of the subjects here, however, reported perceiving systematic brightness differences between the foveal and peripheral flashes. The difference obtained in the onset asynchronies producing maximal uncertainty between the foveal-nasal and foveal-temporal flash pairs indicates greater latency to a stimulus applied to the temporal side of the retina. This finding presents a trend similar to the average differences between foveal and peripheral reaction times reported by Poffenberger (2).

In Poffenberger's study, the excess of peripheral reaction times over foveal reaction times at 30° on the nasal retina was of the order of 9 msec; at 30° on the temporal retina, of the order of 13 msec. By comparison, the estimates of relative latency obtained here show greater latency differences both between the fovea and periphery and between the nasal and temporal positions. These latency differences are apparently a function of the specific retinal location of stimuli and therefore cannot be attributed to the amount of spatial separation (angular distance) between the stimuli. This conclusion is lent support by the finding (5) that the perceived temporal order of foveal-peripheral flash pairs is dependent on both the laterality (right or left eye) and eccentricity of the peripheral flash.

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List Differentiation with Varied Trials on Both Lists

Abstract. *Differentiation, defined as the discrimination of list membership, was studied with a recognition procedure. In each of the two studies, the number of learning trials was varied for one list and the trials on the other list were held constant. Differentiation was a U-shaped function of trials, passing through a minimum when both lists were shown equally often.*

Interference theory attributes forgetting to the learning of other material which interferes with the retention of the forgotten material. In a typical interference experiment on retroactive inhibition, subjects learn two successive lists of verbal items and are then tested on recall of the first list. The loss in retention of the first-list items, as compared with the loss in a control group not learning a second list, is a measure of retroactive inhibition and is attributed to interference from second-list learning. Retroactive inhibition has been shown by several investigators to increase with the number of second-list trials, but a problem associated with this finding has been the lack of correlation between overt intrusions (the occurrence of second-list items during first-list recall) and the amount of retroactive inhibition (*1*, *2*). To account for this discrepancy, the concept of differentiation was introduced (*2*, *3*).

Differentiation is usually defined as the discrimination of the list membership of response items. It is assumed that, because of differentiation, subjects may inhibit intrusions if they implicitly recognize some responses as coming from the second list. Thus, at high degrees of second-list learning, subjects are assumed to be unable to recall first-list items but able to discriminate the inappropriateness of second-list responses.

A general assumption of interference theorists has been that differentiation is a U-shaped function of second-list learning, with differentiation lowest when both lists have been equally learned. Such a function would help to explain both the retroactive inhibition findings just referred to and the puzzling finding from transfer studies that overlearning the first of two lists leads to a decrease in negative transfer on learning the second list (*4*).

The importance of differentiation has led recently to the development of procedures that have made possible the measurement of response availability while attempting at the same time to minimize the contribution of differentiation (*5*). We report here data from a procedure designed to measure list differentiation directly while minimizing the contribution of availability. The effects on differentiation of manipulating the number of second-list trials in one study, and first-list trials in another study, are reported.

To study list differentiation directly, subjects, after having been exposed to two lists of verbal items successively, were required to indicate in a test to which list each item belonged. By showing subjects all of the items from both lists during the test with the assurance that all test items were items already seen, and by demanding that the subjects state on which list each item appeared, a test of differentiation was accomplished. In effect, memory for context was tested.

In the first experiment, the number of first-list trials was held constant and the number of second-list trials was varied for different groups. In each session, groups of from two to ten subjects sat facing a screen. A list of 25 common English nouns was projected serially at a 3-second rate for three trials, with an intertrial interval of 15 seconds. Subjects were instructed to learn the words but were not told that there would be a second list. During the learning trials, the items were shown in different orders on successive trials. After the third trial on list 1, subjects were told that they would now be shown a second list and that they were to learn these words also. The interval between the showing of the lists was 45 seconds. List 2 was shown for one, three, or six trials, making combinations of trials on both lists of three and one, three and three, and three and six. In the second experiment, trials on list 1 were varied, with presentations of list 2 held constant at three trials. Combinations of list 1–list 2 trials of 1-3 and 6-3 were obtained. The data of the 3-3 group of the first study were used as a middle group in the second study as well.

Five groups of 20 subjects each were used. The subjects were male Columbia College students who were paid for their services. Two lists of 25 common English nouns equated for frequency (*6*) were made up. Each list served as list 1 for half the subjects in each group and as list 2 for the other half.

After the last trial of list 2, test instructions were read and the differentiation test was presented. During the test, which started approximately 4

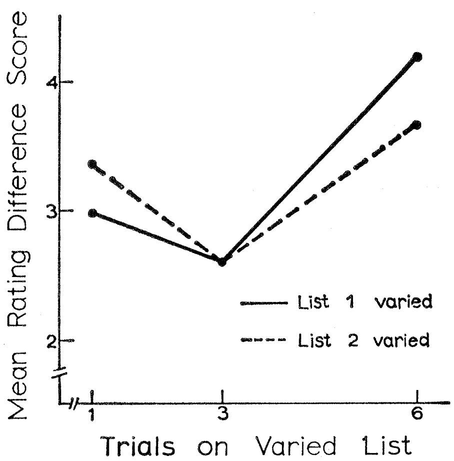

Fig. 1. The mean rating difference score for each group as a function of the number of trials on the varied list. The other list was always presented for three trials.

minutes after the final word in list 2 was shown, the 50 words from both lists were projected in a mixed order at an 8-second rate. Subjects were asked to indicate for each word their confidence that it had appeared on list 1 or list 2. They were assured that each test word had, in fact, been on one of the two lists. The subjects were instructed to use a six-point confidence rating scale in which ratings of "one," "two," and "three" corresponded to decreasing degrees of confidence in assigning a word to list 1, and ratings of "four," "five," and "six" corresponded to increasing degrees of confidence in assigning a word to list 2 (*7*). A rating of "one" meant that the subject was certain the item was from list 1, while a rating of "six" meant he was certain the item was from list 2.

A measure of each subject's differentiation was obtained by computing the difference between his mean ratings of the list 2 and list 1 words. The greater the difference score (the maximum is five) the better the differentiation between the lists. Figure 1 shows the mean rating difference score for each group in both studies as a function of the number of trials on the varied list (there were three trials on the constant list in each case). The 3-3 group serves as the mid-point for both functions. Both functions pass through a minimum at the 3-3 point. The results of a Kruskal-Wallis one-way analysis of variance show that each function differs significantly from chance ($H = 9.156$, $P < .02$, for second-list varied; $H = 21.535$, $P < .001$, for first-list varied). A more stringent test of whether the functions are significantly U-shaped was performed by comparing the differentiation score of the 3-3 group with the four adjacent points by the Mann-Whitney test. The only test that was not significant was of the 1-3 group versus the 3-3 group (for the 3-3 versus 3-1 comparison, $U = 121.5$, $P < .05$; for the 3-3 versus 1-3 test, $U = 168.5$, $P > .05$; for the 3-3 versus 6-3 test, $U = 49$, $P < .001$; for the 3-3 versus 3-6 test, $U = 97$, $P < .01$). The evidence is strong that differentiation is poorest when both lists are presented equally often. The superiority of the 6-3 over the 3-6 group, and of the 3-1 over the 1-3 group is not statistically significant in either case.

An alternative index of differentiation is the number of false identifications. False identifications were computed by regarding ratings of "one," "two," or "three" as equivalent to an identification of list 1, and ratings of "four," "five," and "six" as equivalent to a list 2 identification. Chance performance would produce a score of 25 on this measure. The mean number of false identifications for the 3-1, 3-3, and 3-6 groups are, in order, 6.90, 10.55, and 5.95. For the first-list varied groups, the comparable values are 8.60, 10.55, and 3.30. Statistical tests show the same pattern of outcomes as for the rating difference scores.

These results confirm the predictions of others that differentiation is a U-shaped function of trials on the varied list, with a minimum where both lists are of equal strength. They provide empirical support for the theoretical burden placed on differentiation in analyses of retroactive inhibition and transfer. Furthermore, our technique focuses on a phenomenon of memory which has been neglected by experimental psychologists to a considerable extent, namely the problem of the forgetting of context while retaining familiarity. A homely example is that of the teacher who has the experience of encountering on campus the familiar face of a former student without remembering in what class (or context) he knew the student. Shepard has shown that after one exposure to 540 words presented serially subjects can identify 88 percent of the words in a forced-choice recognition test (*8*). In our experiment, it is likely that the subjects were familiar with almost every word on the differentiation test, yet the 3-3 group achieved an identification score only 60 percent above chance. Apparently, the forgetting of context is a substantial phenomenon. Specification of the functional stimulus for the discrimination of list membership remains a task for research before the implications of these findings can be elucidated. However, our results indicate that the relative strengths of two response systems play an important role in their differentiation.

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Optomotor Responses by Echolocating Bats

Abstract. *Optomotor responses to moving stripes have been elicited from nine species of Microchiroptera. The minimum separable visual angle of two phyllostomids, under the experimental conditions, probably lies between 3.0 and 0.7 degrees; that of* Myotis lucifugus, *between 6.0 and 3.0 degrees. Four species indicate an ability to resolve stripes subtending 0.7 degree, the narrowest tested.*

Bats of the suborder Microchiroptera have a highly developed system for acoustic orientation, but little is known concerning their visual capabilities. All-rod retinas, lacking the mammillations characteristic of the Megachiroptera, have been reported in 16 species studied histologically (*1*). There is behavioral evidence, consisting largely of conditioned responses, indicating an ability by at least four species (*Myotis lucifugus, M. sodalis, Eptesicus fuscus,* and