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The Influence of Error Density on Error Detection Efficiency

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THE INFLUENCE OF ERROR DENSITY ON ERROR DETECTION EFFICIENCY

By

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A Thesis

Submitted in Partial Fulfillment of the

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May 4, 1959
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TABLE OF CONTENTS

LIST OF TABLES

LIST OF ILLUSTRATIONS

CHAPTER 1

INTRODUCTION

The problem of maintaining efficiency in monotonous perceptual tasks has become increasingly important in recent years. Technological advances have increased automation which requires human monitoring of equipment which seldom fails. Radarscopes must be searched by air force personnel for unidentified objects which appear infrequently. Inspection of products in industry represents another monitoring task, to mention a few.

The error of not detecting machinery failures, foreign objects, or imperfect products is of major interest. Regardless whether the error is attributable to mechanical or human perceptual or motor disturbances, the consequence remains the same if the error is allowed to go undetected, i.e., loss of human energy, time, and expense.

Statement of the problem.--It was the purpose of this study (a) to investigate the effect of error density (level, rate, or number of errors) on checking efficiency in a proofreading situation under normal conditions, i.e., comfortable working conditions without stress; and (b) to investigate the effects of experience in detecting errors at one level of density on the detection of errors at a later time in which the density level has been changed. This would show if there is a relationship between signal detection and habituation as well as signal density, and would reflect the possible role of learning in the detection of error signals.

Specifically, the present study was a simulated proofreading experiment. The primary hypothesis stated that checking efficiency,

in terms of percentage of errors caught, increases with the density of errors in the material. As shall be seen in Chapter II, experiments in radar monitoring and dial reading point to the correctness of this hypothesis. The writer was interested in examining proofreading behavior to determine if similar relationships between these variables were present.

Information was also sought on the following subsididary problems. (c) Do false reports (reporting the detection of an error when one is not present) correlate with the probability of error detection? (d) Are different kinds of typographical errors of grossly unequal difficulty to detect?

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CHAPTER II

REVIEW OF THE LITERATURE

Much of the literature concerning our present problem is to be found in technical reports made by or for various branches of the armed services. The majority of the studies deal with factors of time or density in relation to signal detection. Signal refers to those stimuli that the O is instructed to detect.

Sustained activity.--Recent studies on operators monitoring visual displays having infrequent signals indicate a drop in the percentage of signals detected as time on the watch progresses. Mackworth (12) has demonstrated that Ss' efficiency in detection of signals declined as a two-hour watch progressed. The signals were double steps of a clock hand normally stepped 0.3 inches every second. There were 24 double steps per hour which were given at irregular intervals. A breakdown of the two-hour watch into four successive half-hour spells shows that checking efficiency decreased in terms of percent signals detected to 84.3, 74.2, 73.2, and 72.0, respectively. Similarly, an analysis of the data into one-hour-watch periods demonstrated the same advantage in favor of the first half-hour (84.7) compared with the second (69.6). Mackworth interpreted the decrease in efficiency in time as an example of partial experimental extinction of a conditioned voluntary response, this extinction being the product of a lack of reinforcement arising from the absence of knowledge of results. He considered minor stimulus-to-stimulus variations in efficiency to depend more on the S's opinion of the likelihood of a signal occurring at a given moment. Similar decrements in Ss' ability to detect

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In contrast to the above studies, other investigators have failed to find such a decrement in the S's ability to detect signals under sustained activity. Broadbent (2) employed latency of detection of nontransient signals (signals remained until detected) as his criterion of checking efficiency instead of percentage of signals detected as in the previous studies mentioned. He found no increase in the average latency of detection, rather an increase in variance. This could be explained by the difference in response measure employed in this study and that mentioned above. Mackworth's and Deese's Ss had less time to detect a signal than Broadbent's Ss. Specifically, the response measure for the former was all-or-none, whereas the latter's measure was continuous. Whether a decrement was found or not, the underlying fact emerging from these studies is that many signals definitely above the absolute threshold were not detected early, midway, or late in the session.

Signal density.--Deese and Ormond (5) employed a PPI-type cathode ray to simulate a search-radar' scope. Targets were presented at rates of 10, 20, 30, and 40 per hour during a three-hour watch at variable time intervals, resulting in 46, 64, 83, and 88 percent detection, respectively. Mackworth (13) also varied signal density and found that signal detection improved as signal density increased.

In a study designed to determine factors influencing the operation of special double-number dials, Weldon et al (19) studied the infrequent signals have been shown to decrease [illegible] response to [illegible] targets on simulated radar displays (13). Similar results have been found for industrial inspectors (20).

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Signal density.--Deese and Ormond (9) employed a [illegible] ray to simulate a search-radar scope. Signals were presented at rates of 10, 20, 30, and 40 per hour during a three-hour watch at variable time intervals, resulting in 19, 26, 31, and 32 percent detection, respectively. Jenkins (13) also varied signal density and found that signal detection improved as signal density increased.

In a study designed to determine factors influencing the perception of special [illegible], Wallace et al (?) [illegible] effect of error density on error detection in which Ss were asked to check dial settings to determine if they were accurate. Errors were built-into the dial setting procedure at percentages of 1.72, 6.31, 10.17, 13.10, 17.80, and 21.35, resulting in 80.65, 86.34, 93.44, 96.19, 96.88, and 95.31 percent detection, respectively. These data offer more evidence that checking efficiency is a function of density and the probability of an error being detected increases with error density. It is possible that dial setting ability could explain this trend rather than the number of errors faced. However, an analysis of scores on a test of dial setting ability for the various groups made it safe to conclude that dial checking ability in different groups was not responsible for the relationship of error density to checking efficiency.

Theory based on this current work tends to ignore the classical problem of description of subjective states in attention, set, or vigilance. Rather, it has centered around theoretical concepts somewhat useful in describing the relationship between efficiency in detecting signals and various environmental conditions.

Mackworth (12) tentatively postulated vigilance as an excitatory state, and in opposition to it, he proposed an inhibitory process analogous to the concept of external inhibition discussed in the literature on classical conditioning. The decrement in performance is regarded as an example of partial extinction in which an inhibitory state is built up. Improvement in performance following a distraction is intrepreted as a form of disinhibition suggesting the existence of an inhibitory state. When performance returns to the initial level after a break from the vigilance task for an alloted time it is effect of error density on error detection at [illegible] given to check dial settings to determine if they were accurate. Errors were built-into the dial setting procedure in percentages of 1.72, 6.33, 10.17, 13.10, 17.80, and 21.35, resulting in 90.65, 94.86, 95.12, 96.19, 96.58, and 97.31 percent detection, respectively. These [illegible] offer more evidence that checking efficiency is a function of density and the probability of an error being detected increases with error density. It is possible that dial setting ability would explain this trend rather than the number of errors found. However, an analysis of scores on a test of dial setting ability for the various groups made it safe to conclude that dial checking ability in different groups was not responsible for the relationship of error density to checking efficiency.

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Deese (4) takes issue with the application of the inhibitory construct. Mackworth assumes that a continuous decline in detectability is the rule for visual search under monotonous conditions, but studies by Deese and Ormond (5) indicate that sometimes detectability rises instead of falls with continuous search and curves of detectability fluctuate in a highly irregular manner as a function of time. Rather than introduce an "unnecessary" inhibitory construct for any linear decline in the O's ability to detect signals, Deese assumes this represents a dissipation in the initial excitatory state of vigilance.

Deese has suggested two alternative hypotheses, reinforcement and expectancy. The basic assumption involved in both, is that the maintenance of a given level of vigilance in an O depends to some extent upon stimulus events extrinsic to the O.

Sometimes there is a linear decline in the probability of detection, often times not. The reinforcement hypothesis assumes that the signals which occur in the O's field of search determine the future course of his detectability. Specifically, either the <u>occurance</u> or the <u>detection</u> of a signal leads to a near return to the O's initial state of vigilance. One prediction following from this statement would be that signals close together in time will, on the average, have a higher probability of detection than signals spaced at longer intervals. Or, rather than predict from the rate of explained as spontaneous recovery from the inhibitory state. In a paper on classical conditioning and human watch-keeping, [illegible] shares Mackworth's opinions and can also used the idea of stimulus selectivity to explain monitoring behavior and classical conditioning.

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The expectancy hypothesis put forth by Deese (4) assumes that the excitatory state of vigilance is maintained in the following manner: "(a) the O's expectancy or prediction about the search task is determined by the actual course of stimulus events during his previous experience with the task, and (b) the O's level of expectancy determines his vigilance level and hence his probability of detection." The concept of expectation determining efficiency leads to the same prediction as the reinforcement theory in regards to detectability and the average rate of signal appearance i.e., signals at a high frequency have a higher probability of detection than signals at low frequency. However, they differ in regards to the intersignal question. The reinforcement hypothesis predicts that detectability of a second signal would be greater the smaller the interval between two signals. The expectancy hypothesis merely predicts that the detection of a given signal should be determined by the average of all signal intervals before the one in question. Thus, if the distribution of signal intervals is a random function of time, the probability of detection for any given signal in a series would be the same as that for any other signal.

The two hypotheses offered by Deese seem to differ on an elementary point, whether the probability of detection for a given signal is determined only by the temporal location of the signal immediately preceding the signal in question or whether it is determined by a rather indeterminate number of signals preceding the signals, it could be hypothesized that the detectability of a second signal would be greater the smaller the time interval between the signals.

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In reviewing the studies presented above, Holland (8,9) felt the response measures were inadequate since the Es were not able to say what it was that changed during the monitoring task, i.e., whether percentage of signals detected is vigilance or result of vigilance. In an attempt to discover more relevant data, he applied an operant behavior model to the study of monitoring behavior. He hypothesized that success in detecting signals might depend on the emission of responses which make detection possible and termed these observing responses. Moreover, these observing responses might follow the same principles as instrumental responses and be controlled by the same type of environmental variables. Thus, in this scheme, detection of signals would be reinforcement for the observing responses.

Various schedules of signal presentation were employed to determine whether signal detection could serve as reinforcement for observing behavior. Working in the dark, Ss were required to report deflections of a pointer on a dial. The pointer was visible only when the S pressed a key which provided a flash of light for 0.07 second that illuminated the face of the dial. If a signal was detected, it was reported by pressing another key, which reset the pointer.

Ss encountering a fixed interval schedule began with a 1/2 minute interval schedule and after eight 40-minute schedules, the interval was increased to 1, 2, 3, and 4 minutes for eight sessions signal in question. The operating hypothesis, however, is that it is capable of extracting data from the [illegible] signal [illegible]. The reinforcement hypothesis suggests that the observer learns to perceive signals and concentrates on the task [illegible].

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Next, Ss encountered a fixed-ratio schedule of 36 observing responses before the pointer deflected for six 40-minute sessions, followed by 60, 84, 108, and 200 observing responses respectively. In this situation the S could minimize the number of signals by not responding. However, examination of these curves shows that Ss maximized the number of signals detected by observing at a high rate, rendering these results characteristic of conventional reinforcement on fixed-ratio schedules, since closely spaced responses were reinforced. Up to this point Holland demonstrated that signal detections could control the probability of emission of observing responses, thereby serving as reinforcement for these responses.

In order to determine whether the schedules used in classical vigilance studies would generate observing rates parallel to the probability of detection data cited previously, Holland conducted the following studies. Holland's first study dealt with those vigilance studies in which Mackworth and Deese demonstrated a decrement in the probability of detection as a detection session progressed. To tie this phenomenon in with his work, he presented 20 signals per hour to four Ss on a variable-interval schedule. All the Ss showed lower observing rates in the latter portions of the session. This decrement could be explained by the fact that each. Inspection of cumulative response records for each of the different fixed intervals shows a period in which no observing responses are emitted following each detection but an acceleration to a high rate before the next signal. This temporal discrimination indicates that the observing rate is dependent on detections, or reinforcement.

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Previous vigilance studies also demonstrated that the percentage of signals detected increases as the signal frequency increases. To determine if rate of observing responses also increases, Holland presented signals on variable-interval schedules at 30, 60, 120, and 240 per hour in blocks of three 1-hour sessions to two Ss. The cumulative responses records show that the rate of observing is highest for the high signal rate and decreases as the signal rate decreases. Again this finding not only parallels results found in classical vigilance, but, likewise, variable-interval reinforcement in operant conditioning which shows high response rates to be associated with schedules having a short average interval (high density).

Holland's studies have demonstrated that signal detections can serve as reinforcements for observing responses. Further, detection data from vigilance studies may reflect the observing response rates generated by the particular schedules employed. He has provided a means of analysis at the behavioral level. Practical application of this data points to the acknowledgement of the precise control exerted by the environment over observing behavior in human operators, and that a variable interval schedule of signals appears to be the most promising schedules for situations in which it is desirable to maintain vigilance.

CHAPTER III

EXPERIMENTAL DESIGN AND PROCEDURE

Materials.--Two pilot studies suggested the length of the manuscript should be limited to 15 pages to allow college students ample time to complete their simulated proofreading task within the time alloted for a normal class period. The manuscript was chosen on the basis of word familiarity, interest, and lack of emotion-provoking content, argumentative issues, or an exciting climax which might hinder Ss in their task of error detection.

Vernon (16) found that proofreaders were able to indefinitely maintain a mental set toward reading material with misprints of such a nature that the general meaning of the content was relegated to the background, the center of consciousness being occupied with the recognition of small details of the structure of letters and words. Since the Ss in the present study were nonprofessional proofreaders the requirements for the selection of the manuscript were adherred to as far as possible in order to aid the Ss in maintaining a mental set toward typographical errors and, at the same time, not become involved in the content of the material.

An excerpt from Andre Seigfried's book entitled Canada (15) served as the proofreading material. Permission was obtained from the publishers (Harcount, Brace and Co., Inc.) of the book to reproduce Chapter II, Geography and the Canadian Problem. It was thought that this selection met the criteria imposed upon the manuscript to be used, thereby, aiding Ss to assume the main characteristic of proofreading.

Subjects.--Two-hundred and sixteen students were selected at random from the undergraduate student body of the University of New Mexico.

Purpose and nature of built-in-errors.--To test the hypothesis that checking efficiency is a function of error density, the experiment was designed to confront different groups of Ss with manuscripts varying in the rate of errors. The 216 Ss were randomly assigned to six groups. Group I through VI consisted of 36 Ss each who faced 6, 9, 15, 30, 60, and 120 built-in-errors per five pages, respectively. Checking efficiency was defined as the ratio of the number of errors detected to the total number of errors present. Error level refers to the number of errors encountered per five pages.

Errors were systematically built into the material. This was accomplished by typing the 15 page manuscript onto six different sets of stencils. In this way a definite number of typographical errors could be inserted by the typist as a particular set of stencils was typed. This rendered all the manuscripts identical in content, for all practical purposes, yet different in the number and placement of errors for each group.

Uncontrolled factors might possibly be introduced if E arbitarily assigned the errors in the manuscripts. Therefore, for each error that was inserted a table of random numbers was utilized to determine separately the line, the specific word in that line, the letter(s) to be altered in that word, and the type of error to be introduced.

Classification of errors.--The study was not primarily concerned with the kind of typographical error used in the proofreading

situation. Three types of error were selected from a tabulated list of typographical errors prepared by Scheidt (14) on the basis of their prominance. The errors chosen were omission, transposition, and substitution. Table 1 classifies, describes, and illustrates the three types of errors used in the study.

In order to avoid a situation wherein the six groups would be confronted with errors that were of grossly unequal difficulty to detect, the errors were introduced in proportionate numbers for the six different sets of manuscripts. This was easily accomplished since the various error levels were multiples of three. Thus, at the six error level, a S encountered each type of error twice; at the nine error level, each error three times, etc.

Instructions and procedure.--Each S received written directions which were orally read by the E at the beginning of the task. An attempt was made to establish a definite mental set as to the type of error Ss were to locate. For the purpose of the study, a typographical error was defined as any misspelled word or any word which did not fit the context of a sentence, i.e., cone instead of come. (The second clause of the definition was necessary due to the random method employed in inserting errors. The reader will recall that placement and type of error were randomly distributed without access to the actual manuscript to avoid any bias on the part of the E.) Ss were instructed to locate all the errors which fit this definition and to mark them with an X. Ss were not allowed to proofread the manuscript a second time.

Table 1

CLASSIFICATION OF BUILT-IN-ERRORS

Error	Description	Example
Omission	One letter deleted	your - yor
Transposition	Exchange in position of two adjacent letters	time - tmie
Substitution	One letter wrong	work - wark

Since Ss were drawn from several classes, they were randomly assigned to one of the six groups so that a particular class would not have an opportunity to bias any one error level.

CHAPTER IV

RESULTS

Checking efficiency at various error levels.--Although the manuscript dealt with one topic, and can be treated as continuous material, the error density was determined for each 5-page sequence so that three sets of data could be compared. The error level for the first 10-pages of any one manuscript remained constant. That is if a S encountered a 6 error level for the first 5-pages, the same error level followed in the second 5-pages. Thus, it was possible to study the effect of error density on checking efficiency for each set of data and at the same time measure the stability of the phenomenon under consideration.

Figure 1 shows how probability of detection varies as a function of error density for the first and second 5-page sequences. In general, error detection tends to increase with increasing error density up to an optimum point beyond which increments in error density reduce the probability of detection. Table 2 contains the data on percent error detection as a function of error density.

The combined mean percent errors detected by the various groups for the first 10-pages presented in Figure 2 shows the relationship between error detection and error density. Inspection of the curve reveals a steady increase in error detection as error density increases, with a tapering effect at the higher density levels.

The analysis of variance performed on percentage error detection presented in Tables 3 and 4 yeilded F ratios of 14.65 and 7.53 respectively, both of which were significant beyond the 1% level

CHAPTER IV

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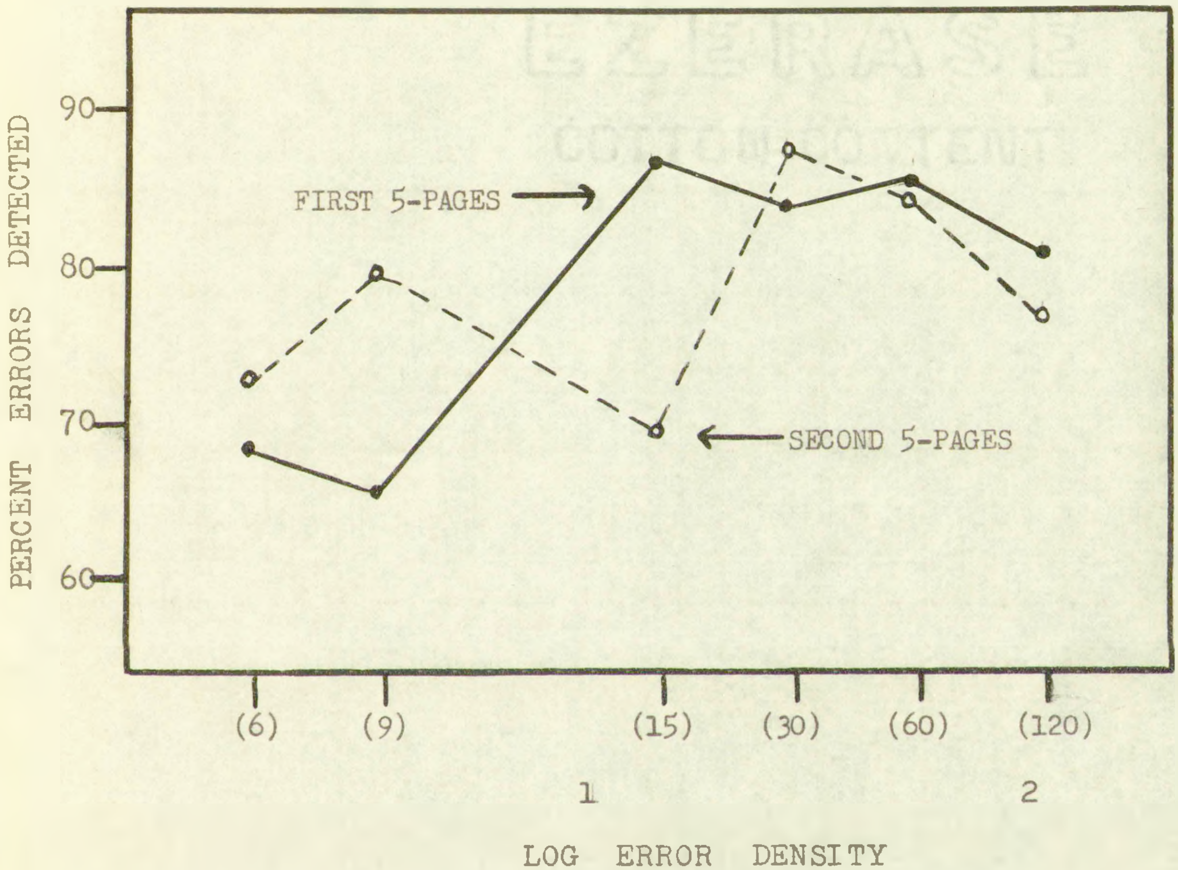

Figure 1. Percent Errors Detected as a Function of Average Rate of Error Appearance. The Number in Parenthesis is the Actual Error Level. Each Point Represents the Average Percent Errors Detected for 5-pages of Continuous Search for 36 Ss.

Table 2

RELATIONSHIP BETWEEN ERROR DENSITY AND MEAN PERCENT ERRORS DETECTED FOR VARIOUS GROUPS

Group	Error Density	Percent Errors Detected Pages 1-5	 6-10	 1-10
I	6	.688	.727	.708
II	9	.663	.802	.733
III	15	.871	.698	.784
IV	30	.844	.878	.861
V	60	.856	.850	.853
VI	120	.812	.774	.793

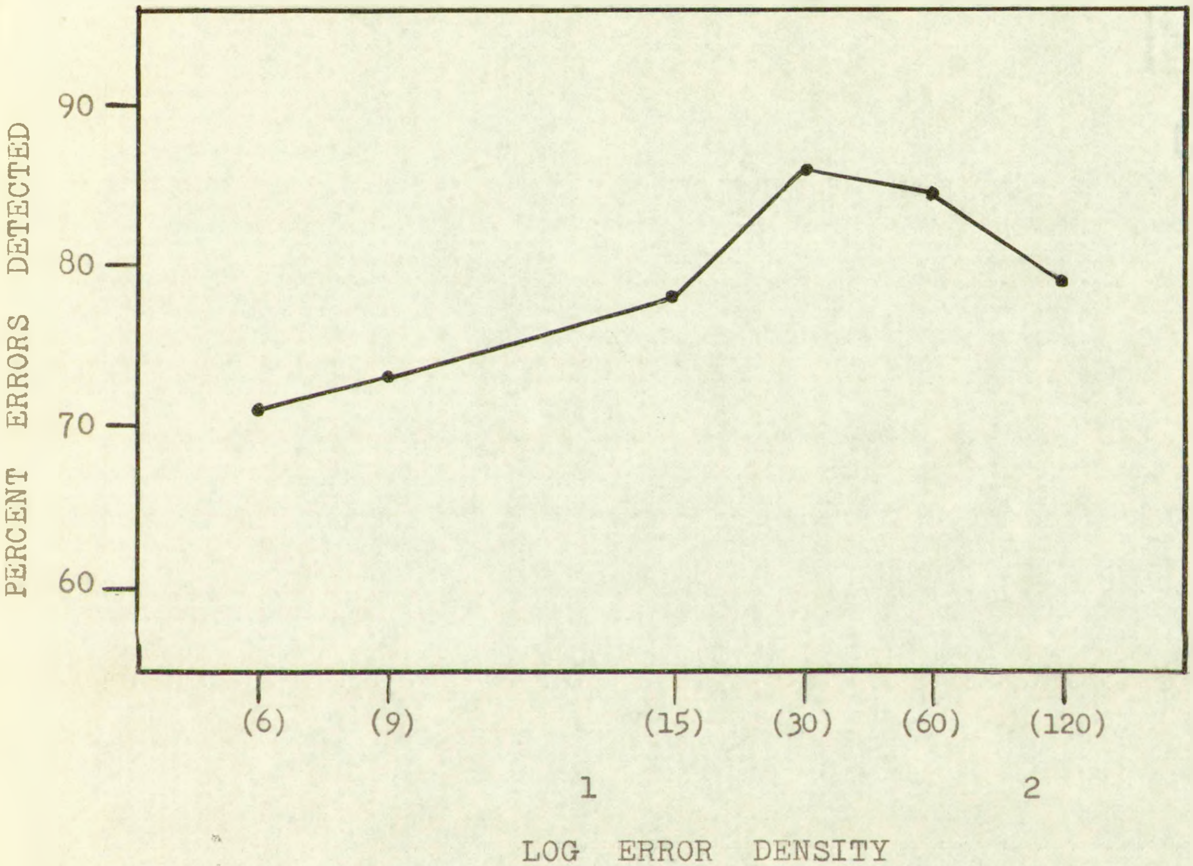

Figure 2. Percent Errors Detected as a Function of Average Rate of Error Appearance. Each Point Represents the Average Percent Errors Detected for the First and Second 5-page Sequences Combined.

Table 3

ANALYSIS OF VARIANCE OF PERCENT ERRORS DETECTED

IN FIRST 5-PAGES FOR VARIOUS GROUPS

Source of Variation	Sums of Squares	df	Mean Square	F
Error density	1.463	5	.293	14.65**
Within	4.156	210	.020	
Total	5.619	215		

** Significant at 1% level

Table 4

ANALYSIS OF VARIANCE OF PERCENT ERRORS DETECTED

IN SECOND 5-PAGES FOR VARIOUS GROUPS

Source of Variation	Sums of Squares	df	Mean Squares	F
Error Density	.865	5	.173	7.53**
Within	4.803	210	.023	
Total	5.668	215		

** Significant at 1% level

of confidence. Thus, the statistical analysis supports the conclusion that error detection varies as a function of error density. Figure 1 and 2 demonstrate that the difference in probability of detection produced by the various error levels is in the direction predicted; the group presented with errors at the lowest rate had the lowest detection and detection increased as error density increased until the highest levels were reached. Moreover, since both sets of data (first and second 5-pages) were statistically significant, and the general shape of the curves remained similar, it would seem to indicate that the relationship between error density and checking efficiency was stable under the conditions imposed by this experiment.

Hartley's (17) F max test was utilized to test for homogeneity of variance for samples of uniform size. The critical region was 2.91 and above. The F ratios were 5.38 and 4.85 for the first and second 5-page sequences respectively, indicating that the variances of the several samples are not equal and the hypothesis of homogeneity of variance was rejected. It is felt, however, that although the assumption of homogeneity of variance could not be strictly met, that this does not invalidate the use of the F test in this study. Lindquist (11, p.86) has pointed out that "in general, unless the heterogeneity of either form or variance is so extreme as to be readily apparent upon inspection of the data, the effect upon the F distribution will probably be negligible." Lindquist does recommend, however, that if one cannot meet the assumption of homogeneity of variance, that the level of significance be increased from, say, the 5% level to the 2.5% level in order to be more on

the safe side. Since the F ratio for error density was significant beyond the 1% level, this recommendation is effectively met.

False detections at various error levels.--Deese (4) states that false reports vary from one individual to another, and do not correlate with the probability of detection in his radar monitoring studies. False detections in this study occurred when Ss reported the appearance of an error by marking a word with an X when the word was not actually a typographical error. Since data of this nature were readily accessible, the answer to this problem was considered as an additional objective.

Table 5 shows the total number of false detections for each group of Ss at the various error levels. An analysis of variance on the false detection data presented in Table 6 yeilded an F of 2.41 which was significant at the 5% level. From Table 5 it appears that the frequency of false detections is independent of error density. There is no systematic increase in false detections as a function of error density as was demonstrated with the probability of correct detection. Moreover, analysis of variance of the false detections in the second and third sets of data presented in Tables 7 and 8 failed to show any such significant effect. Since statistical analysis for the latter two sets of data failed to bear out the initial finding that false reports are related to error density in an unsystematic fashion, this suggests that the relationship between false detections and error density is probably quite unstable.

Error difficulty in error detection.--The three kinds of typographical errors employed in this study were described in Table 1.

the safe side. Since the [illegible] beyond the 1% level, it is [illegible] to [illegible].

False detections in various error density levels. [illegible] that false reports [illegible] would correlate with the probability of detecting the [illegible] stimulus. False detections in this study referred to the reporting the appearance of an error in a particular [illegible] which was not actually a typographical error. Since data of this nature were readily obtainable, the attempt to [illegible] as an additional objective.

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Error difficulty in error detection. [illegible] typographical errors employed in this study are [illegible] in Table 1.

Table 5

RELATIONSHIP BETWEEN ERROR DENSITY AND FALSE DETECTIONS FOR VARIOUS GROUPS

Groups	Error Density	False Detections Pages 1-5	6-10	1-10
I	6	107	74	181
II	9	71	62	133
III	15	64	60	124
IV	30	140	89	229
V	60	73	101	174
VI	120	78	110	188

Table 6

ANALYSIS OF VARIANCE OF TOTAL NUMBER OF FALSE REPORTS BY SUBJECTS FOR FIRST 5-PAGES

Source of Variation	Sums of Squares	*df*	Mean Square	F
Error Density	118.079	5	23.616	2.414*
Within	2054.695	210	9.784	
Total	2172.774	215		

* Significant at 5% level

Table 7

ANALYSIS OF VARIANCE OF TOTAL NUMBER OF FALSE REPORTS

BY SUBJECT FOR SECOND 5-PAGES

Source of Variation	Sum of Squares	*df*	Mean Square	F
Error Density	59.426	5	11.885	1.511
Within	1651.612	210	7.865	
Total	1711.038	215		

Table 8

ANALYSIS OF VARIANCE OF TOTAL NUMBER OF FALSE

REPORTS BY ROWS, COLUMNS, AND INTERACTION

Source of Variation	Sum of Squares	df	Mean Square	F
Present Error Density	43.524	2	21.762	2.173
Previous Error Density	75.778	5	15.156	1.513
Present X Previous Error Density	57.032	10	5.703	-----
Within	1983.000	198	10.015	
Total	2159.334	215		

In order to determine if one error was more difficult to detect than another, the errors were inserted in proportionate numbers at the various error levels to achieve equal representation at each level.

Studying the 216 manuscripts collectively (combining the various error levels) appears to indicate that type of error plays a role in error detection. Table 9 gives the total mean percent error detection per type of error. It can readily be seen that the most difficult type of error to detect was omission, followed by transposition and substitution.

A breakdown of the data into the first, second, and third 5-pages (error levels still combined) is likewise found in Table 9. Inspection of this Table indicates that each type of error retains its relative position in detection difficulty in each phase of the study.

Influence of previous density on present density.--The first 10-pages of the manuscript were concerned with the influence of error density on checking efficiency, whereas the entire manuscript was involved in the secondary problem of determining the effect, if any, of previous density on present density. The first 10-pages became the previous density; the last 5-pages acted as the present density. This was an attempt to determine if Ss develop some sort of habituation or learned set as a result of having 10-pages of proofreading experience with a fixed density level. If this was the case, then presumably the effect of this habituation would appear if the density level were changed for the last 5-page sequence.

Just as the first and second 5-pages were subdivided into six different groups varying in error density, the third 5-pages were

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Table 9

MEAN PERCENT OF EACH TYPE OF ERROR DETECTED

BY TOTAL SUBJECTS AT ALL LEVELS

Classification of Error	Mean Percent Error Detected 1-5	6-10	11-15	Total Mean Percent Error Detected
Omission	.761	.744	.720	.742
Transposition	.822	.776	.810	.803
Substitution	.891	.889	.870	.883

divided into three different error levels per group. Thus, one-third of the Ss in each of the six initial groups had their error level changed to 6, 30, or 120 errors for the remaining 5-page sequence. The result was cast in the form of a 3 X 6 factorial design with Ss randomized.

Figure 3 shows the percent errors detected in proofreading current material as a function of previous error detection experience. The curves suggest that previous experience in detecting a large number of errors may have some slight effect in the later detection of errors. Ss who initially encountered error levels of 30, 60, and 120 appear to have done slightly better in detecting errors than Ss who had previous experience at lower density levels. This relationship reflects itself in the tendency of all three curves to show a slight increase in detection at the higher levels of density.

Statistical analysis of the data in Table 10, however, failed to support the suggested findings outlined in the above paragraph. None of the mean squares presented in Table 11, when tested against the error term, were found to be statistically significant. These results appear to indicate that the Ss did not develop a rigid set due to their previous experience; perhaps, the effect of error density on error detection demonstrated previously overshadowed the effect, if any, that a habituation factor may have had under the conditions of this experiment.

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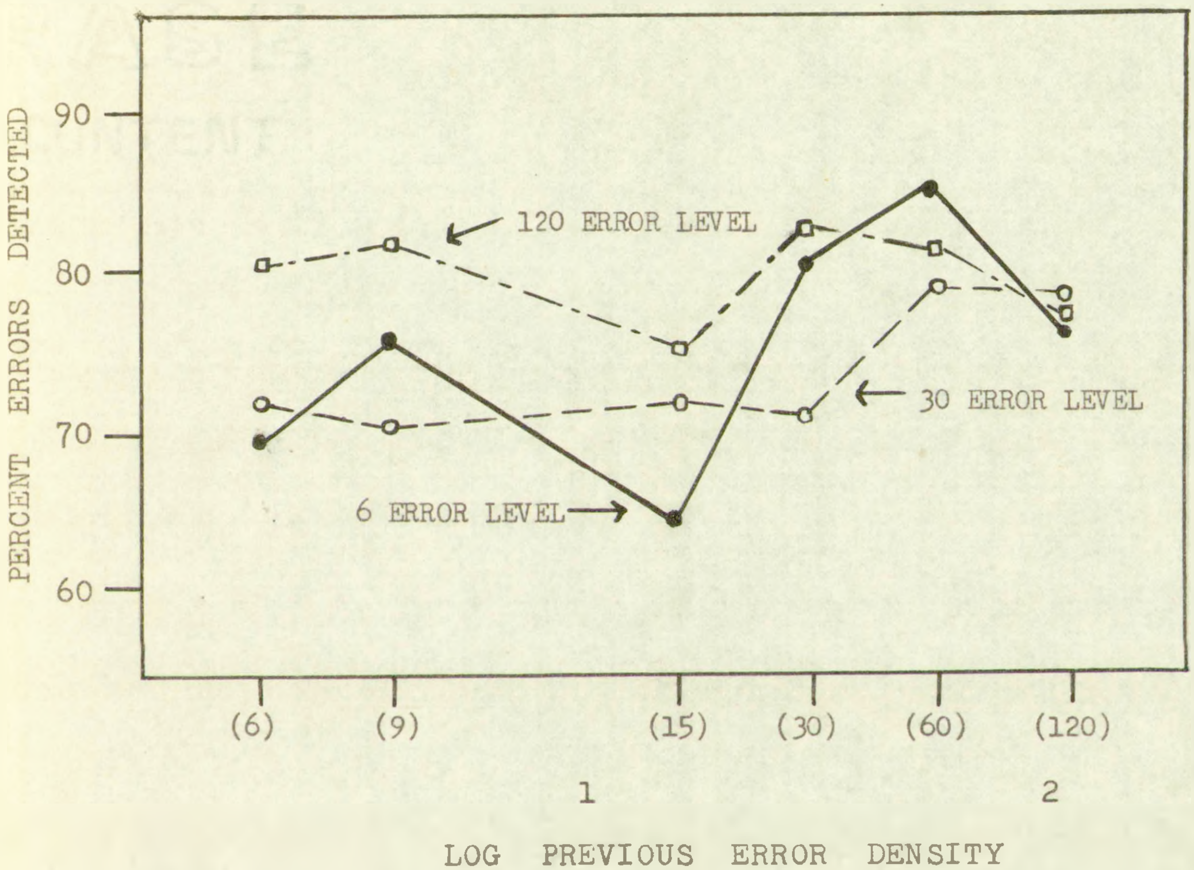

Figure 3. Percent Errors Detected for Present Error Density Groups as a Function of Previous Error Density. The Number in Parenthesis is the Actual Previous Error Level. Each Point Represents the Average Percent Errors Detected for 12 Ss.

Table 10

PERCENT ERRORS DETECTED AT ERROR LEVELS OF 6, 30, OR 120 FOLLOWING PREVIOUS ERROR LEVELS

Group	Previous Error Density	Percent Errors Detected Present Error Density		
		6	30	120
I	6	.695	.725	.806
II	9	.764	.706	.823
III	15	.639	.722	.750
IV	30	.806	.711	.819
V	60	.847	.792	.814
VI	120	.764	.784	.769

Table 11

ANALYSIS OF VARIANCE OF PERCENT ERRORS DETECTED IN THIRD 5-PAGES FOR VARIOUS GROUPS FOLLOWING PREVIOUS ERROR DENSITY

Source of Variation	Sum of Squares	df	Mean Square	F
Present Error Density	.129	2	.065	2.708
Previous Error Density	.261	5	.052	2.167
Present X Previous Error Density	.218	10	.022	.917
Within	4.781	198	.024	
Total	5.389	215		

CHAPTER V

DISCUSSION

It was demonstrated that as the number of errors increased, a corresponding increase in the probability of detection was obtained. What could be a possible explanation of the basic mechanisms behind this empirical relationship?

Before attempting to explain this phenomenon it is necessary to cite a previous study which will aid in the task. A classic experiment by Kulpe (10) may be taken as an illustration of the influence on perception of experimental variation of set established by instructions or induced by a task. He used colored letters presented tachistoscopically and found that, when the S was prepared to see color, he could report the colors of the letters but not much else. When he was set to see the letters or count them, he did so, but then was unable to report the colors. Many other investigations have indicated similar findings.

Psychologically, the relationship between checking efficiency and error density might be explained in the following manner. A proofreader or checker who encounters few errors will come to expect a low occurrance of errors. Consequently, his readiness to perceive an error declines. Since it is well established that perception is partly a matter of readiness to perceive, it is conceivable that a situation involving the detection of few errors will produce a condition unfavorable toward perceiving, hence, detecting errors. Conversely, as the checker faces more errors, his expectancy that an error will occur is high and he is 'set' to perceive and detect them.

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The relationship between rate of errors and checking efficiency should not be interpreted to mean that in a situation where there are few errors, they can not be found and corrected. It must be remembered that a better checking situation could increase checking efficiency. Signal checks are employed in radar monitoring and dial reading to aid in error detection. It would have been possible to have increased the probability of detection of low frequency errors in this study. However, such procedures may have obscured the relationship which the writer desired to investigate.

When error density reaches an extremely high level, it seems quite probable that the psychological situation involved in checking would change. Mackworth (13) statistically analyzed his data on the two-hour watch to see whether reliable evidence could be obtained about the effect on accuracy of the length of blank spell preceding a signal. The results were classified into three main groups according to the length of time following a signal before the next signal appeared. The time interval following any signal detection was broken down into intervals of .75 to 1, 1.5 to 3, and 5 to 10 minutes resulting in 74.1, 75.9, and 79.6 mean percentage of signals detected. The Ss were definitely worse on signals given after blank spells of 1 minute or less than they were with those presented after an interval of 5 to 10 minutes. Mackworth (13) suggests that lapses in visual perception become more frequent when Ss have recently responded to visual signals. At extremely high rates of errors in a proofreading situation, perhaps a drop in the probability of detection occurs due to frequent lapses in perception

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Reinforcement in error detection while proofreading is probably obtained by a professional as he simultaneously observes an original proof and the reproduced copy. This type of reinforcement, i.e., the token reward of knowledge of successful results, was absent in the present study. However, it appears to be replaced by expectancy reinforcement. This depends on self-instructions about the time of onset of the next error, but need not be explicitly formulated by the S. Such predictions probably vary with each error detection or combination of detections. Since the errors are entirely randomized and predictions are probably based on some sort of average of all the preceding detection intervals, it is quite reasonable to suppose Ss become unaware and miss more errors when they are presented in a relatively rapid series at the higher density levels.

In the review of the literature, it was noted that a natural decrement occurs as a function of sustained activity in a search task. It begins relatively early and the decrement slightly increases as the O continues his task. In the present experiment there was an increase in checking efficiency as error density increased from 6 to 30 with a slight decrease at the highest levels. Although reading time per manuscript was not recorded, it may be assumed that it took more time to read higher density manuscripts due to the frequent encounter of errors. If this assumption is reasonable, another explanation of the observed decrement at the higher density levels is possible. In the last three half-hours since the errors are concentrated in pages and they occur more often than at lower error densities.

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In summary, the O begins a session with an indefinite prediction concerning the search task depending on his past experience. As he detects errors, he uses this immediate experience to formulate a prediction concerning the occurrance of errors in the manuscript. His prediction could be based solely on the last detection, but generally, it is probably an estimate of the average interval between all the previous detections. At this point, his readiness to perceive either increases or declines according to the average rate of errors and becomes apparent in the S's detection record.

The mechanism of expectancy seems to explain error detection at the lower density levels (6, 9, 15) and the optimum level (30). However, at extremely high density levels (60, 120) there seems to be a saturation effect which interferes slightly with detection. Since more errors are encountered in rapid succession at higher levels, lapses in visual perception following a detection become more frequent somewhat reducing the probability of detection.

In any event, the psychological relationship between error density and probability of detection would appear to be quite complex.

CHAPTER VI

SUMMARY AND CONCLUSIONS

The ability of Ss to detect typographical errors in a manuscript was studied. Of primary concern were (a) the effect of different rates of errors on the probability of detection, and (b) the influence of previous error density on present error density in terms of error detection. Additional objectives were (c) whether false reports correlate with the probability of error detection, and (d) whether different kinds of typographical errors were of grossly unequal difficulty to detect.

Recent studies have been directly concerned with the problem of fluctuations in detectability as a function of time and signal density with respect to radar observation, inspection tasks, and dial reading accuracy. The writer was interested in examining proofreading behavior to determine if similar relationships between these variables were present in this type of situation.

Two hundred and sixteen Ss were randomly assigned to six groups of 36 each and instructed to mark every typographical error in their manuscript. Group I through VI faced 6, 9, 15, 30, 60, and 120 errors per 5-pages, respectively, for the first 10-pages. This design enabled the E to collect data bearing on problems a, c, and d stated previously. To determine if Ss develop a learned set as a result of having 10-pages of proofreading experience with a fixed density level, it was necessary to change the error density for the last 5-page sequence of the 15-page manuscript. Consequently, one-third of each of the six

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Recent studies have been directly concerned with the problem of fluctuations in detectability as a function of signal or object density with respect to radar observation, inspection tasks, and dial reading accuracy. The writer was interested in ascertaining proofreading behavior to determine if similar relationships between these variables were present in this type of vigilance task.

Two hundred and sixteen Ss were randomly assigned to six groups of 36 each and instructed to mark every typographical error in their manuscript. Among 6 different groups placed 4, 8, 15, 30, 60, and 120 errors per 5-pages, respectively, for the first 10-pages. This design enabled the E to collect data bearing on problems a, c, and d stated previously. To determine if Ss develop a learned set as a result of their 10-page proofreading experience with a fixed density level, it was necessary to change the error density for the last 5-page sequence of the 15-page manuscript. Consequently, one-third of each of the six initial groups encountered 6, 30, or 120 errors for the remainder of their task. Ss were not allowed to proofread the manuscript a second time so their responses may be considered as all or none in contrast to a continuous response measure in which signals remain until detected or, at least, more time is given for a detection. Errors for any density group were varied in time and location so the Os probably experienced difficulty in predicting specifically where and when the next error would appear. The measure used was the percentage of errors identified within a 5-page interval. It was felt that this gave a good approximation to the momentary probability of detection.

The conclusions based on the testing of Ss in a proofreading situation appear to indicate that relationships between variables investigated are similar to results found in other types of checking operations.

(1) The present experiment demonstrated a direct relationship between the probability of error detection and the rate of errors encountered in a proofreading situation. As error density increased, percent error detection increased up to the 30 error level with a slight decrease at the highest levels. To the extent that one experimental situation has confirmed it, the hypothesis has been sustained.

(2) The effect of rate of errors encountered on the probability of detection appears to be a stable function in a continuous work situation, at least within the limits of this experiment.

(3) False detections do not correlate with the probability of

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The conclusions based on the findings of such a proofreading situation appear to indicate that relationships between variables investigated are similar to results found in other types of inspection operations.

(1) The present experiment demonstrated a direct relationship between the probability of error detection and the error density encountered in a proofreading situation. As error density increased, percent error detection increased up to [illegible] error level, with a slight decrease at the highest levels. To the extent that the experimental situation has confirmed it, the hypothesis has been sustained.

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percent errors detected; rather, they appear to fluctuate from one individual to another in an unsystematic fashion.

(4) When the three types of errors employed in the study are encountered in proportionate numbers, they may be listed in their order of difficulty respectively as follows: omission, transposition, and substitution.

(5) No demonstrated effect of a habituation factor was found to be carried over from previous to present error detection working with continuous data in one session.

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APPENDIX

Table 1

PERCENT ERRORS DETECTED FOR EACH SUBJECT AT THE VARIOUS

ERROR LEVELS FOR THE FIRST 5-PAGES

	Error Levels					
Subjects	6	9	15	30	60	120
1	.500	.667	.934	.900	.900	.892
2	.500	.667	1.000	.834	.784	.909
3	.500	.778	.934	.834	.800	.867
4	.667	.778	.867	.967	.850	.975
5	.667	.778	.934	.734	.950	.800
6	.834	.556	.934	.834	.934	.742
7	.500	.778	.934	.767	.934	.925
8	1.000	.556	.934	.900	.884	.625
9	.500	.778	.867	.767	.850	.892
10	.834	.112	.867	.734	1.000	.875
11	1.000	.667	.934	.934	.800	.709
12	.500	.778	.800	.967	.850	.892
13	1.000	.556	.800	.934	.950	.917
14	.834	.667	.734	.934	.850	.742
15	.500	.889	.734	.800	.934	.659
16	1.000	.556	1.000	.900	.784	.775
17	.834	.778	.400	.800	.917	.900
18	.834	.667	.934	.667	.934	.942
19	.500	.556	.734	.967	.950	.850
20	.834	.778	.934	.734	.934	.834
21	1.000	.778	.867	.700	.884	.625
22	.167	.667	.800	.834	.934	.767
23	.667	.223	.934	.900	.634	.925
24	.667	.889	.934	.900	.667	.842
25	.667	.889	.800	.734	.667	.842
26	.667	.667	.600	.734	.750	.734
27	.500	.445	.934	.867	1.000	.809
28	.500	.667	1.000	1.000	.767	.942
29	.834	.445	.867	.800	.834	.717
30	.667	.778	.934	.934	.734	.692
31	.834	.556	.934	.834	.867	.850
32	.334	.778	.734	.900	.934	.842
33	1.000	.778	1.000	.700	.717	.734
34	.667	.556	.934	.900	.850	.717
35	.500	.556	.934	.967	.950	.592
36	.834	.889	.934	.767	.850	.900
Total	24.783	23.901	31.349	30.379	30.828	29.252
Mean	.688	.663	.871	.844	.856	.813
Variance	.073	.029	.015	.008	.009	.010

Table 2

PERCENT ERRORS DETECTED FOR EACH SUBJECT AT THE VARIOUS

ERROR LEVELS FOR THE SECOND 5-PAGES

	Error Levels					
Subjects	6	9	15	30	60	120
1	.667	.778	.667	.934	.950	.850
2	.834	.889	.867	1.000	.750	.934
3	.500	.778	.734	.800	.817	.759
4	.834	.889	.800	.967	.967	.967
5	1.000	.889	.734	.800	.900	.667
6	1.000	.889	.534	.900	.934	.709
7	.667	.889	.734	.867	.967	.934
8	1.000	.778	.734	.900	.750	.567
9	.500	.889	.600	.767	.734	.892
10	.834	.334	.800	.834	.984	.900
11	.667	.778	.934	.967	.800	.625
12	.167	1.000	.734	.967	.767	.900
13	1.000	.778	.734	.934	.934	.900
14	.834	.889	.667	1.000	.884	.709
15	.667	1.000	.467	.900	.917	.734
16	1.000	.556	.934	.934	.817	.734
17	.834	1.000	.467	.834	.934	.775
18	.667	.667	.734	.600	.817	.942
19	.667	.889	.467	.967	.900	.817
20	.834	.889	.734	.767	.900	.842
21	.667	.778	.600	.800	.884	.442
22	.667	.445	.800	.900	.917	.784
23	.834	.334	.667	.934	.717	.859
24	1.000	.889	.867	.867	.634	.717
25	.667	1.000	.734	.800	.750	.675
26	.500	.778	.200	.767	.717	.692
27	.834	1.000	.800	.934	.967	.850
28	.834	.445	1.000	.967	.750	.950
29	.834	.889	.800	.967	.834	.775
30	.667	1.000	.667	.900	.650	.692
31	.500	1.000	.934	.800	.900	.859
32	.500	.889	.267	.934	.884	.767
33	.834	1.000	.534	.800	.884	.700
34	.500	.667	.600	.900	.917	.484
35	.500	.556	.800	.934	.917	.609
36	.667	.778	.800	.767	.850	.875
Total	26.178	28.896	25.146	31.610	30.595	27.887
Mean	.727	.802	.698	.878	.850	.774
Variance	.058	.035	.030	.007	.009	.017

Table 3

NUMBER OF FALSE DETECTIONS FOR EACH SUBJECT AT

THE VARIOUS ERROR LEVELS FOR THE FIRST 5-PAGES

Subject	Error Levels					
	6	9	15	30	60	120
1	2	0	0	1	1	1
2	1	0	0	9	2	3
3	0	1	2	12	3	1
4	1	0	2	3	0	5
5	1	3	0	0	2	2
6	0	4	2	5	1	0
7	1	0	5	4	1	0
8	9	1	0	1	1	1
9	3	2	2	6	0	6
10	0	2	2	0	0	2
11	1	1	3	2	0	2
12	8	5	0	2	1	1
13	0	0	1	4	3	1
14	0	5	0	4	0	2
15	2	0	1	1	0	4
16	0	0	1	3	2	0
17	0	0	0	1	1	0
18	0	1	1	8	4	0
19	1	4	2	11	1	3
20	0	2	2	1	0	2
21	0	17	4	14	11	10
22	10	3	2	2	0	0
23	1	3	1	13	0	0
24	11	0	0	4	2	2
25	0	2	2	3	2	5
26	1	3	2	1	2	3
27	8	1	2	0	1	1
28	5	5	0	0	0	1
29	13	1	1	3	7	0
30	0	1	0	2	3	2
31	1	1	0	3	2	0
32	4	2	12	5	14	8
33	7	0	0	7	0	2
34	10	0	6	2	5	2
35	3	1	4	0	1	3
36	3	0	2	3	0	3
Total	107	71	64	140	73	78

Table 4

NUMBER OF FALSE DETECTIONS FOR EACH SUBJECT AT THE VARIOUS ERROR LEVELS FOR THE SECOND 5-PAGES

	Error Levels					
Subject	6	9	15	30	60	120
1	0	1	0	0	2	3
2	2	0	1	4	2	1
3	0	1	1	8	1	1
4	1	1	2	2	0	2
5	0	2	1	5	4	1
6	1	2	4	5	4	2
7	0	1	1	4	0	3
8	8	3	0	0	0	0
9	2	2	2	7	3	13
10	2	0	0	2	2	6
11	0	0	5	1	0	4
12	1	5	1	1	0	1
13	0	0	1	4	5	5
14	0	6	0	1	2	2
15	4	1	3	0	1	1
16	0	0	2	0	3	5
17	0	2	0	0	2	1
18	2	0	0	0	10	4
19	1	4	1	9	4	3
20	1	4	0	1	1	4
21	0	8	0	11	7	7
22	7	2	3	0	0	1
23	0	0	3	12	0	0
24	6	2	0	1	3	14
25	1	1	2	0	2	1
26	0	1	4	2	2	2
27	4	2	2	1	2	1
28	1	3	1	1	1	0
29	9	2	3	3	2	3
30	1	1	1	0	3	4
31	1	1	1	0	5	4
32	0	3	6	1	12	6
33	0	0	1	1	3	2
34	15	0	6	0	12	0
35	4	1	0	1	1	1
36	0	0	2	1	0	2
Total	74	62	60	89	101	110

Table 5

NUMBER OF FALSE DETECTIONS FOR EACH SUBJECT AT

6, 30, AND 120 ERROR LEVEL FOR THE THIRD 5-PAGES

Subject	Present	Error Levels Previous 6	9	15	30	60	120
1	6	1	0	0	4	10	5
2	6	0	3	0	5	1	3
3	6	0	3	1	2	2	5
4	6	0	0	0	2	2	2
5	6	0	3	1	0	0	3
6	6	0	1	2	0	4	0
7	6	2	6	0	1	1	1
8	6	1	1	2	3	2	0
9	6	0	6	1	3	2	3
10	6	2	3	0	2	2	3
11	6	1	1	1	11	1	4
12	6	6	1	0	1	2	6
	Total	13	28	8	34	29	35
13	30	1	0	1	3	6	6
14	30	3	1	1	3	4	2
15	30	0	3	5	1	3	1
16	30	0	3	3	1	1	2
17	30	1	7	1	0	5	2
18	30	3	4	0	11	2	3
19	30	1	6	1	4	3	2
20	30	3	1	2	3	0	1
21	30	3	4	2	5	2	2
22	30	2	0	0	9	3	5
23	30	2	1	11	4	0	1
24	30	4	5	0	1	3	2
	Total	23	35	27	45	32	29
25	120	1	1	2	0	2	4
26	120	2	1	4	3	2	6
27	120	6	4	2	3	3	5
28	120	3	1	3	2	0	0
29	120	4	1	2	2	4	1
30	120	0	2	2	1	5	1
31	120	3	33	2	1	2	3
32	120	1	8	3	5	13	10
33	120	2	1	0	5	3	0
34	120	6	0	4	2	4	5
35	120	0	0	2	1	2	2
36	120	4	5	1	2	1	5
	Total	32	57	27	27	41	42

Table 6

TOTAL NUMBER OF TYPES OF ERRORS MISSED FOR EACH SUBJECT

AT VARIOUS ERROR LEVELS FOR THE FIRST 5-PAGES

Subject	Error Levels																	
	6			9			15			30			60			120		
	Types of Errors*																	
	O	T	S	O	T	S	O	T	S	O	T	S	O	T	S	O	T	S
1	1	1	1	0	2	1	0	1	0	1	1	1	4	1	1	8	4	1
2	1	0	2	1	2	0	0	0	0	2	2	1	7	5	1	6	4	1
3	1	0	2	0	1	1	0	1	0	2	2	1	7	3	2	9	5	2
4	0	1	1	0	1	1	0	2	0	1	0	0	6	2	1	2	0	1
5	0	0	2	1	1	0	0	1	0	3	3	2	2	1	0	12	6	6
6	1	0	0	0	3	1	0	1	0	4	1	0	1	2	1	15	12	4
7	1	1	1	1	0	1	0	1	0	3	3	1	2	2	0	6	2	1
8	0	0	0	1	2	1	0	1	0	1	1	1	4	2	1	18	16	11
9	1	0	2	1	1	0	0	1	1	3	2	2	6	1	2	8	4	1
10	0	1	0	2	3	3	0	2	0	3	2	3	0	0	0	8	3	4
11	0	0	0	1	2	0	0	1	0	2	0	0	8	4	0	17	9	9
12	1	1	1	0	1	1	0	1	1	1	0	0	6	1	2	7	5	1
13	0	0	0	1	2	1	1	2	0	1	1	0	2	1	0	6	4	0
14	1	0	0	1	2	0	1	2	1	2	0	0	6	3	0	12	15	4
15	0	1	2	0	0	1	0	3	1	5	0	1	3	1	0	13	18	10
16	0	0	0	1	3	0	0	0	0	2	0	1	7	2	4	12	9	6
17	0	0	1	0	2	0	5	3	1	3	1	2	5	0	0	6	5	1
18	0	0	1	0	2	1	0	1	0	6	3	1	4	0	0	4	2	1
19	1	0	2	1	2	1	1	3	0	1	0	0	3	0	0	7	6	5
20	0	1	0	1	0	1	0	1	0	4	4	0	4	0	0	8	5	7
21	0	0	0	1	0	1	0	2	0	4	3	2	4	2	1	18	19	8
22	2	1	2	2	0	1	2	1	0	1	3	1	3	1	0	12	10	6
23	0	0	2	1	3	3	0	1	0	2	1	0	9	9	4	4	3	2
24	1	0	1	0	1	0	0	1	0	1	1	1	10	3	3	9	6	4
25	0	0	2	0	1	0	1	1	1	5	1	2	8	8	4	10	7	2
26	1	0	1	0	2	1	3	2	1	3	2	3	7	5	3	12	13	7
27	1	1	1	2	2	1	0	1	0	2	1	1	0	0	0	10	6	7
28	1	0	2	0	2	1	0	0	0	0	0	0	8	2	4	2	3	2
29	0	0	1	1	2	2	1	1	0	4	2	0	6	3	1	14	13	7
30	0	1	1	1	1	0	0	1	0	0	2	0	8	3	5	18	12	7
31	0	0	1	1	2	1	0	1	0	3	0	2	4	1	1	8	6	4
32	1	1	2	0	1	1	0	3	1	3	0	0	3	0	0	8	6	5
33	0	0	0	2	0	0	0	0	0	4	2	3	8	2	2	18	6	8
34	1	0	1	1	2	1	0	1	0	1	1	1	4	2	2	15	11	7
35	1	1	1	1	2	1	0	1	0	1	0	0	2	1	0	17	17	15
36	1	0	0	0	1	0	0	1	0	3	2	2	5	3	1	5	5	2
Total	19	12	36	26	54	29	15	46	8	87	47	35	176	76	46	364	277	159

* O = Omission T = Transposition S = Substitution

Table 7

TOTAL NUMBER OF TYPES OF ERRORS MISSED FOR EACH SUBJECT

AT VARIOUS ERROR LEVELS FOR THE SECOND 5-PAGES

Subject	Error Levels																	
	6			9			15			30			60			120		
	Types of Errors																	
	O	T	S	O	T	S	O	T	S	O	T	S	O	T	S	O	T	S
1	0	1	1	0	2	0	2	2	1	1	0	1	3	0	0	7	9	2
2	1	0	0	1	0	0	1	1	0	0	0	0	6	7	2	3	4	1
3	1	1	1	2	0	0	2	2	0	3	1	2	4	4	3	11	12	6
4	0	1	0	0	1	0	1	2	0	0	1	0	1	1	0	2	2	0
5	0	0	0	1	0	0	2	2	0	4	1	1	5	1	0	15	12	13
6	0	0	0	0	1	0	3	2	2	2	1	0	2	0	2	13	17	5
7	1	1	0	1	0	0	1	2	1	1	3	0	1	0	1	5	3	0
8	0	0	0	1	1	0	2	2	1	1	2	0	9	3	3	23	18	11
9	1	1	1	1	0	0	3	2	1	4	2	1	10	5	1	3	8	2
10	1	0	0	2	2	2	1	2	0	3	2	0	1	0	0	3	7	2
11	1	0	1	1	1	0	1	0	0	1	0	0	7	3	2	18	19	8
12	1	2	2	0	0	0	2	1	1	1	0	0	7	4	3	4	6	2
13	0	0	0	1	1	0	2	2	0	1	1	0	4	0	0	3	5	4
14	0	1	0	0	1	0	2	2	1	0	0	0	4	2	1	12	13	10
15	1	0	1	0	0	0	1	4	3	2	0	1	3	1	1	11	17	4
16	0	0	0	2	1	1	0	1	0	1	1	0	5	5	1	11	15	6
17	0	0	1	0	0	0	4	2	2	2	2	1	3	1	0	12	10	5
18	1	1	0	1	0	2	2	1	1	5	3	4	6	4	1	3	3	1
19	1	1	0	1	0	0	2	4	2	1	0	0	4	2	0	10	7	5
20	1	0	0	1	0	0	2	2	0	5	1	1	3	2	1	7	8	4
21	0	1	1	1	0	1	4	2	0	3	2	1	2	4	1	26	27	14
22	0	0	2	1	3	1	0	2	1	1	2	0	3	1	1	6	18	2
23	0	0	1	3	2	1	3	2	0	2	0	0	10	5	2	5	10	2
24	0	0	0	1	0	0	0	2	0	2	0	2	8	3	3	15	14	5
25	1	1	0	0	0	0	1	2	1	3	0	3	5	6	4	17	12	7
26	1	1	1	1	1	0	5	3	4	4	3	0	9	6	2	13	20	4
27	0	1	0	0	0	0	1	2	0	0	2	0	1	0	1	10	5	3
28	0	1	0	2	2	1	0	0	0	1	0	0	10	5	0	5	1	0
29	0	0	1	1	0	0	1	2	0	0	1	0	2	6	2	17	9	3
30	1	1	0	0	0	0	3	1	1	2	0	1	7	8	6	20	12	5
31	1	1	1	0	0	0	0	1	0	1	3	2	3	0	0	9	5	3
32	1	1	1	1	0	0	4	4	3	1	1	0	4	1	1	12	11	5
33	1	0	0	0	0	0	2	3	2	3	1	2	3	1	1	15	11	10
34	1	1	1	0	1	2	2	2	2	2	1	0	2	1	1	24	20	18
35	1	1	1	0	2	2	1	1	1	1	1	0	3	2	0	16	21	10
36	0	1	1	1	1	0	1	2	0	2	3	2	4	4	1	9	3	3
Total	19	21	19	28	23	13	64	69	31	66	41	25	164	98	48	395	394	185

Table 8

TOTAL NUMBER OF TYPES OF ERRORS MISSED FOR EACH SUBJECT

AT VARIOUS ERROR LEVELS FOR THE THIRD 5-PAGES

Subject	Present	Error Levels																	
		Previous																	
		6			9			15			30			60			120		
		Types of Errors																	
		O	T	S	O	T	S	O	T	S	O	T	S	O	T	S	O	T	S
1	6	0	0	1	1	0	1	1	0	2	0	0	0	1	0	1	1	0	0
2	6	2	0	1	1	0	0	1	0	1	1	0	0	1	0	1	0	0	0
3	6	1	0	1	0	0	1	2	1	1	0	0	0	0	0	0	1	0	0
4	6	1	0	0	1	0	0	0	0	0	0	0	1	0	0	0	1	1	0
5	6	0	0	0	1	0	0	1	2	1	1	0	2	0	0	0	1	0	1
6	6	1	1	0	1	1	0	0	0	1	1	0	0	1	0	0	1	0	0
7	6	1	1	1	1	0	1	2	0	1	0	0	0	0	0	0	0	1	0
8	6	1	0	1	0	0	0	1	0	1	1	0	1	0	0	0	1	0	0
9	6	1	0	0	0	0	1	1	1	1	1	1	1	0	0	2	1	2	0
10	6	1	2	2	2	1	0	1	0	0	1	0	0	0	0	0	1	0	2
11	6	1	0	0	0	2	1	0	1	1	0	1	0	1	0	1	1	0	0
12	6	1	0	0	0	0	0	1	0	0	1	0	0	0	2	2	1	0	0
Total		11	4	7	8	4	5	11	5	10	7	2	5	4	2	7	10	4	3
13	30	3	5	0	1	6	0	4	4	0	2	2	0	1	1	2	3	2	0
14	30	2	1	0	3	2	0	5	4	2	2	2	0	4	2	0	3	2	0
15	30	6	7	2	4	1	1	2	1	0	4	6	3	4	4	0	3	3	1
16	30	2	4	1	3	1	1	3	3	0	2	0	0	4	2	1	1	0	0
17	30	4	0	1	3	3	0	9	3	1	8	6	1	2	2	1	5	4	3
18	30	3	1	0	9	5	2	7	4	2	4	2	0	2	1	0	2	3	0
19	30	5	4	1	2	1	1	3	2	1	5	6	2	1	1	0	1	2	0
20	30	0	1	0	5	3	0	4	3	1	6	3	1	3	3	1	5	4	3
21	30	9	8	3	3	3	1	6	4	3	5	4	2	4	4	0	2	3	0
22	30	4	3	2	9	8	5	3	1	2	8	6	3	0	1	1	1	1	0
23	30	3	2	0	5	3	1	3	1	0	1	1	1	3	2	2	9	6	4
24	30	5	6	1	5	4	2	6	0	0	2	3	1	8	7	1	2	0	0
Total		46	42	11	52	40	14	52	30	12	49	41	14	36	30	9	37	30	11
25	120	7	9	3	7	4	4	16	11	20	17	13	9	12	8	10	11	6	13
26	120	17	12	14	10	5	6	16	17	18	17	16	6	13	5	6	18	17	12
27	120	19	7	10	10	9	7	10	4	6	8	3	4	4	0	3	8	7	6
28	120	3	3	1	18	9	7	4	3	0	3	0	1	11	3	9	5	1	0
29	120	8	6	5	9	6	5	11	5	6	7	8	4	10	4	2	8	8	4
30	120	9	8	4	3	2	0	13	6	6	9	6	3	19	17	17	12	10	9
31	120	10	4	3	13	9	7	3	5	1	3	3	2	6	4	4	12	9	4
32	120	12	6	11	9	3	6	29	27	24	6	2	2	10	5	5	8	8	1
33	120	5	2	0	5	4	1	10	8	11	13	9	9	12	5	5	17	7	7
34	120	3	6	2	7	2	5	12	8	3	15	5	3	5	6	6	20	16	19
35	120	14	11	10	11	7	12	6	3	7	10	5	3	5	1	1	13	9	9
36	120	12	5	6	3	9	4	11	11	9	19	8	10	9	5	5	8	5	6
Total		119	79	69	105	69	64	141	108	111	127	78	56	97	41	73	140	103	104

Table 9

PERCENT ERRORS DETECTED FOR EACH SUBJECT FOR THE

THIRD 5-PAGES FOLLOWING PREVIOUS ERROR LEVELS

	Error Levels						
		Previous					
Subject	Present	6	9	15	30	60	120
1	6	.834	.667	.500	1.000	.667	.834
2	6	.500	.834	.667	.834	.667	1.000
3	6	.667	.834	.334	1.000	1.000	.834
4	6	.834	.834	1.000	.834	1.000	.667
5	6	1.000	.834	.334	.500	1.000	.667
6	6	.667	.667	.834	.834	.834	.834
7	6	.500	.667	.500	1.000	1.000	.834
8	6	.667	1.000	.667	.667	1.000	.834
9	6	.834	.834	.500	.500	.667	.500
10	6	.167	.500	.834	.834	1.000	.500
11	6	.834	.500	.667	.834	.667	.834
12	6	.834	1.000	.834	.834	.667	.834
	Total	8.338	9.171	7.671	9.671	10.169	9.172
	Mean	.695	.764	.639	.806	.847	.764
13	30	.734	.767	.734	.867	.867	.834
14	30	.900	.834	.634	.867	.800	.834
15	30	.500	.800	.900	.567	.734	.767
16	30	.767	.834	.800	.934	.767	.967
17	30	.834	.800	.567	.500	.834	.600
18	30	.867	.467	.567	.800	.900	.834
19	30	.667	.867	.800	.567	.934	.900
20	30	.967	.734	.734	.667	.767	.600
21	30	.334	.767	.567	.634	.734	.834
22	30	.700	.267	.800	.434	.934	.934
23	30	.834	.700	.867	.900	.767	.367
24	30	.600	.634	.700	.800	.467	.934
	Total	8.704	8.471	8.670	8.537	9.505	9.405
	Mean	.725	.706	.722	.711	.719	.784
25	120	.842	.875	.609	.675	.750	.750
26	120	.642	.825	.575	.675	.800	.609
27	120	.700	.784	.834	.875	.934	.825
28	120	.942	.717	.942	.967	.767	.950
29	120	.842	.834	.817	.842	.867	.834
30	120	.825	.859	.792	.850	.559	.742
31	120	.859	.717	.925	.934	.884	.792
32	120	.659	.850	.334	.917	.800	.859
33	120	.942	.917	.759	.742	.775	.742
34	120	.909	.884	.809	.809	.850	.542
35	120	.709	.750	.867	.850	.942	.742
36	120	.809	.867	.742	.692	.842	.842
	Total	9.680	9.879	9.005	9.828	9.770	9.229
	Mean	.806	.823	.750	.819	.814	.769

Table 10

INSTRUCTIONS

This is an experiment to determine how well people can proofread manuscripts. The manuscript we will give you is an excerpt from the book entitled "Canada", written by Andre Siegfried. Read through the manuscript and mark the errors as you come to them. We are only interested in typographical errors. For the purpose of this study, a typographical error may be defined as any misspelled word or any word which does not fit the context of a sentence due to a typing error, i.e., cone instead of come. It is not necessary to determine what the error is; but just locate it by putting an X on the word. Do not circle the word, but put an X on it. Work rapidly but carefully and try to locate every error in the manuscript without taking too much time.

Do not pay any attention to what your neighbor is doing. Although you are all proofreading the same passage, keep in mind that each of us reads at a different rate. Some will take longer to complete the work than others. Work steadily until you are finished. When you are through place the manuscript on the front desk and you are free to leave. Do not go over the material a second time.

Here are three sentences that contain errors.

1. Please park your car on the rght side of the street.
2. What tmie are you planning to leave?
3. How is the wark developing in your project?

Remember, mark all errors that you locate with an X. Work rapidly and accurately.

Are there any questions?

Table 11

SAMPLE PAGE OF SIX ERROR LEVEL

CANADA

by Andre Siegfried

translated from the French by

H.H. Hemming and Doris Hemming

PREFACE

Exactly thirty years have passed since I published a book entitled Le Canada, les Deux Races. Before embarking upon this study of contemporary political problems, I had concluded my third trip to Canada. My first was made as early as 1898.

Since the publication of my first book I have made several more journeys to Canada, and I have followed its evolution with the same intense interest that I previously devoted to studying the regime of Sir Welfrid Laurier, which now seems so long ago. I spent the year 1915 with the First Canadian Heavy Battery, acting as interpreter for the Canadian army in France. Shortly after the Armistice I was a member of a Mission which was sent by the French Govrnment to the Canadian Government. I have now crossed Canada from Quebec to Victoria three times, in 1914, in 1919, and in 1935. I have seen the Canadian people in prosperity and in depression, in war and in peace, at home and abroad.

Table 12

SAMPLE PAGE OF THIRTY ERROR LEVEL

CANADA

by Andre Siegfried

translated fro the French by

H.H. Hemming and Doris Hemming

PREFAC

Eactly thirty years have passed since I published a book entitled Le Canada, les Deux Races. Before embarking upon this study of contemporary political problems, I had concluded my third trip to Canada. My first was made as early s 1898.

Since the publication of my first book I have made several more journeys to Canada, and I have followed its evolution with the same intense interest that I previously devoted to studying the regime of Sir Wilfrid Laurier, which now seems so long ago. I spent the year 1915 with the First Canadian Heavy Battery, acting as intrpreter for the Canadian army in France. Shortly after the Armistice I was a member of a Mission which was sent by the French Government to the Canadian Government. I have now crossed Canada from Quebec to Victoria three times, in 1914, in 1919, and in 1935. I have seen the Canadian people in prosperity and in depression, in war and in peace, at home and abroad.

Table 13

SAMPLE PAGE OF ONE HUNDRED-TWENTY ERROR LEVEL

CANADA

yb Andre Siegfried

translated frim the French by

H.H. Hemming and Doris Hemming

PREACE

Exactly thirty yers have passed since I publisled a vook entitled Le Canada, les Deux Races. Before embarking upon this stuy of contemporary political problems, I had concluded my third trip to Canada. My first was made as earlt as 1898.

Since the publication of my first book I have made several more journys to Caanda, and I have followed its evolution with the same intense interest thar I previously devoted to studying the regime of Sir Wilfrid Laurier, which now sems so long ago. I spent the year 1915 with the First Canadian Heavy Battery, acting as interpreter for the Canadin army in Francd. Shortly after the Armistice I was a member of a Mission which was sent by the Frenhc Governmsnt to the Canadina Ogvernment. I have now crossed Canada from Quebec to Victroia three times, in 1914, in 1919, and in 1935. I have seen the Canadian people in prosperity and in deression, in war and in peace, at home and abraod.

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

Nearly thirty years have passed since I published a study entitled *Le Canada, les deux Races*, [illegible] this study of contemporary political problems, I [illegible] my first visit to Canada, [illegible] as early as 189[illegible].

Since the publication of [illegible] several more journeys to Canada, and I have [illegible] evolution with the same interest [illegible] devoted to studying the [illegible] which now seem so [illegible] ago. I spent the [illegible] the First Canadian [illegible], acting as [illegible] for the Canadian Army in France. Shortly after the Armistice I was a member of a [illegible] sent by the French Government to the Canadian Government. [illegible] crossed Canada from [illegible] times, in 19[illegible], in 19[illegible], and in 19[illegible]. I have met the Canadian people in [illegible] and in [illegible].