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ABSTRACT

              Two experiments are presented to clarify the
relationships among different information codes available to a fluent
reader and the utilization of syntactic and semantic knowledge to
facilitate word identification. Use of context is measured with a
word boundary task on passages with either coherent or random
organization. Orthographic pattern and prior knowledge are also
manipulated. The results indicate a reduction in use of context with
unfamiliar orthography but an independence of information code
levels. Results are discussed in terms both of alternate models of
the reading process and of the development of fluency in reading.
(Author/AA)

Relation of Context Utilization and Orthographic Automaticity

in Word Identification

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Relation of Context Utilization and Orthographic Automaticity

in Word Identification (HYP)

Much of the emphasis in beginning reading instruction is directed toward the goal of code breaking at the word level. Investigations focus on the importance of information from a variety of constituent code levels for the facilitation of word identification. This emphasis is in part derived from an assumption that comprehension processes in the visual and auditory modes are essentially the same once word recognition is achieved, and from a lack of theoretical specification of these higher processes in either mode. Recent research, however, has demonstrated the relationship of information codes (see Rumelhart, 1976 for a brief review). Of particular interest is the effect of syntactic/semantic information on word recognition. The influence of this factor is demonstrated in a study by Tulving and Gold (1963). They found that the tachistoscopic presentation threshold for identification of the final word of a sentence is lowered by prior exposure to the preceding context.

Klein and Klein (1973) have demonstrated a similar "context utilization" effect within a word boundary paradigm. This procedure requires subjects to separate words from a uniformly spaced array of letters. The subjects are instructed to work as quickly as possible without errors. The rate at which words can be separated is compared on trials in which the array constitutes a coherent passage versus randomly arranged words.

This is an interesting paradigm in that performance on random arrays is mediated by a number of low-level codes, such as recognition of initial and final clusters, vowel complexity, spelling patterns, and sequential and spatial frequencies of English orthography. Context utilization, then, is demonstrated by increased performance on coherent passages which provide additional syntactic/semantic information codes. Results such as these require that an adequate model of reading explicate the facilitative effect of higher-level codes on lexical decisions.

Various reading models have been advanced to account for the relationship among code levels. LaBerge and Samuels (1974) suggest a model in which automatic processing of lower code levels allows attention to be directed at higher level units. While they have not elaborated the type of processing which would be possible with attention focused at the semantic level, attentional processing can only operate at a single code level; thus, lower-level demands on attention will reduce semantic analysis.

To account for the context utilization effect reported by Klein and Klein (1973), it is necessary to hypothesize some type of "top down" information flow. That is, previous syntactic/semantic information must function to reduce the set of possible lexical alternatives and strengthen "bottom up" hypotheses, resulting from featural or spelling pattern data, which converge on acceptable lexical items. This interactive perspective on code use is an essential feature of the reading model advanced by Rumelhart (1976).

Such processing operations could be incorporated into the LaBerge and Samuels perspective when attention is directed at the semantic level.

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"So long as word meanings are automatically processed, the focus of atten-
tion remains at the semantic level and does not need to be switched to
the visual system for decoding ... (LaBerge & Samuels, 1974)." This semantic
orientation has the potential to facilitate processing at lower levels.
Any reduction in automatic processing, however, would preclude interactive
operations. The botton-up, dependent nature of attentional processing
requires that for a lexical decision task, code elaboration terminates
at the lexical level. Further processing at higher levels would be use-
less, since the maintenance of these codes would require continued attention
in order to aid in word recognition. This is not possible in a non-automatic
decoding situation since "the number of existing codes of any kind that can
be activated by attention at a given moment is sharply limited, probably
to one (LaBerge & Samuels, 1974)."

Rumelhart's model, on the other hand, postulates a set of "independent
knowledge sources", each containing specialized information "about some
aspect of the reading process (Rumelhart, 1976)." Thus, the models generate
contrasting predictions. A manipulation which would hamper what LaBerge
and Samuels characterize as automatic processing should, from their perspective,
prevent syntactic/semantic codes from aiding in a word identification task.
However, the independence of knowledge sources within Rumelhart's model
would lead to the prediction that such a manipulation would have little
effect on the utility of context.

A second issue addressed in this investigation is the nature of semantic
information responsible for the context utilization effect. Klein and Klein (1973)
have shown that within-sentence syntactic/semantic organization facilitates

word recognition. Information at the theme or framework level represents an additional knowledge source. Prior exposure to context information at this level can increase comprehension of prose passages as demonstrated by enhanced recall performance (Bransford & Johnson, 1972). It seems reasonable to hypothesize that prior provision of thematic or framework context can operate in a manner similar to within-sentence organization in order to facilitate word recognition.

Experiment 1

In the first experiment, normal and reversed orthographic forms of the word boundary task are used in combination with random and coherent passage organization to test the effect of impaired low-level code information on the facilitative effect of coherent organization.

In addition, a test of the information value of context at the theme/framework level, within this task, is conducted by providing half the subjects with an appropriate framework statement along with the letter arrays.

If context information at this level does facilitate word recognition, there should be an interaction between the passage organization factor and the presence or absence of context, with coherent organization increasing performance more when an appropriate framework is provided.

The reversed orthographic conditions should significantly reduce performance rates. If this manipulation also eliminates the facilitative effect of coherent organization, that is, if performance in the reversed/random condition equals that in the reversed/coherent condition, then the LaBerge and Samuels model will be supported. Increased performance in the reversed/coherent condition over that shown in the reversed/random condition will support the Rumelhart model.

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Method

Subjects. The first experiment utilized thirty-two undergraduate students enrolled in an introductory Educational Psychology course during the summer session at the University of Illinois, Urbana-Champaign. Data from one additional subject was discarded for failure to follow the task instructions.

Materials. The four passages used in this experiment were short-action narratives ranging in length from 97 to 116 words. The level of difficulty was appropriate for college students. These stories were modified to eliminate proper names, capitalized words, symbols, and sentence constructions requiring punctuation other than commas and periods. The words from each of the passages were then rearranged to yield an equivalent but randomly organized word list for each story. Both of these organizational forms were then placed in the word boundary format by omitting punctuation and printing each passage in lower case letters with a space after every letter; there were no additional spaces to indicate word or sentence units.

An orthographic factor was created by printing the letters from each row in the coherent and random forms in reverse order. That is, they were printed from right to left with the margins right justified; thus, letter features are unchanged but sequential scan patterns were disrupted. An arrow was placed next to the first letter of each passage to indicate the starting point and orthographic pattern--normal or reversed. The following sample illustrates this reversed orthographic form:

s s e l e p o h e t a r e p s e d a w o n t h g i l f s a w t i ←

    s r u o h r o f n o m i h d e i r r a c t a h t t h g i l f

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A third factor was the presence or absence of a context/framework statement preceding the passage. In the framework-present condition the words "story about" were followed by a short, one-line phrase summarizing the situation (e.g., "a recital at a society party"). This context statement was printed at the top of the page, approximately one inch above the array of letters forming the appropriate target passage.

Procedure. There are two within-subjects variables--coherent versus random passage organization and normal versus reversed orthography. The combination of these two factors yields four presentation conditions. Each subject participated in four trials, one in each condition. The between-subjects factor is context, either present or absent.

The sixteen combinations of four passages in four formats were counter-balanced according to a Greco-Latin Square to yield four presentation sequences. Thus, each condition appeared in combination with each story and in each trial position (1st to 4th) once in the four sets.

The materials--one page for each of the four conditions--were arranged in test booklets with a cover sheet. This cover page included a brief form of the task instructions and a three-line practice passage for each condition. These materials were all derived from one short narrative story. For the context-present condition the set of practice passages was preceded by an appropriate framework statement.

Subjects were tested in two groups during the usual class period. Each group received different levels of the context factor. The four types of test booklets were randomly distributed. Instructions were given describing

the task: the subject was to draw slashes between words, working as quickly as possible without making mistakes. Since each line begins and ends with a complete word, it was explained that failing to include any letter in a word would constitute an error. Incorrect divisions were to be crossed out and redrawn in the correct position.

An explanation of each format was given prior to subjects working the practice materials for that condition. Subjects in the context-present group were told to read the summary statement prior to separating words in the target passage, since even in the random condition the words would relate to the theme. After completing the practice materials, the subjects were informed that there would be four trials, each lasting 1.5 minutes with 30 seconds between trials. The experimenter signaled when to begin and end work on each. A short rationale for the experiment was provided after the last trial.

Results

There was no significant effect of the order of presentation of experimental conditions, so these data were combined for the remaining analyses. The mean number of words correctly identified per trial for each of the eight experimental conditions are presented in Table 1. The mean number of errors per trial remained small across conditions, averaging 1.03 overall.

Both the organization of the passage and the orthographic form had the predicted effect on word boundary performance. The presence or absence of a context statement, however, had no effect on performance: $F_{(1,30)} = .003$, $p > .05$. The reversed orthography reduced performance significantly: $F_{(1,30)} = 312.30$, $p < .001$. This effect was strong for both types of organization.

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Performance in the reverse/random condition was significantly slower than in the normal/random condition: $F (1,30) = 235.74$, $p < .001$. Similarly, in the reverse/coherent condition, performance was significantly slower than in the normal/coherent condition: $F (1,30) = 229.49$, $p < .001$.

Table 1 also shows a significantly greater number of words per trial for coherent passages than for random passages: $F (1,30) = 65.99$, $p < .001$. This difference was significant both for the normal orthographic passages, $F (1,30) = 52.25$, $p < .001$, and the reversed orthographic conditions: $F (1,30) = 28.86$, $p < .001$. There was, however, a greater difference in performance between random and coherent passages in the normal orthographic form, such that the Organization X Orthography interaction was significant: $F (1,30) = 23.98$, $p < .001$.

This interaction can also be viewed in terms of the relative facilitative effect of coherence in normal versus reversed orthographic forms compared to the base rate performance of random organization. This yields two proportion scores per subject, one for normal orthography and one for reversed orthography, (Coherent-Random)/Random. Table 2 presents the mean scores on this proportional measure.

In Table 2 the main effect of orthography is comparable to the above interaction effect. However, in this relative form there is a marginally significant tendency for coherence to increase performance more for the reversed orthography than for the normal orthographic condition: $F (1,30) = 4.58$, $p < .05$.

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Experiment 2

This second study represents a stronger test of the utility of frame-work information to facilitate word recognition than conducted in the previous experiment. In the first study, the coherent passages were such that a subject could spontaneously generate a framework from the first few lines. The target passage in this second study cannot be readily interpreted without prior exposure to the appropriate framework information (Bransford & Johnson, 1972). Again, an interaction effect is predicted reflecting a greater increase in performance due to coherent organization when appropriate context is provided.

Method

Subjects. In this experiment, 133 undergraduates participated; they were enrolled in an introductory Educational Psychology class during the spring semester at the University of Illinois, Urbana-Champaign. Data from three additional subjects were discarded, two because of prior knowledge of the target story and one for failure to follow directions.

Materials. One passage of 134 words was used in this study. The story was developed and utilized by Bransford and Johnson (1972); a coherent and random version of this passage was prepared in the word boundry format the procedure described in the previous experiment. The coherent version is presented in Figure 2.

A context/framework condition was created independent of the passage by an overhead projector transparency, showing the "appropriate context picture" developed by Bransford and Johnson (1972), and reproduced in Figure 1.

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Procedure

The experiment consisted of two between-subjects variables, coherent versus random passage organization, and the presence or absence of context.

Each subject received a test booklet consisting of a target passage and cover sheet. The cover page included a brief form of the task instructions and two five-line practice passages--one in a coherent format, the other randomly organized.

Subjects were tested in groups during their usual class period. Half the subjects in each group received random target passages, half coherent target passages. The general instructions for the word boundary task were presented as described in the previous experiment. Prior to attempting the coherent practice passage, the subjects heard a short framework statement; they were then given 20 seconds to work on the passage. Words from the first three lines were read off for self-checking. This procedure was repeated for the random practice passage.

The subjects were informed that they would be allowed 1.5 minutes to work on the final passage. It was suggested that keeping track of the story might help them separate words.

In the context-present condition, the subjects were told that the passage would relate to the following picture, which they should study in order to understand the situation. The context picture was projected for 30 seconds.

The experimenter signaled the subjects when to begin and stop

working. A short rationale for the experiment was provided after this

target trial.

Results

The mean number of words correctly identified per trial for each of

the four experimental conditions are shown in Table 3. As in the previous

study, the number of errors per trial was small across conditions, aver-

aging .53 overall.

As is apparent in Table 3, the effect of passage organization is

highly significant: $F (1, 129) = 246.36$, $p < .001$. The main effect of

context is marginally significant--$F (1, 129) = 3.92$, $p < .05$-- with the

presence of context resulting in slightly higher scores (3.81 words per

trial). The predicted interaction, Organization × Context, is not

significant: $F (1, 129) = .10$, $p > .05$.

Discussion of Results

While the word boundary task in itself disrupts word recognition,

the normal orthographic format does not impair the use of code informa-

tion below the lexical decision level. The large decrease in performance

rates on the reversed orthography indicates a severe reduction in the

utility of lower-level codes to produce lexical decisions. In terms of

LaBerge and Samuels' model, this manipulation disrupts automatic pro-

cessing of codes above the letter level and thus attentional processing

is required to produce word recognition.

The increment in performance resulting from coherent organization

in the normal orthographic condition can be explained within the LaBerge

and Samuels perspective by hypothesizing that lexical decisions can be

made with attention focused at the syntactic/semantic code level. Indeed,

this is the level at which fluent readers normally operate (LaBerge &

Samuels, 1974); as previously noted, a facilitative effect on word recog-

nition resulting from automatic processing up to this level can be in-

corporated in the attentional system.

The problematic result for this model arises from the significant

increase in performance due to coherence in the reversed orthographic

condition. Since the reversed format requires attentional processing

below the lexical level, a facilitative effect due to coherence cannot

be handled without postulating an interaction of independent knowledge

sources. The bottom-up, dependent flow of attentionally activated in-

formation characterized in LaBerge and Samuels' model would reach a

lexical decision prior to semantic analysis, so no facilitation from this

higher code level is possible.

While the Organization x Orthography interaction signifies a smaller

absolute gain due to coherence in the reversed format, this reduction

results from the impaired information value of the lower codes. Accord-

ing to Rumelhart's (1976) interactive model, any lexical decision will be

based on convergent hypotheses supported by independent knowledge sources

at higher and lower code levels. Thus, the value of syntactic/semantic

information should not decline in proportion to other knowledge sources

affected by the reversal in orthography, but rather increase relative

to these codes. This effect is demonstrated in Table 2 by the superior-

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ity of performance on this relative measure in the reversed orthographic condition.

The absences of any effect due to prior context in the first experiment suggested that perhaps subjects were able to generate an appropriate thematic context on their own. Therefore, the second experiment again attempted to test this effect using materials on which prior exposure to the appropriate context has been shown to enhance recall of the passage, and for which the spontaneous generation of a suitable context was unlikely (Bransford & Johnson, 1972).

The failure to obtain the predicted interaction between context and passage organization in either experiment indicates that the word boundary task is not sensitive to information from this knowledge source. The effect of coherence appears to be limited to within-sentence regularity.
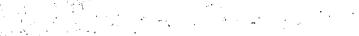
The main effect of context in the second experiment can best be explained in terms of activation of certain words which directly relate to the context picture. Evidence for this interpretation is provided by subjects' responses to the initial letter string in the random passage:

b e s t r i n g

The set allows two possible divisions without creating an error--"be string" and "best ring." Table 4 presents the contingency table for these two responses in the context present versus context absent conditions. Pearson χ^2 test of association (Hays, 1963) indicates a significant relationship between the response alternatives and the context conditions: $\chi^2 = 6.94$, p < .01. As shown in Table 4, subjects in the no-context

condition were more likely to perceive "best ring," while those subjects

having had prior exposure to the context picture were more likely to mark

"be string."

Although this does not represent the type of top-down processing

initially hypothesized it does indicate a framework effect on word

rcognition. The "be string" set is activated by a knowledge source

related to the framework picture. According to the interactive position,

this information affects hypotheses at the spelling pattern level to give

priority to the "string" grouping. The priority of the "best ring" set

in the no-context condition could reflect the semantic and syntactice

integrity of this response over the alternative. Just as in the coherent

condition, a meaningful grouping can gain convergent validation from

higher level knowledge sources. Further investigations of the parameters

of this effect are in progress.

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General Discussion

The results of Experiment I are similar to those reported by Klein (1976). He used random and coherent forms of the word boundary task either in a normal format or in combination with secondary task demands. Reduction in the clarity of individual letters created a secondary task similar to the reversed orthographic condition of Experiment I. This visual clarity manipulation resulted in a decreased, yet still signifi-cant effect of coherent organization. Unlike the results of Experiment I, however, Klein's task appears to cause both an absolute and relative reduction in the context utilization phenomenon.

The difference in these results can best be explained by considering the visual clarity and reversed orthography conditions as two points on a scale which reflects the extent of information code disruption below the lexical level. The potential information value of coherent organi-zation, as measured by the performance gain in the normal format, can then be contrasted with information available from the lower code levels. The latter value is demonstrated by performance on the randomly organized passages. This type of comparison indicates that the cognitive value of, the low-level codes in the visual clarity condition exceeds the potential information gain due to coherence, which, in turn, exceeds that value available through the reversed orthographic patterns. Thus, the relative information levels of the different codes, in the rough sense outlined here, can account for variations in the contribution of coherent organi-

zation to word recognition performance. This argument supports the model

of independent knowledge sources, since the information value of higher

level codes remains constant, only the relative contribution to perfor-

mance changes.

In another experiment, Klein (1976) does demonstrate a reduction in

the information value of syntactic/semantic codes. This is accomplished

by introducing a secondary task which requires subjects to rehearse a

digit set while performing the word boundary task. Performance on random

passages is not affected by this condition, but the facilitative effect

of organization is reduced (though still significant). Apparently,

digit rehearsal interferes with syntactic/semantic code elaboration

necessary to generate lexical hypotheses. This result is the converse

of that obtained through the reversed orthographic presentation. The

rehearsal task reduces top-down processing while leaving other codes

intact; the orthographic mainipulation reduces the effectiveness of

bottom-up processes, but not syntactic/semantic codes. Both results

confirm the independence of knowledge sources.

Rumelhart's (1976) model represents the processing system of a

fluent reader. Some indication as to how an independent, interactive

knowledge systems could develop is provided by Schwartz (1977). This

perspective on strategic processes in beginning reading emphasizes the

importance of specific strategic skills at different knowledge levels,

and a general executive function (Brown, 1975), necessary to coordinate

strategic selection with task demands.

The reading model advanced by LaBerge and Samuels (1974) has specific implications for instruction. The bottom-up, dependent nature of information processing suggests a hierarchical approach to instruction with heavy emphasis on repetition and drills to increase automaticity of low-level codes.

The alternative representation of reading advanced by Rumelhart (1976) and Schwartz (1977) supports a different instructional approach. The independence of knowledge sources suggests that curriculum materials should be developed to train beginning readers on information use at a variety of code levels. Then specific training could be directed at strategic coordination of these knowledge sources. Since the latter process creates difficulties for poor readers at all levels of skill development (Schwartz, 1977), a direct instructional approach to this problem seems both appropriate and necessary.

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Table 1

Words Per Trial as a Function of Context

Organization and Orthography

Experiment 1

Orthography	Context			
	Present		Absent	
	Random Org.	Coherent Org.	Random Org.	Coherent Org.
Normal	43.1	63.1	45.5	68.1
Reversed	11.2	19.1	8.8	14.8

0

Table 2

Relative Performance, (Coherent-Random)/Random,

as a Function of Context and Orthography

Experiment 2

	Context	
Orthography	Present	Absent
Normal	.51	.68
Reversed	.87	1.76

Table 3

Words Per Trial as a Function of

Context and Organization

Experiment 2

	Context	
Organization	Present	Absent
Random	54.8	50.3
Coherent	85.2	81.9

Table 4

Association Between Response Types and

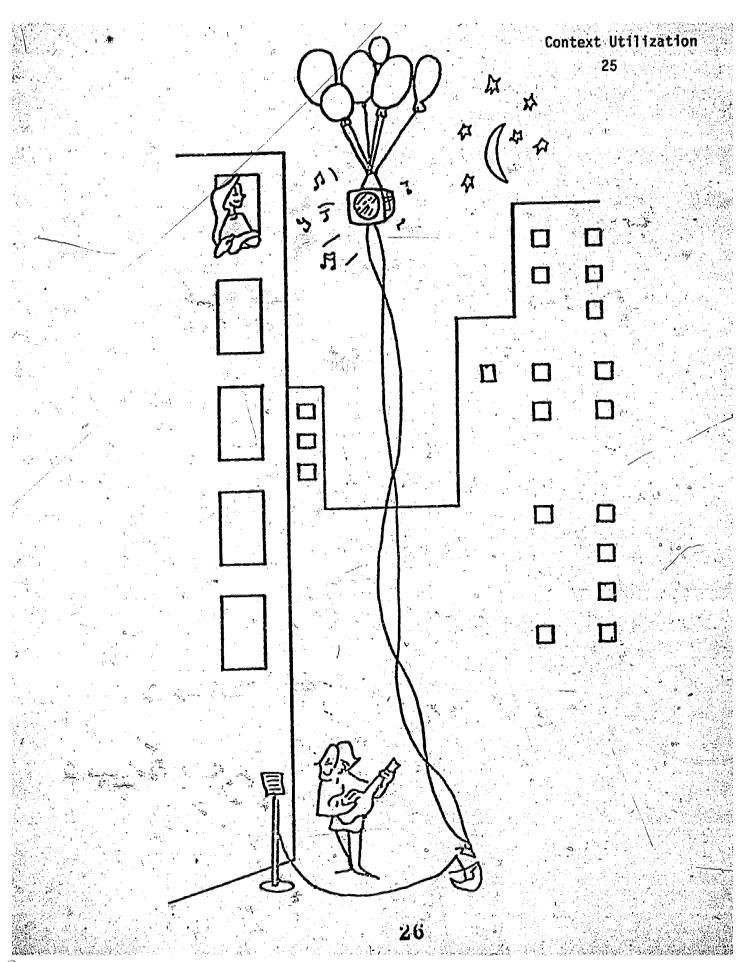Context on Random Passages

Experiment 2

	Context	
Response Type	Present	Absent
"be string"	18	8
"best ring"	14	25

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Figure Captions

Figure 1.   Appropriate context picture for Experiment 2 (from Bransford
& Johnson, 1972).

Figure 2.   Coherent target passage in Experiment 2 (from Bransford &
Johnson, 1972).

iftheballoonspoppedthesoundwould
notbeabletocarrysinceeverything
wouldbetoofarawayfromthecorrect
flooraclosedwindowwouldalsoprevent
thesoundfromcarryingsincemost
buildingstendtobewellinsulated
sincethewholeoperationdependsona
steadyflowofelectricityabreakin
themiddleofthewirewouldalsocause
problemsofcoursethefellowcould
shoutbutthehumanvoiceisnotloud
enoughtocarrythatfaranadditional
problemisthatastringcouldbreakon
theinstrumentthentherecouldbeno
accompanimenttothemessageitis
clearthatthebestsituationwould
involvelessdistancethentherewould
befewerpotentialproblemswithface
tofacecontacttheleastnumberof
thingscouldgowrong

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