category, and therefore, the observed relationships occurred under equivalent response repetition conditions.

It is of theoretical importance to establish that the apparently continuous results presented in Fig. 1 are not a misrepresentation of a discrete function. That is, the continuous variation in the mean reaction speed of the various categories may be due to differences in the proportion of trials on which the S is "set" in a discrete way. For this reason, an analysis of the distribution of reaction times in each of the categories was calculated and plotted by an IBM 360 computer system. As is evident in Fig. 2, the distribution of times in each category is relatively normal and is definitely unimodal. Although the distributions presented in Fig. 2 are summed over all Ss, the distributions for each S were examined and also found to be unimodal.

DISCUSSION

The results presented in Fig. 2 are critical for the interpretation of Fig. 1. That is, the singularity in mode of each distribution implies that there are, indeed, several discrete levels of expectancy or that expectancy is, in fact, a continuous dimension. Perhaps the notion of expectancy as a continuous dimension can provide the most parsimonious explanation of the present data.

In addition to replicating the earlier finding that Ss respond faster to predicted than to nonpredicted stimuli (e.g., Keele, 1969; Hinricks & Krainz, 1970), the present study demonstrated intrasequential effects on CRS of the prediction outcomes which preceded an event. Specifically, third-order sequential effects were indicated by the significant interactions between the outcome of preceding predictions (correct vs incorrect) and the run length of that prediction outcome. The interaction between prediction outcome and run length preceding predicted stimuli confirmed the hypothesis generated by the continuous expectancy notion entertained herein. That is, according to the notion that expectancy is a continuous process, a run of correct prediction outcomes increased Ss' degree of expectancy for the next predicted stimulus, which in turn augmented the response facilitation to identify a correctly predicted stimulus. On the other hand, a run of incorrect prediction outcomes reduced Ss' degree of expectancy for the stimulus predicted and thus decreased the facilitation to identify a correctly predicted stimulus.

However, the observed interaction between prediction outcome and run length preceding nonpredicted stimuli

was not as hypothesized. Therefore, a response facilitation notion should be expanded to explain the present finding that a preceding prediction outcome influences CRS to an incorrectly predicted stimulus. In other words, preceding correct predictions facilitate Ss' reactions to subsequent stimuli, even though the stimuli may be nonpredicted; likewise, preceding incorrect prediction outcomes reduce response facilitation to nonpredicted stimuli.

Consequently, whether or not stimulus expectancy or response facilitation are appropriate mediating mechanisms for the present CRT task, it was apparent that Ss were not simply faster following correct predictions and slower following incorrect predictions; rather, given a correct or incorrect prediction, Ss' reaction speeds were influenced by the prediction outcomes on immediately preceding trials. Thus, the present

results indicated that CRT models which describe prediction outcome effects must account for the fact that there are at least third-order sequential effects of prediction outcome.

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Encoding as a function of the presentation-rehearsal interval in short-term memory*

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The Ss participated in a short-term memory distractor task in which the presentation-rehearsal interval was systematically varied. Three presentation-rehearsal intervals were employed: a 2-sec (2-0) visual presentation group, a 5-sec (5-0) visual presentation group, and a 2-sec visual plus 3 sec of additional rehearsal time (2-3) group. Both recall and recognition test results showed the 2-3 group's performance to be the same as the 2-0 group. Increased rehearsal time, without the TBR material present, did not result in an increased level of encoding, while increased rehearsal concurrent with increased visual presentation (the 5-0 group) did allow an increased complexity of encoding.

Anisfeld & Knapp (1968) proposed that when a word is stored for future retrieval it is stored as a "feature complex." This complex is a composite of the word's physical, acoustic, and semantic characteristics. During the presentation of the word, the S engages in an analysis and a storing of the presented word on the basis of these characteristics.

It has been proposed further that these "features" of encoding should be thought of as a hierarchy of encoding "levels," the more complex the level, the more time it takes to encode on that level (Cermak, 1970). Physical characteristics are more readily

encoded than are the acoustic, which in turn take less time than the semantic. Consequently, the more time the S has to encode a word, the higher the level of encoding he is likely to achieve and the more precision he can attain within that level of encoding.

Several studies have demonstrated that the longer the presentation-rehearsal interval in an STM distractor task, the greater the retention (e.g., Peterson & Peterson, 1959; Pollack, 1963; Miller, 1970). However, in all these cases, the S was either instructed to repeat the TBR item a specified number of times or the material was present visually for the entire interval. Research of this type has always assumed that the S actively processes the information throughout the entire interval and that the increased processing time results in increased recall probability. The purpose of the

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present experiment is to determine whether or not Ss actively process information when it is not present. This problem was investigated by giving Ss additional time without an increase in the amount of visual presentation time before initiating the distractor in a STM task. Recall was measured following the distractor task. A recognition task, similar to that used by Grossman & Eagle (1970) to determine level of encoding, followed the entire experiment.

SUBJECTS

The Ss were 90 undergraduate psychology students at Tufts University who chose to participate in the experiment as partial fulfillment of course requirements. They were assigned to one of three groups in order of appearance.

DESIGN

The Peterson & Peterson (1959) technique was used, in which a word triad was projected on a screen for a predetermined amount of time; the S was then distracted from rehearsal until recall was signaled. The distractor task consisted of counting backward by threes from a number flashed on a screen in time with a metronome beating at 1 beat/sec. Additional trials followed, consisting of different word triads but using the same procedure. Eight sets of word triads were presented, consisting of 24 common English words bearing no obvious acoustic or semantic relationship to each other.

The experimental conditions differed in terms of the length of the presentation-rehearsal interval. The triads were projected on the screen for 5 sec (5-0), 2 sec (2-0), or 2 sec, followed by 3 sec (2-3), during which a shutter closed over the lens of the projector. The timing and sequence of events was: asterisk (ready signal), 2 sec; word-triad presentation, either 2 or 5 sec; retention interval, 15 sec; recall interval, 10 sec; and a rest interval of 6 sec. The Ss' responses during the 10-sec recall interval were recorded. Immediately following the final trial, a recognition task was presented and Ss were instructed to circle the words which had been previously presented. The recognition task consisted of a list of three 23-word columns dittoed on a vertically held sheet of paper. Only 9 of the 69 words had been previously presented. The rest of the list consisted of 15 synonyms and 15 homonyms of the words presented in the experiment. Thirty unrelated words were included as filler words on the recognition list.

APPARATUS

The S was seated in a small room, facing a screen, upon which the stimulus material was projected by a

Table 1
Mean Number of Words Circled in a Recognition Task as a Function of Presentation Group, Divided into Correct Responses, Acoustic and Semantic Errors

	Presentation Group		
	2-0	2-3	5-0
Correct Responses	3.93	4.47	4.53
Acoustic Errors	2.47	2.03	2.63
Semantic Errors	1.47	1.37	2.40

Carousel 800 projector. Four sample cards were presented to familiarize the S with the type of material to be presented. A Seth Thomas electric metronome, beating at 60 beats/min, comprised the rest of the apparatus.

RESULTS

There was a significant difference between the presentation groups, $F(2.87) = 4.94$, $p < .01$, in the percentage of words that were recalled correctly during the recall interval following the distractor task. The 5-0 group, which recalled 72.4% of the words presented during the experiment, differed from both the 2-0 group (59.3% correct) and the 2-3 group (64.0%), $ts(58) = 3.10$ and 1.98 , $p < .05$. The 2-0 and 2-3 groups did not differ from each other on this recall score.

The results of the recognition task are shown in Table 1. A correct response was recorded when the S circled a word that had actually been presented during the experiment. An acoustic error occurred when the S circled a homonym, i.e., a word which sounded like a presented word. A semantic error occurred when a synonym was circled. The unrelated words that were circled were so few that they were left out of the analysis. Separate analysis determined that significantly fewer ($p < .01$) unrelated words were circled than words from any of the other categories.

Only two between-group comparisons were significant on the recognition task. These occurred when the semantic errors made by the 5-0 group were compared with those of the 2-0 and the 2-3 groups, $ts(58) = 1.85$ and 2.15 , $p < .05$. The 2-0 and 2-3 groups each made more acoustic than semantic errors ($p < .05$), but there was no difference in the type of errors made by the 5-0 group.

DISCUSSION

The three treatment groups differed only in the nature of the presentation-rehearsal interval; therefore, the difference in performance was probably a function of how well the material was encoded. The 5-0 group's superior performance over the 2-3 group during recall following the distractor task indicates

that rehearsal time alone is not the sole determinant of how well information is encoded. The 5-0 group's superior performance over the 2-0 group on the same task does indicate that increased visual presentation time has an effect on recall probability. Apparently, the length of the visual presentation-rehearsal interval is a major factor in determining how well information is encoded. This is further supported by the fact that three additional seconds of encoding time without visual presentation did not facilitate recall performance for the 2-3 group when contrasted to the 2-0 group.

The recognition task provides evidence about the complexity of encoding achieved by each group. The finding that there were no significant differences in the number of acoustic recognition errors made by the different groups indicates that maximum acoustic encoding had taken place within 2 sec. Increased rehearsal time did not increase further the precision of the acoustic encoding but was used to initiate encoding on a semantic dimension. This semantic encoding did not reach a precise level, as indicated by the fact that the 5-0 group made significantly more semantic errors than any other group on the recognition task. However, unlike the other two groups, some semantic encoding had taken place, since confusions in meaning can occur only when some meaning has been encoded (Anisfeld & Knapp, 1968; Cermak, 1970).

In summary, increased visual presentation allows encoding to progress toward a more complex level of analysis than can occur at the shorter presentation intervals. However, mere increases in rehearsal time, not accompanied by visual presentation, does not result in an increased level of encoding.

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