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SELECTIVE FEEDBACK AS A TRAINING AID TO ON-LINE TACTICAL DATA INPUTTING

Paul A. Gade, Allison F. Fields, and Irving N. Alderman

HUMAN FACTORS TECHNICAL AREA

U. S. Army
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Training as Message Input Output Device (MIOD) operators was given to 53 Army enlisted personnel under one of four training methods that were based on different instructional strategies. Performance of each participant was assessed during training and under one of two operational configurations of the Tactical Operations System (TOS).

Results showed that the response-sensitive training strategy was effective in reducing training time without loss of performance accuracy during

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transfer-testing. None of the training methods significantly reduced the amount of undetected errors that enter the system through manual data entry.

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FOREWORD

The Human Factors Technical Area is concerned with the demands of increasingly complex battlefield systems that are used to acquire, transmit, process, disseminate, and utilize information. This increased complexity places greater demands upon the operator interacting with the machine system. Research in this area focuses on human performance problems related to interactions within command and control centers as well as issues of system development. It is concerned with such areas as software development, topographic products and procedures, tactical symbology, user-oriented systems, information management, staff operations and procedures, decision support, and sensor systems integration and utilization.

An issue of special concern within the area of user-oriented systems has been the improvement of manual data input procedures, especially in the Tactical Operations System (TOS). The main source of information for tactical data systems is manual data entry--a slow, error-prone process. The capability of tactical data systems such as TOS to support command staff actions with accurate, complete, and timely information depends on the performance of the human operator who must manually enter information into the system. Previous ARI research on data entry has resulted in simplified message formats, improved reference codes, and aids for on-line preparation and verification of message entries. Although progress has been made, data entry remains a major system bottleneck. The research reported here demonstrated the effectiveness of a response-sensitive training strategy in reducing the amount of time required for operator training.

Research in the area of user-oriented systems is conducted as an in-house effort augmented through contracts. The current report resulted from an in-house research effort initiated under the program direction of Mr. James D. Baker and responsive to requirements of Army Project 2Q763743A774 and to special requirements of the U.S. Army Combined Army Combat Development Activity, Fort Leavenworth, Kans. Special requirements are contained in Human Resource Needs 75-150, "Online Aids for Tactical Data Inputting."

JOSEPH ZEIDNER
Technical Director

SELECTIVE FEEDBACK AS A TRAINING AID TO ON-LINE TACTICAL DATA INPUTTING

BRIEF

Requirement:

To evaluate alternative on-line computer-assisted training strategies for improving performance of the Message Input Output Device (MIOD) operator in the Tactical Operations System (TOS).

Procedure:

MIOD training was given to 53 Army enlisted personnel under one of four training methods: minimum feedback, edit feedback, remedial feedback, and response-sensitive feedback. The first three methods were based on the traditional linear instructional strategy model, and the fourth method was based on a response-sensitive model of instruction. The transfer of this training was tested under two different operational configurations of TOS: no feedback and edit feedback.

Findings:

Use of a response-sensitive instructional strategy markedly reduced training time. No differences in data entry speed or accuracy were found among the four training conditions, or for participants tested in each of the two operational configurations. Mean entry accuracy was more than 80%. Most of the errors (more than 90%) were types that could not be detected by computer edit routines.

Utilization of Findings:

A response-sensitive training strategy is an effective method for reducing MIOD training time without sacrificing inputting accuracy. The decision to adopt a response-sensitive training strategy for specific training should consider the trade-off between the added cost of training development and the cost savings of reduced training time.

Development of more elaborate edit routines may help reduce errors but probably will not eliminate them. Improved formats and definition of legal entries may provide an effective, simple method to reduce input errors.

SELECTIVE FEEDBACK AS A TRAINING AID TO ON-LINE TACTICAL DATA INPUTTING

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SELECTIVE FEEDBACK AS A TRAINING AID TO ON-LINE TACTICAL DATA INPUTTING

INTRODUCTION

The primary function of the Army's evolving semiautomated Tactical Operations System (TOS) is to provide commanders and their staffs with current, accurate battlefield information on which to base tactical decisions. The effectiveness of TOS in providing timely and accurate information is heavily dependent on the performance of the Message Input Output Device (MIOD) operator who must manually enter tactical information into the system. During the evolution of TOS, it became apparent that data inputting was perhaps the most crucial component of the system. Delays or errors in data entry can have a devastating impact on the quality, completeness, and timeliness of the subsequent processing of information by the system. Data entries also need to be relatively error-free, since more than 80% of operator errors probably will enter the system undetected (Strub, 1975).

Previous research (reviewed by Alderman, 1975) focused on improving the data inputting performance (reducing time and errors) of MIOD operators by reallocating the inputting functions/tasks and development of job/training aids. However, if data entry time as well as the number of data entry errors are to be reduced further, MIOD operators must be trained to become more proficient.

The problem of training a human operator for effective on-line data input to the TOS is threefold: initial training of the MIOD operator, optimum transfer of new skills to operational settings, and maintenance of the high levels of proficiency developed during the first two phases. One approach to training MIOD operators is to develop training modules that can be embedded within the TOS software. Modules could be used to train operators and to maintain trained operators at a high level of proficiency. The effectiveness of an embedded training module is highly dependent upon development of optimizing training strategies. Such optimizing strategies should be arranged to accommodate individual differences among learners (e.g., educational history, current skill level) as well as quantitative and qualitative differences in the material to be learned (Atkinson & Paulson, 1972).

A response-sensitive instructional strategy provides the basis for an instructional system that accommodates differences in individuals as well as differences in the material to be learned (Atkinson, 1972). Briefly, this strategy uses a trial-by-trial response history to assess the student's current state of learning so that further instructional items can be selected to optimize learning. To illustrate how this strategy works, assume you wish to train potential MIOD operators to use the specific message input format EC1 (see the Appendix for format listings). During the initial stages of training, you would begin to select items for further training based on the operator's performance history. For example, suppose after giving three EC1 format messages you observed that a particular student never made a mistake on the sections labeled AGENCY and SOURCE, but performed inconsistently on other sections of the format. Under a traditional or linear strategy you would continue to give this student practice on all items. Under a response-sensitive strategy you would reduce the frequency of student practice (possibly to zero) on the sections labeled AGENCY and SOURCE and concentrate the training on those items where performance has been inconsistent.

Strub (1971) has shown that inputting accuracy can be increased when MIOD operators use a cathode-ray tube (CRT) to input data directly into the TOS computer system. He also found that entry times could be decreased by providing a computer-generated format on the CRT as an aid to data entry (Strub, 1975). Strub (1975) suggested that an automated training program incorporating these inputting aids with a response-sensitive instructional strategy might be used to train MIOD operators more effectively. The present experiment was designed to investigate the relative effectiveness of following Strub's suggestion of using these inputting aids within the framework of a response-sensitive instructional strategy to train MIOD operators.

It was hypothesized that use of a response-sensitive instructional strategy in conjunction with computer-generated feedback would have two desirable effects on MIOD operator training. First, it was expected that such a strategy would allow subjects to progress through the training material at a faster rate than would other more conventional strategies. Second, it was thought that a response-sensitive strategy would produce better transfer of training to operational environments than would other training strategies. This enhancement of transfer of training was expected to result in greater input accuracy scores and/or faster entry times during transfer-testing.

The objective of the research, then, was to assess the impact of response-sensitive training on the speed and accuracy of tactical data inputting by MIOD operators in a TOS environment.

METHOD

Participants

The participants were 71 enlisted personnel who volunteered to serve for 7 to 8 hours a day for 2 consecutive days. To approximate the capabilities necessary for assignment as an MIOD operator, participants were requested who had General Technical (GT) scores of 105 or higher and who had normal vision or vision correctable to 20/20.[1]

Apparatus

The experiment was conducted on-line in four separate work stations. Each station contained an IBM 1050 printer/keyboard terminal and a CDC 210 CRT display and associated keyboard entry panel.[2] The 1050 terminals printed out free-text messages that simulated battlefield information. Messages consisted of two general types, those concerned with enemy activities and those concerned with the activities of friendly forces. The CRT's displayed the formats into which participants entered information translated from the free-text messages. All information about enemy activities used the same format. Friendly activities, however, required that the participant choose one of nine other formats based on the subject matter of the free-text message. With slight modifications, the messages and the formats used in the present experiment were the same as those used by Strub (1975). Copies of the 10 formats (9 friendly, 1 enemy) appear in the Appendix along with a list of the order in which they appeared in the experiment. Participants were given a notebook containing a detailed set of instructions that outlined, step by step, each task they were to learn. In addition, participants were given another notebook that contained an entry-by-entry description of each of the 10 message formats and a list of legal entries for each of the format entry items.

Procedure

Each participant took part in a training session and a transfer-testing session, which were conducted on 2 consecutive days. After receiving a brief description of the experiment, participants were randomly assigned to one of the four work stations and given notebooks that contained detailed descriptions of their tasks, legal entry tables, and a scenario that described the simulated combat environment in which they would be operating.

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[1]No attempt was made to verify GT scores with participant records.

[2]Commercial names are used for purposes of clarity only and do not indicate endorsement by the Department of the Army or ARI.

Participants were given a brief keyboard orientation that included a practice drill using the various keyboard functions. This was followed by a 12-item typing exercise to familiarize them with the typewriter output and CRT keyboard inputting procedures. After the participants had completed both the keyboard drill and typing exercise and had read the detailed instructions for the experiment, the experimenter demonstrated the method to be used for inputting free-text messages into the computer. The demonstration consisted of a step-by-step message analysis and a detailed entry procedure for a sample friendly message. The procedure was demonstrated to each group of four participants on a large piece of posterboard that had the appropriate format inscribed on it. Participants returned to their work stations to enter the sample message. If participants failed to identify the correct entry, it was supplied by the experimenter with an explanation. Entries might be correct, incorrect, or illegal (not a member of the appropriate legal entry table).

Participants were required to complete 21 messages during training: 15 training messages on the first day and 6 on the second day. Each participant received one of the following four types of training feedback:

1. Minimum Feedback. Participants received messages on the lower part of the CRT whenever illegal or incorrect information was entered. The error message informed them that their last entry was in error and that they should continue to the next entry. Participants could not go back to correct their mistakes.

2. Edit Feedback. An error message was provided when an illegal entry was made. The participant was instructed to refer to the appropriate legal entry tables and to reenter the information before proceeding to the next entry item. Incorrect entries in legal format produced no feedback.

3. Remedial Feedback. If an entry was incorrect, an error message containing both the incorrect and the correct entry was displayed at the bottom of the CRT. A correct entry was required before the participant could proceed to the next entry.

4. Response-Sensitive Feedback. This condition was identical to the Remedial Feedback condition with the following exception: After the participant had entered information correctly into a particular element of a particular type of format three consecutive times, the computer would fill in the correct answer for the participant thereafter when that element of the format was encountered (auto-fill). The figure of three consecutive correct entries was chosen as the criterion for receiving auto-fill based on the performance of 20 pilot subjects. This figure represents the median number (rounded to the highest whole number) of consecutive errors made by the pilot subjects on all common entry items occurring on the first

21 messages. Because none of the friendly formats occurred more than three times during the training session (Appendix), auto-fill was possible only for enemy messages.

After completing the training, participants were briefed about the type of feedback they would receive during transfer-testing. Each participant received one of two types of feedback during transfer-testing:

1. No Feedback. Under this condition the participant was never given information about the correctness or legality of his entries. All entries were accepted by the computer.

2. Edit Feedback. This condition was exactly the same as that for Edit Feedback training.

Participants then completed as many messages as possible, up to the maximum of 43, in the testing session which lasted the rest of Day 2.

A summary of the error feedback features for each of the feedback conditions is given in Table 1.

Table 1

Summary of Error Feedback Features

Feedback condition	Error report	Correction required	Correct entry given	Auto-fill
No feedback	-	-	-	-
Minimum	+	-	-	-
Edit	+[a]	+	-	-
Remedial	+	+	+	-
Response-sensitive	+	+	+	+

[a]Errors in Edit Feedback are detected by computer edit and validate routines only.

Experimental Design

The experimental design, shown in Table 2, was a 2 x 2 factorial with two appended control groups, yielding a total of six independent groups. Each of the 71 participants was randomly assigned to one of these groups.

Table 2

Experimental Design

Training Mode	Transfer-Testing Mode No Feedback	 Edit Feedback
Experimental condition		
Remedial Feedback	n[a]= 10	n = 9
Response-Sensitive Feedback	n = 8	n = 10
Control condition		
Minimum Feedback	n = 7	--
Edit Feedback	--	n = 9

[a]Number of participants in each group who completed both phases of the experiment (N = 53).

Independent Variables. The two between-group independent variables were Training Mode and Testing Mode. The Training Mode had four conditions: two experimental (Remedial Feedback and Response-Sensitive Feedback) and two control (Minimum Feedback and Edit Feedback). Data from the control conditions were combined for analysis and the resulting combination referred to as the Combined Control Feedback condition. The Testing Mode had two conditions: No Feedback and Edit Feedback.

In addition to the two between-group variables, there were two within-group independent variables: Message Type (friendly and enemy) and Sessions (training and testing).

Dependent Variables. The three dependent variables were mean time per entry, mean accuracy of first entries, and mean accuracy of final data entries.

Mean time per entry, as a function of training and testing feedback conditions, was the average time to complete each entry item of a single message.

Accuracy of first data entries during both training and testing was the accuracy of the first response a participant made for each entry. Accuracy was measured as a percentage:

$$\frac{\text{Number of correct items}}{\text{Number of items possible}} .$$

Accuracy of final data entries was measured during testing only. If a participant made an error that was caught by the computer (e.g., a misspelling) and that the participant then corrected to a computer-acceptable form, only the final response was counted as correct or incorrect. Thus, this analysis explored the quantity of errors that were not detected by computer validation. If a response was correct the first time, of course, the first was also the final entry.

RESULTS AND DISCUSSION

To assess the relative effects of the response-sensitive instructional strategy on speed and accuracy of performance during training and transfer of training, the following dependent measures were analyzed: mean time per entry, mean accuracy of first entries, and mean accuracy of final data entries. Mean time per entry and mean accuracy of first entries were analyzed for both training and transfer-testing phases of the experiment. Mean accuracy of final data entries was analyzed only for the transfer-testing phase. Since the mean time per entry during the 12-item typing exercise (given at the beginning of the experiment) showed a significant within-cell correlation with each of the dependent measures, it was used as a covariate in all analyses.[3]

All covariate analyses and all subsequent simple effects tests were accomplished using a significance level of $p = .05$. All simple effects testing was carried out using either analysis of variance or Tukey's HSD test where appropriate (Kirk, 1968).

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[3]Typing-exercise entry time was positively correlated with mean time per entry ($r = +.57$) and negatively correlated with mean accuracy of first data entries ($r = -.43$) and mean accuracy of final data entries ($r = -.44$). Typing-exercise accuracy did not show any significant within cell correlation with any of the three dependent measures ($r = -.09$, $r = +.10$, and $r = +.05$ for entry time, first accuracy, and final accuracy, respectively).

Entry Time

The results of a four-way analysis of covariance performed on the time taken per entry are presented in Table 3. The four factors analyzed were type of training feedback, type of transfer-testing feedback, type of message (enemy versus friendly), and sessions (training versus transfer-testing). The data from 18 participants were excluded from all of the data analyses because six participants failed to complete the first 31 transfer-testing messages, one failed to complete training, one became ill, one failed to return on the second day, and nine were eliminated due to system malfunctions. Table 2 shows the number of participants remaining in each of the training/transfer feedback combinations. A chi squared test was applied to the number of participants eliminated from each of the groups to determine the likelihood that the loss of data from any of the groups was due to a systematic bias. This test showed that the probability of such a systematic bias was low ($\chi^2(2) = 2.26$, $p > .25$).

Data from all 21 training messages were used whenever training was analyzed. Only the data from the first 31 transfer-testing messages were selected for analysis because (a) most participants failed to complete all 43 possible messages, and (b) the first 31 messages included participant responses to all 10 possible formats.

Training. The mean entry times for type of feedback given and type of message received during training are presented in Table 4. The results show unequivocally the potential time-saving characteristic of the response-sensitive instructional strategy used here. During training, Response-Sensitive Feedback produced a mean savings of 4.09 seconds per item over the Combined Control Feedback conditions on Enemy messages ($p < .01$). Response-Sensitive Feedback also produced significant time savings on Enemy training messages when compared to Remedial Feedback; the mean time per entry was 3.82 seconds faster under Response-Sensitive Feedback ($p < .01$). Remedial and Combined Control Feedback conditions did not differ significantly from one another on Enemy training messages.

Because auto-fill could not occur on Friendly messages, it is not surprising that the Response-Sensitive Feedback condition did not differ significantly from the Remedial Feedback condition on mean item entry times. Remedial Feedback produced significantly faster entry times than did Combined Control Feedback on Friendly training messages ($p < .05$), but Response-Sensitive Feedback did not. This result was unexpected, because the Response-Sensitive and Remedial Feedback groups received identical feedback on Friendly messages. Failure of Response-Sensitive Feedback to produce faster entry times on Friendly messages may have been due to the differences in feedback experienced by this group between Friendly messages without auto-fill and Enemy messages, on which auto-fill was available. The fact that Enemy messages were processed significantly faster than Friendly messages ($\bar{X} = 10.04$

Table 3

Analysis of Covariance for Mean Time per Entry

Source	df	MS	F
Between subjects			
Training Feedback (TF)	2	19.59	<1
Transfer-Testing Feedback (TTF)	1	6.11	<1
TF x TTF	2	34.84	1.58
$Error_b$	46	22.06	
Within subjects			
Message Type (M)	1	82.34	15.45***
M x TF	2	37.85	7.10**
M x TTF	1	.45	<1
M x TF x TTF	2	20.48	3.84*
$Error_1$	47	5.33	
Sessions (S)	1	1135.62	121.58***
S x TF	2	50.62	4.29*
S x TTF	1	.01	<1
S x TF x TTF	2	10.69	<1
$Error_2$	47	11.81	
M x S	1	244.31	60.52***
M x S x TF	2	46.85	11.61***
M x S x TTF	1	.01	<1
M x S x TF x TTF	2	8.24	2.04
$Error_3$	47	4.04	

*p < .05.
**p < .01.
***p < .001.

sec/item versus $\bar{X}$ = 16.59 sec/item) in the Response-Sensitive group ($F(1, 94) = 82.67$, $p < .001$) lends support to this hypothesis. There were no significant differences in entry times between Enemy and Friendly messages for any other feedback group.

Table 4

Mean Item Entry Time in Seconds for Type of Message and Mode of Training

Training Mode	n[a]	Message type: Enemy	Message type: Friendly
Training Session			
Combined Control	16	14.13	17.47
Remedial Feedback	19	13.86	14.16
Response-Sensitive Feedback	18	10.04	16.59
Transfer-Testing Session			
Combined Control	16	9.12	8.43
Remedial Feedback	19	9.55	8.65
Response-Sensitive Feedback	18	10.15	8.96

[a] Number of scores combined across transfer-testing modes and participants.

The effect of Response-Sensitive Feedback on training time can be summarized as follows. Compared to the Combined Control group, Response-Sensitive Feedback produced a mean time savings of 40 minutes over the course of the 21 training messages. It also resulted in a mean savings of 37 minutes over Remedial Feedback training.

Transfer-Testing. The time savings produced by Response-Sensitive Feedback training did not transfer to the simulated operational environment. In fact, no significant differential effects on transfer-testing entry times were produced by any of the training feedback conditions. As Table 4 shows, all participants made their entries at about the same rate during transfer-testing, and there were no significant differences in entry times between Enemy and Friendly messages.

These results contradict those of Strub (1975), who found faster inputting speeds for Friendly messages under all conditions. However, Strub used mean time in minutes per format, whereas we used time in seconds per entry as the measure of input entry speed. Use of the entry time per format measurement necessarily makes input speed appear slower for Enemy messages since the Enemy format contains on the average 12 more entries than the Friendly formats. If one applies the time-per-entry analysis to Strub's data, the differences in entry speed between Enemy and Friendly messages virtually disappear, with Enemy message entry times averaging slightly over 1.5 seconds slower than Friendly message entry times.

It should be noted that type of transfer-testing feedback did not influence response times. The error detection routines used in the Edit Feedback condition did not significantly affect inputting speed.

Entry Accuracy

First-Entry Accuracy. A four-way analysis of covariance was used to assess the effects of training and transfer-testing feedback conditions on accuracy of performance.[4] The results of this analysis appear in Table 5. The four factors analyzed were type of training feedback, type of transfer-testing feedback, type of message, and sessions.

Because a response-sensitive training strategy enables students to bypass material already learned and to concentrate their efforts on items not yet learned, it was assumed that the use of this strategy would facilitate the transfer of MIOD training to operational testing environments. Table 6 shows that the results of the present experiment do not support this assumption. Only the Edit Feedback trained and tested participants showed even a hint of positive transfer of training as evidenced by a small, nonsignificant increase in performance accuracy.

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[4] An unresolved error in the computer program used for automatically scoring participant entries produced some falsely incorrect entries and generated several instances of false error feedback during training. The incidence of such errors was small, and the effects on the performance of the participants involved was judged to be minimal. Specifically, there were 63 such cases of computer-generated error in the 44,679 entries made during training (.14%). Prior to computing the accuracy scores for each participant, however, all entry errors were manually rescored and corrected for computer error.

Table 5

Analysis of Covariance for First Entry Accuracy

Source	df	MS	F
Between subjects			
Training Feedback (TF)	2	1294.27	9.39**
Transfer-Testing Feedback (TTF)	1	399.49	2.90
TF x TTF	2	140.42	1.02
$Error_b$	46	137.85	
Within subjects			
Message Type (M)	1	1165.84	60.40**
M x TF	2	159.77	8.28**
M x TTF	1	39.76	2.06
M x TF x TTF	2	4.22	<1
$Error_1$	47	19.30	
Sessions (S)	1	730.20	51.17**
S x TF	2	102.85	7.21**
S x TTF	1	.17	<1
S x TF x TTF	2	83.34	5.84**
$Error_2$	47	14.27	
M x S	1	1.60	<1
M x S x TF	2	12.15	<1
M x S x TTF	1	137.90	7.77**
M x S x TF x TTF	2	13.19	<1
$Error_3$	47	17.75	

*p < .01.
**p < .001.

Table 6

Mean Percentage Accuracy Scores for Training and Transfer-Testing Sessions as a Function of Training and Transfer-Testing Feedback Modes

Training Mode	n[a]	Session: Training	Session: Transfer-Testing
No Feedback Transfer-Testing Mode			
Minimum Feedback[b]	14	79.36	75.04
Remedial Feedback	20	89.35	87.10
Response-Sensitive Feedback	16	86.41	81.72
Edit Feedback Transfer-Testing Mode			
Edit Feedback[b]	18	81.72	82.61
Remedial Feedback	18	89.96	85.86
Response-Sensitive Feedback	20	91.94	83.76

[a]Number of scores combined across message types and participants.

[b]Control condition.

Under No Feedback testing conditions, both Minimum and Response-Sensitive Feedback training groups showed a significant decline in performance during transfer-testing ($F(1, 47) = 12.33$, $p < .01$). The decline in performance by the Remedial Feedback training group was not significant.

Under Edit Feedback testing, both the Remedial and Response-Sensitive Feedback training groups showed a significant decline in performance during transfer-testing ($F(1, 47) = 10.60$, $p < .01$ and $F(1, 47) = 46.89$, $p < .01$, respectively). The Edit Feedback trained and tested participants showed a small, if nonsignificant, gain in performance accuracy during transfer-testing. This result is not surprising, since training and transfer-testing feedback conditions were identical, and one would expect positive (or at least nonnegative) transfer to occur.

Table 6 also shows that neither Remedial Feedback training nor Response-Sensitive Feedback training provided participants with any special advantage when tested under the Edit Feedback compared to the No Feedback condition, the differences in performance in each case being trivial and nonsignificant. The Edit trained and tested participants were clearly superior in performance to those receiving Minimum Feedback training and No Feedback transfer-testing ($F(1, 93) = 5.68$, $p < .05$). This result was probably due to the slight positive transfer found in the Edit trained and tested participants combined with the general decrement in transfer-testing performance experienced by all other participants. The accuracy scores in Table 6 show that there were no significant differences in training performance between No Feedback and Edit Feedback transfer-testing conditions for any of the training groups. This finding is important for two reasons. First, the lack of differences between the two Remedial Feedback training groups ($F(1, 93) < 1$, $p > .05$) and between the two Response-Sensitive training groups ($F(1, 93) = 3.42$, $p > .05$) indicates that no systematic confounding occurred in the initial assignment of participants to these groups. Second, the absence of differences between the two control groups ($F(1, 93) < 1$, $p > .05$) during training suggests that Minimum Feedback and Edit Feedback are similar in their influence on response accuracy.

Since transfer-testing feedback conditions were not in effect during training and since the Minimum Feedback and Edit Feedback groups did not differ significantly during training, the transfer-testing factor was ignored in analyzing the effect of type of training feedback on performance accuracy during the training session. Minimum Feedback and Edit Feedback groups were considered to be a single group (i.e., Combined Control) with an overall mean of 80.69. The mean performance of Remedial and Response-Sensitive Feedback groups was virtually the same during training (89.64 and 89.48, respectively). Both groups show significantly superior performance compared to the Combined Control group when tested with Tukey's HSD test ($p < .01$ in both cases).

During transfer-testing, the performance accuracy for Remedial and Response-Sensitive Feedback trained groups was also higher than their respective control groups under both No Feedback and Edit Feedback testing conditions. However, the only statistically significant difference was for the Remedial Feedback trained group compared to the Minimum Feedback trained group under No Feedback testing ($p < .01$). Although Remedial and Response-Sensitive training strategies were mildly effective in improving performance accuracy during training, little of this positive influence was transferred to either of the two testing environments used here.

Strub (1975) found that participants completed Friendly message formats with greater accuracy than Enemy message formats. Our results agree with Strub's in that the overall accuracy on Friendly messages (87.32%) was significantly higher than on Enemy (82.65%) messages ($F(1, 47) = 60.40$, $p < .001$). The analysis of covariance revealed a significant training feedback x message type interaction ($F(2, 47) = 8.28$, $p < .001$). This result, coupled with the fact that the training feedback x message type x sessions interaction was not significant, indicates that performance accuracy on Enemy and Friendly messages was differentially affected by the various training feedback conditions. Furthermore, this effect was essentially the same during transfer testing as it was during training. Table 7 shows the mean accuracy scores on Enemy and Friendly messages for each of the three training feedback conditions. Subsequent analyses showed that all three training feedback groups performed more accurately on Friendly than on Enemy messages ($F(1, 47) = 57.06$, $p < .001$; $F(1, 47) = 17.32$, $p < .001$; and $F(1, 47) = 7.59$, $p < .001$ for Combined Control, Remedial Feedback, and Response-Sensitive groups, respectively). The results of HSD tests revealed that on Enemy messages both Remedial and Response-Sensitive groups performed significantly better than the Combined Control group ($p < .001$ in both cases), but did not differ significantly from each other in performance accuracy. On Friendly messages, both Remedial and Response-Sensitive groups performed more accurately than the Combined Control group, although the difference was significant only for the Remedial group ($p < .05$). As on the Enemy messages, the two groups did not differ significantly from each other in performance accuracy. Remedial and Response-Sensitive Feedback training led to reduced errors on both Enemy and Friendly messages. However, Remedial Feedback was somewhat more effective than Response-Sensitive Feedback in eliminating errors on Friendly messages. This result must be interpreted cautiously since auto-fill was not given on Friendly messages.

Table 7

Mean Percentage Accuracy Scores for Type of Message and Mode of Training

Training Mode	n^a	Message type: Enemy	Message type: Friendly
Combined Control	32	75.84	84.14
Remedial Feedback	38	85.98	90.17
Response-Sensitive Feedback	36	85.20	87.13

[a]Number of scores combined across transfer-testing conditions, sessions, and participants.

As can be seen in Table 8, the type of transfer-testing feedback also affected performance on Enemy and Friendly messages differently. Under Edit Feedback, performance was significantly more accurate on Friendly messages than on Enemy messages ($F(1, 94) = 36.97$, $p < .001$). Performance did not differ under the No Feedback condition. These differences are primarily due to the lowered performance on Friendly messages found under No Feedback testing as compared to Edit Feedback testing. However, this difference was not statistically significant.

Table 8

Mean Percentage Testing Accuracy Scores for Type of Message and Type of Transfer-Testing Feedback

Transfer-Testing Feedback	n[a]	Message type: Enemy	Message type: Friendly
No Feedback	25	81.03	82.96
Edit Feedback	28	80.57	87.56

[a]Number of scores combined across training feedback modes and participants.

First Versus Final Entry Accuracy. A four-way analysis of covariance was used to assess the relative effectiveness of the various training feedback conditions in reducing detectable and nondetectable error rates. The results are presented in Table 9. The four factors analyzed were type of training feedback, type of transfer-testing feedback, type of message, and error detection accuracy. Error detection accuracy was measured by comparing first and last entry accuracy during transfer-testing. Differences between first and last entry were observed only in those participants receiving Edit Feedback during transfer-testing, since they alone were allowed to correct illegal entries made on first entries. Most of the errors made in the testing situation were not caught by the Edit routine. Although the difference in performance accuracy between the first entry and the entry finally accepted by the computer was significant ($F(1, 47) = 69.48$, $p < .001$), it can hardly be called important (mean accuracy = 84.12% and 85.21% for first and final entries, respectively). This performance difference of 1.09% means that only 7% of all errors were detected by the Edit routine. The lack of a significant error detection x accuracy training feedback interaction ($F(2, 47) < 1$, $p < .05$) shows that all of the training feedback conditions were equally effective (ineffective?) in reducing final error rates. Since none of the interactions involving either message type and/or error detection accuracy were significant, it appears that the error detection routine was equally effective on Enemy and Friendly messages.

Table 9

Analysis of Covariance for First Versus Last Attempt Accuracy

Source	df	MS	F
Between subjects			
Training Feedback (TF)	2	1022.37	6.33*
Transfer-Testing Feedback (TTF)	1	588.33	3.65
TF x TTF	2	335.45	2.08
$Error_b$	46	161.39	
Within subjects			
Attempts (A)	1	15.61	69.48**
A x TF	2	.11	<1
A x TTF	1	15.61	69.48**
A x TF x TTF	2	.11	<1
$Error_1$	47	.22	
Message Type (M)	1	1112.43	29.67**
M x TF	2	101.68	2.71
M x TTF	1	343.09	9.15*
M x TF x TTF	2	7.66	<1
$Error_2$	47	37.49	
A x M	1	.22	3.58
A x M x TF	2	.14	2.24
A x M x TTF	1	.22	3.58
A x M x TF x TTF	2	.14	2.24
$Error_3$	47	.06	

*$p < .01$.
**$p < .001$.

SUMMARY AND CONCLUSIONS

In summary, a response-sensitive training technique, covering only those format items in which errors occur, is effective in reducing training time. This technique is also at least as effective as other training strategies in reducing error rates. However, the decision to adopt a response-sensitive strategy for a specific training problem should consider the trade-off between the cost of training development and the benefit of reduced training time.

The type of error detection routine provided by Edit Feedback was only minimally effective in reducing errors and was not enhanced by any of the training methods used. The results of the present experiment suggest that training probably will not help catch many of the errors that escape the usual operational error detection routines. Although more sophisticated error-detection routines might help reduce such errors, a simpler and perhaps more effective way to eliminate the errors would be to clarify the meaning of the terms used as legal entries in the various formats. For example, there was confusion among participants about the terms Observation and Reconnaissance as descriptors for information sources. The distinction between other items, such as "Mines" versus "Demolition Equipment" and "Demolished" versus "Destroyed," was also unclear. If these terms were changed or clarified, a fairly high percentage of otherwise undetectable and unavoidable errors might be eliminated.

REFERENCES

Alderman, I. Tactical Data Inputting: Research in Operator Performance and Training. In Proceedings of Second National Symposium on Management of Data Elements in Information Processing. Gaithersburg, Md.: National Bureau of Standards, 23-24 October 1975.

Atkinson, R. C. Ingredients for a Theory of Instruction. American Psychologist, 1972, 27, p. 921-931.

Atkinson, R. C., & Paulson, J. A. An Approach to the Psychology of Instruction. Psychological Bulletin, 1972, 78, No. 1, p. 49-61.

Kirk, R. E. Experimental Design: Procedures for the Behavioral Sciences. Belmont, Calif.: Brooks/Cole Publishing, 1968.

Strub, M. H. Evaluation of Man-Computer Input Techniques for Military Information Systems. ARI Technical Research Note 226, May 1971. (AD 730 315).

Strub, M. H. Automated Aids to On-Line Tactical Data Inputting. ARI Technical Research Note 262, February 1975. (AD A0130350).

APPENDIX

DESCRIPTION OF DATA ENTRY FORMATS

Table A-1

Format Index

Designator	Description
EC1[a]	Enemy situation/action
UC1	Front line trace/coordination point
UD1A	Command post/center of mass
UE1	General on post/combat on post
UF1	Assembly area/operational area
UG1A	Line of departure/phase lines
UG1B	Axis of advance/direction of attack
UG1C	Objectives
UG1F	Movement control points
UG1I	Fire control lines

[a]All information about enemy activity was entered on the EC1 format. The remaining nine formats were used to describe friendly activities only.

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Table A-2

Training Formats

Message number	Format required	Message number	Format required
1	UC1	33	UG1F
2	UE1	34	UF1
3	UE1	35	EC1
4	UE1	36	" "
5	UD1A	37	" "
6	UG1A	38	" "
7	EC1	39	" "
8	" "	40	UE1
9	" "	41	" "
10	" "	42	EC1
11	" "	43	" "
12	" "	44	" "
13	" "	45	" "
14	" "	46	" "
15	" "	47	" "
16	" "	48	" "
17	" "	49	" "
18	" "	50	UG1C
19	UG1C	51	UG1A
20	UG1A	52[a]	UG1B
21	UG1B	53	UC1
22	UG1I	54	" "
23	UC1	55	" "
24	UG1I	56	UD1A
25	" "	57	EC1
26	UD1A	58	" "
27	UE1	59	" "
28	" "	60	" "
29	" "	61	" "
30	EC1	62	" "
31	" "	63	" "
32	" "	64	" "

[a]Participant responses to items beyond message number 52 were not used in data analysis.

Table A-3

Format Scorable Entries

Format designator	Number of entries
EC1	45
UC1	24
UD1A	21
UE1	25
UF1	31
UG1A	46
UG1B	47
UG1C	59
UG1F	51
UG1I	46

Data Entry Format--Printouts

```
EC1 ENSIT DATA MESSAGE
MSG-NR(       )PREC( )SCTY(  )ORIG(     )RFSTR(      )
RECD-FR(     )RPT-ID(                  )
AGENCY(       )SOURCE(      /              )
EVENT-TIME(              )EN-UNIT(  /      /      )
--SUBJ---ACTV---QUANT-DESCRIPTION--------LOCATION-
1(      /      /    /                 /        )
2(      /      /    /                 /        )
3(      /      /    /                 /        )
4(      /      /    /                 /        )
5(      /      /    /                 /        )
PARENT(  /      /       )RELAT-TO(      )
REMARKS(

                                               )
DISTR(    .    .    .    .    )INTEREST( )
```

Data Entry Format--Printouts (continued)

```
UC1 FLT COORD DATA MESSAGE
MSG-NR(       )PREC( )SCTY(  )ORIG(     )RFSTR(       )
UNIT-ID-OR-IF-NAME( /  /  / /              )
FLT-COORD-1(          )FLT-COORD-2(         )
FLT-COORD-3(          )FLT-COORD-4(         )
FLT-TIME(              )
CO-ON-LINE-POSIT( / )
BN-ON-LINE-POSIT( / )
LT-COORD-PT(          )
LT-COORD-PT-TIME(              )
RT-COORD-PT(          )
RT-COORD-PT-TIME(              )
```

```
UD1A CP-COM DATA MESSAGE
MSG-NR(       )PREC( )SCTY(  )ORIG(     )RFSTR(       )
UNIT-ID-OR-IF-NAME( /  /  / /              )
--ITEM-/LOCATION/----TIME----/
-CUR-CP(       /           )
-PLN-CP(       /           )
-ALT-CP(       /           )
CUR-COM(       /           )
PLN-COM(       /           )
```

```
UE1 GOP-COP DATA MESSAGE
MSG-NR(       )PREC( )SCTY(  )ORIG(     )RFSTR(       )
UNIT-ID-OR-IF-NAME( /  /  / /              )
GOP-NAME(              )
LOC(      .       .       .        )
TIME-FR(          )TIME-TO(           )

COP-NAME(              )
LOC(      .       .       .        )
TIME-FR(          )TIME-TO(           )
```

Data Entry Format--Printouts (continued)

```
UF1 OP AREA DATA MESSAGE
MSG-NR(        )PREC( )SCTY(   )ORIG(       )RESTR(       )
UNIT-ID-OR-TF-NAME( /  /  / /               )
OP-AREA-TYPE(        )EFF-TIME(                  )
OP-AREA-1-NAME(                 )
LOC(          ,         ,         ,         ,          ,-
----          ,         ,         )
REMARKS(                                                  )
OP-AREA-2-NAME(                 )
LOC(          ,         ,         ,         ,          ,-
----          ,         ,         )
REMARKS(                                                  )
```

```
UG1A CON MEASURES DATA MESSAGE    PHASE LINES
MSG-NR(        )PREC( )SCTY(   )ORIG(       )RESTR(       )
UNIT-ID-OR-TF-NAME( /  /  / /               )
PL-1-NAME(                 )
LOC(          ,         ,         ,         )
TIME(         )
PL-2-NAME(                 )
LOC(          ,         ,         ,         )
TIME(         )
PL-3-NAME(                 )
LOC(          ,         ,         ,         )
TIME(         )
PL-4-NAME(                 )
LOC(          ,         ,         ,         )
TIME(         )
--LD-NAME(                 )
LOC(          ,         ,         ,         )
TIME(         )
```

Data Entry Printouts (continued)

```
UG1B CON MEAS DATA MESSAGE    AXIS ADV + DIR ATTACK
MSG-NR(       )PREC( )SCTY(  )ORIG(      )RESTR(    )
UNIT-ID-OR-TF-NAME( /  /  / /             )
AXIS-OF-ADV-1-NAME(                )
LOC(          ,      ,       ,       ,        )
AXIS-OF-ADV-2-NAME(                )
LOC(          ,      ,       ,       ,        )
AXIS-OF-ADV-3-NAME(                )
LOC(          ,      ,       ,       ,        )
-DIR-OF-ATK-1-NAME(                )
LOC(          ,      ,       ,       ,        )
-DIR-OF-ATK-2-NAME(                )
LOC(          ,      ,       ,       ,        )
-DIR-OF-ATK-3-NAME(                )
LOC(          ,      ,       ,       ,        )
```

```
UG1C CON MEAS DATA MESSAGE OBJECTIVES
MSG-NR(       )PREC( )SCTY(  )ORIG(      )RESTR(    )
UNIT-ID-OR-TF-NAME( /  /  / /             )
OBJ-1-NAME(                  )TIME(         )
LOC(          ,      ,       ,       ,      ,-
----          ,      ,       )
RESP-UNIT( /   /   / /  /    )
OBJ-2-NAME(                  )TIME(         )
LOC(          ,      ,       ,       ,      ,-
----          ,      ,       )
RESP-UNIT( /   /   / /  /    )
OBJ-3-NAME(                  )TIME(         )
LOC(          ,      ,       ,       ,      ,-
----          ,      ,       )
RESP-UNIT( /   /   / /  /    )
```

Data Entry Format--Printouts (continued)

```
UGIF CON MEAS DATA MESSAGE   MUT CTL POINTS
MSG-NR(      )PREC( )SCTY(  )ORIG(     )RFSTR(      )
UNIT-ID-OR-TF-NAME( /  /  / /              )
-ITEM-NR-LOCATION--ITEM-NR-LOCATION
-SP-1(  /         )-SP-2(  /        )
-SP-3(  /         )-SP-4(  /        )
-RP-1(  /         )-RP-2(  /        )
-RP-3(  /         )-RP-4(  /        )
LUP-1(  /         )LUP-2(  /        )
LUP-3(  /         )LUP-4(  /        )
CKP-1(  /         )CKP-2(  /        )
CKP-3(  /         )CKP-4(  /        )
-PP-1(  /         )-PP-2(  /        )
-PP-3(  /         )-PP-4(  /        )
```

```
UGTI CON MEAS DATA MESSAGE   FIRE CONTROL LINES
MSG-NR(      )PREC( )SCTY(  )ORIG(     )RFSTR(      )
UNIT-ID-OR-TF-NAME( /  /  / /              )
FSCL-LOC(         ,         .         ,         ,-----
---------         ,         )TIME(              )
-NFL-LOC(         ,         .         ,         ,-----
---------         ,         )TIME(              )
-FCL-LOC(         ,         .         ,         ,-----
---------         ,         )TIME(              )
BRH-NAME(               )LOC(           ,          ,---
---------         ,         .         ,         )
BHD-NAME(               )LOC(           ,          ,---
---------         ,         .         ,         )
```

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1 HQUSAF (DPXXA)
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1 Ministeris van Defensie, DOOP/KL Afd Sociaal Psychologische Zaken, The Hague, Netherlands