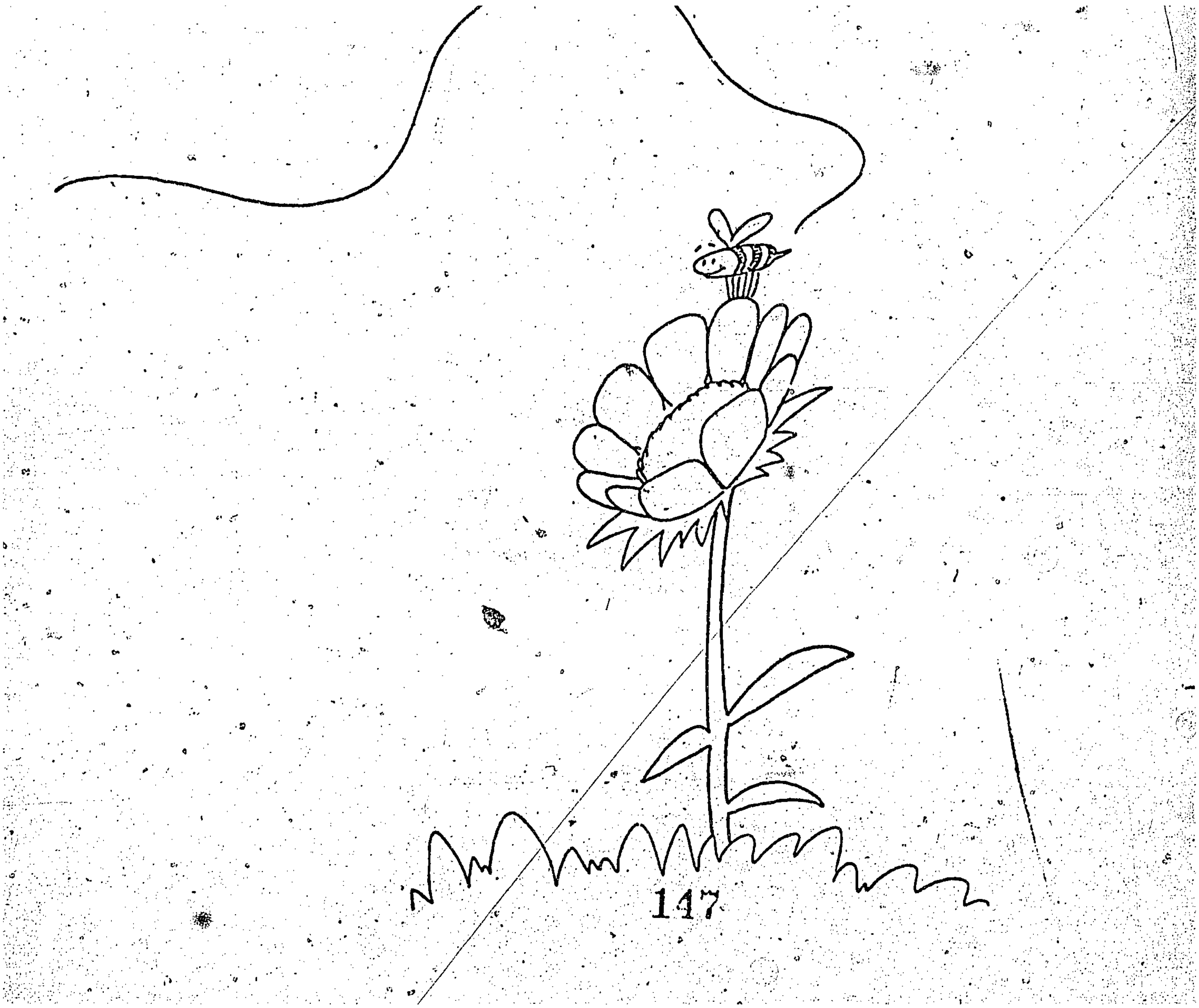


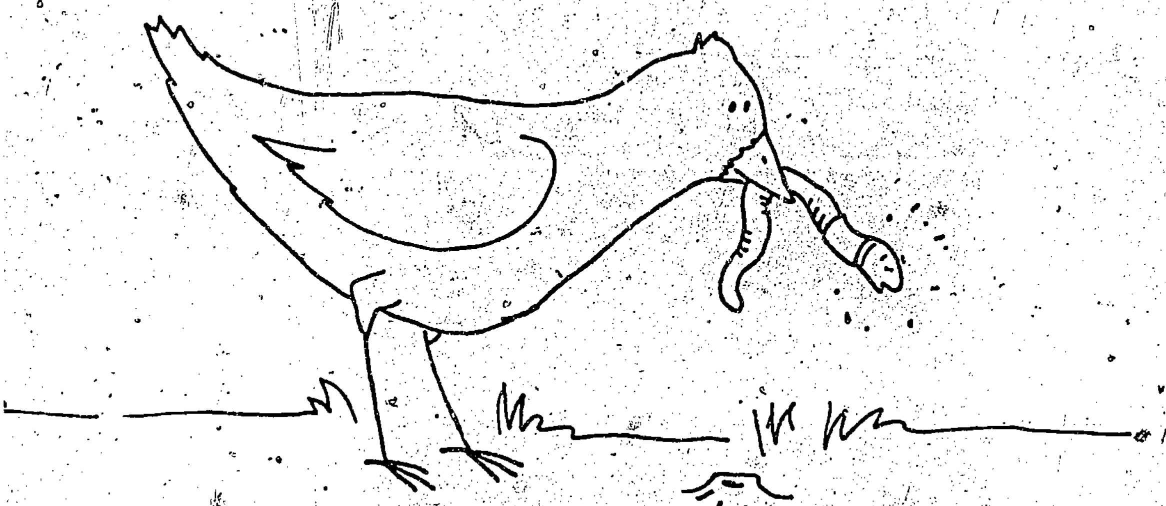

SNAP


BONG
BONG
BONG









APPENDIX II

RAW DATA

Numbers of Correct, Old Errors, and New Errors for Younger Control Subjects, According to Item Type

Subject Number	Experi-mental Condition*	Implicit						Explicit					
		Related			Unrelated			Related			Unrelated		
		C	O	N	C	O	N	C	O	N	C	O	N
1	8							4	1	2	2	3	2
3	5	3	2	2	2	1	4						
4	6							2	3	2	2	1	4
6	7	4	0	3	3	2	2						
9	6							1	6	0	6	0	1
10	7	4	0	3	5	2	0						
11	5	5	2	0	4	0	3						
16	6							5	1	1	2	2	3
19	5	4	3	0	4	1	2						
21	8							4	0	3	1	3	3
22	8							4	1	2	5	0	2
23	6							4	2	1	4	3	0
25	5	3	2	2	4	2	1						
26	7	7	0	0	6	0	1						
29	7	2	0	5	4	2	1						
30	6							4	2	1	4	0	3
31	5	3	4	0	3	1	3						
34	6							1	3	3	7	0	0
36	8							3	3	1	5	2	1
38	7	5	1	1	5	2	0						
42	5	2	4	1	6	1	0						
43	8							6	1	0	5	2	0
44	6							5	1	1	3	4	0
45	7	5	2	0	2	3	2						
50	8							2	1	4	4	2	1
51	5	4	3	0	3	1	3						
53	6							1	4	2	2	2	3
56	7	2	1	4	2	3	2						

(CONTINUED)

(Younger Control Subjects - Continued)

Subject Number	Experi-mental Condition *	Implicit						Explicit					
		Related			Unrelated			Related			Unrelated		
		C	O	N	C	O	N	C	O	N	C	O	N
58	6							4	3	0	7	0	0
59	5	5	1	1	5	0	2						
61	7	4	2	1	2	3	2						
62	8							4	1	2	4	2	1
66	8							2	4	1	2	2	3
68	6							2	2	3	3	3	1
69	5	3	4	0	4	0	3						
70	7	3	2	2	2	3	2						
73	7	4	0	3	4	2	1						
76	5	2	3	2	6	0	1						
78	6							2	2	3	2	2	3
79	8							2	0	5	4	1	2
81	7	6	0	1	2	5	0						
82	6							2	4	1	4	2	1
83	5	2	4	1	6	0	1						
85	8							4	1	2	3	4	0
89	5	2	3	2	5	0	2						
90	8							5	1	1	4	3	0
94	7	4	2	1	2	4	1						
95	6							6	1	0	6	0	1
97	5	2	2	3	6	1	0						
98	6							5	2	0	3	2	2
102	8							2	3	2	4	2	1
103	7	5	1	1	2	3	2						

C = Correct
O = Old Errors
N = New Errors

*See footnote on page 72 for description of experimental conditions.

Numbers of Correct, Old Errors, and New Errors for Younger Pictures Subjects, According to Item Type

Subject Number	Experimental Condition *	Implicit						Explicit					
		Related			Unrelated			Related			Unrelated		
		C	O	N	C	O	N	C	O	N	C	O	N
2	1	6	1	0	5	1	1						
5	4							6	0	1	7	0	0
7	2							4	2	1	6	0	1
8	3	6	1	0	4	3	0						
12	2							7	0	0	6	1	0
13	4							6	1	0	2	3	2
14	3	7	0	0	6	1	0						
15	1	6	0	1	3	3	1						
17	2							5	1	1	6	1	0
18	1	4	2	1	5	1	1						
20	3	7	0	0	6	0	1						
24	4							6	1	0	6	1	0
27	3	3	1	3	2	5	0						
28	2							3	3	1	4	1	2
32	4							5	2	0	5	1	1
33	1	4	1	2	6	1	0						
35	2							1	5	1	3	1	3
37	3	4	2	1	5	2	0						
39	4							3	2	2	4	3	0
40	1	1	5	1	3	1	3						
41	2							4	3	0	7	0	0
46	3	5	0	2	7	0	0						
47	1	5	2	0	6	0	1						
48	4							6	1	0	5	2	0
49	3	5	2	0	3	3	1						
52	1	4	2	1	6	1	0						
54	2							4	2	1	6	0	1
55	4							4	1	2	4	1	2

(CONTINUED)

(Younger Pictures Subjects - Continued)

Subject Number	Experimental Condition *	Implicit						Explicit					
		Related			Unrelated			Related			Unrelated		
		C	O	N	C	O	N	C	O	N	C	O	N
57	4							4	2	1	5	2	0
60	3	5	1	1	4	3	0						
63	1	4	2	1	3	1	3						
64	2							3	4	0	6	0	1
65	4							3	3	1	3	3	1
67	3	3	1	3	3	2	2						
72	2							5	2	0	4	2	1
71	1	5	1	1	5	0	2						
74	1	5	2	0	7	0	0						
75	3	4	1	2	4	2	1						
77	4							3	2	2	3	2	2
80	2							5	2	0	6	1	0
84	4							5	2	0	4	1	2
86	1	7	0	0	7	0	0						
87	2							5	2	0	3	2	2
88	3	4	1	2	4	3	0						
91	1	3	2	2	5	0	2						
92	2							3	4	0	5	1	1
93	4							2	3	2	3	2	2
96	3	4	3	0	6	1	0						
99	2							5	2	0	7	0	0
100	1	5	2	0	5	1	1						
101	4							1	1	5	2	3	2
104	3	2	5	0	3	1	3						

C = Correct

O = Old Errors

N = New Errors

*See footnote on page 72 for description of experimental conditions.

Numbers of Correct, Old Errors, and New Errors for Older Control Subjects, According to Item Type

Subject Number	Experimental Condition *	Implicit						Explicit					
		Related			Unrelated			Related			Unrelated		
		C	O	N	C	O	N	C	O	N	C	O	N
1	7	3	2	2	5	2	0						
2	8							5	1	1	3	2	2
5	6							7	0	0	6	1	0
6	7	5	2	0	6	1	0						
9	5	6	1	0	5	1	1						
13	8							4	3	0	4	3	0
15	7	4	0	3	4	2	1						
16	6							3	3	1	6	1	0
17	8							3	2	2	2	4	1
18	5	6	1	0	5	2	0						
21	7	7	0	0	4	2	1						
24	6							4	3	0	3	1	3
27	5	5	1	1	3	2	2						
28	7	3	2	2	3	2	2						
31	6							5	2	0	4	2	1
32	8							3	3	1	3	3	1
33	6							3	4	0	5	1	1
36	8							4	1	2	4	3	0
39	7	7	0	0	2	4	1						
40	5	2	5	0	3	3	1						
46	8							6	1	0	4	3	0
47	6							3	1	3	6	0	1
48	7	5	1	1	3	2	2						
49	8							5	1	1	4	3	0
50	5	5	1	1	2	1	4						
51	5	1	5	1	3	2	2						
52	6							6	1	0	6	1	0
55	7	7	0	0	6	1	0						

(CONTINUED)

(Older Control Subjects - Continued

Subject Number	Experimental Condition *	Implicit						Explicit					
		Related			Unrelated			Related			Unrelated		
		C	O	N	C	O	N	C	O	N	C	O	N
57	5	6	1	0	5	1	1						
58	6							3	4	0	3	3	1
61	7	6	0	1	6	1	0						
63	8							3	1	3	4	3	0
65	5	2	4	1	3	1	3						
69	6							4	2	1	5	2	0
71	7	5	1	1	7	0	0						
72	8							7	0	0	5	1	1
73	7	7	0	0	6	0	1						
74	5	5	1	1	5	1	1						
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81	8							6	0	1	6	1	0
84	5	4	2	1	5	1	1						
86	6							4	3	0	4	1	2
88	7	5	0	2	7	0	0						
89	5	4	2	1	2	2	3						
91	6							2	4	1	5	2	0
94	7	7	0	0	6	1	0						
95	8							3	3	1	2	3	2
101	6							4	2	1	3	2	2
102	5	3	3	1	6	0	1						
103	8							4	1	2	5	1	1
104	7	7	0	0	6	1	0						

C = Correct

O = Old Errors

N = New Errors

*See footnote on page 72 for description of experimental conditions.

Numbers of Correct, Old Errors, and New Errors for Older Pictures Subjects, According to Item Type

Subject Number	Experi-mental Condition *	Implicit						Explicit					
		Related			Unrelated			Related			Unrelated		
		C	O	N	C	O	N	C	O	N	C	O	N
3	4							7	0	0	6	1	0
4	1	5	2	0	5	1	1						
7	3	6	0	1	6	1	0						
8	2							4	3	0	6	1	0
10	4							6	1	0	6	1	0
11	1	5	2	0	4	2	1						
12	3	4	1	2	4	2	1						
14	2							4	1	2	5	1	1
20	3	5	2	0	5	1	1						
19	2							3	3	1	6	1	0
22	1	6	1	0	4	2	1						
23	4							6	0	1	4	2	1
25	4							6	0	1	7	0	0
26	2							3	3	1	3	0	4
29	1	6	1	0	6	1	0						
30	3	2	1	4	5	2	0						
34	3	6	1	0	6	1	0						
35	1	6	1	0	5	1	1						
37	2							6	1	0	6	0	1
38	4							6	1	0	6	1	0
41	1	2	4	1	5	2	0						
42	4							6	1	0	4	3	0
43	3	6	1	0	7	0	0						
44	2							7	0	0	5	1	1
45	1	7	0	0	6	1	0						
53	3	6	1	0	7	0	0						
54	4							6	1	0	5	2	0
56	2							6	0	1	4	2	1

(CONTINUED)

(Older Pictures Subjects - Continued)

Subject Number	Experimental Condition *	Implicit						Explicit					
		Related			Unrelated			Related			Unrelated		
		C	O	N	C	O	N	C	O	N	C	O	N
59	4							5	1	1	6	1	0
60	3	7	0	0	5	2	0						
62	1	5	2	0	3	2	2						
64	2							5	2	0	5	2	0
66	2							3	4	0	3	2	2
67	4							6	0	1	5	2	0
68	1	5	1	1	6	1	0						
70	3	6	1	0	5	1	1						
75	3	3	3	1	5	1	1						
76	1	4	2	1	3	4	0						
78	2							6	1	0	7	0	0
79	4							5	2	0	6	1	0
82	3	6	1	0	7	0	0						
83	4							4	3	0	7	0	0
85	1	6	0	1	7	0	0						
87	2							5	1	1	5	2	0
90	2							6	1	0	4	1	2
92	1	6	1	0	7	0	0						
93	4							6	1	0	3	4	0
96	3	7	0	0	7	0	0						
97	3	6	0	1	6	0	1						
98	2							7	0	0	5	0	2
99	1	4	2	1	5	1	1						
100	4							3	3	1	5	1	1

C = Correct

O = Old Errors

N = New Errors

*See footnote on page 72 for description of experimental conditions.

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