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ABSTRACT

Research suggests that when subjects are given a rule as to how to translate auditory or verbal information into images, the images have many common characteristics with cognitive representations derived from visual perceptions. This experiment examined the process of cognitive integration and the similarities and differences between how imagined and perceived information is processed in solving problems. The information integrated consisted of straight lines and semi-circles. All subjects learned to identify lines or curves corresponding to one of eight numbers through a paired-associate procedure. In the integration phase, subjects had to mentally construct one or more letters from 26 subsets of three different lines previously learned. Lines were presented to different subject groups by two methods, display or imagery. Unlike similar research, subjects could use different strategies: work forward from lines to letters, or backward from letters to lines. Results showed that different stimulus information sources can produce different situational and cognitive demands. These factors can affect the subject's choice of problem solving strategies and produce different response patterns. This research illustrated that methods are needed for perception and imagination research which do not restrict subjects' processing strategies. (BS)

The effects of imagining and perceiving on problem solving strategies

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In the process of accumulating evidence for mental imagery, some researchers (Peterson, Holsten, & Spevak, 1975; Peterson, Thomas, & Johnson, 1977) have exploited people's ability to deliberately integrate separate bits of information into images.

Insert Figure 1 about here.

The typical methodology involved having subjects imagine a matrix and listen to a sequence of signals. One of the two alternative signals would indicate that a cell in an imaginary matrix should be filled in and the other alternative indicated an unfilled cell. The subjects were also given a rule to translate the signals into the cells of a matrix. The top section of Figure 1 shows an example of a matrix and such a rule: the first signal corresponded to the top, right corner cell, the second signal corresponded to the top, right-middle cell, etc..

After the sequence of sounds was presented, the subjects were asked to identify the letter in the alphabet represented within the imagined matrix. Peterson, Holsten,

& Spevak (1975) have shown that more than 90% of the time, subjects were able to transform the auditory signals into their corresponding visual components and integrate them into an identifiable letter. Peterson et. al. (1975) also found that subjects were able to identify letters rotated from the upright position equally well. Murphy and Hutchinson (1982) also used a very similar methodology; they instructed subjects to translate a series of verbal descriptions into an image. They demonstrated that the visual complexity of the constructed image had a substantial effect on subjects' abilities to recall the imagined pattern.

The data suggests that when subjects are given a rule as to how to translate auditory or verbal information into images, the images have many common characteristics with cognitive representations derived from visual perceptions. From these and similar experiments (Copper and Shepard, 1973; Finke, 1980), Shepard and Podgorny (1978) have hypothesized that the cognitive processing of images and the perceptual processing of visual stimuli involve many of the same component processes which in turn produce similar response patterns in imagery and perceptual tasks.

The present experiment further examined the process of cognitive integration and the similarities and differences between how imagined and perceived information is processed in solving problems. The information integrated consisted of straight lines and semi-circles (see bottom of Figure 1).

The study was conducted in two parts: the Paired-associate learning phase and the Integration phase.

Method

PAL phase: All subjects were run individually and each learned to identify the line or curve that corresponded to one of the eight numbers through a paired-associate procedure. The bottom of the slide shows the eight pairs of lines and numbers. When the subject was given a number, s/he had to identify the corresponding line from a set of four distractors

Integration Phase: After learning to associate the lines with the numbers, all subjects were instructed that the lines viewed during the first part of the experiment were actually elements of upright, capital letters in the English alphabet. From a subset of three different lines, the subject had to mentally combine these lines in different ways to construct one or more letters. When one or more letters could be constructed, the subject said the letters aloud. They were given one minute to generate as many letters as they could. There were twenty-six letter-construction trials, all subjects were presented with the same, random sequence of trials, and no feedback about the correctness or incorrectness of the subjects' responses was given.

There were two methods of presenting lines to be integrated. Forty subjects received the display method which involved visually presenting subjects with the actual lines. Another 40 subjects received the second method, the imagery method, which involved visually presenting the subjects with three numbers only and they had to imagine the lines corresponding to the numbers.

The letters in the alphabet were classified into five groups by the number of elements needed to form the letters (1, 2, or 3 lines needed) and by the type of transformation needed to form the letters (change position or size of the lines). A letter was one-element if a single line could be identified as that letter; C, I and U were one-element letters. O, D, X, V, T, and L were classified as two-element position letters because two lines had to change their relative positions in order to construct the letter. To construct size letters, both the size and relation positions of the lines had to be transformed. The two-element size letters were P, J, S, and Y. The three-element size letters were A, G, K, Q, and R. To review, subjects were given 3 lines or 3 numbers and they had to mentally combine the perceive or imagined lines in different ways to construct as many capital letters as they could. As the subjects said the letters aloud, the experimenter recorded their responses.

Insert Figure 2 about here.

Figure 2 shows the mean percentage of letters generated for the imagery and display conditions for the 4 types of letters. Subjects who saw the lines and curves generated significantly more letters than the subjects who imagined the the lines (51.1% vs. 33.2% respectively, $F(1,71) = 23.24$, $p < .05$). There was no difference in the number of inappropriate letters for the display and imagery groups (4.5 letters each).

Figure 2 also shows that this difference between the perception and imagery groups was consistent over the 4 types of letters. The parallel response pattern was statistically supported by the lack of an interaction between type of letter and information source (imagining vs. perceiving) ($F(3,213)=1.81$, $p < .05$) and suggests that subjects in the imagery and display conditions used similar cognitive processes to integrated the lines and curves into letters. Furthermore, this similarity demonstrated here occurred when subjects themselves were able to select their own rules for mentally combining the elements rather than being given a specific rule by the experimenter which is typical of previous investigations.

At this point it is important to identify a second methodological difference between the present and previous experiments. Subjects could use two different global strategies to perform the task; they could work forward or they could work backward (Newell & Simon, 1972). Subjects could begin with the three lines and mentally manipulate the different combinations of lines to generate a letter (the goal response), i.e. work forward from lines to letters, or they could begin each trial by mentally going through the alphabet (possible goal responses) and evaluate whether a letter could be divided into the lines presented, i.e. work backward from letter to lines. If subjects work backward, they should consistently report sequences of alphabetically ordered letters. Working forward should not result in a high percentage of alphabetic sequences.

The order in which the subject emitted letters of the same type was recorded and the letter sequences were coded as being either alphabetically or non-alphabetically ordered. The analysis of the percentage of alphabetic and non-alphabetic two-letter sequences indicates that the display condition generated more alphabetic sequences than non-alphabetic sequences while the imagery condition generated more non-alphabetic sequences than alphabetic sequences.

This significant interaction between the type of response sequence and the source of the elements (imagined vs. perceived) suggests that the display subjects were more likely to work backwards, while subjects who imagined the lines were more likely to work forwards.

To further examine this hypothesis, we classified subjects as working backward if 80% or more of their two-letter sequences were alphabetically ordered. Subjects were classified as working forward if less than 80% of their two-letter sequences were alphabetic sequences. Subjects with 6 or fewer two-letter sequences could not be reliably classified as using either working forward or backward because of the relatively high probability of reporting alphabetic two-letter sequences 80% of the time by chance.

Insert Figure 3 about here.

Figure 3 shows the mean percentages of each letter-type of subjects who imagined and perceived the figures after they were assigned to the alphabetic or non-alphabetic groups. No imagery subjects were classified as working backwards while about a third of the display subjects who could be classified, were identified as working backwards. As shown in Figure 3, the different global strategies effected subjects' performances. Subjects working backward generated signigicantly more size letters than either the display or imagery subjects who worked forward. Furthermore, there were no differences between the percentage of one-element letters, two-element, and three-element size letters generated by the subjects who worked backward.

When subjects worked forward, whether they saw or imagined the lines and curves, they generated significantly fewer size letters than one-element letters. When working forward, subjects who imagined the elements and subjects who perceived the elements performed the same on letters requiring integration.

Discussion

The interesting feature of the present experiment is that it showed both similarities and differences in how imagined and perceived information is integrated within a single task. The parallel response patterns for the imagery and display condition shown in Figure 2 suggests that the same cognitive processes were used to integrate the imagined and perceived stimuli, with the exception that the integration of imaginery figures was in general, less successful. But we also found that the percentage of alphabetic sequences was differentially affected by Imagery/Perception manipulation. These results suggest that displaying the elements created a situation in which subjects were more likely to work backward and the working backward produced a different pattern of letter generations than working forward.

To perform the task, subjects in the imagery condition had to recall the newly learned figure-number associations, store the images and mentally manipulate the images. If the imagery subjects also used an alphabetic strategy, they would have to mentally go through the alphabet as well as recall, rehearse and manipulate various combinations of elements. All of these cognitive demands could result in competition for the limited capacity of primary memory.

There is not an excessive cognitive load when the stimuli are physically stored in the environment, that is when the person perceives the lines, because the elements do not have to be recalled and rehearsed while manipulating them. The display subjects could sequentially evaluate if each mentally represented letter alphabet could be divided into the figures displayed in front of them. The display condition made the task-effecient alphabetic strategy a viable strategy while the imagery condition made the alphabetic strategy a difficult one to successfully employ.

In conclusion, the different sources of stimulus information can produce different situational and cognitive demands. These factors can effect the subject's choice of problem solving strategies and consequently, different strategies can produce different response patterns. The present study points to the need to develop methods illustrate the the similarities and difference in imagination and perception by not restrict the strategies subjects might use in processing imagined and perceived information. By removing some restrictions, the experiments designed may produce results that may be more than self-fulfilling prophecies.

References

Cooper, L. A. & Shepard, R. N. (1973). Chronometric studies of the rotation of mental images. In W. G. Chase (Ed.), <u>Visual Information Processing</u>, New York: Academic Press.

Finke, R. A. (1980). Levels of equivalence in imagery and perception. <u>Psychological Review</u>, <u>87</u>, 113-132.

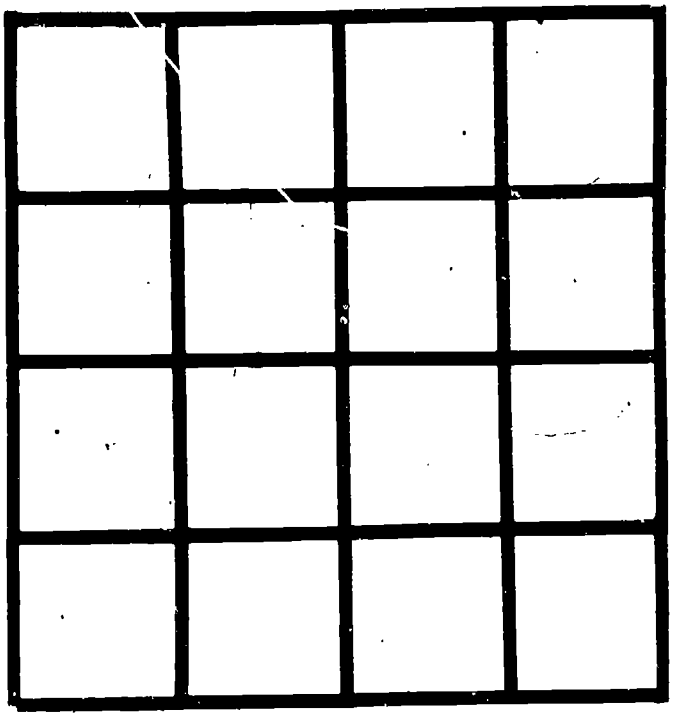
Murphy, G. L. & Hutchinson, J. W. (1982). Memory for forms: Common memory formats for verbal and visual stimulus presentations. <u>Memory and Cognition</u>, <u>10</u>, 54-61.

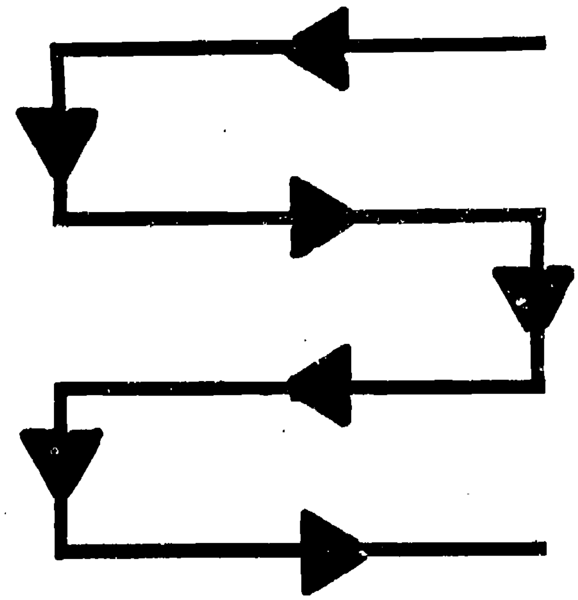
Newell, A. & Simon, H. A. (1972). <u>Human Problem Solving</u>, N.J.: Prentice Hall.

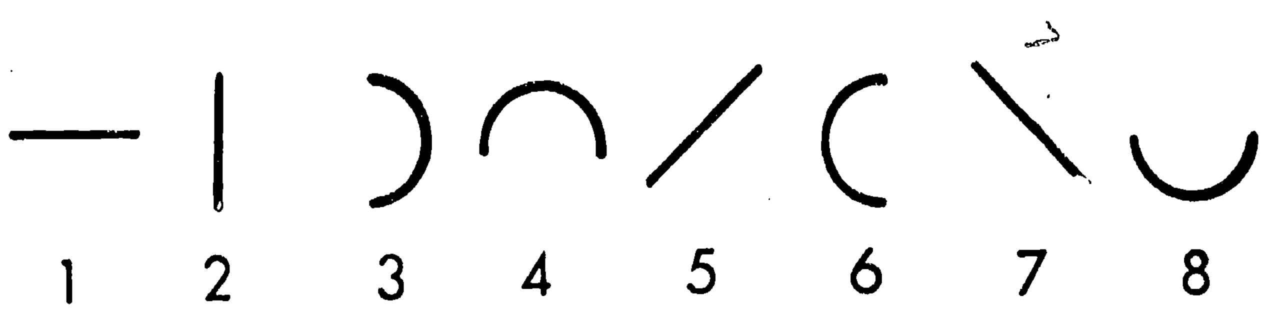
Peterson, L., Holsten, J., & Spevak, P. (1975). Spatial coding of auditory signals. <u>Memory and Cognition</u>, <u>3</u>, 243-246.

Peterson, M. J., Thomas, J. E., & Johnson, H. (1977). Imagery, rehearsal, and the compatibility of input-output tasks. <u>Memory and Cognition</u>, <u>5</u>, 415-422.

Shepard, R. N. & Podgorny, P. (1978). Cognitive processes that resemble perceptual processes. In W. K. Estes (Ed.), <u>Handbook of Learning and Cognitive Processes</u>, Hillsdate, N.J.: Lawrence Erlbaum.



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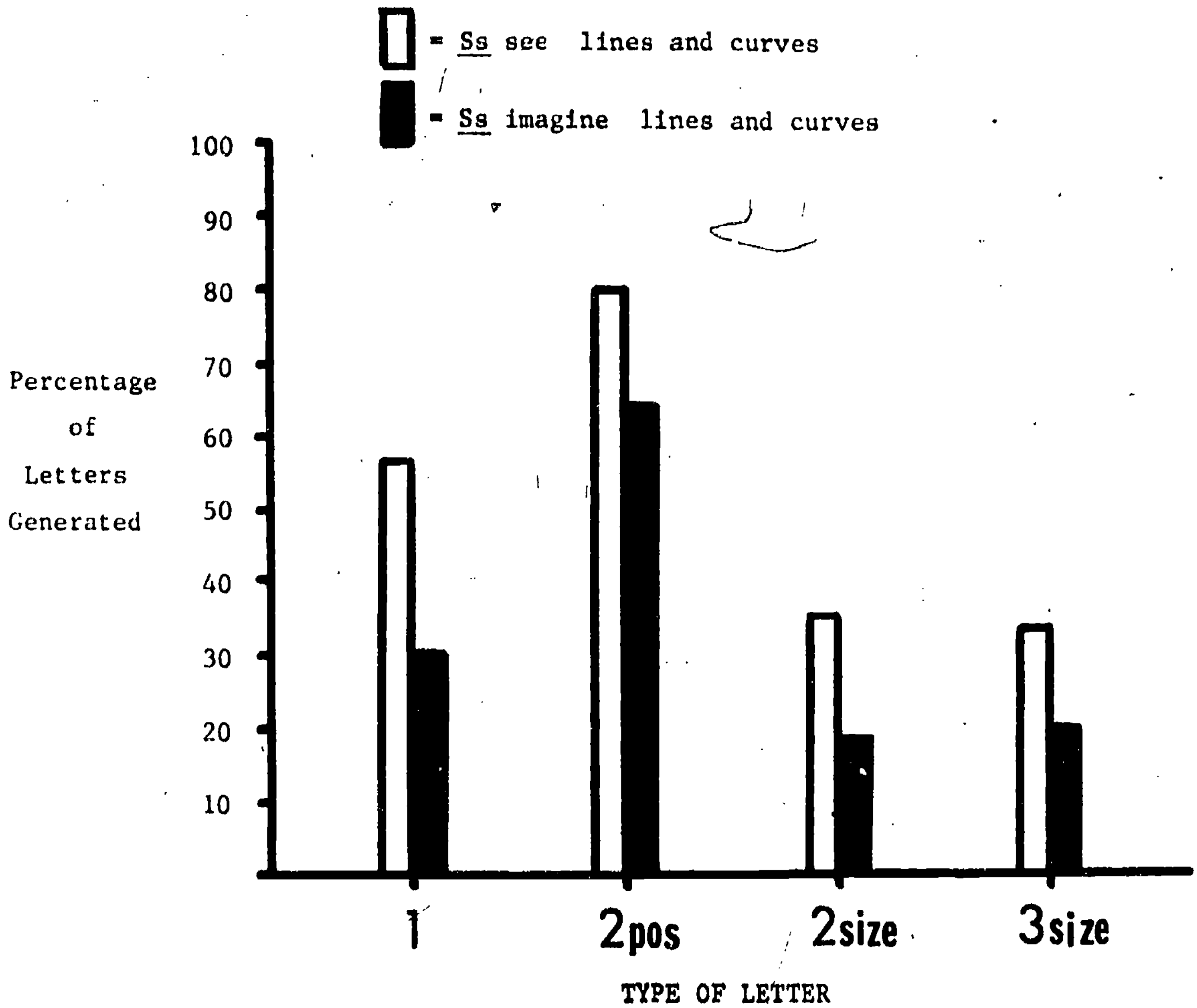
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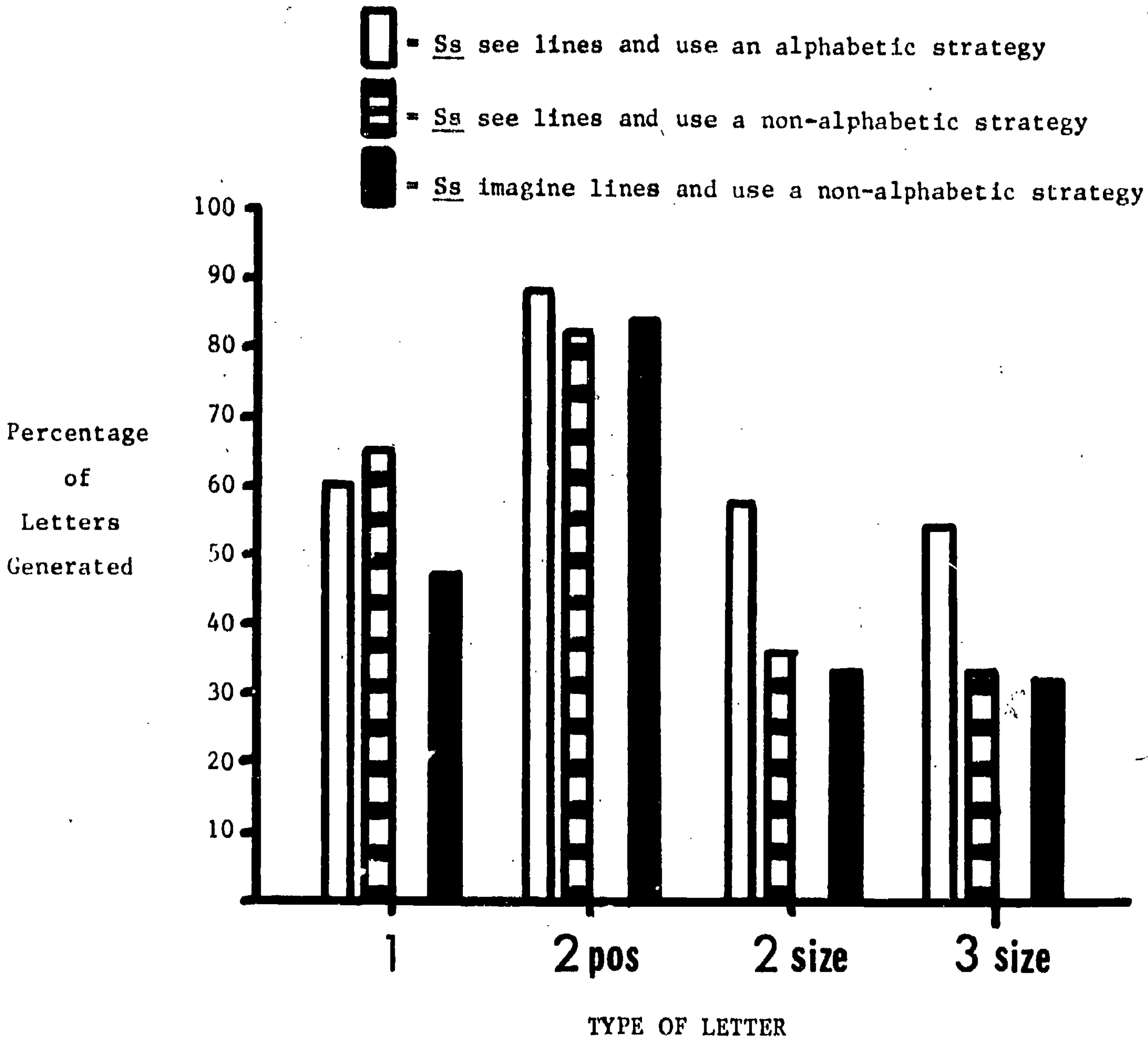
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