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MACHINE DEFINITION OF ONGOING SILENT AND ORAL READING RATE[1]

ISRAEL GOLDIAMOND[2]

ARIZONA STATE UNIVERSITY, TEMPE

A procedure is described by which a machine defines the ongoing silent and oral reading rates, and thus subjects them to environmental control and experimental analysis. Reading is considered as a form of monitoring in which response sequences are linear and successive. Applications for other types of monitoring are considered.

A page is projected on a screen, and the subject is required to read, aloud or silently. Through the same optical system, an opaque loop is presented that masks the projection, and a transparent slit on the opaque loop exposes part of a line of type. With each frame, the slit moves linearly and sequentially, exposing successive reading material. Recycling the loop triggers the presentation of another page. The subject controls the loop by pressing a microswitch to advance the frame, thereby explicitly defining a monitoring response. The procedure is sensitive to variables such as signal-noise ratio, item difficulty, transient and long-term effects, reinforcement schedules (pay-offs), and age. Monitoring rates are extremely steady, suggesting their use as a base line.

Procedures are suggested for training subjects to be differentially attentive to different parts of a complex display.

In reading aloud, textual stimuli control vocal behaviors, and response rate can be measured by voice-operated devices (Starkweather, 1960; Shearn, Sprague, & Rosenzweig, 1961). However, it can also be measured by human monitors reading along with the subject from a separate book. At each mark placed every tenth or hundredth word [Goldiamond, in press (a)], the monitors activate a recording device. Because such a device can also activate equipment which provides immediate consequences according to some schedule, such a definition of vocal response may also provide for control and analysis of reading behavior.

However, no such procedures for defining ongoing silent reading are available. The purpose of this report is to present such a procedure, some preliminary data obtained from its use, and some applications for other forms of silent monitoring. These applications are relevant because reading can be considered a special case of monitoring in which the response sequences are linear and successive. Reading can also be considered a form of recognition behavior (Goldiamond, 1962), in which the printed material is to be monitored or observed. Holland has resolved many problems posed by the absence of an explicit response (1957, 1858). His procedures involve a target to be monitored, with its visual presentation contingent upon *S*'s activation of a switch that momentarily turns on a light. These responses are called *observing* responses, and they have proved amenable to control by stimuli governing other operants.

The rationale for the present procedure was similar. A printed page from a film strip was projected on a screen. A loop of opaque film projected through the same optical system effectively masked the page, except where the transparent slit in the mask exposed half a line of the printed page. Closing a switch presented the next frame of the opaque loop, in which the transparent slit exposed the remaining half line; further depressions moved the slit progressively until the bottom of the page, when the next page appeared and the loop recycled. The *S* was in control of the switching apparatus, and was instructed to read aloud or silently.

The presentations of successive segments from a narrative passage are dependent upon explicit responses by *S*, and any successive

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reading is dependent upon such presentations. The responses involved will be called *monitoring* responses.

METHOD

The subjects were two college girls and a 9-year-old girl. Five sessions a week were run during the spring semester, 1961. Although the sessions were scheduled for 2 hr, they lasted only about 90 min. The pay was $2.50 a session, with a $8.75 bonus every 2 weeks for perfect attendance. Payment was cut when a point system was introduced. The points were made contingent on monitoring responses and were convertible into money; they were so arranged as to keep expenditures within the original range.

The reading was in a small laboratory cubical, and the *S* read into a microphone-receiver which was part of a two-way communication system. The projection equipment was behind *S*'s chair, and the films were projected on a wall. Buzzers signalled the start and end of sessions. Standard operant control and recording equipment was used, and was placed in a control room considerably far from the experimental room.

The instructions were to read as rapidly as was consistent with comprehension. When the point system was introduced, a remotely controlled digital counter was placed on the table before *S*, who was told the relationship between points and money; each digit change was audible. The relationship between monitoring behavior and points was not mentioned, however.

The projection equipment was the PerceptoScope, an automatic, remote-control 16-mm film strip projector which projects two separate films through the same optical system [Goldiamond, in press (b)]. The films were from the PerceptoScope Reading Training Improvement series. The stories were popular-magazine-type articles, each approximately 2000 words; slightly under 3 words were exposed per monitoring response.[3] There were 5-min breaks between stories, when *S* could drink water from a cup. The same story was read orally, then silently, and the order was reversed for the next story. It took well over a week to go through the series of 26 stories used, and the series was repeated several times. The *S* controlled the advance of the masked loop by pressing a large black button connected to a microswitch, and *E* had control over reverse or forward movement.

Further details of procedures will be presented with the results.

RESULTS

Figure 1 shows the response rates for two *S*s. Sections A and B present rates for oral and silent reading, respectively, for the same story. Sessions 1, 2, and 3 are consecutive. Sessions 4 and 5 are also consecutive, but 3 weeks after Sessions 3. Sessions 5, 6, and 7 are about a week apart. The curves shown an overall regularity and similarity under similar conditions.

The passage was on medical triumphs; and right below Point E, a series of medical terms of Greek origin appeared ("miracle" drugs and the like). The depression in oral reading rate was evident in Sessions 1, 3, 4, and, to a lesser extent, in 6 and 7. This depression contrasts to the transient disturbance at Point F, which marked the end of a paragraph. At Point E, silent reading, a break analogous to the breaks during oral reading was not evident. The very high and steady rate of monitoring which characterized silent reading continued unabated through the medical terms. Articulatory behaviors are not required during silent reading; however, during oral reading, a microphone whose output is monitored by an experimenter may provide control over the reading of each word. At Point G, *E* threw the projector out of focus, so that the monitoring rate was considerably attenuated. Focus was readjusted, and the rate returned to its characteristic state.

Section C presents a different passage; the second reading was somewhat more rapid than the first. The trend continued into Session 3, when DRL was in effect, with the timer set to produce no points if responses were spaced closer than 1.5 sec apart. This schedule was not effective in attenuating rate. Nor was it effective in Sessions 6 and 7 of Section A, when the DRL was 1.0 and 1.5 sec, respectively. For Session 4 of Section C, DRL was shifted to 5.0 sec; and payment by the session was

[3]Other loops are commercially available from the manufacturer cited. They may expose a whole line, singly or cumulatively; or may be gray instead of opaque; and so on.

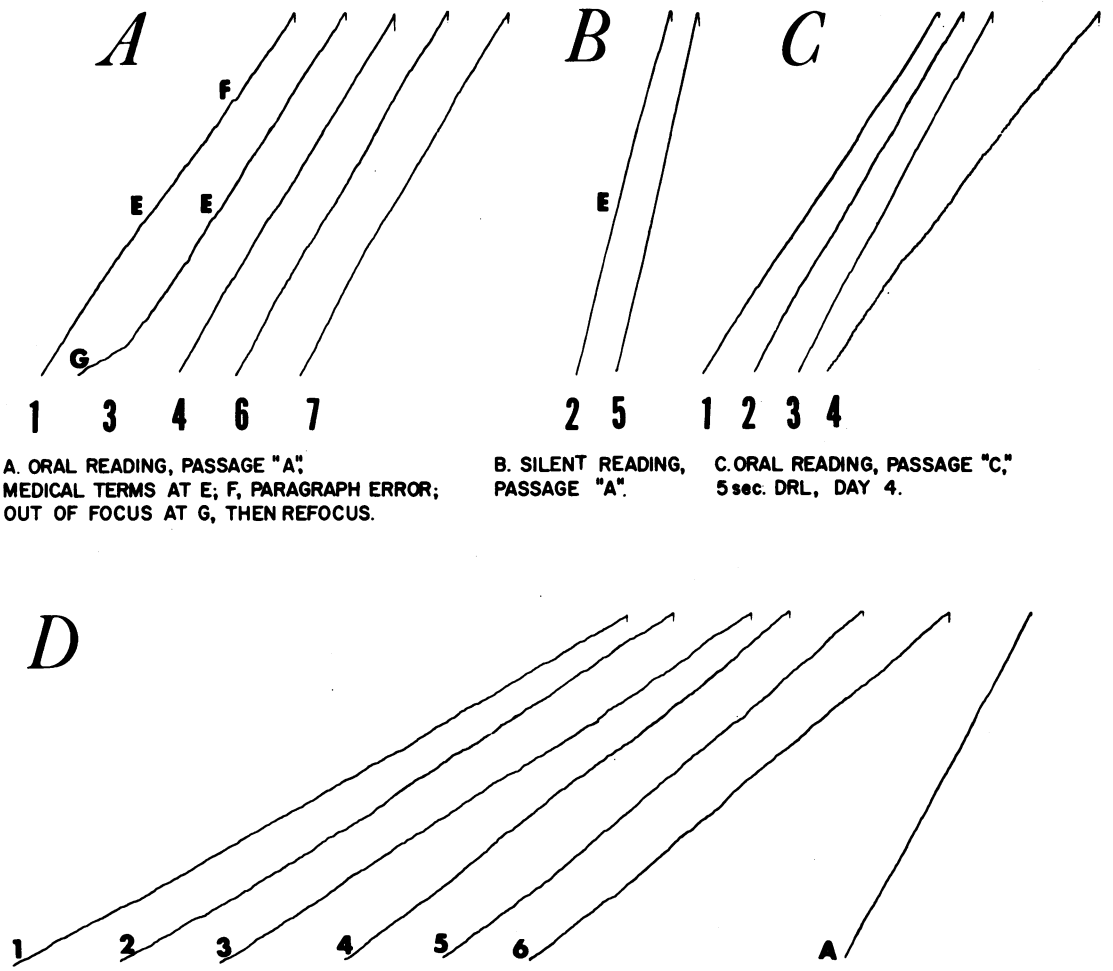

Fig. 1. Silent and oral reading rates under differing conditions.

eliminated, with each point set at 5 cents. Here, the monitoring rate was attenuated. Responding was characterized by rapid bursts and long pauses. If there had been complete control by the DRL schedule, 3 words would have been read every 5 sec. This was not consistent with the initial instructions to read rapidly. The resulting behavior was pauses governed by the DRL schedule, with rapid reading during bursts of monitoring responses, possibly governed by initial instructions.

Section D presents repetitive readings of a passage by a 9-year-old girl, with three consecutive readings on each of 2 days. The rate rose during the first four sessions, then stabilized somewhat. Session A shows the same passage read by a college girl; her rate is both more regular and more rapid than that of the child.

DISCUSSION

The preliminary data presented suggest that the procedures are sensitive to a variety of variables. These include item difficulty (Points E); legibility, signal-noise ratio, or strength of stimulus control (Point G); re-

inforcement schedule or pay-off (DRL); developmental and familarity variables (Section D); and transient and steady-state disturbance (Points F and E).

Difficult words which slowed monitoring rate in oral reading did not have a similar effect during silent reading. During oral reading, *E* can monitor *S*'s ongoing reading. In silent reading, this is not possible. Such differences in control have their parallel in automated instruction: the superiority of machine-programed presentation over textbook presentation of identical material is in the substitution of environmental (machine) control for subject control over sequential behaviors. Brooks (1961) investigated the amount of time required for responding to different frames in programmed material. He suggested explicit reinforcement schedules which may, in effect, penalize hasty responding to frames requiring longer consideration. By making silent reading contingent upon explicit monitoring responses, the present procedure lends itself to such selective control.

Complex displays other than textual material may be investigated. For example, the film strip can present pictures of a machine, painting, or advertisement; and the opaque loop can expose quadrants or smaller sections of the display.[4] In this way, the comparative interest or attractiveness of parts may be defined behaviorally. Further, such definition may be used to shape differential self-exposure to parts of the display, as required by the task. It should be possible to train *S*s to generalize from one task to another, that is, to abstract the characteristics of sections requiring more prolonged monitoring than others. The material can come to control selective monitoring. Relationship between the current procedure and the Holland procedure should also be noted. Indeed, experiments using the Holand apparatus can be duplicated with the current procedures.

Reading *rate* may differ according to the procedures used to define the response unit. For example, Shearn, Sprague, and Rosenzweig (1961) indicate that the printed difinition of a word may differ from a vocal definition. A light-sensitive device (normally the eye) may pick up four spaces in the phase "What do you call it?" and thereby define five response units (words). But a voice-sensitive device may pick up only one space in the vocal rendition "Wadaya kolit?" and thereby define two response units in the same time, so that a slower rate is produced. Conversely, pauses during a long (visually defined) word may give vocal definition a higher rate. Typically, reading rate is defined in visual units, and the results found suggest the need for further analysis. The procedure described in the present report provides a third definition of the response unit, namely, a mechanical response related to a visual stimulus unit of a specified size (the slit opening). Because a vocal response does not enter into its definition (although it may affect its rate), it may be used for silent reading as well as control by textual stimuli of vocal responses (oral reading) or finger responses (finger-alphabet reading by the deaf, *cf.*, Hofsteater, 1959). Recently, Edfeldt (1960) has obtained electromyographic recordings from vocal muscles during silent reading; however, the procedures involve electrode implantation.

The regularities in reading rates (*cf.*, Goldiamond, Atkinson, & Bilger, 1962) suggest the use of this behavior as a base line in research. Such behavior is widespread and easy to obtain. Skinner (1957, P.66) commented that "textual behavior is so strongly reinforced that one is likely to find oneself reading not only letters, books, and newspapers, but unimportant labels on packages, subway advertisements, and billboards." Indeed, once the book is glanced at, its title is often as unescapable as its color. Such control suggests that when the experimenter can continuously present such stimuli, reading behavior may, under proper conditions, serve as the free human operant.

[4]Currently being developed at Arizona State University.

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