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ABSTRACT

An exploratory study was conducted to test the assumption that multimode knowledge of results is superior to traditionally presented knowledge of results in maintaining a student's interest and attention. In addition, the relative merit of pictorial format in a lesson was compared with a basic lesson display. The study involved 32 kindergarten children randomly assigned to four treatment groups, each group receiving a version of a PLATO lesson. A 2x2 factorial analysis of variance was used to assess the effects of two independent variables on four dependent variables. Results of the study suggest that multimode knowledge of results may be superior to simple knowledge of results in maintaining a student's interest and attention during a lesson. Subjects in the multimode conditions were less distracted than those in the simple knowledge of results conditions. Type of format had no effect on the dependent variables perhaps because the children satiated their interest in pictorial lesson materials during the warm up period. (CH)

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MULTIMODE KNOWLEDGE OF RESULTS IN PLATO COURSEWARE

KATHY A. LUTZ

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2

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Knowledge of results (KR) is widely used as a reinforcer in programed instruction and computer-assisted instruction despite the fact that there is little substantiating evidence for the assumption that KR facilitates learning in programed instruction. Much of the research concerning the effects of KR on learning indicates that programs teach as well or better when continuous KR is <u>not</u> present (Moore & Smith, 1961; Feldhusen & Birt, 1962; Krumboltz & Weisman, 1962; Hough & Revsin, 1963; Ripple, 1963; Lublin, 1965; Jacobs & Kulkarni, 1966; Blank & Pysh, 1970). It should be noted that in each study cited above, KR was operationally defined as the presentation of the correct answer in printed form following the student's response. The application of KR need not, however, be restricted to print mode for lessons administered via a computer-based educational (CBE) system; rather, KR may subsume a large variety of stimulus modes presented after the student's response. Since the reinforcing effect of KR is questionable when KR refers to printed feedback, the need for an alternative is indicated. The intention of this paper is to suggest a mode of presenting KR that is uniquely compatible with a dynamic computer-based educational system such as PLATO IV [1].

NEW MEDIUM WARRANTS NEW PEDAGOGICAL APPROACH

A sophisticated CBE system can be used effectively for the traditional pedagogical functions of diagnosis, prescription, and presentation of subject matter. In this role, the system models the best of teachers and may be thought of as a substitute for the human instructor. But the computer's application to education can transcend the limits of performing

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traditional tasks. A high-speed computer linked with a graphic pictorial display terminal can now provide educational experiences and resources previously unavailable to the student. One example of a new learning environment is a simulated laboratory experiment. The student in this situation may change various parameters in the experiment and then see the results of his manipulations immediately calculated and displayed to him. (For specific descriptions of such lessons see Bitzer et al., 1971 and 1972.) With the advanced computing and display capabilities come exciting possibilities in the design of courseware.[2] Yet there seems to be a tendency to rely on traditional educational styles and practices despite the fact that the new medium warrants innovative pedagogical approaches that embody its unique features. Many CAI programs, for example, supply reinforcement in the form of printed KR sometimes in combination with social reinforcers as in the auditory message, "Good, Johnny. Your answer is right." Such an application is a carry-over from the traditional classroom and does not incorporate the full potential of a CBE system in administering knowledge of results. The system can respond to the student in a mode more commensurate with its capabilities. It is proposed here that rather than supply KR through printed or auditory messages alone, the system should be programmed to respond with appropriate and interesting changes in the visual display as well--changes involving pictorial or graphic animation. The key word is respond: the system should respond to the student's actions via every possible mode. Presentations of KR which are not restricted to print or verbal modes but which involve graphic or pictorial modes will be referred to as multimode knowledge of results.

MULTIMODE KNOWLEDGE OF RESULTS

Perhaps the nature of multimode knowledge of results may best be revealed through example. Some learning environments inherently allow for higher level feedback. One example is a lesson for a young child experimenting with word creation. Using a sophisticated CBE system, the student may type d-o-g onto the screen of his terminal; the system can respond to the child's creation of a real work.by pronouncing the word, displaying a pictorial example of the word (picture of a dog), supplying appropriate sound effects ("arf-arf"), and using the word in context.

Unfortunately, not all learning tasks lend themselves to visual presentations of response consequence. Lesson formats which allow for multimode knowledge of results may be engineered for such learning tasks. The lessons cited below have been thus designed by the author for the PLATO IV system. The first lesson is a simple practice and drill for the young child learning letter-sound associations. The child sees four magicians' hats, each containing a different letter, on the display screen. He is given a phoneme aurally as a referent and is asked to point to its corresponding letter. If the child chooses the correct letter, a bunny hops out of that hat as a reward (Fig. 1) and a positive audio message is given. (The pictorial animation of the hopping bunny along with the verbal message constitute multimode KR.) A wrong response evokes no immediate action on the screen but the child does receive verbal feedback. In this lesson, the student knows that only a correct response results in an interesting change on the screen. Perhaps this knowledge motivates him to respond correctly not only for the sake of knowing he is "right" but also for the reward of seeing an amusing animation on the screen.

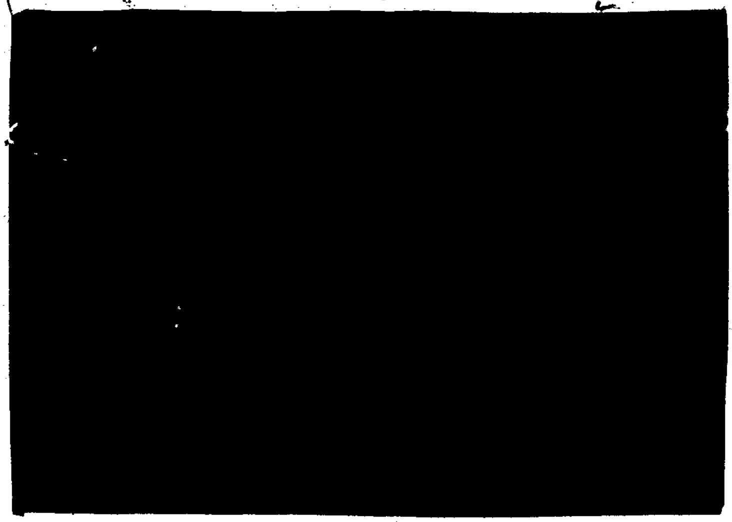

Fig. 1 Drill and practice lesson
on grapheme-phoneme correspondence.

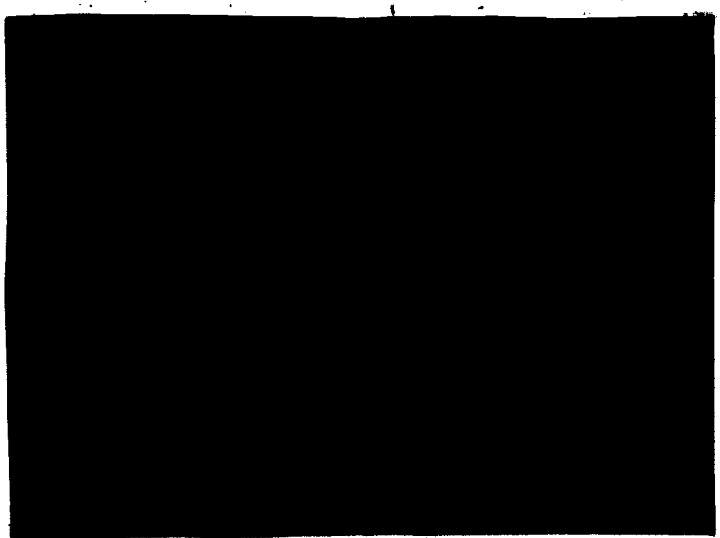

Fig. 2 Introductory lesson.

Another lesson displaying the feature of multimode KR was designed for a child with no previous experience with PLATO. The child must learn to respond to the machine by touching the display screen accordingly. He first learns to touch a prespecified area on the screen: following a brief animation involving a frog, the child is to touch the rather small frog (one inch high) with his finger. It will hop across the screen if touched accurately (Fig. 2) and the activity will be continued until the child has accurately performed several successive touched. KR is implicit; that is, the frog will hop only when properly touched. (Verbal feedback is provided, however, when the child is responding incorrectly.) This activity is followed by a similar activity in which the child himself chooses the area of the screen to be touched. The frog hops to the point on the screen which the child has specified by touching. The final portion of the lesson involves a display of animals that write the child's name on the screen (Fig. 3) move, or tell amusing jingles (Fig. 4 and 5) when accurately touched by the child. In all portions of the lesson, then, correct responses (i.e. accurate touches) are rewarded by their appealing and stimulating consequences.

As illustrated above, multimode knowledge of results involves feedback beyond the fundamental level used in most programs. It may involve a simple stimulus such as brightening letters that are correctly identified (Fig. 6) or letters in a correctly identified word (Fig. 7); or it may entail a more elaborate display such as pictorial animation (Fig. 9 and 10). In any case, it provides information to the learner about the adequacy of his response in a less direct yet perhaps more reinforcing manner than simple KR. A student may not be reinforced merely by hearing from a machine that he is "right", but there is reason to believe that, in general,

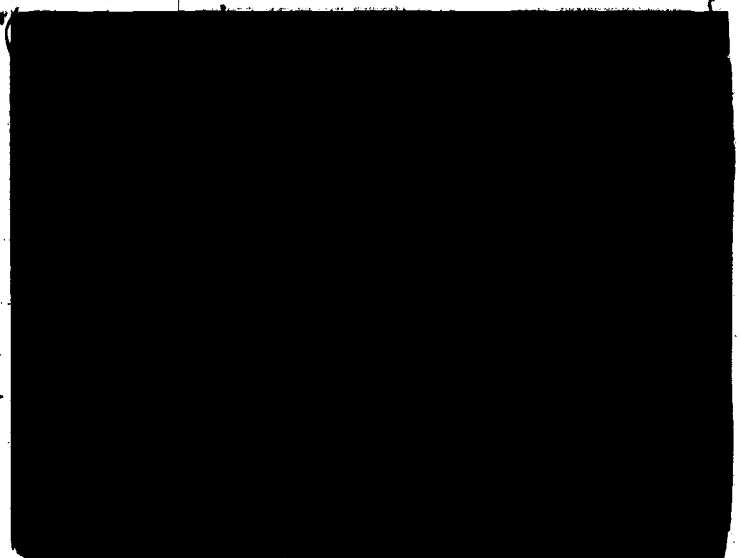

Fig. 3 Introductory lesson.

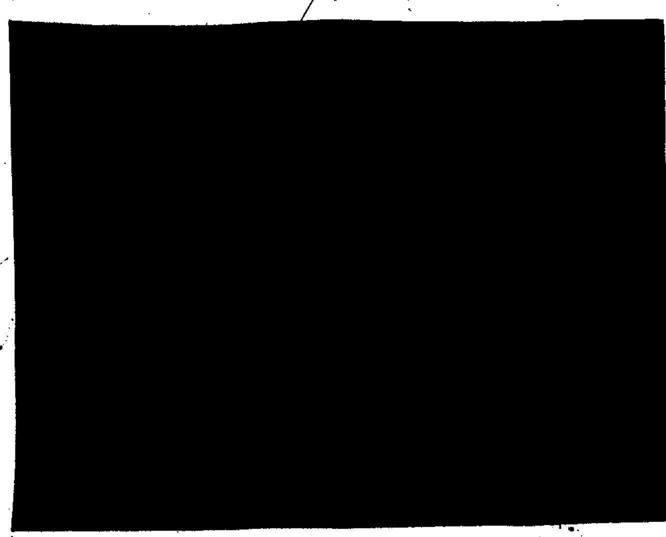

Fig. 4 Introductory lesson.

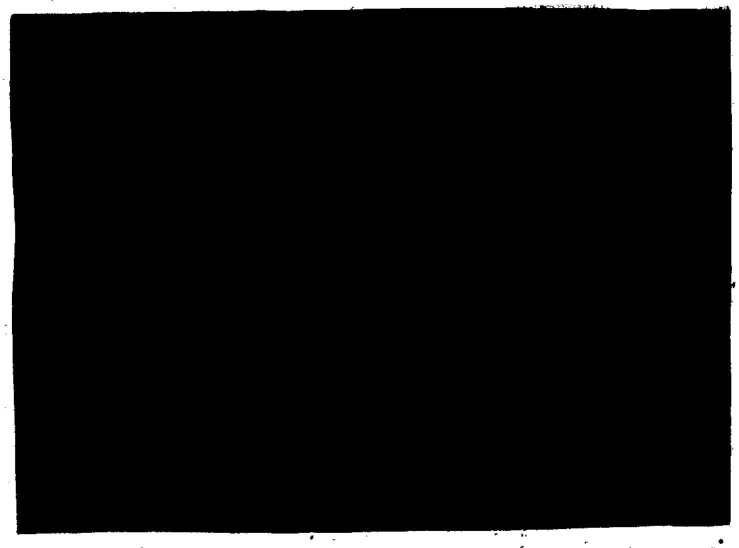

Fig. 5 Introductory lesson.

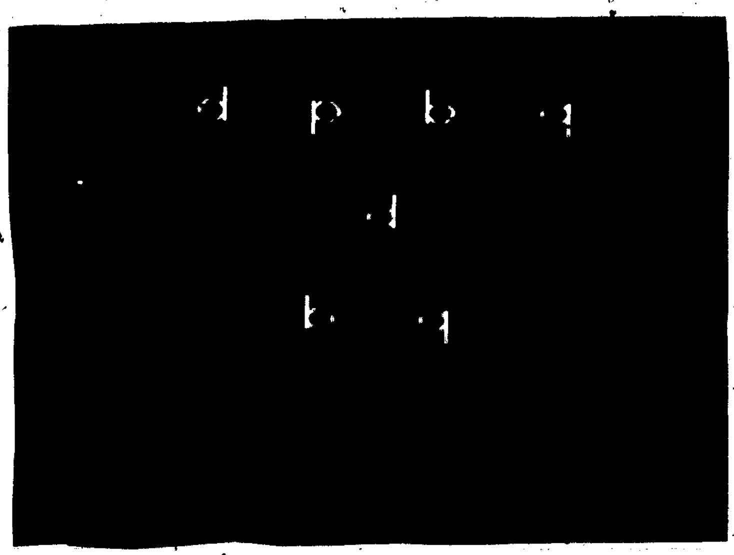

Fig. 6 Lesson on grapheme discrimination.

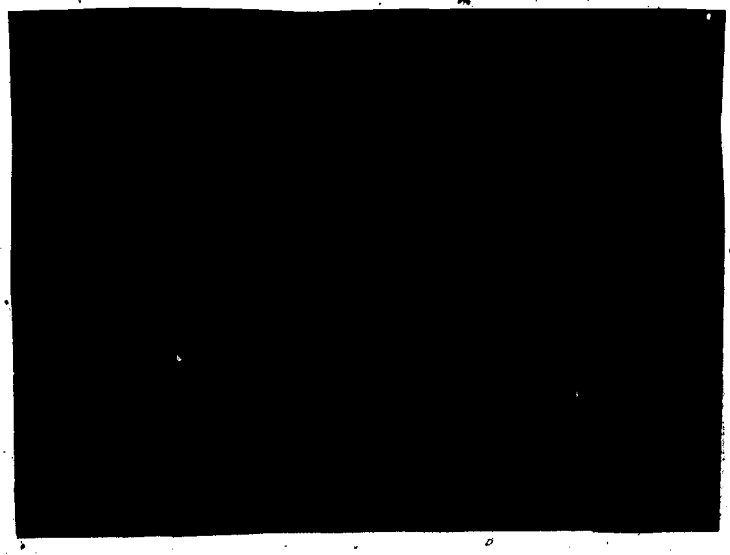

Fig. 7 Attention to word detail.

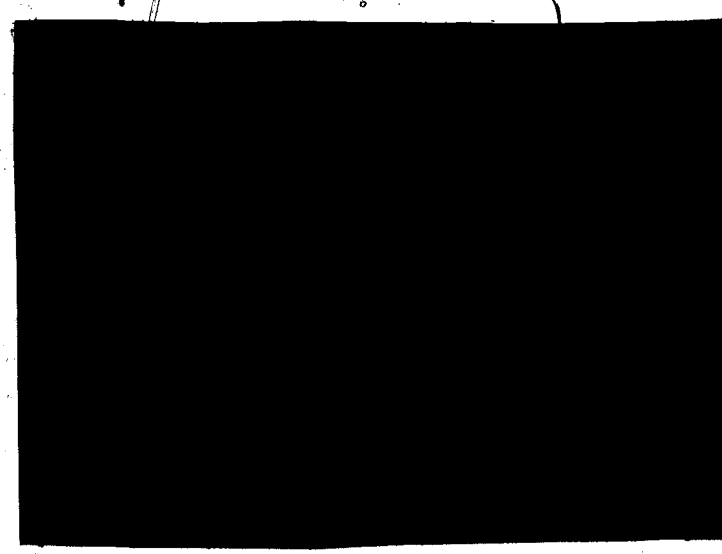

Fig. 8 Pictorial Format X Multimode KR

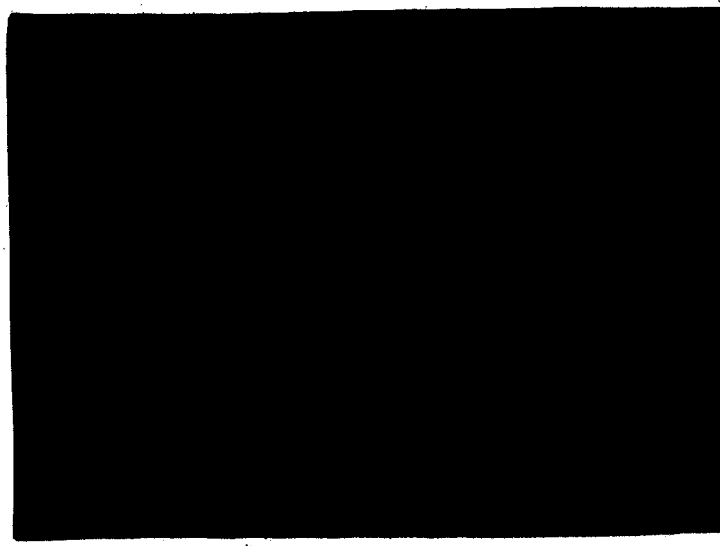

Fig. 9 Lesson on grapheme-phoneme correspondence
(Horses in first postion)

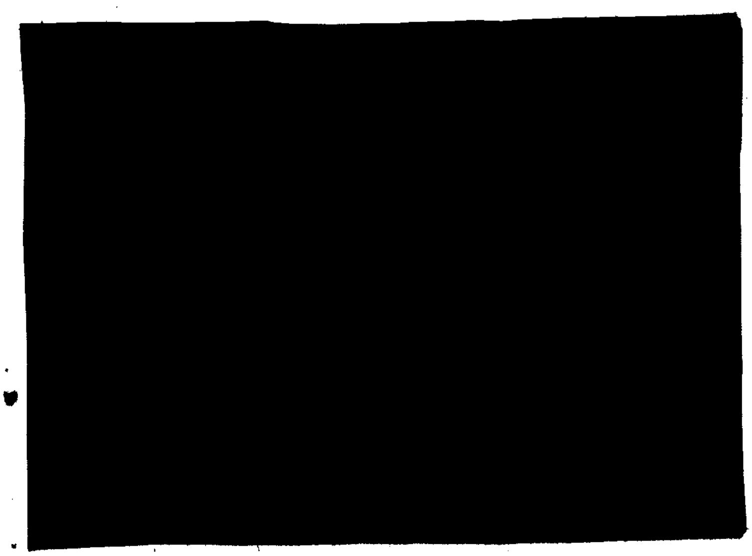

Fig. 10 Lesson on grapheme-phoneme correspondence
(Horses in final position)

children will be motivated to respond in ways that result in interesting visual changes and stimulating displays.

MOTIVATIONAL FOUNDATION

The theory of motivation supporting the use of multimode knowledge of results is effectance motivation, which is inborn desire to effect stimulating changes in the environment with which he is dealing. This desire to deal with the environment and cause changes in it has been recognized by many as a motivational force: Schachtel (1954) claims that man has a "relatively autonomous capacity for object interest" and that this interest in the environment is potentially inexhaustible. Woodworth (1958) considers the tendency to deal with the environment basic in motivation. He claims that direction of activity toward the environment is "the fundamental tendency of animal and human behavior and that it is the all-pervasive primary motivation of behavior." White (1959) suggested the previously mentioned term, effectance motivation, to describe a child's interest in causing pronounced effects upon the environment--by making something happen as a consequence of his activity. He contends that a child is interested in causing changes which offer as Hebb (1949) puts it, "difference-in-sameness"; that is, interest is best maintained when the child's action produces one particular change in the stimulus field while the remainder of the field stays constant. That is not to imply that White believes effectance motivation is involved in every action resulting in some change. Interest is aroused, according to his theory, only when the child sees a change in something that he is attending to. White uses the idea of focal attention[3] in defining his notion of effectance:

Dealing with the environment means directing focal attention to some part of it and organizing actions to have some effect on this part.

As applied to a controlled learning environment, White's theory of effectance motivation implies that the student will be motivated to respond so as to effect stimulating changes in what he is watching. Hence, the assumption can be made, based on the theory of effectance motivation, that a student will be more highly motivated in the efficacious situation afforded by multimode KR than in the traditional learning environment accompanying fundamental KR.

POTENTIAL REINFORCER

Manipulation of and interaction with the environment have already been recognized as possible reinforcers in instructional systems (Geis & Chapman, 1971). Glaser (1969) cites "overt control of the physical environment" as a potentially powerful reinforcer in programed learning. He says that actions causing a change in the stimulus displayed to the individual may be reinforced by that change. (Indeed, a number of studies have shown that visual as well as other types of stimulus change can be reinforcing; Cofer & Appley (1964) present an excellent review of such experiments.)

The reinforcing nature of effectance plays an important role in the "responsive environments" described by Gotkin (1966) and Moore & Anderson (1969). Their talking typewriter is engineered to respond to the student's explorations by informing him immediately about the consequences of his actions. The talking typewriter closely approximates multimode knowledge of results but is lacking the capability to provide computer-based pictorial and graphic animation.

If multimode knowledge of results proves to be an effective reinforcer, it will be a welcomed alternative to traditional KR. As Gotkin points out, the assumption that "getting an answer correct, and being told so, will be just as effective a reinforcer as a piece of candy" is apparently mistaken.

An exploratory study was conducted to probe the assumption that multimode knowledge of results is superior to traditionally presented KR. Specifically, the study is designed to determine if a lesson involving multimode KR maintains the student's interest and attention better than a version of the lesson providing only fundamental KR. Also explored by the study is the relative merit of pictorial format in a lesson compared with a basic lesson display, where pictorial format refers to the inclusion of nonessential display elements (pictures). If a simple display holds the student's attention as effectively as a more elaborate display, desire for cost efficiency favors the former approach. Pictorial format may also affect the power of multimode KR in maintaining interest; that is pictorial animation may differ in effectiveness from a simple change in the visual stimulus.

SUBJECTS AND DESIGN

The study involved kindergarten children from Washington Elementary School in Champaign, Illinois. The students were randomly assigned by computer to four treatment groups, each group receiving a version of a lesson presented via PLATO. A two X two factorial analysis of variance was used to access the effects of the two independent variables--type of knowledge of results and type of display format--on the major dependent variables: total time spent in the lesson (T_1), amount of time distracted from the lesson (T_2), adjusted total time ($T_t = T_1 - T_2$), and percent time distracted of total time ($T_d = 100(T_2/T_1)$). In addition, six other dependent variables were assessed: total number of responses, number of correct responses, number of incorrect responses, percent responses incorrect, number of responses per minute, and number of letters correctly identified on the criterion test. (The criterion test required the student to say each letter name that he knew aloud as it appeared on the screen.)

MATERIALS AND APPARATUS

Each S received a version of a drill and practice lesson on letter naming presented via PLATO IV, a computer-based educational system featuring a random-access audio device and a touch panel (a touch sensing panel which allows the child to respond simply by pointing to the answer). The task remained the same for all four versions of the lesson. The student was required to choose (from a field of five) the letter named verbally. The four versions of the lesson differed only in type of display format and type of KR while all other features remained constant. Audio messages, including directions and feedback, were identical. Following a correct response, all groups received a message randomly selected between "That's right!" and "Good!". An incorrect response was followed by a message randomly chosen from:

No, touch a different letter.
No, pick another.
No, try again.

Also held constant across conditions was the allowable response rate; all versions allowed a maximum of six correct responses per minute.

Type of KR varied between versions with two groups receiving only a positive audio message and the other two receiving the audio message plus a change in the visual stimulus following a correct response. Type of display format also varied between versions with two groups seeing a simple display of the five letters only while the other two groups saw the letters in a pictorial setting of five carrots and a bunny rabbit. (Fig. 8)

PROCEDURE

Each of the 32 was run individiually on PLATO, beginning with a 10-15 minute "warm up" time using lessons or games not directly related to the subject matter of the experimental conditions. This short time period was included so as to dissipate any novelty effects of encountering PLATO. Just before entering the target lesson, the student was instructed by an audio message that he would be allowed to spend as much or as little time in the lesson as he wished before proceding to another lesson. S was instructed to inform the proctor when ready to stop. The computer started an internal clock when the lesson started and stopped it when the lesson terminated. Thus T_1 was recorded by the terminal itself while T_2 was kept by the observer. (T_2 included time S's head was not directed toward the PLATO screen.) With the exception of T_2 and the score on the criterion test, all other measures were gathered and stored by the system; following each session, all data was displayed on the screen and was recorded or photographed.

RESULTS

Analysis of variance[4] revealed the information presented in Tables 1 through 5 below. The total and distracted time means are higher and lower respectively for the multimode KR conditions than for the simple KR groups, but the differences are not statistically significant. The adjusted total time means for the multimode KR conditions are higher than those of the simple KR groups, and the difference between conditions does approach significance. The most interesting result, however, is the difference in T_d scores between the multimode KR conditions and the simple

KR conditions. Subjects in the multimode conditions spent a significantly larger proportion of their time attending to the lesson than did Ss in the other two groups.

Table 1 Group Scores

Type of Format	Type of KR	Multimode				Simple			
		T_1	T_2	T_t	T_d	T_1	T_2	T_t	T_d
Pictorial	mean	416.9	21.2	359.7	4.9	307.8	45.1	263.9	17.5
	s.d.	159.7	17.7	145.7	3.4	121.5	26.2	123.7	13.8
Simple	mean	392.4	41.1	351.3	9.3	341.7	50.5	291.2	16.4
	s.d.	170.6	50.1	147.5	9.1	154.7	29.8	153.7	10.3

Table 2

Analysis of Variance for Dependent Variable T_1 (Total time)

Source of variation	d.f.	mean square	F Ratio	Probability
Type of KR	1	51,096.1	2.19	.15
Type of Format	1	175.3	.01	.93
KR x Format	1	6,818.2	.29	.59
error	28	23,330.6		

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Table 3

Analysis of Variance for
Dependent Variable T_2 (Distracted Time)

Source of variation	d.f.	mean square	F Ratio	Probability
Type of KR	1	2,211.1	2.01	.17
Type of Format	1	1,275.1	1.15	.29
KR x Format	1	424.9	.39	.54
error	28	1,099.4		

Table 4

Analysis of variance for
Dependent variable T_3 (Adjusted total time)

Source of Variation	d.f.	mean square	F Ratio	Probability
Type of KR	1	64,297.0	3.11	.09
Type of Format	1	1,749.4	.08	.77
KR x Format	1	14,170.8	.69	.41
error	28	20,681.2		

Table 5

Analysis of Variance for
Dependent Variable T_d (% time distracted)

Source of Variance	d.f.	mean square	F Ratio	Probability
Type of KR	1	774.2	7.90	.009*
Type of Format	1	21.5	.22	.64
KR x Format	1	62.1	.63	.43
error	28	98.0		

* p is significant at the .01 level

DISCUSSION

The results suggest that multimode KR may indeed be superior to simple KR in maintaining the student's interest and attention during a lesson since subjects in the two multimode conditions were less distracted than those in the simple KR conditions--the former group spent a larger percentage of their time attending to the lesson. It must be pointed out, however, that Ss receiving only the audio message seemed to direct their attention toward the audio device (located next to the PLATO terminal itself) during feedback while the Ss receiving a visual stimulus along with the audio message seemed to look at the screen during feedback. The amount of time Ss head was directed toward anything other than the screen (including the audio device) was recorded as distracted time. Perhaps the effects of type of KR would be different if distracted time was re-defined as time spent not looking at some component of the PLATO system. Despite this fact, the results of the study are such that further investigation of the hypothesis is warranted. The possibility remains that multimode knowledge of results may serve as a reinforcer in computer-based education.

Type of format had no effect on the dependent variables in this study. One possible explanation may be that the children spent all or part of their warm up period with pictorial lesson materials and may have experienced a satiation effect on their interest in pictures. Although this study does not suggest any direction for future research concerning the effects of pictures in lesson material, the author believes that research of that nature is needed to guide proper courseware development on PLATO.

NOTES

1
For a general description of the PLATO system and its uses see Bitzer et al. (1971 and 72) along with the following:

Alpert, D. and Bitzer, D.L. Advances in Computer-based Education. Science, 176, p. 1582.

Lyman, E. A Summary of PLATO Curriculum and Research Materials, Computer-based Education Research Laboratory (CERL) Report X-23. (August, 1972)

2
Courseware refers to lesson materials for a CBE system as distinguished from hardware and software.

3
Focal attention as conceived by Schachtel refers to the individual's focusing or centering of attention on one particular object or event in the environment to the exclusion of the remainder of the field.

4
The author wishes to thank Richard J. Lutz and A. Avner for their assistance with the statistical analysis and for Priscilla Obertino for her assistance as proctor. The statistical analysis was performed through the use of STAT, a PLATO lesson developed by A. Avner, and the SOUPAC package of the University of Illinois, Urbana.

5
The animal figures shown in all photographs of the PLATO displays were created by Lezlie Fillman.

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