The Influence of Developmental Level on Perceptual Learning

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A few years ago in the Research Laboratories at the Menninger Foundation we inaugurated a series of experiments in which we employed an unusual stimulus which contained a word "embedded" between some apparently meaningless black shapes. This stimulus was chosen for a number of reasons. First of all, it has rather unusual figure-ground properties in that its more obvious characteristics are less meaningful than its less-obvious ones. Further, a good deal of pilot work had indicated that some subjects are able to perceive the word quickly, while others experience a great deal of difficulty in doing so even after being helped in "seeing" it. In addition, the restructing of the stimulus and the subsequent perception of the inconspicuous word (as we have come to call it) is almost invariably accompanied by a startle-like "aha" reaction which is easily observed, and subjects usually find the task interesting and amusing. Those subjects who quickly and strongly react to the black nonsense-like forms often have considerable difficulty in overcoming this orientation and in perceiving the inconspicuous word contained within the nonsense-like forms.

This stimulus thus seemed most appropriate for studying the attentional and perceptual processes, because of the unambiguous, meaningful stimulus that is potentially available along with the relatively meaningless configuration and the clear, sudden and dramatic shift that can occur from the perception of one to the other. This provides an excellent opportunity to manipulate and measure the relative facilitation or inhibition of perception that can be developed through prior experience.

Before presenting the study which is of primary concern in this report, some background research should be mentioned (5). In earlier experiments carried out by the present authors, different subjects were given one of several different training conditions after which they were presented the inconspicuous word that is shown in Figure 1. All subjects were asked to look at the inconspicuous word and to tell the experimenter what they saw. Figure 2 includes some examples of the training materials that were used in the initial studies.

One group of subjects had the task of identifying black nonsense forms on a white background by means of specified numbers, prior to being shown the inconspicuous word (Coding Training). The subject was instructed to label verbally each form according to the model at the top of the page and to work as rapidly and accurately as possible. Another group of subjects was given a task which required the formation of words from a series of white letters on a black background, arranged so that approximately sixty-five words could be formed (Word Training). Another group was required to practice the reversal of figure and ground, to observe visual illusions and to find specific figures within complex figures as rapidly as possible (Reversal Training). In addition to these basic groups, a number of control groups were employed in which white and black aspects of the materials were reversed. Still other

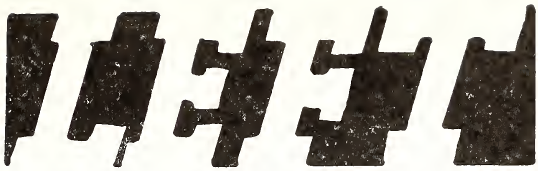

Figure 1. Inconspicuous word test stimulus used in the present experiment.

Figure 2. Samples of the training materials used in previous studies. Same reversal materials used in present investigation.

groups were given more training or a longer delay between training and exposure to the inconspicuous word than the original groups. A large number of male and female subjects were also tested to determine whether sex was an important variable in finding the inconspicuous word and an attempt was made to produce via instructions the effects that had been brought about through actual training and experience.

Briefly, reversal training was found to have a strong tendency to increase the probability that the inconspicuous word would be discovered rather quickly in a group of subjects, whereas the coding training inhibited its identification, and the word training tended to fall between the two. Significant sex differences were not found in any of the experiments but the differences were consistent and suggestive, especially in the reversal condition. Increasing the amount of reversal training increased the facilitory effects in finding the inconspicuous word and a delay of testing after reversal training allowed some of these effects to dissipate so that performance was hindered. The results of additional training and delayed testing were not quite so consistent for coding training but they were not significantly different from what was expected and predicted. Finally, it was found that verbal instructions could be used to bring about effects similar to those produced via training procedures. Thus, if the subject was told to look at the black nonsense forms, this tended to inhibit the location of the inconspicuous word, whereas if the subject was told to attend to the white areas, the results were quite similar to those obtained with the reversal condition.

These studies were carried out to secure some evidence relating to influence of learning on attention and perceptual selectivity. The findings indicated that some of the variables which have been found to be important for other types of learning can have an obvious and significant influence upon perceptual performance. Beyond this, however, we became interested in a number of other variables. One of these, which is the subject of our present paper, is the influence that age level might have upon perceptual flexibility. A number of different age groups separated by a number of years were used to represent somewhat different developmental levels that could be compared with respect to perceptual performance. These included subjects from elementary schools (ages 7-9), high schools (14-18), colleges (19-27), and a geriatric population (60-71). Subjects between the college and geriatric levels will soon be added but they have proven to be difficult to obtain.

Thus, for the age study the groups were made up of sixty-six elementary school subjects, forty-one high school subjects, seventy-seven college subjects, and thirty-nine geriatric subjects. All of these were exposed to the inconspicuous word and were asked simply to tell what they saw. They were allowed seven minutes to locate the word, and if they asked further questions or attempted to give up, they were urged to continue, without being given any clues as to what they were looking for. As indicated in Table I, on the first testing only three elementary school subjects (or about 4% of the group), nine high school subjects (or about 22% of the group), thirty-two college subjects (or about 42% of the group) and two geriatric subjects (or 5% of the group) were able to find the inconspicuous word. For the second phase of the experiment only those subjects were used who were not able to locate the inconspicuous word. These subjects were again brought into the experimental situation after delays ranging from seven to twenty-eight days, and were given reversal training with materials such as those shown in Figure 2, after which the test stimulus was again presented for seven minutes with the usual instructions. A few subjects were not available for the second session, but the drop-outs were relatively small in proportion to the total number that was eligible within each group.

TABLE 1

Detection of the inconspicuous word before and after reversal training

		Before Training		
	Success	Failure	N	% Successful
Elem.	3	63	66	4.5
H. S.	9	32	41	21.9
Col.	32	45	77	41.5
Ger.	2	37	39	5.1
		After Training		
	Success	Failure	N	% Successful
Elem.	11	49	61	18.3
H. S.	10	15	25	40.0
Col.	25	11	36	69.4
Ger.	17	20	37	45.9

The results of the original testing given in Table 1, were quite in keeping with our expectations, namely, that elementary school subjects and the geriatric group would show about the same level of performance with the inconspicuous word. In the case of the elementary subjects, it was reasoned that their perceptual processes had probably not yet developed a great deal of flexibility, whereas in the geriatric group, it seemed likely that some of the flexibility which had been present in earlier years would have been lost so that they would show perceptual rigidity. On the other hand, the high school students were expected to show greater flexibility than elementary or geriatric subjects but not quite as much as college students.

The results that were obtained from the four groups after reversal training were quite surprising and encouraging. Briefly, the expectations on retest were that since the geriatric subjects had already achieved a certain degree of perceptual flexibility, the reversal training might reinstate some of this, whereas for elementary subjects, who had not yet achieved any great flexibility, the reversal training would be too brief to produce any considerable change. It was anticipated that high school students would show more improvement following training than elementary or geriatric groups, and college subjects were expected to show the greatest improvement. Essentially, these expectations were confirmed by the results in Table I which were obtained after the reversal training with the exception of those for the geriatric group. Of the sixty-one returning elementary school subjects, eleven (or about 18%) located the inconspicuous word; of the twenty-five high school subjects, ten (or about 40%) found the inconspicuous word; of the thirty-six returning college subjects, twenty-five (or about 70%) found the inconspicuous word; and of the thirty-seven geriatric subjects seventeen (or about 45%) found the inconspicuous word.

While it is obvious that reversal training had a general tendency to improve performance in all groups, the change from the first to the second trial is especially dramatic for the geriatric subjects. From an initial level approximately the same as the elementary subjects, the geriatrics outdid even the high school subjects on retest. Of course, it is recognized that improvement within any given group depends upon initial level. That is, the higher the initial level the greater must be the change to show an impressive shift. Nevertheless, the relatively low initial levels of the geriatrics and the relatively high level following training suggests that some dormant but easily awakened potential for perceptual flexibility exists in these subjects that can be released with minimal effort and exercise.

The present findings will have to be followed up with further experiments to determine what is responsible for the initial differences and especially what changes so radically in the geriatric subjects following such a brief training experience. The information that is presently available indicates only that young children have difficulty in shifting from parts to the whole of a configuration (3) and that they tend to rely on immediate and passive perceptions until intellectual and perceptual growth changes this with succeeding years (1). Older subjects have likewise been found to have difficulty in ignoring irrelevant information while reacting to relevant stimuli (4) and like the very young they seem to be more "stimulus bound" and thus inflexible in their perceptual performance (2). Beyond providing some data for comparison of different age levels in perceptual efficiency, little has been done to suggest what underlying mechanisms are responsible for the differences or how performance can be improved at early ages or maintained at a higher level in older persons. At either age extreme knowledge of this sort would be useful in training as well as therapy.

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