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AUTHOR Thompson, David R.
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ABSTRACT

A study examined the effects of column rules, justification, and the interactive effect of column rule and justification on memory. Subjects, 40 undergraduate students enrolled in journalism courses, read 12 text samples (taken from standardized reading tests) randomly assigned to one of six format conditions and presented on separate, simulated magazine pages in a four-column format in four randomly selected orders. Subjects responded to recall and recognition questions and a personal information data sheet. Three column rule conditions--column rule, no column rule, and "middle rule" (a vertical line running down the middle of the column of text)--were combined with two justification conditions (left and right justification or flush left/jagged right) to yield the six format conditions. Results indicated that the best score for recall was recorded in the flush left/jagged right and middle rule condition, the most "disruptive" graphic presentation. Findings suggest that graphic elements, especially justification and column rules, affect memory for magazine text. (Five figures and a table of data are included, and 40 references are attached.) (RS)

Reading Print Media: The effects of justification and column rule on memory

by

David R. Thompson
The University of Texas at Austin

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David R. Thompson
Department of Journalism
The University of Texas at Austin
Austin, Texas 78712

(512) 471-7708 ext. 29

David R. Thompson is a PhD student at The University of Texas at Austin and President of SENSS Publications and Seminars, Inc.

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ABSTRACT

The appearance of the printed page is one factor in the overall study of the linkage between the act of reading and the mass media.

Evidence shows that graphic elements convey information. This study asks: What combination of column rules and justification yields the best memory scores?

The Graphic Elements Model of Reading is presented and applied to an experiment with a within-subjects 3 (no column rule, column rule, middle rule) X 2 (justified, flush left/ragged right) factorial design.

Significant main effects and interactions are found.

Establishment of an interesting and pertinent page pattern, or format -- the size and style of the printed page (Bruno 1989, Click & Baird 1986) -- may assist publishers, editors and graphic designers in their efforts to be read and remembered.

This study examines the role of magazine design in the reading process and tests the effect of format on memory of material read.

The goal of this research is to discover and develop empirically-based principles concerning cognitive processing of print media messages.

There are three specific goals of this study: (1) Examine the effect of column rules -- vertical divisions of text, usually a thin line of ink placed between columns of text -- on memory. This study manipulates column rules in three ways: (a) no column rules -- the absence of ink dividers of text; (b) column rules -- use of vertical dividers of text placed between columns of text; and (c) middle rules -- a novel application which superimposes the vertical divider on the text of each column, actually "cutting through" the letters of the text.
(2) Examine the effect of justification, the alignment of text, on memory. This study manipulates two kinds of alignment: (a) justified -- flush left and flush right, a uniform presentation in which all lines of a column are the same length; and (b) flush

left/ragged right -- even and uniform left margins, but uneven right margins, as determined by various line lengths.
(3) Examine the interactive effect of column rule and justification on memory.

THEORY

A review of mass communication literature provides little empirical evidence of the effect of magazine layout, or presentation of printed information in general, on memory.

Manipulations of instructional material provide evidence that (1) test performance is improved by outline-type indentations (Jewett 1981); (2) readers prefer one layout over another (Hartley & Trueman 1981); and (3) underlined sentences in textbooks are recalled better than non-underlined sentences, but "overall passage retention [is] not improved" (Johnson 1988).

Siskind (1979) surveyed newspaper readers for their preference of newspaper design. She found that newspapers that use contemporary design, an element of which is no column rules (empty alleys), are considered more informative and interesting than those that use column rules (vertical dividing lines placed between columns of print), a more traditional design characteristic. Her study did not measure memory.

A historical precedent exists for the idea of the middle rule. **The New York Herald**, June 18, 1864, ran a full-column ad on page one which employed a form of middle rule. A dash, about

five characters wide, was centered and placed beneath each line of type. (See Figure 1.) This gives the effect of "weighting" that column, and presumably, drawing attention to the advertisement.

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Figure 1 about here

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A review of psychology of reading literature provides more background.[1]

Kennedy (1989) states that one way to reduce "memory load [and, by extension, improve cognitive efficiency] is to use the spatial coordinates of selected items to direct eye movements. ... Such a process argues for a division between thinking and looking. ... The pattern of refixations itself simply serves as an aide-memoire. ... The page functions like a stable map (in the sense used by MacKay, 1973), or as a memory addressed directly through spatial coordinates." This suggests that graphic elements may have a direct impact on cognitive efficiency and memory strategies.

In a justified (even left and right margins) format, the eye "knows," through repetition, how far it must travel to perceive a line of print. Thus, the justified format may minimize pauses in

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[1] For a more extensive discussion of the application of psychology of reading to study of mass media messages, see Thompson (1990).

eye motion following backward eye movements, regressions, within a line of print (Bayle, 1942; Rayner & Pollatsek, 1989). This suggests that the longer the look, the longer the processing time (McConkie 1989).

By extension, flush left/ragged right margins may force the reader to process each line's end point and re-evaluate the distance of each return sweep (Rayner & Pollatsek, 1989). These assessment strategies may require "extra" time to process information presented with flush left/ragged right margins (Glass & Holyoak, 1986).

A column rule -- a thin vertical line separating columns -- provides a visual boundary which may eliminate peripheral processing of letters and words in an adjacent column (Glass & Holyoak, 1986; McConkie & Rayner, 1975). However, since the column rule conveys no semantic information, it may be ineffective as a barrier. Peripheral vision may "jump" the gap between columns and perceive "gross featural information." This information is called "visuospatial representation," to indicate that it contains both visual (e.g., brightness, color, shape) and spatial information" (Glass & Holyoak, 1986). This visuospatial information is temporarily held in a sensory register. This is a short-term store for literal, "verbatim," one-to-one mapping of new information that is used when that peripheral area becomes the point of focus (Rayner & Pollatsek, 1989; Neisser, 1967; Sperling, 1960).

A format with no column rules may be functionally equivalent to a format with column rules. The "empty" margin between columns may serve as a boundary that prevents the eye from jumping from one column to the adjacent column. But again, the letters in the adjacent column may be pre-processed (identified as letters, and "measured" for word length) for an anticipated reading of that information (Rayner & Pollatsek, 1989). As in a flush left/ragged right grid, a no column rules presentation may require an increased attentional load.

A novel application of column rules, the middle rule -- a vertical rule drawn directly through the text in the center of the column -- may function as a "guideline" for the eye. Yet, eye movement patterns may be altered because this intrusive visual device may provoke regressions, backward eye movements. The regression is used for visual assessment and reassessment (McConkie, 1989; Tinker, 1946).

Kennedy (1989) states: "It has proved quite difficult to construct materials that will reliably trigger regressions." The middle rule condition may trigger regressions and, therefore, contribute to research which seeks evidence of improved memory from manipulations of reading habits and eye movements.

The middle rule may have another effect: Interference. The middle rule degrades letters by literally "cutting" through them. In other words, unpracticed subjects may be confused by the

middle rule. Automatic reading processes,[2] such as letter recognition (Sperling 1963, Smith 1971, Gough 1972, Rayner & Pollatsek 1989), may fail, and the reader may resort to conscious processing. In effect, the middle rule may enhance memory for material read, since the disruption may induce irregular eye movement patterns such as those used in reading to remember details (Anderson, 1937; Tinker 1946).

This study applies the **Graphic Elements Model of Reading** (Thompson 1990), an information processing model derived from Wyer and Srull's (1986) model of human cognition and Glass and Holyoak's (1986) explanation of recognition. (See Figure 2.)

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Figure 2 about here

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The Graphic Elements Model predicts that information processing and subsequent storage of that information in memory is affected by a very early stage of the reading process -- visuospatial analysis (Glass & Holyoak, 1986). The Graphic Elements Model predicts that an increase in the amount of mental effort required for visual and spatial analysis of textual cues

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[2] According to Posner & Snyder (1975), automaticity means that [1] the person is unaware of the process, [2] the execution of the process in not consciously controlled, and [3] the process takes no processing capacity.

will result in enhanced memory for information derived from that input.

As the reader sees the printed page, the Sensory Register records the stimulus, preserving incoming information briefly -- just long enough for selection of information for further processing (Atkinson & Shiffrin, 1968, Lachman, Lachman & Butterfield, 1979). Iconic information not attended to, or activated, rapidly decays or fades (Neisser, 1967).

The incoming visual message (for this study, the magazine article) undergoes visuospatial analysis. This is where elements of the page are perceived. At this low level of cognitive processing, components of the stimulus are identified: photographs, illustrations, shape of the layout (columns, justification, rules, leading, and other graphic elements), headlines, bylines, and text (type size and font, letters, words, phrases, sentences, and paragraphs.

This study suggests that effects of graphic design components on memory begin at this low level of cognitive processing. This study asks: What combination of column rule and justification results in a format which may stimulate, or tax, mental effort at the visuospatial analysis stage?

From visuospatial analysis, stimulus components analyzed as pertinent are sent directly to the Work Space -- the "central" processor which is conceptually analogous to working memory (Bower, 1975; Klatzky, 1975; Wyer & Srull, 1986). It consists of

the "concurrently activated nodes in memory" (Shiffrin & Schneider 1977).

The Graphic Elements Model predicts that an increase in mental effort for visuospatial analysis results in greater demand for space in this limited-capacity Work Space.

The Work Space may draw items from the Buffer (a temporary store for potentially pertinent information) for processing. This is made possible by a decision device -- the Executor. Information which receives no further activation is discarded from the Buffer and is irretrievably lost.

Attention, Emotion, the Executor (the decision mechanism), and Knowledge activated from Permanent Storage (functionally analogous to Shiffrin and Schneider's (1977) long term storage) contribute their specialized functions to the processing of new input. These processing catalysts are available "on demand" and serve to maintain efficiency of cognitive processing. Their intensity is adjustable. Such adjustments of processing intensity are determined by the Executor.

Comprehension relies on the reader's prior knowledge of language, reading, and the medium -- the nature of the stimulus. This Knowledge is held in Permanent Storage and reactivated by the Executor.

The Executor, the decision device, constantly assesses and re-evaluates cognitive efficiency. The Executor is the conceptual equivalent of the computer's executive, or decision maker (Wyer & Srull, 1986).

Once information is processed, the Executor displaces it from the Work Space for 1) Discard, or 2) Rehearsal -- repeating the information to facilitate Encoding the processed information in Permanent Storage, or long term memory (Klatzky 1980).

Finally, rehearsed information is encoded and placed in Permanent Storage. Permanent Storage consists of content-addressable storage bins. Each bin is identified by its contents (Wyer & Srull, 1986). The content-addressable storage bins of concern in this study are Knowledge of Medium -- experience with magazines, Knowledge of Reading, and Knowledge of Language.

Unlike Collins and Loftus' theory of spreading activation (1975), which predicts gradually decaying activation of nodes related by hierarchical organization the Graphic Elements Model suggests a process of "convergent reactivation." Processing components, reactivated from Permanent Storage, converge on the Work Space at full strength. No hierarchical organization is implied.

Convergent reactivation, as modeled in this study, may be illustrated by the digestive process: First, "Do I want to put this in my mouth?" If so, "Does it taste good?" If yes, swallow; if no, eliminate it. Once consumed, the digestive system is reactivated and digestive enzymes converge on the "input." Only enough digestive "effort" is used. Then, if nutritious, the body retains it. Waste is eliminated.

For magazines, Knowledge of the Medium is built upon the experience of reading magazines. The reader expects to see

magazine design components such as: photographs, advertisements, letters to the editor, table of contents, masthead, date, page numbers, and features and departments. Unlike books (no columns) and unlike newspapers (usually six columns), magazines may have two, three or four columns (Click & Baird, 1986). Experience with such features forms a prototype, or schema (Klatzky 1980) for magazines. "A schema is a mental structure composed of abstract knowledge reflecting prototypical properties of the individual's experiences. The schema is assumed to be acquired and modified by induction from previous and ongoing experience" (Anderson & Lorch, 1985).

This schematic knowledge is based on an interaction between bottom-up processing of new information the Work Space receives from Visuospatial Analysis of the printed page and top down processing using information from the Permanent Store.

The Graphic Elements Model predicts the following.

The justified margin and column rule format is familiar and "comfortable" to the eye. Readers may have become highly practiced, or habituated (Glass & Holyoak 1986) to this common prototypical format. "There are conditions under which skills follow different principles after much practice" (Fitts & Switzer, 1962). This implies "shallow" visuospatial analysis -- little, if any, new information is sent to the Work Space as a result of this cursory analysis. The justified margin and column rule presentation of written material may not stimulate activation of attention or controlled processing mechanisms.

Readers are expected to skim these stories without fully processing their content.

The flush left/ragged right margin and middle rule condition is expected to be the most effective format for memory of magazine text. This format is the least familiar to the eye and, therefore, should require the most mental effort to process. This implies more attention to visuospatial analysis. This may result in stimulation, or sensitization (Groves & Thompson, 1970) of information processing mechanisms. The duration of fixational pauses may lengthen, and regressive pauses may be more frequent -- irregular eye movement patterns should result. This may induce a reading pattern similar to that used in reading for detail. Although this study does not measure eye movements, the flush left/ragged right margin and middle rule condition is expected to have the greatest effect on memory for the material read.

Therefore:

H1: The flush left/ragged right format will be better remembered than the justified format.

H2: The middle rule condition will be better remembered than the no rule condition.

H3: The middle rule condition will be better remembered than the column rule condition.

H4: The flush left/ragged right margin and middle rule condition will generate the highest memory scores.

METHOD

Stimulus Materials

Packets were assembled that included reading samples, subject information questions (age, sex, magazines usually read) and memory questions (recall and recognition tests). The order of the stimulus pages was randomized to control for order effects.

The text samples were produced with Ventura (desktop publishing software) on an IBM AT computer, and printed by an IBM Graphics Printer.

The rules (dividing lines) factor had three conditions: 1) Column rule -- a vertical line placed in the alley to separate the columns, 2) No column rule, and 3) a novel application, Middle rule -- a vertical line superimposed on the text and centered in the column.

The margins factor had two conditions: 1) Justified -- even left and right margins, and 2) Flush left/ragged right. (See Figure 3.)

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Figure 3 about here

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Each of the six conditions was presented twice. The text passages were randomly assigned to conditions.

Twelve different text passages were used. Each text passage (approximately 150 words) was presented on a separate, simulated magazine page in a four-column format. The twelve "stories" were presented in four randomly selected orders to avoid primacy and recency effects.

The text samples were taken from Ekwall Reading Inventory (Ekwall, 1986) and Standard Test Lessons in Reading (McCall and Crabbs, 1926). A variety of reading levels (grades four through nine) were used to counterbalance subject variations in reading ability (See Appendix B).

An 8-1/2" x 11" page was used. A four-column format was used. Though not as common as a three-column format, the four columns allowed the text sample to be three columns wide, with a fourth column used for placement of a distractor article. The manipulated text samples were framed in a box, 31-1/2 picas by 29 picas, at the lower right on the page. A distractor article was included to fill out the page. A date and page number were included. Column widths were eight picas; column depth of the text samples varied with length of text. The alley width (space between columns) was 1-1/2 picas. Type was set in a 20 point

sans serif headline, a 14 point sans serif byline, and 10/12 point serif font for body copy. Column rules were one point thick.

Subjects

Forty undergraduate students enrolled in journalism courses at the University of Texas at Austin participated for course credit.

Experimental Design and Dependent Measures

The independent variables are 1) justification -- the alignment of text, and 2) column rules -- a thin vertical line which divides columns of text. The dependent variable, memory, is measured by recall and recognition tests.

A within-subjects, 3 (no column rule, column rule, middle rule) X 2 (justified margin, flush left/ragged right margin) factorial design was used.

Memory for text passages was measured by 1) cued recall tests, and 2) recognition tests. A cued recall question for each text sample asked subjects to list any and all details, main points, gist, phrases, etc. To test recognition, six four-choice questions were asked about each of the twelve text samples.

Procedure

The subject received the stimulus materials packet and was instructed to read the twelve text passages quickly, but

carefully. The subject was told that memory tests concerning the material will follow the reading. The subject was told to disregard the distractor article. Prior to reading the twelve experimental text passages, a practice passage and sample of the recognition and recall tests, was completed. A one-hour time limit was stated for completion of the experiment. Reading times for each text passage were not measured.

After reading the twelve text passages, the subject completed a personal information data sheet. This served as an interference task to prevent rehearsal of the information read last.

Then, the subject completed the recall and recognition tests.

Subjects were not tested for prior knowledge.

RESULTS

Recognition tests were scored by number correct (from zero to six). Recall tests were coded for propositional content -- exact words, phrases, and gist.

For recall, main effects were found for column rule (F (2,39) = 8.47, p < .001) (See Table 1 for results.) and justification (F (1,39) = 6.29, p < .05).

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Table 1 about here

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For the recognition test, main effects were found for column rule (F (2, 39) = 35.69, $p < .001$) and justification (F (1,39) = 20.49, $p < .001$).

On recall tests, the flush left/ragged right format (M = 26.4) scores appear higher than the justified format (M = 23.7). On recognition tests, the flush left ragged right format (M = 3.7) scores appear higher than the justified format (M = 3.0). This seems to support H1: The flush left/ragged right format will be better remembered than the justified format.

Evidence from recall tests appears to support H2: The middle rule condition (M = 27.0) will be better remembered than the no rule condition (M = 23.4). However, for recognition tests the no rule condition scores appear higher (M = 3.8) than the middle rule condition (M = 2.6). Actually, the middle rule condition scores lowest on main effects for recognition.

Similarly, recall tests appear to support H3: The middle rule condition (M = 27.0) will be better remembered than the column rule condition (M = 24.8). However, for recognition tests the column rule condition scores appear higher (M = 3.6) than the middle rule condition (M = 2.6).

The Graphic Elements Model predicted H4: The flush left/ragged right margin and middle rule condition will generate the highest memory scores.

A significant interaction was found between justification and column rule for recall scores (F (2,78) = 5.65, $p < .05$). This interaction resulted in the highest recall scores for the flush left/ragged right and middle rule condition (M = 27.1), as shown in Figure 4.

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Figure 4 about here

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The justified and middle rule condition scored second highest in the recall test (M = 26.8). The lowest interaction for recall was found when the justified and no rule conditions are combined (M = 20.4).

An interaction between justification and rule was also found for the recognition test (F (2,78) = 36.86, $p < .001$). (See Figure 5.)

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Figure 5 about here

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The extremes of interaction scores for the recognition test were both found in the column rule condition. The high score was found in the flush left/ragged right and column rule condition (M = 4.66). The justified and column rule condition and the flush left/ragged right and middle rule condition shared the lowest scores for the recognition test (M = 2.6).

DISCUSSION

These results provide evidence that graphic elements specifically justification and column rules, affect memory for magazine text.

The best score for recall was recorded in the flush left/ragged right and middle rule condition -- the most novel and "disruptive" presentation.

The middle rule may induce regressions (backward eye movements) which "reintroduce" information for visuospatial analysis (a very low level of cognitive processing). This may increase the chance of admitting this information to the Work Space for further processing.

This is speculation. Without attention measures from eye tracking equipment (eye movement and reaction time data), no conclusive evidence may be obtained.

In the recall test, only one subject mentioned the location of column rules. This suggests that readers do not recognize graphic elements as information. The Graphic Elements Model

predicts and this study reveals evidence that print format does include and convey information used in processing printed messages.

The middle rule condition was novel. Three subjects asked if they should read "the ones with the line through the words." One subject thought the middle rule was a "printing glitch." This may indicate a need to test subjects practiced in reading middle-ruled text.

A variation of the middle rule may also yield interesting results. Rather than a solid black line as a rule, a band of gray (or other color) may serve as the middle rule. This should be more inconspicuous, and may reduce or eliminate the novelty effect.

Ink screens were not considered for this study. Similar procedures may be applied to test the effect of various percentages of ink screens. Such a study would alter the background-to-letter contrast. But, this is a visually-consistent presentation and is not the same as the middle rule. For the reader, a screened background may be like walking through mud, whereas a middle rule may be like walking into a brick wall.

A centered text format was not used for this study. The combination of centered text in a column and the middle rule may effect memory for text read. As mentioned, The New York Herald, June 18, 1864, demonstrates a historical precedent for manipulations of graphic elements. A portion of the

advertisement which used a version of the middle rule was presented in a centered format.

Apparently, graphic elements do affect memory. This study provides evidence for the effect of justification and column rule on memory for print messages. But, before publishers, editors and graphic artists consider adopting new formats such as the flush left/ragged right and middle-rule, further testing should be done to explain the low recognition scores for the middle rule. Also, testing for the effects of novelty, by giving subjects practice with all conditions in a replication of this experiment, is recommended.

Also, reading times may provide evidence for the amount of mental effort involved in reading the various conditions. Future studies will include this factor.

There are possible confounds in this study. There was no test for prior knowledge. The content of some text passages may have been easier to remember than others, despite the equivalence and readability efforts of the Ekwall Reading Inventory. Also, the recognition tests were not tested for equivalence -- some of the questions may have been more difficult than others. And, the same text passage was presented in the same condition to all the subjects. This was done by design. However, future studies may choose to use a between subjects design.

To assuage these possible confounds: 1) Two text passages were used for each condition; 2) text passages were selected from a source which had tested the passages for equivalent content and

readability; and 3) the text passages were randomly assigned to conditions.

The results of this study suggest practical applications of graphic elements to improve memory for magazine text, educational material, advertisements, public service announcements, political information, health information, product warnings and other consumer information.

Will messages presented in a middle rule with flush left/ragged right margins improve literacy skills? influence consumer behaviors -- from purchase to product use? effect voting habits? improve patient compliance with doctors' orders and proper use of medication?

And, what type of memory should we seek to enhance with manipulations of graphic elements -- recall, or recognition? Future studies may find answers to such questions.

Will a black line superimposed on a column of text help beginning readers? Will non-readers learn more by "seeing" the same information more than once (through regressions)?

If so, at what level of reading development can this be applied? And how can mass media professionals help apply and disseminate such knowledge?

Future research will provide evidence for the answers.

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Figure 1. The New York Herald, June 18, 1864

THE NEW Y

WHOLE NO. 10,137. NEW YORK, SATURDAY,

GRANT.

Secretary Stanton's Despatch to General Dix.

FREDERICKSBURG IN OUR HANDS.

The Rebel Intrenchments Attacked and Captured.

Generals Smith and Kautz in Possession of the City.

Capture of Artillery and Prisoners.

Six Guns, Out of the Sixteen Taken, Captured by the Colored Troops.

Additional Details of Gen. Crawford's Fight Near Long Bridge.

The Crossing of the James River the Most Brilliant Scene of the War.

SEE MAP OR SUPPLEMENT SHEET.

The Rebel Report of Sheridan's Defeat.

THE TOWN

POCAHON

THE HERALD DESPATCH

Figure 2. The Graphic Elements Model of Reading

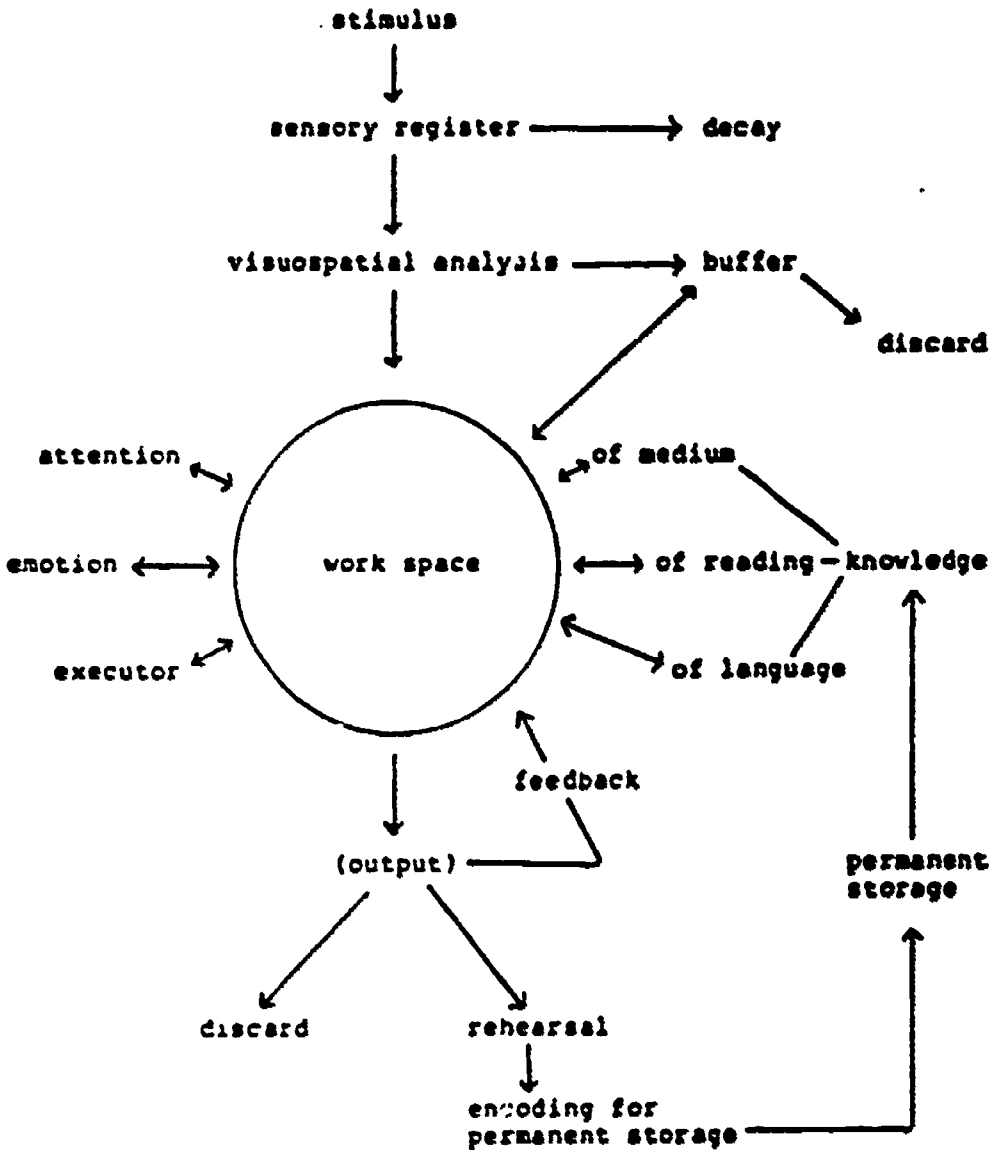
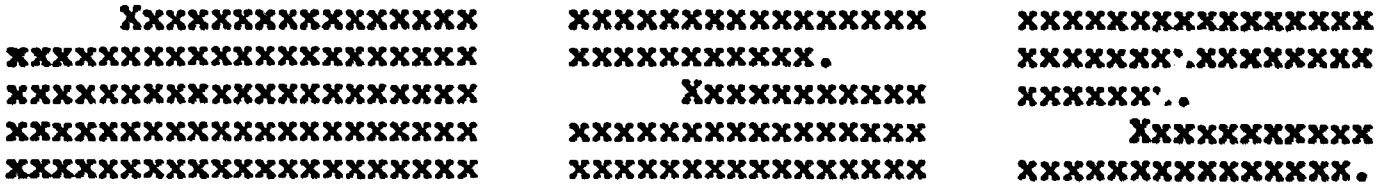
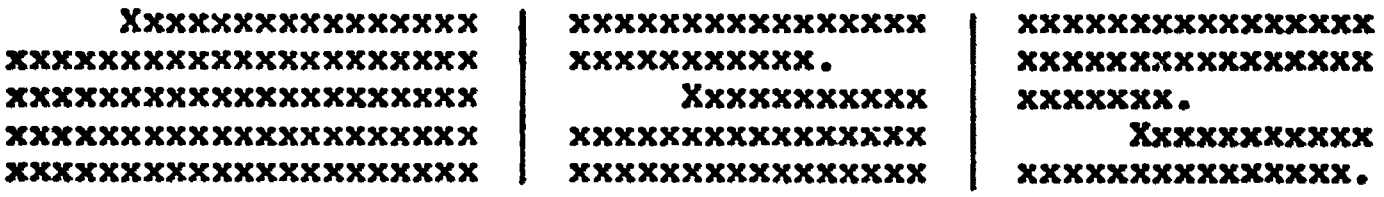


Figure 3. The six levels of justification and rule

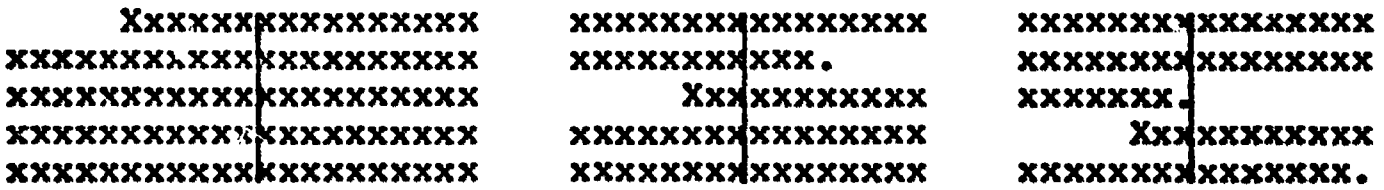
1. Justified + No Rule



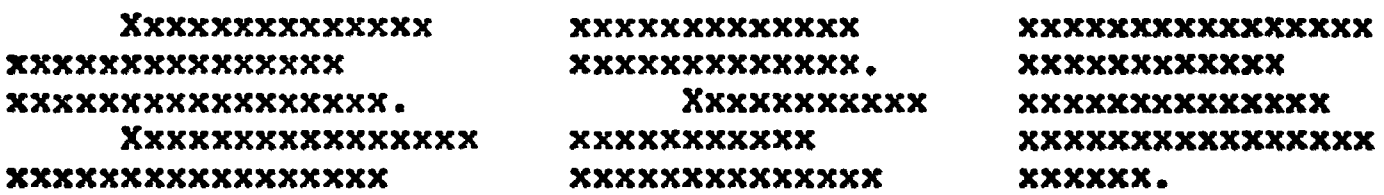
2. Justified + Column Rule



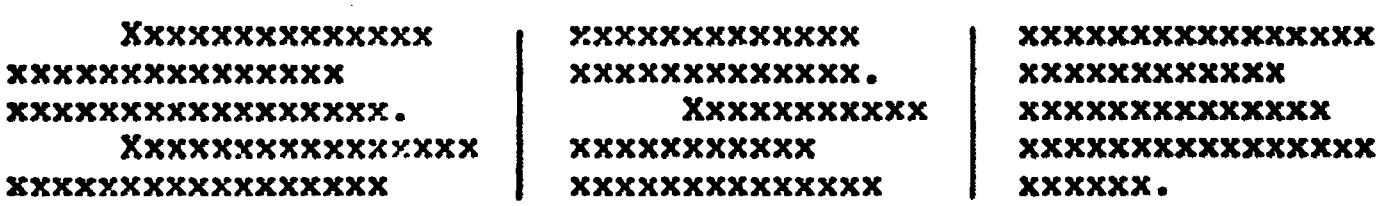
3. Justified + Middle Rule



4. Flush left/Ragged right + No Rule



5. Flush left/Ragged right + Column Rule



6. Flush left/Ragged right + Middle Rule

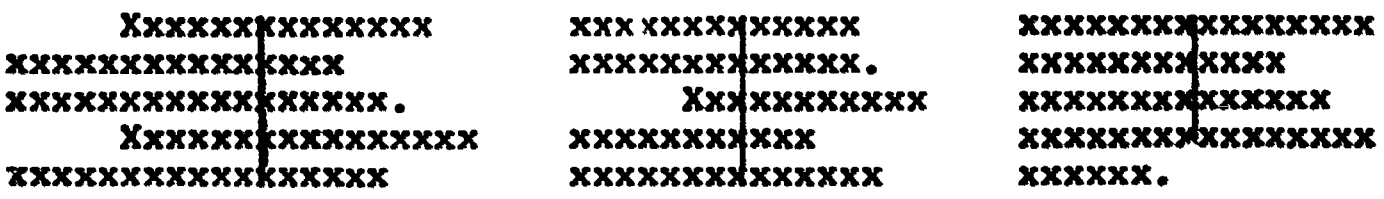


Figure 4. Number of items recalled as a function of column rule and justification.

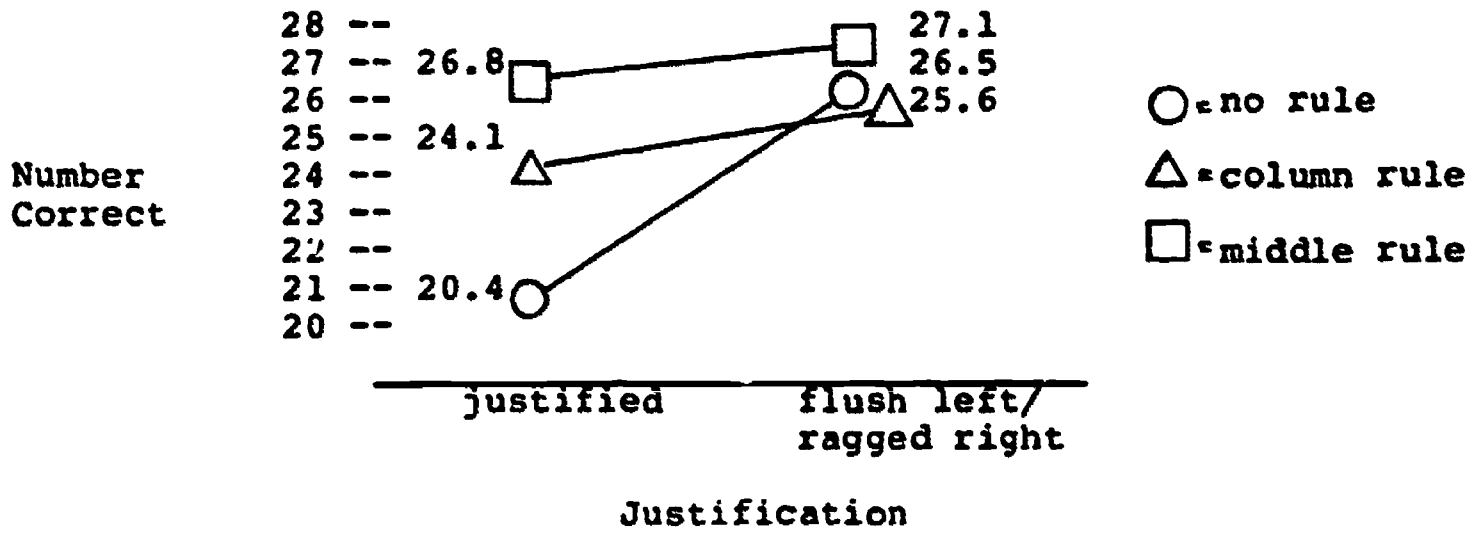


Figure 5. Number correctly recognized as a function of column rule and justification.

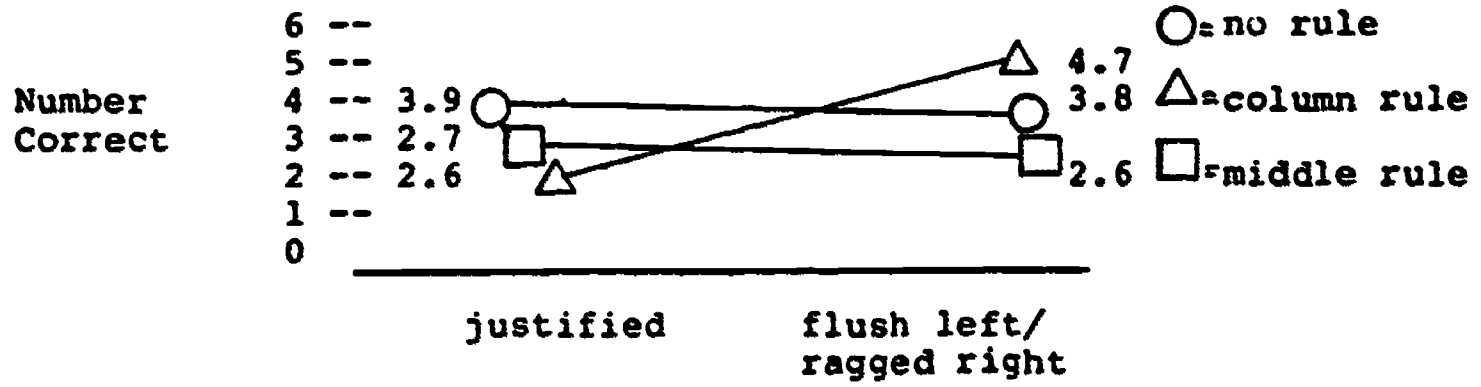


Table 1. Results of analysis of recall and recognition scores for column rule and justification

	Mean Number Correct	F	df	p-value
1. RECALL				
Column Rule		8.4	(2,39)	$p < .001$
no rule	23.4			
column rule	24.8			
middle rule	27.0			
Justification		6.29	(1,39)	$p < .05$
justified	23.7			
fl.left/rag right	26.4			
Interaction		5.65	(2,78)	$p < .05$

	justified	fl. left/rag right
no rule	M = 26.8	M = 27.1
column rule	M = 24.1	M = 25.6
middle rule	M = 20.4	M = 26.5

2. RECOGNITION				
Column Rule		35.69	(2,39)	$p < .001$
no rule	3.8			
column rule	3.6			
middle rule	2.6			
Justification		20.49	(1,39)	$p < .001$
justified	3.0			
fl.left/rag right	3.7			
Interaction		36.86	(2,78)	$p < .001$

	justified	fl. left/rag right
no rule	M = 2.7	M = 2.6
column rule	M = 2.6	M = 4.7
middle rule	M = 3.9	M = 3.8