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An Analysis of the Effects of Time and Competing Responses on Data Reliability

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AN ANALYSIS OF THE EFFECTS OF TIME AND COMPETING RESPONSES ON DATA RELIABILITY

by

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INTRODUCTION

Increasing interest in the development and deployment of behavior modification strategies in the classroom is being evidenced in a number of ways. Programmed texts are being marketed at practically every grade level, with some sets, such as Englemann's Distar, providing teachers with cues for the proper delivery of consequences. The Office of Education, in conjunction with Project Follow Through, has allocated federal grant monies for the partial support of the 1970 through 1973 Annual Kansas Conferences on Behavior Analysis in Education. A multitude of studies reporting successful changes in classroom behavior due to the systematic use of contingencies have been published in the past five years (Broden et al., 1970 a & b; Hall et al., 1968; Madsen et al., 1968; etc.). As noted by Hall et al. (1971), however, many educational applications of behavior modification strategies are carried out and reported by "outside experimenters and observers..." This has resulted in a general lack of information concerning the ability of teachers to simultaneously conduct a class, carry out behavior modification strategies and reliably record observations of behavior. Some of the potential sources of error or variability which may affect teacher-recorded data will be discussed below.

Reid (1970) reported results which call into question the reliability of data recorded by an unmonitored observer.

Seven female students were trained in the use of an observational code, being given feedback after every response concerning their agreement to a standard protocol of the video taped behavior being observed. All subjects reached a preset criterion after three sessions consisting of six 5-minute observations each day. The subjects then underwent overt assessment, during which feedback was withheld until the end of each session. After the subjects reached a predetermined criterion level of reliability, they were told that they would be making the only data records to be made on a set of video tapes. The E remained in the room but re-stressed that there was no monitoring being carried out on the reliability of the observer's data. Results indicated that the mean levels of reliability dropped approximately 25 per cent between the overt assessment period and the covert assessment period. Reid (1970) goes on to note that inflated reliability estimates can result in one of two possible outcomes; either an incorrect interpretation of the failure to reject a statistical hypothesis as being due to theoretical rather than methodological inadequacies or the statistical support of faulty hypotheses. Data which indicate observer controlling variables such as those mentioned above bring up serious questions concerning the value of high teacher reliability scores, such as those reported by Hall et al. (1971). How representative of behavior can data be if it only corresponds to the occurrence of a universally accepted definition of behavior when the observer is being observed?

Research in the area of vigilance provides data that point toward variables which may contribute to a decrement in the reliability of teacher-recorded data. Foremost among these variables is time.

Mackworth (1948, 1950) reported a time related deterioration in the performance of a vigilance task involving the observation of a clock face and the recording of specified changes in hand rotation. The greatest deterioration was noted during the first half-hour with subsequent performance deterioration occurring at a slower rate during the course of the session. Studying a similar task, Singleton (1953), noted a deterioration in performance within the first few minutes of the session. Factors which have been demonstrated to affect the deterioration of performance in tasks requiring the reciprocal observation and recording of events include task training techniques, task complexity, knowledge of results, and knowledge of session duration. It is, therefore, of singular importance that the factors affecting the reliability of teacher-recorded data be carefully assessed before too much credence is placed on the objectivity of those data. It is toward this end that a discussion of the role of competing responses in teacher-recorded data ensues.

The measurement of behavior involves the persistent occurrence of observing responses (the attention process) in conjunction with discriminative coding responses which are emitted as behavior, which conforms to one or many definitions

of behavior, is seen (the instrumental process). The above analysis of the components of behavior measurement correspond quite closely to the explanation of discrimination learning as proposed by Wyckoff (1952) and by Zeaman and House (1963). In light of this interpretation of measurement, the current emphasis in reliability assessment, as stated by Bijou et al. (1968) ("1. the observational code, 2. the training of observers, and 3. the method of calculating reliability"), deals only with the instrumental process of measurement. Another salient area for observer assessment, particularly as it relates to the educational setting, might involve the effects of competing responses which impede the ongoing observation of behavior. Broadbent (1963), in discussing the results of research concerning irrelevant stimulation and vigilance performances, states, "I should regard the impairment of performance as probably due to an increase in frequency of competing responses; this is, in fact, the distraction effect..." The "distraction effect" cited by Broadbent was evident in the results of a study conducted by Hohmuth (1970) to determine the effects of a secondary vigilance task on the performance of a primary vigilance task. In this instance it was concluded "that when two vigilance tasks are being presented simultaneously, the one to which S's attention is primarily directed is not necessarily the one which will show a decrement". The differential performance decrement was explained in terms of the relative detectability and relative importance of the tasks in question.

Regardless of the differential performance decrement seen when two tasks involving the observation of and response to specific environmental events are to be performed simultaneously, it remains the case that at least one of the tasks is impeded. Since the measurement of behavior in the classroom usually involves the modalities of vision and audition, it might be reasonable to assume that classroom instruction, which depends primarily on the same modalities, would occasionally compete, resulting, most probably, in the overall decrement of observing performance, i.e., data reliability. This study attempts to determine the relative effects of time and a competing visual observing response on the reliability of data collected from video tapes of classroom-related behavior.

METHOD

Subjects: Twelve college students who had enrolled in the sophomore level abnormal psychology course volunteered to participate in the experiment in order to earn bonus points in the abnormal psychology course. The data from ten of the twelve students were included in the final results (one subject missed a session resulting in the invalidation of the data of both members of the matched pair). Of the subjects whose data were included in the final results, eight were male and two were female. All subjects were naive with respect to the specific variables being examined.

Apparatus: A video tape recording was made on DAK Enterprises video tape with a Panasonic NV-3020 video tape recorder and a Pansonic WV-200P video tape camera, equipped with a f/ 1:1.5 wide angle lens. The video tape was recorded in a 5' x 9 1/2' x 8' booth, the camera being located seven feet from the floor. The audio portion of the video tape recording was punctuated every ten seconds by a 2900 Hz tone which had been tape recorded (using a Craig cassett tape recorder, Model 2622) from a Mallory Sonalert, Model SC-628. The tape recorded interval tones were added to the audio portion of the video tape recording through the use of a Sony Microphone Mixer, allowing the interaction to proceed without the tone occurring in the booth. All video recording was monochromatic and the final recording contained 240 intervals. The experimental chamber was a 5' x 11' x 7' fully enclosed room. At the end of the chamber was a school desk, whose top was 2 1/2' from the floor. On top of the desk was a 12" Panasonic Video Tape Monitor and a Sony cassette audio tape recorder. Three feet in front of the monitor was the chair in which the subjects sat. Six inches to the right of the chair was a 22" x 22" x 6 1/2' columnar manipulandum. On the side of the column facing the subject was a recording button (1" in diameter and 25" from the floor); a row of colored buttons, green, white, and red from left to right, which were 1" in diameter, 3" apart and 34" from the floor; an exposed feedback light 39" from the

floor; and 44" from the floor, a 9" square back projection screen. Mounted in the middle of the screen was a column of three lights, white, green, and red from top to bottom, which were 1" apart. All of the bulbs used in the matching and feedback lights were rated at 110 volts and were dimly operated on 28 volts. Other than the lights (matching and feedback) and the monitor, there was no source of lighting in the chamber. Observing data was recorded on a Gerbrands 6 pen recorder, Model P2C6, operating in conjunction with standard electro-mechanical equipment.

Procedure:

Session 1

All Ss--Each S was seated in the experimental chamber and asked to listen to a tape recording of instructions (see Transcription of Instructions, #1 below) which stated that during the video tape program, consisting of a therapist training a 6 year old boy in a two object discrimination, the behavior of following directions would occur. Ss were further instructed to depress the designated response button during each tone which followed an interval in which "following directions" behavior was observed. Instances of "following directions" which involved "heavy prompting" by the therapist, defined as guiding the behavior through physical contact, were to be discounted. The instructions went on to say that each interval designation, either positive or negative, which corresponded to a standard protocol of the tape (as

determined by E and two independent observers) would result in the brief illumination of the feedback light after the termination of the tone. Any questions concerning the observing task were answered by E after the completion of the tape recorded instructions. The chamber doors were closed and the video tape was begun, with E manually operating the feedback light each time the S's interval designation matched that of the protocol. After scoring 110 intervals, the video tape was stopped and the doors of the chamber were opened, ending the session.

Reliability was determined for each S by dividing the number of intervals in which the S agreed with the protocol concerning the occurrence of a response by the same number (agreements of occurrence) plus the number of intervals in which S disagreed with the protocol about the occurrence of a response in an interval. Instances in which Ss and the protocol agreed that the behavior didn't occur in an interval were deleted from the computation of reliability, as is suggested by Bijou et al. (1968). These data provided the basis for the formation of two matched-pair groups.

Session 2

Time group--Upon entering the experimental chamber, Ss assigned to the Time group were asked to be seated and to listen to recorded instructions (see T of I #2) which directed them to observe and record behavior in the same manner that they did on the preceding day. The recorded instructions

went on to state that the feedback light, which was covered with black electrical tape, would not be in operation during the session. Following these instructions, answers were given only to questions which did not pertain to the response being measured. The chamber doors were closed and the session proceeded as it did during Session 1 with the following exceptions: 1) no feedback was given concerning S agreement to a protocol and 2) 30 intervals of the initial portion of the tape were deleted and thirty previously unseen intervals were added to the end of the tape, resulting in the Ss scoring 80 old and 30 new intervals.

Competing Response group--Ss assigned to the CR group, after being seated in the experimental chamber, listen first to the instructions given the Time group Ss and then listened to further instructions (see T of I #2 and 3) about the additional matching task. It was stated that periodically during the course of the observation session one of three lights would go on. Their task was to press the button which corresponded to the color of the illuminated light. Immediately following a correct match, the instructions stated, the counter mounted immediately below the screen would advance. Nothing was to occur following incorrect matches. Ss were asked to make their matching responses promptly but there was no limited hold value stated or observed. After the chamber doors were closed and the session had been in progress for three minutes, E illuminated the matching lights in a

random order and with a randomly assigned series of inter-stimulus intervals. The random order and inter-stimulus intervals were the same for all CR Ss during Session 2. The only restrictions on the occurrence of the matching lights were that 30 single presentations occur between the third and the eighteenth minute of the session. E advanced the counter in the chamber each time the light and button pressed corresponded. Ss observed the same intervals in the same order as those observed by the Time group Ss during Session 2.

Session 3

Time group--Upon entering the experimental chamber, Ss were played a tape recording instructing them to perform the same task they carried out on the preceding day (see T of I #4). All questions which did not pertain to the response definition were answered, after which time the chamber doors were closed and the session was begun. Session three differed from Session two solely due to the deletion of the first twenty-one intervals from the Session two video tape and the addition of twenty-one previously unseen intervals to the end of the video tape.

Competing Response group--Ss were played the same instructions as those played for the Time group Ss at the beginning of their Session 3 (see T of I #4). Any questions which didn't pertain to the response definition were answered after which, the doors to the chamber were closed and the video tape (same video tape as that described above for the Time group Ss

during Session 3) was begun. The only difference between the CR group S's second and their third session was that the order of matching light presentations and the inter-stimulus intervals, while still random, were different.

Session 4

Time group--The recorded instructions played during this session (see T of I #5) stated that as well as performing the observing task which had been carried out during the preceding three sessions, Ss would also be expected to perform a matching task, matching the color of the periodically illuminated lights and the colored buttons. The instructions also noted the significance of the counter advancing, indicating a correct matching response. After answering any questions which didn't pertain to the response being observed, the doors of the experimental chamber were closed and the video tape was begun, starting with the second interval of the tape seen in Session 1 and ending 110 intervals later. The order of matching light presentations and the inter-stimulus intervals employed were identical to those used in the CR group's second session.

Competing Response group--Ss in this group were instructed, via audio recording, that they would only be responsible for performing the observing response during this session: that the stimulus lights would remain off entirely. After answering any questions not pertaining to the response being

observed, the chamber doors were closed and the session was begun, employing the same intervals used by the Time group during their fourth session.

TRANSCRIPTION OF INSTRUCTIONS

1. (Instructions heard by all subjects immediately before session one.)

During the next half hour, you will be observing a therapist as he teaches a two object discrimination to a six year old boy. A tone has been placed on the sound track of the video tape you are about to see, dividing it into 10 second intervals from tone to tone. Your task is to press the designated button during the tone if you have seen "following directions" behavior occur during the ten second interval preceding the tone. If the behavior of following directions occurs with heavy prompting, which would involve the therapist touching the child and guiding his behavior, do not score it as following directions. Correct observing responses, defined as either pressing the button during the tone which follows as interval in which the behavior did occur or failing to press the button during the tone which follows an interval in which the behavior did not occur, will result in the brief illumination of the feedback light, found immediately below the counter to your right. Errors will result in nothing. Do you have any questions?

2. (Instructions heard by subjects in time and competing response groups immediately before session two.)

Today your task will be to observe and record behavior in exactly the same way you did yesterday. Remember to press the button during the tone which follows an interval in which the behavior occurred, rather than upon the occurrence of the behavior in the interval. As you might notice, the feedback light is no longer in operation.

3. (Additional instructions heard by subjects in the competing response group immediately before session two.)

In addition to the observing task, you will be required to match to sample. If you will look to your right, you will notice a column of three lights. Periodically during the course of the session, one of the lights will become illuminated. When this happens, you are to press the colored button which corresponds to the color of the illuminated light. A correct match will result in the advancement of the counter found immediately below the column of lights. An incorrect match, a non-match, will result in nothing. Please try to make the match promptly. Are there any questions?

4. (Instructions heard by all subjects immediately before session three.)

Your task today is the same as it was yesterday. Remember to press the button during the tone which follows an interval as opposed to pressing it upon the occurrence of the behavior in the interval. Do you have any questions?

5. (Instructions heard by subjects in the time group immediately before session four.)

During today's session, you are to observe and record behavior as you have been for the past three days. In addition, you are to match to sample. Periodically one of the three lights found in the column of lights to your right will become illuminated. Your additional task will be to press the button which corresponds to the light being illuminated. A correct match will result in the advancement of the counter found immediately below the column. An error will result in nothing. Do you have any questions?

6. (Instructions heard by subjects in the competing response group immediately before session four.)

You will only have to observe and record behavior today. The column of lights will remain off during the entire session. Do you have any questions?

RESULTS

The primary datum of this study is reliability, specifically, the degree to which the observing behaviors of the subjects corresponded to a standard protocol for the video tapes viewed. As is noted above, each subject's session reliability score was determined by dividing the number of intervals in which the subject and the protocol agreed about the occurrence of a behavior by the number of agreements plus the number of disagreements about the occurrence of

the behavior. Intervals in which there was agreement that the behavior "following directions" did not occur were deleted from the computation of reliability.

Insert Table One here

The improvement of total mean reliability scores across sessions 1, 2, and 3 might be most parsimoniously explained

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Insert Fig. 1 here

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on the basis of the "high profile" nature of the behavior being observed; following directions. The occurrence of the behavior was invariably preceded by the giving of instructions and was usually followed by the contingent presentation of consequences.

The Kruskal-Wallis test was computed on all individual reliability scores as they appeared within sessions to determine whether the apparent differences between sessions was statistically significant. Significance was obtained at the .05 level of confidence. In order to determine the specific session differences which were contributing most to the findings of significance reported above, the Mann-Whitney U test was computed for all the combinations of sessions. Sessions 1 and 2 and sessions 1 and 3 were found to be significantly different at the .01 level of significance.

Table 1

Individual subject reliability scores,
clustered according to group designation, across sessions

TABLE 1

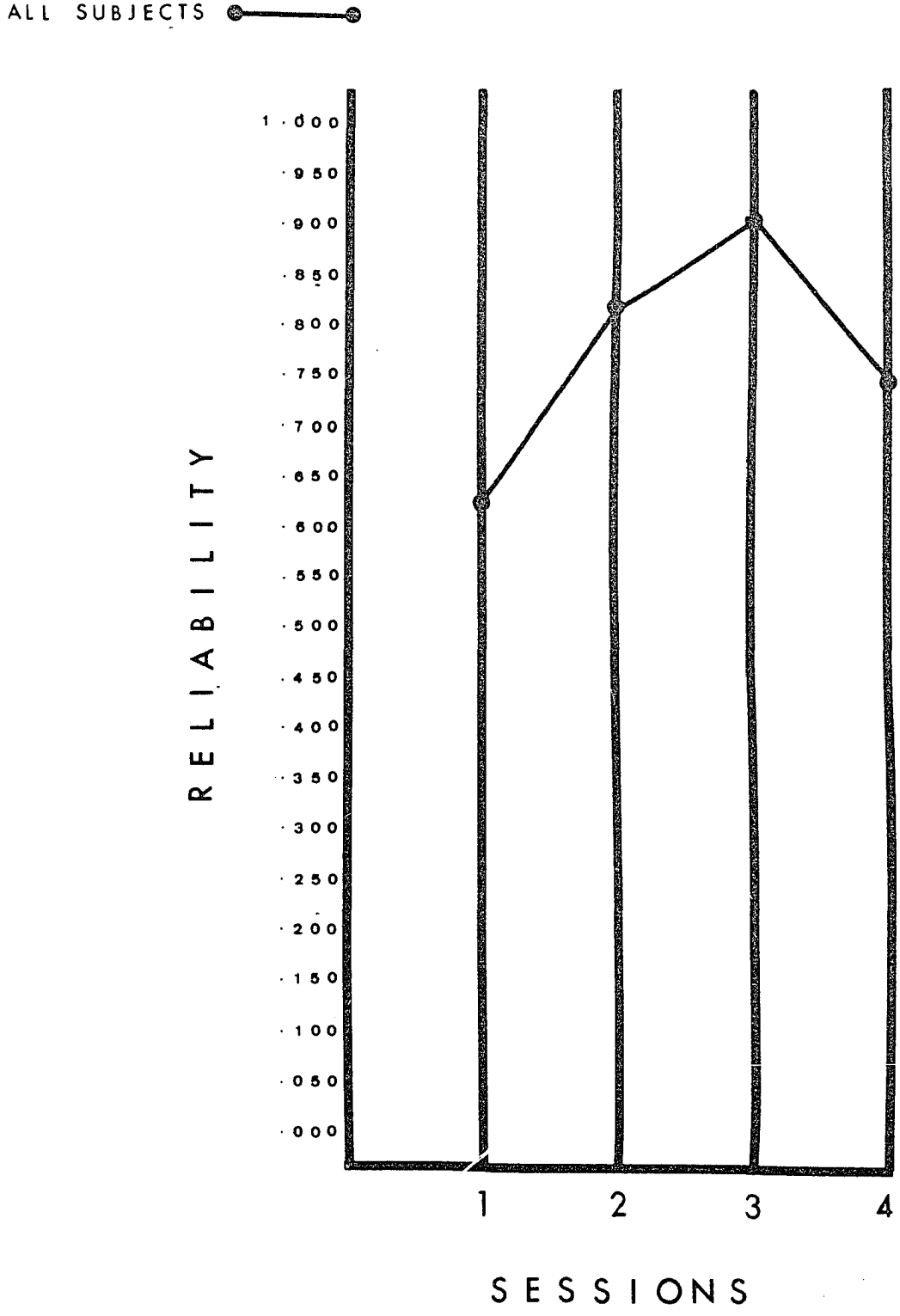
SUBJECT RELIABILITY SCORES

		SESSIONS			
		1	2	3	4
COMPETING RESPONSE GROUP	1	.637	.868	.968	.816
	2	.666	.789	.836	.862
	3	.625	.674	.650	.630
	4	.583	.720	.813	.684
	5	.458	.666	.861	.666
	Mean	.634	.747	.826	.731
TIME GROUP	6	.769	.939	1.000	.864
	7	.659	.914	.939	.832
	8	.589	.833	.937	.659
	9	.522	.882	.968	.741
	10	.520	.892	.967	.733
	Mean	.611	.892	.982	.766
Total Mean		.623	.820	.904	.748

Figure 1

Mean reliability scores of all subjects across sessions

FIG. 1



Furthermore, sessions 3 and 4 were found to be significantly different at the .05 level of confidence. When considered independently, statistically significant differences are seen both between groups during specific sessions and within groups as they vary between sessions.

Insert Fig. 2 here

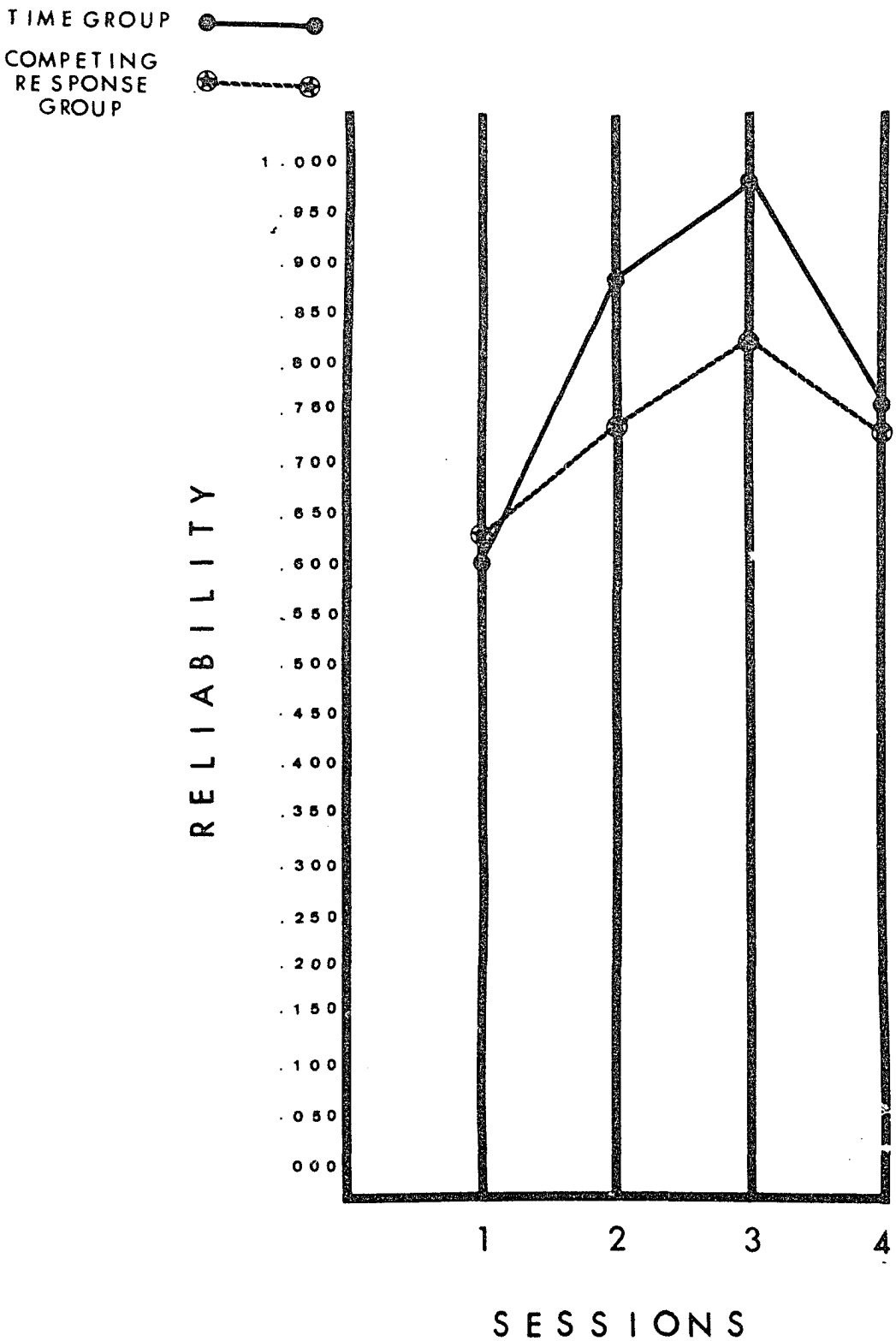
The Mann-Whitney U test was computed to determine the significance of the difference between groups for each session. Session two was the only occasion during which a significant difference was found, at the .05 level of confidence. The lack of a significant difference between group reliability for session three may be due to a ceiling effect, while factors which may pertain to the negative slope (and consequent lack of significance) produced by **both** groups during session 4 will be discussed below. It should be noted at this point, that while the competing response group maintained a consistently lower mean reliability score across sessions, their mean reliability scores remained between .634 and .826, with a total mean score of .735, which is well within generally accepted tolerances of data reliability.

The difference between group reliability scores can also be seen by examining the angle of the positively accelerated

Figure 2

Mean reliability scores, by group, across sessions

FIG. 2



Insert Fig. 3 here

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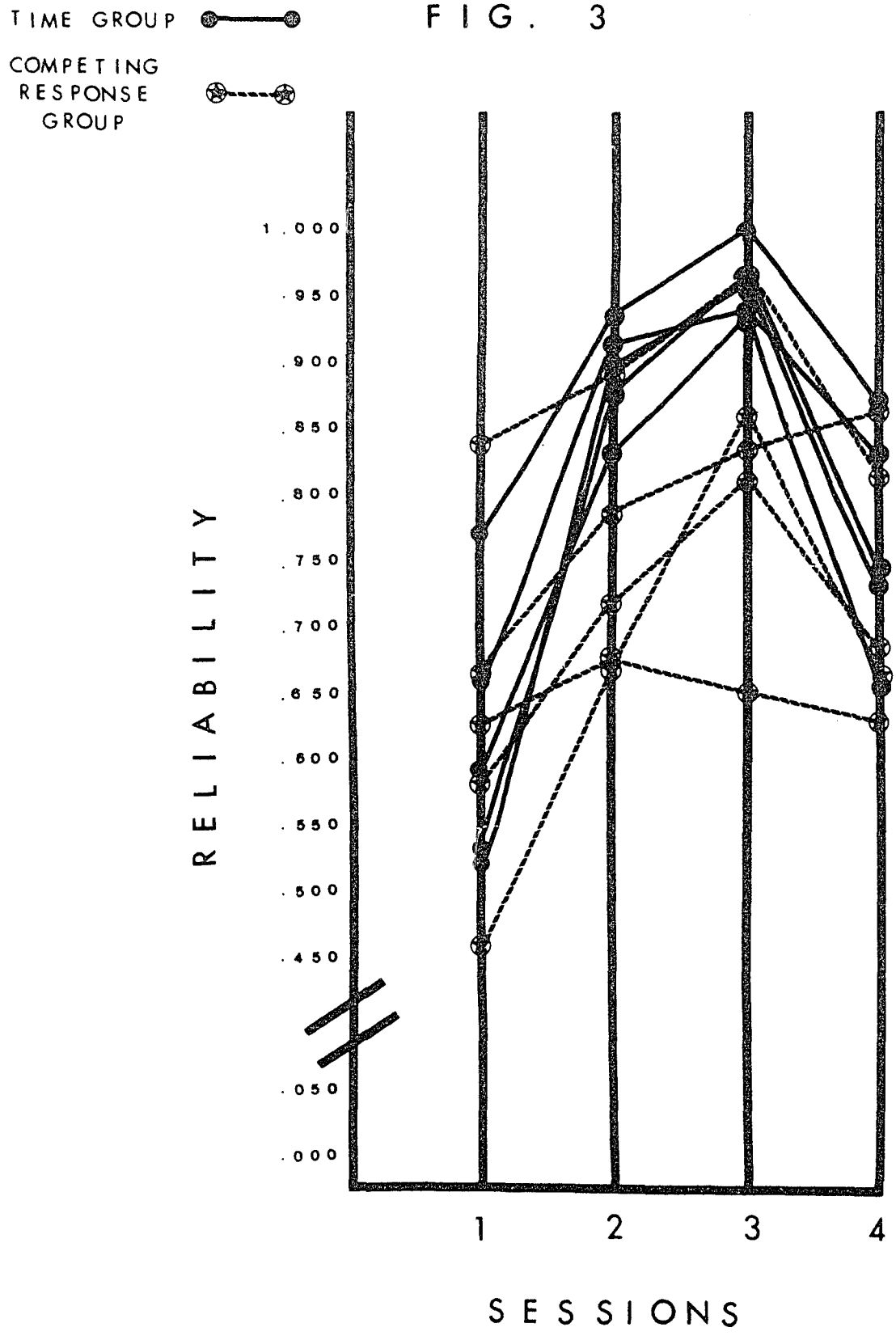
slopes of individual group members. Notice the consistently steep positive slopes produced by time group members between sessions 1 and 2 and sessions 2 and 3, as opposed to the somewhat less consistent and less steeply inclined slopes of the competing response group members as their reliability scores vary between the same sessions. The same non-parametric test of statistical significance carried out above, the Mann-Whitney U test, was made of group reliability scores as they varied between sessions. It was found that while the differences between sessions 1 and 2, sessions 1 and 3, and sessions 3 and 4 were not significant for subjects in the competing response group, sessions 1 and 2 and sessions 3 and 4 were significantly different for members of the time group at the .01 level of confidence. In addition, the difference between sessions 2 and 3 was significant at the .05 level of confidence for members of the time group.

These data show a consistent, statistically significant improvement in the reliability of behavior measurement for members of the time group as they proceeded from session 1 through session 3, with an expected decline in reliability during session 4 due to the inclusion of a competing task. The data also show that there was a smaller, statistically

Figure 3

Individual subject reliability scores,
with group designations, across sessions

FIG. 3



insignificant improvement from session 1 to session 3 in the reliability scores of the members of the competing response group. The decline of the mean reliability score of this group for session 4, though statistically insignificant, was not expected since they were no longer carrying out a competing response task. Factors such as vigilance, perseverance, and motivation, which may pertain to the unexpected decline in reliability as seen among members of the competing response group during session 4, will be considered in the Discussion section, below.

DISCUSSION

The two stage account of discrimination learning (Wyckoff, 1952; Zeaman and House, 1963) provides an instructive format for the analysis of behavior measurement. Both attentional and instrumental processes must operate in conjunction in order for discriminative responding to occur. The measurement of behavior, being an instance of discriminative responding, involves both attentional and instrumental processes. By manipulating conditions relating to observation and assessing consequent changes in the evaluation of those observations, factors pertaining to the nature of attention in behavior measurement have been examined.

The apparent superiority of the time group over the competing response group during sessions two and three seems to be due to the absence of a competing vision-related task

in the time group. This interpretation is corroborated by the mean reliability decrement experienced during the time group's fourth session, when a competing vision-related task was included. The lack of improvement among members of the competing response group during session four, when their competing task had been deleted, does not support this interpretation.

Before discussing possible factors affecting the decline in reliability seen among subjects in the competing response group during session four, it should be noted that this decline, while indicative, was not statistically significant. Random variability may have affected the mean reliability score as readily as any of the variables discussed below.

A factor somewhat less moot if not more likely is that of vigilance. Holland (1958) notes that the correct detection of discrete environmental events declines in certain situations as the duration of the intervals between events increases. It may be the case that higher levels of attention were maintained during the competing response groups' second and third sessions and that this greater attention, as contrasted to that of the time group, was masked by the competing response that maintained it. When the competing response task was removed, attention may have declined due to the relative diminution of discriminative (reinforcing) environmental events.

It may also be the case that the lowered level of reliability for the competing response group during session four, instead of being due to a decrement in attention, is due to the perseveration of a situationally inappropriate attentional response; orientation toward the matching light display. It may even be the case that increased rates of inappropriate matching light orientation were occasioned, as is often seen during extinction, resulting in even greater visual competition.

Motivational variables during the fourth session of the competing response group may have affected the level of reliability achieved. Besides being the last day of the experiment and a Saturday, the response requirement had been reduced significantly, minimizing the possibility of error. Two of the subjects spontaneously told E that they had become drowsy during the session. Both were from the competing response group.

Aside from the more pedantic considerations found above, these results raise serious doubts about the qualitative nature of data recorded by teachers in the classroom. If the competing response group is taken to represent teachers, while the time group represents uninterrupted observers, it might be concluded that, even in the case of an easily observed response, teachers are significantly less reliable in their collection of data than are observers. Assuming that teacher-recorded data

corresponds to actual events significantly less than observer-recorded data, behavior modification strategies which are developed from and assessed in terms of teacher-recorded data are less likely to address the actual events as they occur within the classroom. In diminishing the reliability of teacher-recorded data, competing classroom responses, such as instruction, downgrade the objective basis upon which classroom intervention is predicated. It is, therefore, necessary to either find means of improving teacher-recorded data or resign behavior modification in the classroom to the level of the carrot and the stick. Attempting to avoid the latter of these alternatives, the possible uses of video tape recording, either in the training of teachers or in the recording of classroom behavior, will be discussed below.

In relation to the present study, the response definition, either in verbal or feedback form, was not presented after the first session. Regardless of this lack of definition, a consistent improvement was seen by all subjects during sessions 2 and 3. Whether due to a focusing of attention, an increased familiarity with the behavior in question or an increased familiarity with behavior measurement in general, the reliability improvement seen when data was recorded from video tapes suggests that this medium may prove useful for training teachers in data collection. Moreover, by amalgamating the verbal definition of a response with response

contingent feedback, as seen in the present study, the parameters of the response could be cited on each instance of the video taped behavior.

In the event that future research does not provide adequate measures for improving teacher recorded data, video tape recording may serve as a means of keeping exact records of classroom behavior. Using either relatively simple electronic devices or auxilary staff members, samples of behavior could be video tape recorded easily and cheaply. These recordings would then provide an adequate basis for the development and implementation of behavior modification strategies as well as the subsequent assessment of their effect.

The results of this study indicate that the qualitative nature of data recorded by teachers is impaired by the competing responses inherent in teaching. In order to offset this effect, improved training techniques, methods of teacher remediation and/or alternative data collection practices must be explored. Video tape recording may prove to be a useful medium to investigate in the pursuit of a solution to the problem of impaired reliability. If a solution is not found, behavior modification in the classroom will be perpetually hampered by the difference between the data and reality.

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