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ABSTRACT
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Implications of the methodological paradigm and appropriateness of
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(Author)

## Abstract

### The Experimental Development of Reading Strategies in Children

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and of a new methodological approach, children read 40 text cards, each

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The Experimental Development of Reading Strategies in Children

Taking Rothkopf's conceptualization and explication of mathemagenic behaviors (Rothkopf & Coke, 1963; Rothkopf, 1965) as a starting point, a number of researchers have demonstrated the efficacy of inserting questions following reading passages on learning from such materials (e.g., Frase, 1968; Bruning, 1968a; Natkin & Stahler, 1969; Watts and Anderson, 1971). Within the general area of prose learning research, a recurring theme has been the attempt to develop specific reading and review strategies by such post-questioning procedures. This approach has no doubt been stimulated, at least in part, by the fact that the development of focused strategies for processing textual materials, coupled with a systematic delineation and understanding of these processes, has considerable importance to the educational community. If, for example, the potential exists for reliable development of subcomponents of reading such as attending to or ignoring contextual variables, searching for particular classes of information, or drawing inferences, the availability of such technologies would greatly enhance the instructional capabilities of our educational systems.

One view of the function of such post-questions is that the question event functions as a consequence for behaviors which precede it, serving to selectively reinforce or "shape" these behaviors (Rothkopf, 1965; Rothkopf, 1970; Frase, 1970; McGaw & Groteleuschen, 1972). In general, however, findings regarding a "shaping" function for post-questions have been equivocal to this point. Frase (1968) found consistent effects but no significant improvement over 20 paragraph-question blocks, leading him to conclude that facilitation which occurred was not acquired in the course of the reading task; that is, the requisite

behaviors did not appear to be shaped by post-questions, but rather involved the maintenance of previously learned skills. In contrast, Morasky and Willcox (1970) found that differences in time spent reading developed in later passages between question-before and question-after g.,ups, findings supporting a shaping hypothesis. Rothkopf and Bisbicos (1967) found that posttest performance was facilitated on some item types encountered as experimental questions but not for others, with effects associated with later portions of reading. Bruning (1968b) employed materials structured in subordinate-superordinate form with review questions drawn from each level, but selective facilitation was present only for subordinate level post-questions on subordinate level posttest items. While Watts and Anderson (1971) found general facilitation for application-type experimental questions across a variety of posttest item types, performance was not necessarily enhanced on item types earlier encountered as experimental questions. Also, performance on posttest items relating to later portions of the reading and on later experimental question was not improved, both findings also inconsistent with expectations based on a shaping hypothesis. Like Watts and Anderson (1971), McConkie and his associates (McConkie, Rayner, & Wilson, 1972) have demonstrated effects of question-type on reading speed, but there were no significant effects of this variable on overall posttest performance, nor was within-class superiority consistently apparent on posttest items (e.g., recognition and higher order question groups performed poorly on their respective item types on the posttest).

Frase (1973) has recently called for an examination of methodology in the study of prose learning phenomena, a point having particular cogency to examination of the shaping hypothesis. For the most part, investigation of the viability of this conceptualization has taken place under conditions which were not necessarily well designed with regard to either demonstrating or understanding these phenomena.

For example, with few exceptions experimental subjects have been adults, likely
to have already well-developed reading strategies quite possibly resistant to
short term manipulation. At the same time, the hypothesized behavior chains
terminating with the question contingency must, of necessity, be exceedingly
complex, given the usual methodological paradigm of insertion of post-questions
following relatively large blocks of prose with generally unspecified characteris-
tics, (see Frase, 1973; Carver, 1972). A related issue involves a need for
clear definition of conceptual categories represented both within the materials
and by post-questions, certainly problems of considerable magnitude for research
of this type. Also, the relatively small number and relatively infrequent
encounters with such questions in several studies perhaps do not comprise a set
of conditions well suited to selective development of complex behavioral chains.

The present suudy, while conceptually consonant with prior research,
represents a departure, methodologically, in the analysis of prose learning
phenomena. Although the basic experimental paradigm, consisting of prose unit
presentations with alternating questions was employed, both the materials and
the reading strategies analyzed were reduced in complexity. Materials were
constructed with standardized format and content, with text units to be read
consisting of short four-sentence sets specifying attributes of countries.
Attributes represented four concept classes, with multiple presentations
encompassing forty selected nations. Attributive statements were randomly
assigned four to a text card in a double column format, with each concept
class represented once per card. The experimental questions following each
text card, repeatedly focused on one of the following: (a) a single concept[o]
(b) a single position on the card (c) two concepts (d) two positions or (n) randomly
tested information presented on the text card. Children served as subjects
and performance on the experimental questions, together with reading latencies,

was continuously monitored across twenty training trials, where questioning
was consistent with the development of one of the strategies, and twenty "test"
trials where questioning shifted to a random presentation condition.

It was hypothesized that, if a reading strategy ere being acquired, then
performance on questions during training should show improvement across
trials. Additionally, comparisons on questions shared by a strategy group
and the random group should show superior performance for the strategy groups.
A subsequent shift to random questioning, it was argued, should result in an
increase in reading latencies relative to those on the training trials, based
on the assumption that there would be general deterioration in performance if a
strategy had been adopted and that such deterioration would lead to increased
concentration on the textual materials. At the same time, a decrement in perfor-
mance was predicted in related item categories for associated strategy groups
between the latter portion of the training trials, where a strategy would have
been operative, and the test trials, where the strategy would be repeatedly
disconfirmed by the random questioning.

## Method

### Subjects:

Subjects were 50 sixth-grade students enrolled at a public elementary
school. Because pilot analyses indicated that task requirements were relatively
difficult for pupils of this age, only students whose total language score on
the Iowa Test of Basic Skills was above grade level (grade 6.0) were selected
from among the sixth grade population. Mean total language score on the ITBS
of participants was 7.19. Subjects were drawn from five separate classrooms
and randomly assigned to experimental conditions.

## Materials:

Task materials encountered by subjects consisted of eighty 5 by 7 inch

cards, 40 text cards presenting four typewritten statements, alternating with

40 question cards which tested information from the immediately preceding

text card. Basic text and question materials were derived from a listing

of 70 new or emerging nations drawn from a recent atlas, with a selection of

attributes for each nation. These attributes included capital, major rivers,

exports, constituent populations, bordering nations, and so on. Inspection

of the total matrix of nations indicated that four attributes (capital, major

river, bordering country and monetary unit) had similar verbal characteristics

for a sufficient number of nations to permit their use in constructing the

final set of materials. General criteria for selection required a low

probability of prior subject acquaintance with the nation, that the attributes

consist of a pronounceable single word of from five to nine letters, and

that an attribute was not repeated for other nations within the same category.

However, within the other parameters delineated, this latter requirement was

not always possible.

Sentence format for materials was standardized to mitigate against

inadvertently providing discriminable information not relevant to the

variables under investigation. The format for each category was as follows:

The capital of ____(name)____ is ____(name)____ .

A country near _____ is _____ .

The monetary unit of _____ is the _____ .

A major river of _____ is the _____ .

The final set of materials, identical across all trials for all subjects,

consisted of the four attributive sentences for 40 nations, totaling 160

statements. To construct the text cards, two randomizations were required.

Statements within each attribute class (e.g. statements about capitals) were

randomly assigned to one of the 40 trials. A second randomization determined
the position of attribute statements on the card. Items were positioned in a
double column format, with position 1 and 2 located on the left hand side and
position 3 and 4 located on the right. Vertical separation of items was
approximately 5 cm. and horizontal separation about 3 cm. Each question
card consisted of a statement from the preceding text card, typed in the
middle of the card, with the selected attribute deleted. Variations in
these questions constituted the experimental manipulation in the present
study.

During twenty training trials, subjects in each of the five groups
answered questions intended to develop a particular strategy for reading
the materials. In the first group, a Single Concept condition, all questions
during training tested knowledge contained in the capital statement presented
on the preceding text card, while the second group, a Single Position condition
was tested on information appearing in position 2, the lower left position, on
the text card. Thus, in the single concept group, information tested may
have appeared in any of the four positions on the preceding text card, while
for the single position group, each of the four concept classes had an
equal probability of being tested. In a third group, a Double Concept
condition, questions during training tested information about either capitals
or rivers, with order determined randomly across trials, while a fourth group,
a Double Position condition, encountered questions exclusively relating to
text sentences in positions 2 and 3 (lower left and upper right sentences).
Again, specific position, 2 or 3, for a given trial was randomly determined.
A fifth group, a Random condition serving as a control group, received
questions randomly selected from the four sentences on the text card, with all
sentences and positions equally likely to be questioned.

During the test phase, the final twenty trials, questioning became

random for all groups subject to the restriction that the initial test trial
constitute a disconfirming instance for the four non-random strategy
conditions. Thus all groups now encountered random questioning, a procedure
involving no change for the random position condition The card deck consisted
of both training and test phases, with no features separating the former
from the latter, except for the potentially discriminable shift in questioning
for the non-random strategy groups.

## Procedure:

All subjects were individually tested by the experimenters. Each subject
was presented with a card deck for his assigned treatment condition. Instructions
read to the subject indicated that the purpose of the study was related to a
general interest in how children read, and discriminated between the present
situation and examination settings. Subjects were instructed to read each text card
"as quickly and as carefully as possible," that each card would be followed
by a question to be answered in writing on a provided sheet of paper, that
the rate of progress through the deck was under his control. and that the
experimenters were not interested in the accuracy of the spelling of the
various names. Three warm-up trials, involving information on three
familiar nations, were employed; the first warm-up trial demonstrated the
procedure to be followed, the second and third allowed the experimenters
to monitor the efficacy of the instructions. A blank card signaled the
end of the warm-up trials and allowed time for the experimenters to answer any
procedural questions submitted by the subject. All sample items for each
group were consistent with the strategy to be encountered in the following
card deck. Immediately following the sample items, but prior to the training

trials, the scoring key, operated by the experimenters, was pointed out to

the subject, together with a brief statement regarding the necessity of

externally recording the subjects responses. The recording apparatus

itself was shielded from the subject by a plywood panel.

Progress through the text and question materials was monitored on an

event recorder (Gerbrands, Model P2-C6), with reading latency, testing lat-

ency and correct or incorrect response scored for each subject by the experi-

menter, positioned approximately .5 meter to the right of the subject.

Written responses were judged as correct or incorrect on the basis of phonetic

correspondence with the actual response; e.g. if the response, pronounced

by the experimenter as written, corresponded with the actual pronunciation,

it was scored correct. During warmup, training and test trials, noncontingent

verbal reinforcement was provided by the experimenters to maintain task

performance. After completing his session, each subject was questioned by

the experimenter concerning his perceptions of the difficulty of the task,

overt awareness of the questioning contingency encountered, and whether

he had concentrated on any particular aspect of the text cards while responding.

Results:

The proportion of items correct across training trials for each of the

experimental conditions is presented in Fig. 1. Since each curve represents

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Insert Fig. 1 about here

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the number of items correct within that particular training condition, and

the items in each trial block represent a random subset of items of that

type, separate repeated measures analyses of variance were conducted for

each group. Significant gains in number correct were revealed for the

Single Concept group (F = 12.57, 3/27 df, $p < .001$), the Single Position

group (F = 4.40, 3/27 df, $p < .025$), the Double Concept group (F = 12.88,

3/27 df, $p < .001$), and the Double Position group (F = 10.57, 3/27 df,

$p < .001$), while changes in the Random group were not significant (F = 1.25,

3/27 df, $p > .20$).

As questions in the Random condition were randomly assigned, both during

training and test phases, the number of questions shared across strategy

groups varied. During the training phase, questions were identical for

Single Concept and Random groups on trials 3, 5, 8, 11, 15, and 17; for Double

Concept and Random groups on trials 5, 9, 11, 15, and 16; for Single Position

and Random groups on trials 8, 9, and 17; for Double Position and Random

groups on trials 2, 9, 12, and 18. A significant difference was obtained

in favor of the Single Concept group over the Random group on shared items

($\bar{X}_{SC} = 4.6$, $\bar{X}_R = 2.2$; $t = 3.60$, $p < .001$), while no other comparison with the

Random group on shared items was significant.

Analysis of mean reading latencies across training and test trials,

transformed logrithmically, indicated significant changes over trials

(F = 24.70; 7/315 df; $p < .001$), no significant main effects for conditions,

and a significant conditions by trials interaction (F = 2.74; 28/315 df;

$p < .001$). Inspection of Fig. 2 reveals a sharp increase in reading latency

occurring by the second trial block for all conditions, an effect apparently

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Insert Fig. 2 about here

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resulting from subject adjustment to the relatively more difficult reading/

recall task presented by the training trials in comparison to the warm-up

trials. Additionally, in relation to the trials by conditions interaction,

one can note a marked upward shift in latency for the Single Concept group

with the onset of test trials, providing support for the hypothesis that a
reading strategy had been adopted during training and was disrupted by the
onset of the random questioning of the test trials.

Two features of the error data during random question test trials are
pertinent to questions of establishment and persistence of reading strategies.
If a reading strategy had been adopted during the training trials and persisted
during the test phase of the study, the proportion of items correct during
random questioning which were consistent with that particular strategy should
be significantly higher than proportion of correct items from other categories.
Comparison of the Same and Other columns in Table 1 shows that this was not the

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Insert Table 1 about here

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case, but that almost complete disruption of the strategy appeared to occur.
Supportive of this view are the comparisons between proportions correct for
each subject on the last five training trials and the proportion correct on
strategy-consistent items appearing during test trials. Since such items
represented random subsets of item pools of that type, differences may be
attributed to the development and subsequent disruption of a reading strategy,
or to general factors for which the Random group should serve as a control.
Comparison of proportion scores for the Random condition in the last five trials
of training and on test trials showed no significant change ($t$ = 1.25, 9 $df$,
$p$ > .20). However, similar correlated $t$ tests for the strategy groups indicated
significant declines in performance for the Single Concept group ($t$ = 8.16, 9 $df$
$p$ < .001), the Single Position group ($t$ = 2.69, 9 $df$, $p$ < .025), and the Double
Position group ($t$ = 4.13, 9 $df$, $p$ < .003) but not for the Double Concept group
($t$ = .99, 9 $df$, $p$ > .30).

Correlational analysis revealed non-significant relationships between ITBS total language scores and number of questions correct during training, test or total trials for the entire group. Similar non-significant relationships to number correct during training and test trials also held for training and test latencies.

## Discussion

Results of the present investigation support the contention that postquestion manipulation can influence the acquisition of and, conversely, disrupt certain reading strategies employed by children. In particular, for the Single Concept group, the evidence clearly indicates the development of specialized modes of responding during reading tasks, with improvement in performance over trials, and significant facilitation on shared items compared to random questioning. Additionally, with the change in contingency introduced by the random questioning during test trials, strategy disruption is indicated directly by the deleterious effects on same-type item performance and indirectly by the sharply increased reading latencies. For the other non-random groups, significant performance improvements across training trials were present and, for all but the Double Concept group, significant decrements occurred on related item types with the introduction of random questioning.

The present data, based on children's responses, extend the generality of an earlier observation by Frase (1968) that persons tend to approach written materials with pre-developed modes of interaction; i.e., strategies either confirmed or disconfirmed by postquestioning. Examination of Fig. 1 provides indication that the initial effect of regularizing the reading/questioning contingency was not necessarily to improve performance but rather may have been to produce decrements in performance level. It would appear that efficient processing developed in the strategy groups only after repeated trials, in that in

early performance under random questioning was relatively better than performance in the strategy groups. Although items are not strictly comparable across conditions, one would predict substantially higher performance for all of the strategy groups, given that the necessary reading/retention load for these groups was only one-fourth to one-half of that of random questioning. However, the modal pre-experimental reading strategy of children in the present study appeared to be to read and process all the textual information, a strategy consistent with random questioning requirements.

Selective-focus postquestion arrangements appeared to be initially disruptive for all but the simplest of questioning arrangements, the Single Concept arrangement. It seems likely that any perceived regularity in questioning, albeit only an apparent regularity produced by randomization, may have led to relatively rapid strategy selection on the part of the subject. The strategy selected, however, may not have necessarily been congruent with the actual questioning contingency in force for the subject's experimental group. In the present study, subsequent improvement was gradual over trials; with more sophisticated subjects, one might expect rapid and relatively decisive shifts in strategy on the basis of increased skill in contingency identification. For example, most adults might be expected to adopt the Single Concept strategy of the present study in one or two trials.

As a descriptor for the experimental method and learning processes involved in this and earlier studies of directed-focus adjunct questions, the behavioral shaping analogy would appear to be realitvely inadequate. Major features of the shaping process, as it has been traditionally approached in the literature, involve the development of a new behavioral repertoire, previously nonexistent, by means of reinforcement of approximations to a requisite terminal performance. Generally however, the experimental arrangements within the mathemagenic framework have not been conceptualized to provide for the reinforcement of approxima-

tions to a requisite terminal performance, but rather have employed the question-event as a fixed criterion for terminal performance, an arrangement more closely analogous to a discrimination learning paradigm. Also, improvement in performance appears to depend not so much on the development of a new repertoire of responses as it does upon selective confirmation and disconfirmation of pre-existing behaviors and strategies. Within the Skinnerian framework, such processes seem more adequately described as recurrent behaviors (Skinner, 1968, p. 121); behaviors which while not directly reinforced themselves, function to make subsequent behavior more likely to be positively confirmed.

The facile adoption of appropriate strategies seems most clearly dependent upon the identifiability of concept classes represented by post-questions and existing within the task materials, and learner skills in mediating his performance in terms of such recognition. Among the questioning arrangements employed, the Single Position arrangement imposed the least demanding behavioral requirement upon subjects, requiring only that subjects process textual information from a single location. Relative gains in performance, however, show much more pronounced affects for the Single Concept group, suggesting that such content-based concepts have a functional history easily represented within questions, whereas questions have seldom functioned in relation to positional orientation and hence are less recognizable in reading tasks. In contrast to the Single Concept arrangement, the Double Concept condition presented what was essentially a disjunctive concept attainment task, with difficulty further increased by the serial nature of feedback in all conditions. Indeed, comparisons on shared training items (N = 10) between the Single and Double Concept groups showed significantly poorer performance for the Double Concept group on such items ($\overline{X}_{SC}$ = 7.5; $\overline{X}_{DC}$ = 3.8; $\underline{t}$ = 4.60; $\underline{df}$ = 18; p < .001).

From a methodological standpoint, the "shift" method employed appears
to be potentially productive for investigation of a number of strategy/materials
interactions and strategy/strategy interactions in learning from text. With
regard to such questions, the present study was conceptualized as a first-level
exploration of effects of simple conceptual and positional contingencies upon
processing of materials of limited complexity. However, the investigative model
seems also applicable for higher order investigations of interactive effects of
basic strategies and behaviors as components of more complex analytical skills,
(e.g., the effects of training in hypothesized sub-skills upon inference making
from various types of textual materials), for the investigation of the function
of mediating processes in learning from text, and for investigation of adaptive
processes given variation in text characteristics. Given the relatively straight-
forward nature of the basic arrangements involved and sophistication of methods
for textual analysis, methods and materials developed within this paradigm may
contribute to the development of effective training procedures to teach children
and adults important skills in information processing from written materials.

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Table 1: Proportions correct of given item types for associated strategy
groups during the final 5 training trials and during the test trials.

| Item Type-Group | Training | | Test Same | | Test Other | |
|---|---|---|---|---|---|---|
| | $\overline{X}$ | S.D. | $\overline{X}$ | S.D. | $\overline{X}$ | S.D. |
| Single Concept | .94 | .10 | .37[1] | .17 | .40 | .22 |
| Single Position | .52 | .25 | .33 | .15 | .33 | .22 |
| Double Concept | .50 | .24 | .40 | .26 | .45 | .31 |
| Double Position | .60 | .19 | .30 | .18 | .28 | .21 |
| Random Position | .46 | .21 | .38 | .23 | — | — |

[1]For the 20 test trials, N of Single Concept items = 6, Single Position = 10, Double Concept = 16, Double Position = 13, and Random = 20.

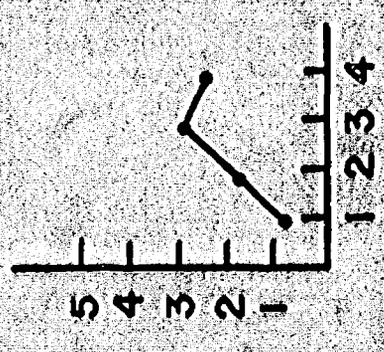Fig. 1: Mean correct responses to experimental questions within blocks of 5 training trials.
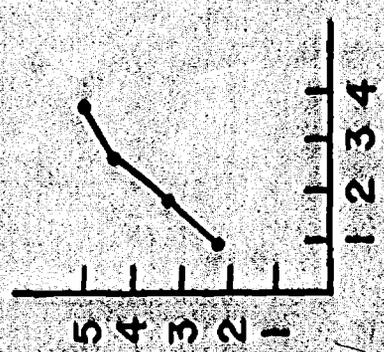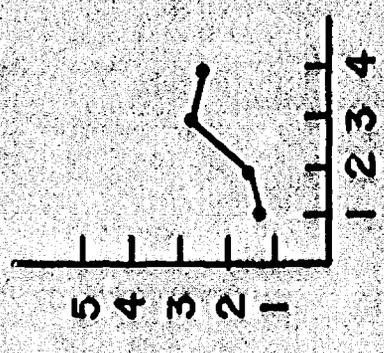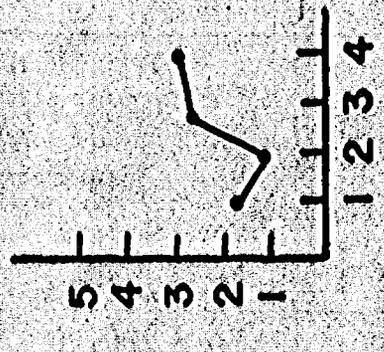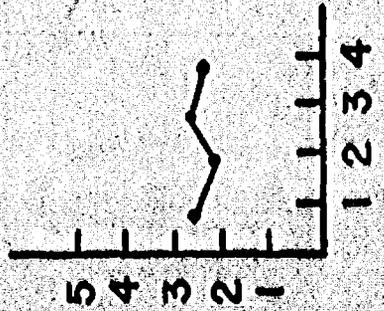
SINGLE CONCEPT · SINGLE POSITION · DOUBLE CONCEPT · DOUBLE POSITION · RANDOM

NUMBER CORRECT

TRIAL BLOCKS

Fig. 2: Summed reading latencies for five-trial blocks during training and test phases.

SINGLE CONCEPT
SINGLE POSITION
DOUBLE CONCEPT
DOUBLE POSITION
RANDOM

READING LATENCY (SEC.)

TRAINING BLOCKS — TEST BLOCKS